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Guidance on reporting and accounting for Revegetation and Wetland Drainage and Rewetting Activities in accordance with Article 3(3) of EU Decision 529/2013/EU

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Acronyms

AR/D	Afforestation, Reforestation / Deforestation
C	Carbon
CM	Cropland Management
CS	Country Specific
CMP	Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol
DOC	Dissolved Organic Carbon
EF	Emission factor
ERA-NET	Funding programme of the European Commission and the Member States for Networking the European Research Area
ERT	Emission Review Team
EU	European Union
GHG	Greenhouse gas
GPG	Good Practice Guidance
GM	Grazing Land Management
IE	Included Elsewhere
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre of the European Commission
KP	Kyoto Protocol
LIDAR	'LIght Detection And Ranging' or 'Laser Imaging, Detection and Ranging' technology. LIDAR is a remote sensing method. It measures distance by sending a laser beam on a target and analysing the reflected light. It is typically used for altimetry measurements.
LIFE	LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. See http://ec.europa.eu/environment/life/index.htm
LULUCF	Land Use, Land Use Change and Forestry
MRV	Monitoring, Reporting, Verification
MS	Member State
NA	Not Applicable
NE	Not Estimated
NO	Not Occurring
NFI	National Forest Inventory
NIR	National Inventory Report
RV	Revegetation
UNFCCC	United Nations Framework Convention on Climate Change
WDR	Wetland Drainage and Rewetting

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Overview

Article 3(3) of Decision 529/2013/EU (the 'LULUCF Decision') sets out the elective option for Member States to account for Revegetation (RV) and Wetland Drainage and Rewetting (WDR) (in line with internationally agreed rules under KP-LULUCF). The target audience for this guidance document is decision makers on LULUCF reporting and accounting and inventory experts implementing LULUCF accounting decisions.

This guidance document provides information on how to report and account for Revegetation (RV) and Wetland Drainage and Rewetting (WDR), should these be elected by Member States. For each issue, the information is structured according to the decision chain that would need to be followed if Member States wanted to consider electing RV and WDR as follows:

- Current reporting
- Potential relevance
- Requirements
- Good practice examples that could be used as a basis for elaboration in other Member States.

This guidance includes a rough Tier 1 type assessment of general and national circumstances favourable for RV or WDR including theoretical emission levels and mitigation potential.

The guidance is organised in three complementary chapters, as illustrated in Figure 1. An Annex with references is also provided.

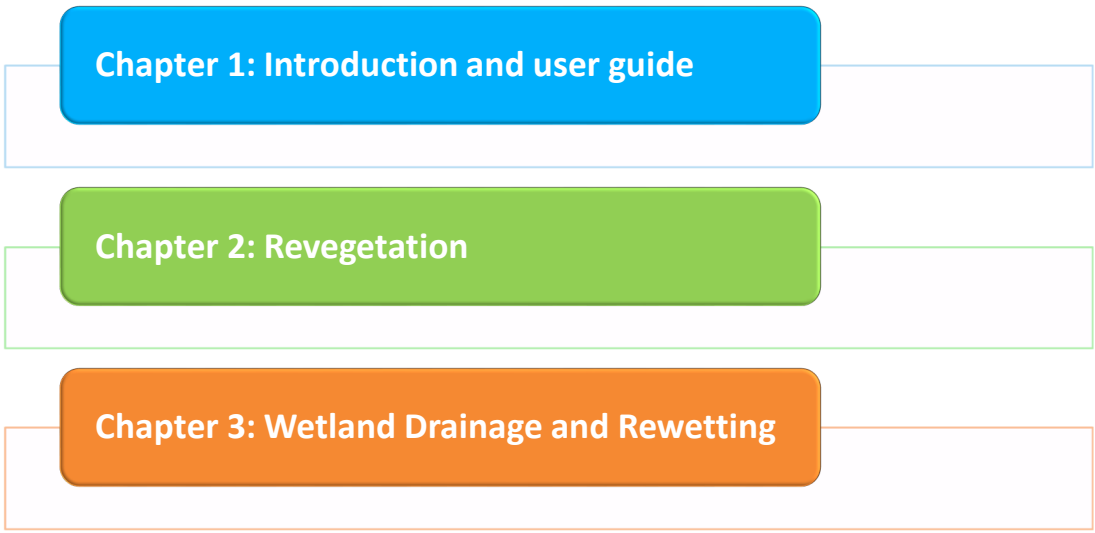

Figure 1: Overview of Guidance

Chapter 1, the 'Introduction and user guide' describes the purpose of the Guidance document. It presents best practices and general recommendations for setting up and enhancing accounting systems for the activities RV and WDR, within the context of internal and international Monitoring – Reporting – Verification (MRV) provisions. The introduction

summarises the legislative context for RV and WDR reporting and the key principles of reporting requirements that form the basis of this Guidance.

Chapter 2 focuses on 'Revegetation' and provides guidance on reporting RV based on past experience and assesses those measures that may be potentially attractive for RV. RV is a direct human-induced activity to increase carbon stocks on specific sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation[1]. The chapter introduces the scope of RV and summarises the reporting experiences to date from Iceland, Japan and Romania, the countries that elected RV in the 1st commitment period under the Kyoto Protocol. The Guidance compares the different interpretations of baseline reporting by the three countries and the UNFCCC with the principles set out in the Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2014a), or 2013 IPCC KP Supplement for short. This document also clarifies the IPCC principles. Potentially attractive RV measures relate to increasing woody biomass outside forests, e.g. in perennial crops, hedgerows and urban trees. The guidance document assesses the current status of reporting on the woody biomass pool by Member State and gives a qualitative assessment of RV potential in the Member States. The chapter finally provides guidance for RV reporting, where to find data and suggests cost-effective ways to develop RV reporting in terms of methodologies, organisational and operational issues.

Chapter 3 'Wetland Drainage and Rewetting' (WDR) introduces the WDR activity. Decision 2/CMP.7 (Land use, land-use change and forestry) contained in FCCC/KP/CMP/2011/10/Add.1, p.13[2], defines Wetland Drainage and Rewetting (WDR) as: *'a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined above, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage'.* WDR was introduced for the first time for the commitment period 2013 – 2020 and therefore there is no experience with WDR reporting so far. WDR reporting is based entirely on the two most recent IPCC guidance documents, the 2013 IPCC KP Supplement (IPCC 2014a) and the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, or 2013 IPCC Wetlands Supplement (IPCC 2014b) in short. Their structure and important issues for reporting (changes to previous guidelines, new rules etc.) are summarised. If elected, WDR can only be accounted when it occurs outside the other activities AR/D, FM, CM, GM and RV. It is therefore more or less restricted to organic soils in the Wetlands category. Current reporting of organic soils and of the Wetlands category is assessed as background for WDR reporting and a qualitative assessment is made on the maximum extent to which WDR could contribute to GHG mitigation to help inform decisions by Member State about whether or not to elect WDR. Finally the chapter provides guidance for WDR reporting, where to find data and suggests cost-effective ways for the development of WDR reporting in terms of methodologies, organisational and operational issues.

[1] IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003), p. 4.9
[2] Add link

1 Introduction and user guide

1.1 Purpose of the Guidance

This guidance document presents best practice and general recommendations for setting up and enhancing accounting systems for the activities RV and WDR, within the context of internal and international Monitoring – Reporting – Verification (MRV) provisions.

There is little experience with RV from the first Kyoto commitment period because only Japan, Iceland and Romania have elected to account for RV. Romania, as the only EU Member State to do so, has focused on hedges and tree rows in croplands. The RV activities chosen by Iceland and Romania could have been reported under grazing land management (GM) and cropland management (CM) respectively if these activities had been elected. The Kyoto Protocol treats CM, GM and RV activities at the same hierarchical level. However, the 2013 IPCC KP Supplement clarifies that mandatory activities have priority over elective ones. Since at the EU level the LULUCF Decision makes CM and GM mandatory, it seems logical to prioritise reporting and accounting for CM and GM before RV. This means that the scope for future RV accounting will be limited to areas not reported under afforestation, reforestation and deforestation (AR/D), forest management (FM), CM and GM, unless a country chose to elect RV previously. Nevertheless, there is some flexibility (within the boundaries set by the IPCC) for Member States to decide their own definitions of CM and GM and RV. If they define them together for reporting under Art. 3(2) of the LULUCF decision for 2013-2020, they can also define some or all of the areas with woody biomass as RV. Romania will have to continue to report for RV having elected the activity already.

WDR has only been introduced for the second Kyoto commitment period so that there is no experience with this activity to date. Drained organic soils are hotspots of GHG emissions. As a result, there is significant potential for reducing GHG emissions through rewetting areas to near natural water table levels.

RV and WDR activities have in common the fact that they focus on specific measures and small areas compared to FM, CM and GM. RV and WDR may offer low-cost, effective GHG mitigation options in situations where, for example:

- The cover of trees and other woody vegetation outside forests is increasing, e.g. through urban greening (RV),
- Peatland restoration from former peat extraction or drainage has taken place since 1990 or is planned, e.g. for nature conservation (WDR).

1.2 Target audience and focus

The target audience for this guidance document is:

- Decision makers on LULUCF reporting and accounting; and
- Inventory experts implementing LULUCF accounting decisions.

The guidance document is structured in line with the decision chain for electing RV and WDR, namely:

- Current reporting
- Potential relevance
- Requirements
- Good practice examples that could be used as the basis for further developments in other Member States.

This guidance includes a rough Tier 1 type assessment of general and national circumstances favourable for RV or WDR including theoretical emission levels and mitigation potential.

1.3 Legislative context

1.3.1 The EU Context: EU LULUCF accounting framework

Article 3(3) of Decision 529/2013/EU provides Member States with the option to elect to account for Revegetation (RV) and Wetland Drainage and Rewetting (WDR) (in line with internationally agreed rules under KP-LULUCF).

1.3.2 The International Context: Framework for UNFCCC reporting and KP reporting and accounting

- Revegetation:
  - Elective activity in 1st and 2nd KP commitment period
  - To date, only elected by Iceland, Japan and Romania
  - IPCC Guidance updated in the 2013 IPCC KP Supplement with methodologies in the 2006 Guidelines

- Wetland Drainage and Rewetting:
  - New elective activity in 2nd KP commitment period
  - IPCC Guidance in the 2013 IPCC KP Supplement with the methodologies in the 2013 IPCC Wetlands Supplement

1.4 Key principles

This guidance has been designed according to the following principles, i.e. that actions for LULUCF should:

- ensure linkages are made to other national strategies and plans associated with cross-sectorial and climate policies;
- use and build on information available or under preparation within Member States' land use, forestry and/or agriculture policies;

- Identify and indicate potential synergies in existing spatial land data and information collection methods which should be available in Member States;
- be adaptable to the varying needs and situations in different Member States; and
- ensure compatibility with current KP reporting and accounting processes and with up-to-date UNFCCC reporting requirements and IPCC methodologies.

2 Revegetation

2.1 Introduction

Revegetation (RV) is a direct human-induced activity to increase carbon stocks on specific sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation[3]. RV covers a range of activities that establish vegetation to replace the previous ground cover following land disturbance. The sorts of activities that might quality as revegetation include, for example:

- reclaiming or restoring herbaceous ecosystems on degraded or carbon-depleted soils;
- the establishment of vegetation cover on disturbed construction sites or mined lands;
- planting of trees, shrubs, grasses or other non-woody vegetation on various types of land.

Under the Kyoto Protocol emissions and removals from RV in the inventory years of the commitment period are compared with emissions and removals from the base year[4].

Only Romania, Iceland and Japan elected RV in the first Kyoto commitment period. They chose different measures, which provides Member States with a range of experiences in these countries on which to build. When comparing the reporting and the reviews by the UNFCCC of RV it is striking, however, that there remains considerable ambiguity in the interpretation of accounted GHG emissions and removals in the base year. This has immediate effects on the accounting in the commitment period. It is important to resolve this ambiguity so that Member States can safely assess whether they will have net sinks or sources when electing RV.

RV reporting is based on the IPCC guidelines. The 2006 IPCC Guidelines and the 2013 IPCC KP Supplement, chapter 2.11, contain the mandatory guidance for the period 2013 – 2020. Current reporting experience, however, is based on the older guidance in the 1996 IPCC Guidelines and the 2003 Good Practice Guidance (GPG) on LULUCF[3]. The updates mainly clarify issues but do not drastically change the 2003 guidance. The 2013 IPCC KP Supplement[5] has clarified the guidance on base year reporting (see section 2.6). Given that Member States have ample experience in using the IPCC guidance, the information and issues discussed in the IPCC guidance documents are not repeated in this document.

[3] IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003), p. 4.9
[4] Net-net accounting approach.
[5] Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2013), or 2013 IPCC KP Supplement for short

2.2 Useful IPCC guidance

Member States have a lot of experience in working with the IPCC guidelines, so the content of the IPCC guidelines is not repeated here. The 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, also known as 2013 IPCC KP Supplement (IPCC, 2014a) supersedes the previous guidance related to RV from the 2003 IPCC Good Practice Guidance on Land-Use, Land-use change and Forestry (IPCC, 2003). Member States may not yet be completely familiar with the RV sections in the IPCC documents. This section therefore summarises the RV chapter 2.11 of the 2013 IPCC KP Supplement (IPCC, 2014a).

The RV guidance in the 2013 IPCC KP Supplement (IPCC, 2014a) is essentially the same as in the 2003 IPCC GPG. Set out in chapter 2.11, it covers the following issues:

Section 2.11.1 Definitional issues and reporting requirements: The principles remain unchanged from the 2003 IPCC GPG, but the text was clarified and references were updated to the IPCC documents relevant for 2013-2020. A box with national examples of the RV definition was added.

Section 2.11.2 Base year: Guidance on base year reporting only links to the section on cropland management (CM). The latter was clarified with regard to what land and what emissions and removals are included in the base year.

Section 2.11.3 Choice of methods for identifying lands: The principles remain unchanged from the 2003 IPCC GPG, but the text has been clarified and references were updated to the IPCC documents relevant for 2013-2020.

Section 2.11.4 Choice of methods for estimating carbon stock changes and non-CO_2 GHG emissions: The guidance is structured along carbon stock change factors, management data and non-CO_2 greenhouse gases. References were updated to the 2006 IPCC Guidelines.

2.3 Current Reporting on Revegetation

This section provides a brief overview of the current situation in relation to reporting on RV in Romania, Japan and Iceland, setting out their rationales for electing RV, the definitions they used, the approach taken and information available on reporting.

2.3.1 Romania

Rationale for electing RV: Romania had a strong reforestation programme from the mid-1970s. This programme had declined over time, but there were plans to stimulate reforestation again through the reintroduction of a shelterbelts initiative. RV was elected to highlight the benefits of creating shelter belts for climate change mitigation.

Romania´s RV definition: Revegetation is applied to forest patches and shelterbelts with a width of less than 20 metres and an area less than 0.5 hectares, planted for protecting crop

fields and short rotation forestry crops for bioenergy[6]. RV comprises the establishment of woody plantations on land not eligible for the national forest fund[7]. These include roadsides, shelterbelts, areas around cities and erosion-prone lands. Planting trees on degraded croplands are also included within the definition, meaning that RV areas were classified as Croplands remaining Croplands and implemented in the same way as afforestation on Croplands. The RV trees do not fall under the national forest definition.

Applicability of Romania´s RV definition to other Member States under EU Decision 529/2013/EU: Tree plantations outside forests can be applied in any Member State. Romania chose to classify the land with planted trees as Cropland remaining Cropland. If Member States include trees and shelterbelts in their definition of Cropland, the activity may also be reported under CM rather than RV.

Romania´s RV reporting: The RV area established by tree planting reached 103,150 ha in 2012 compared to 87,990 ha on 1 January 1990, taking into account the entire area planted since 1970. The area estimate for the base year 1989 took into consideration all areas subject to RV since 1970. The area estimate for the commitment period years included all RV areas existing in the years of the commitment period including those established before 1990[8].

Reporting Method 1 was applied to report RV. This uses a spatially-referenced approach to delineate the geographic boundaries containing multiple land units subject to RV (2013 IPCC KP Supplement, p. 2.15). Carbon pools were estimated exactly as for Cropland converted to Forestland (artificial plantations) under the assumption that plantations differ only by their legal status (land classification as Cropland rather than Forestland). Data were taken from the national forest inventory, which also assesses trees and vegetation outside the forest fund, and should allow updates on the area falling under RV to be reported[9].

RV occupies a very small area (less than 0.1% of the total area of land included under the 5.B.1 Cropland remaining Cropland category)[10]. Romania does not identify RV activities as a key category under KP[11].

Romania´s approach to base year reporting: Romania´s net estimate of its base year (1989) includes all areas subject to RV since 1970[12]. This decision was made in response to recommendations by the expert review team (ERT) of the UNFCCC, who recommended that Romania should calculate its emission estimates for the RV base year by including all areas and associated GHG emissions and removals that had been subject to RV since 1970. The ERT argued that in their opinion the use of a single year 1989 of RV activity to estimate the base year emissions would lead to the underestimation of removals in the base year and

[6] Romania´s Initial Report under Kyoto Protocol (Assigned Amount Calculation), 2007, p. 16.
[7] NIR Romaina 2014; 813.
[8] NIR Romania 2014, p. 825.
[9] NIR Romania 2013, p. 933.
[10] NIR Romania 2014, p. 649.
[11] NIR Romania 2014, 826.
[12] NIR Romania 2014, p. 825.

therefore would lead to an overestimation of the accountable removals for RV over the commitment period[13].

The ERT recommendation goes beyond the RV definition, where RV only includes activities since 1990 and not those having started before 1990. As Romania had a higher annual RV rate before 1990 than afterwards and seems not to report any net carbon removals on RV land for longer than 20 years, the net carbon removals in the base year exceed those in the commitment period. Consequently, Romania accounts a net GHG source from RV.

2.3.2 Japan

Rationale for electing RV: Japan has a number of policies and 'green space' programmes for urban greening. RV was elected to highlight the synergies of urban greening with climate change mitigation.

Japan´s RV definition: In Japan, RV is defined as practices for the creation of 'parks and green space', 'public green space', and 'private green space guaranteed by administration' which have been carried out in settlements since 1990[14]. Activities which cover less than an area of 0.05 ha or meet the definitions of AR are not included.

Applicability of Japan´s RV definition to other Member States under EU Decision 529/2013/EU: Tree planting in settlements can be applied in any Member State. Japan chose to classify RV into many different sub-categories, differentiated by legal definitions of the green space, location or purpose. This led to many sub-categories and complications in land tracking because some of the sub-categories could not be easily distinguished. The activity could be simplified as tree planting in settlements or urban space. RV would only apply to Settlements remaining Settlements and Land converted to Settlements that does not fall under AR/D. There is no overlap with FM, CM and GM activities.

Japan´s RV reporting: Reporting Method 1 was applied to report RV In Japan, the urban green facilities subject to RV activities are divided into eight sub-categories: 'urban parks', 'green areas on roads', 'green areas at ports', 'green areas around sewage treatment facilities', 'green areas by greenery promoting systems for private green space', 'green areas along rivers and erosion control sites', 'green areas around government buildings', and 'green areas around public rental housing'[15].

Activity data are derived from:

- Periodically updated high-detailed land-use maps of urban land-use;
- An annually updated park cadaster; and
- Periodically repeated Road Tree Planting Status Surveys by prefecture, using the following data and equation[16]:

[13] https://unfccc.int/files/kyoto_protocol/compliance/questions_of_implementation/application/pdf/cc-2011-1-9_romania_eb_add.1_saturday_paper.pdf, p. 4.
[14] Japan´s base year is 1990.
[15] NIR Japan 2014, p. 11-3
[16] NIR Japan 2014, p. 11-11

Area of land where tall trees have been planted since 1 April 1990 and whose size is 500 m^2 or more (ha)
= Number of tall trees planted since 1 April 1990 (tree)
** Ratio of the number of tall trees planted on land which is 500 m^2 or more (%)*
** Land area per tall tree (ha/tree)*

The data used are shown in Table 1.

Table 1 Data applied by Japan in estimating RV

Sub-division	Data type	Method for data collection
Urban parks	• Area for each urban park	• Urban Parks Status Survey (FY2008, 2009, 2010, 2011, 2012)
Green area on roads	• Number of tall trees	• Road Tree Planting Status Survey (FY1987, 1992, 1997, 2002, 2007, 2008, 2009, 2010, 2011, 2012, 2013)
	• Land area per tall tree	• Basic Data Collection Survey on Tall Tree Planting on Roads (February, 2007)
Green areas at ports	• Service area	• Complete census for FY2008, 2009, 2010, 2011, 2012
Green areas around sewage treatment facilities	• Green area	• Sewage Treatment Facility Status Survey (FY2008, 2009, 2010, 2011, 2012)
Green areas by greenery promoting systems for private green space	• Greening area • Wall greening area • Number of tall trees	• Application form for greenery promoting systems for private green space • Urban Greening Status Survey (FY2008, 2009, 2010, 2011, 2012)
Green areas along river and erosion control sites	• Planted land area	• Survey on carbon dioxide absorption at source in river works (FY2008, 2009, 2010, 2011, 2012)
Green areas around government buildings	• Total land area and building area	• Complete census for FY2008, 2009, 2010, 2011, 2012
Green areas around public rental housing	• Total land area and building area	• Progress survey on tree planting for public rental housing (FY2008, 2009, 2010, 2011, 2012)

Source: NIR Japan 2014, Table 11-10

The annual C stock change resulting from tree growth was estimated by combining defaults with country-specific growth functions for the tree species in Japan growing in urban spaces from tree surveys. Emissions from above-ground and below-ground biomass were also taken into account. Dead wood was reported IE (included elsewhere) and litter was reported, based on data from a national study. Organic soils do not occur on RV land. C stock changes in mineral soils were reported based on a national study. In conclusion, Japan has very detailed activity data on urban trees and has undertaken national studies to develop country specific EFs.

Japan identified RV activities as a key source/sink category under 'Settlements remaining Settlements' and 'Land converted to Settlements'.

Japan´s approach to base year reporting: Japan does not mention any RV activities prior to 1990. The RV area in 1990 equals the area subject to tree planting in 1990. The area does not include the land that has been subject to tree planting after 1990. The base year net removals in RV are those from the RV area in 1990.

In the UNFCCC's annual inventory review process, Japan´s reporting of RV activities was mostly approved. In 2014 the ERT advised Japan to improve the transparency of the uncertainty estimates but Japan has not been given any recommendations regarding the pre-1990 effects and net GHG emissions and removals on land that was subject to RV after that date.

2.3.3 Iceland

Rationale for electing RV: Since the settlement of Iceland, large areas of formerly vegetated land have been severely eroded and the entire soil mantle has been lost on a significant proportion of these. For the vast majority of land where RV occurs, the original vegetation cover is less than 20%. Iceland has elected RV to highlight synergies between land rehabilitation and climate change mitigation.

Iceland´s RV definition: In Iceland, RV is defined as a direct human-induced activity to increase carbon stocks on eroding or eroded/desertified sites, through the establishment of vegetation or the reinforcement of existing vegetation that covers a minimum area of 0.5 hectares and does not meet the definitions of afforestation or reforestation.[17]

Applicability of Iceland´s RV definition to other Member States under EU Decision 529/2013/EU: RV in Iceland mainly leads to the establishment of grasslands or small areas of scrub. The general idea to define RV as rehabilitation of eroded/desertified sites could be relevant for EU Member States as well. Iceland, however, is untypical for Europe due to its vast devegetated areas and very low land-use pressure. EU Member States would not necessarily rehabilitate the land to Grassland, but also to other land-use categories, for example by afforestation. Improving the grass sward or reinforcing existing grass vegetation could also be included under the GM definition.

Iceland´s RV reporting: The eroded/desertified land is classified as 'Other Land'. RV is identified as 'Other Land converted to Grassland'.

Reporting Method 1 was applied to report RV also in this case. The area of land being revegetated is divided into two subcategories, based on when the activity started i.e. 'Land revegetated before 1990' and 'Land revegetated since 1990'. The latter category represents activity accountable as Kyoto Protocol commitments. This subdivision also reflects difference in methods used for area estimates prior to 1990[18], which have a greater degree of uncertainty.[19]

Iceland identifies Revegetation activities as a key source/sink category for:

- Other land converted to Grassland - Revegetation since 1990 - Mineral soil; and
- Other land converted to Grassland - Revegetation before 1990 - Mineral soil.

[17] Iceland NIR 2010, p. 170.
[18] Iceland´s base year for RV is 1990.
[19] Iceland NIR 2010, p. 130.

Iceland´s approach to base year reporting: Activities which started prior to 1990 are not included in the base year net emissions and removals. In UNFCCC's annual inventory review process, Iceland´s reporting of RV activities was mostly approved. As of 2013 and 2014 the ERT advised Iceland to establish a suitable tracking system for land subject to RV.

2.4 Activities with potential for Revegetation

The choice of definitions of RV by Romania, Iceland and Japan reflects the diversity of national circumstances. The scope for RV also depends on national land classification definitions. In general, tree planting outside forests is typically a RV activity applicable to all Member States. This is discussed further below. If the national definitions of CM and GM include tree planting on cropland and grassland, the tree planting on these land-use categories would, however, be reported under CM and GM.

Activities with potential for RV are for instance:

1. Planting or regeneration of trees and shrubs that do not meet the national definitions of FM, CM and GM. They could include hedges, tree rows, small islands of forest and shrublands.
2. Planting or regeneration of trees and shrubs in settlements, such as parks, gardens, trees along roadsides. We suggest that this activity may be further split into:
    a. RV by urban trees in settlements remaining settlements
    b. RV by urban trees in land converted to settlements

2.5 Current EU Member State Reporting of carbon pools or land-use sub-categories that may qualify as Revegetation

2.5.1 Woody biomass: hedgerows, orchards, agroforestry or similar

Many Member States report woody biomass in hedgerows, orchards, Christmas tree plantations, tree nurseries etc. Many of these biomass types may fall under the national definitions of CM and GM. But Member States could also choose CM and GM definitions that leave out some of the management systems or sub-categories of land-uses with woody biomass, such as coppices, orchards, Christmas tree plantations, tree nurseries and define them as RV.

Activity data can be derived from land-use or agricultural statistics, cadastres or high-resolution land-use maps or airborne images (e.g. colour-infrared, orthophotos). Linear elements recorded as lines on maps, e.g. tree lines, roadside trees, hedgerows, often have additional attributes that specify the average width. These attributes allow the lines to be converted into polygons.

Emission factors are already available in many Member States. The ground surveys of the National Forest Inventories (NFI) in some Member States covers areas outside forests. These inventories produce national data of woody biomass outside forest, which can serve as a good basis for data on RV. Some Member States have developed national EFs for woody biomass in hedgerows, orchards, vineyards, Christmas tree plantations, tree nurseries etc. These EFs could serve as a Tier 2 estimate for other Member States as well. These EFs could

also serve as proxy for similar types of woody biomass, e.g. roadside trees. When using EFs from other Member States it needs to be explained that they are more suited to country specific (CS) conditions than the defaults, or that no detailed defaults suitable for the national circumstances are available, as in the case of perennial crops.

A more detailed assessment on gathering activity data and developing more accurate emission factors is provided in the 'Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/'.

2.5.2 Urban trees

Member States generally do not stratify Settlements. Three Member States – Latvia, Poland and Sweden – report C stock changes in woody biomass and partly also dead organic matter in the sub-category 'Settlements remaining Settlements'. These are outlined in **Box 1**.

Box 1: Examples of countries reporting C stock changes in woody biomass for 'Settlements remaining Settlements'

Latvia: Latvia´s NFI includes settlements. CO_2 removals in living and dead biomass were estimated using the NFI data on the increment of growing stock in settlements, which represented mostly overgrown roadsides, power lines and other infrastructure. The age of woody vegetation on settlements was calculated backwards to account for trees emerging in the reporting period. Harvesting, if any takes place, is reported under forest land remaining forest, because it is not possible to separate harvests by land use category[20].

Poland: Poland used data on tree crown cover in urban areas combined with default emission factors (EF) for estimating carbon stock changes in living biomass. Estimates were based on the crown cover area method (urban green area) which was derived from national data sources. Carbon stock changes in living biomass were calculated based on equation 3.a.4.1. page 3.295 (IPCC 2003). For the calculations, the default accumulation rate of 1.8 t C ha^{-1} was used (IPCC 2003, page 3.297)[21].

Sweden: Sweden´s NFI includes settlements in the 16 national land use categories monitored. C stock changes are derived from NFI observations.

Urban trees can also occur on land converted to Settlements. Some Member States use data from the NFI, others estimate average C stocks in Settlements by estimating the fraction of sealed area and average cover by herbaceous and woody vegetation. The latter estimates are highly uncertain.

2.6 Qualitative assessment of Revegetation potential in EU Member States

Section 2.2 highlighted the different approaches carried out for RV accounting in the first commitment period under the Kyoto Protocol, reporting the base year area and net GHG emissions and removals. This has immediate consequences on the accounted net GHG emissions and removals in the commitment period.

[20] NIR Latvia 2014, p. 327
[21] NIR Poland 2014, p. 207

Table 2 summarises the magnitude of reported net GHG emissions and removals in the year 2012 to provide an idea of the order of magnitude of the area and net CO_2 removals on land with the potential for RV.

Table 2: Area and net CO_2 emissions and removals in the year 2012 on land potentially accountable under RV. Data sources: NIRs 2014

Member State	Land-use category or Activity	Area		Net CO_2 emissions and removals		Implied emission factor per area
		kha	% of national area	Gg CO_2 equivalents	% of national GHGs including LULUCF	Mg CO_2 ha^{-1}
Romania	Shelterbelts (Revegetation since 1970)	103.15	0.4%	-1,197.74	-1.2% reduction of total GHG emissions	-11.61 (sink)
Latvia	Settlement remaining Settlement	240.01	3.7%	-110.37	8.3% contribution to total net GHG sink	-0.44 (sink)
Poland		2,066.98	6.6%	-88.77	-0.02% reduction of total GHG emissions	-0.04 (sink)
Sweden		1,562.64	3.6%	-70.81	-0.3% reduction of total GHG emissions	-0.04 (sink)

The Member State examples in Table 2 demonstrate that the potential for RV is very limited if it relies on changes in existing urban trees as in the cases of Latvia, Poland and Sweden. However, dedicated tree planting, as in the case of Romania, has a substantial net C sequestration rate per hectare.

Some Member States may have policy programmes for hedgerows, shelterbelts or urban greening, which may offer some potential for net C sequestration. The overall effect on total GHG emissions, however, heavily depends on national circumstances.

2.7 Revegetation reporting in the base year

2.7.1 Revegetation reporting guidelines for the base year

Countries used the IPCC GPG (2003) for RV reporting in the first commitment period (2008-2012) and will need to use the 2013 IPCC KP Supplement (2014a) for the period 2013-2020. The 2013 IPCC KP Supplement (2014a) explicitly mentions 1990 as base year. Some Member States, however, use a different base year. For consistency, they should check whether they can use the same base year for RV as for the other LULUCF activities.

The IPCC Report on Good Practice Guidance for Land Use, Land Use Change and Forestry (2003) advises countries *'to extrapolate a consistent time series, where the 1990 base year net carbon emission and removals cannot be established using the default carbon emission and removal factors. Further data on the land management history for the past 20 years is required, because the default method for estimation of the greenhouse gas emissions/removals assumes that it takes 20 years for the soil carbon pool to reach a new equilibrium after a land-use change to agriculture'*. The guidance refers to '*options that*

address the lack of reliable data for the period of 1970 to 1990 can be found in the section for the base year for cropland management'.[22]

The 2013 IPCC KP Supplement (IPCC, 2014a) states that land should be classified as RV if it meets the RV definition and if the activity has taken place since 1 January 1990. This could be interpreted that the onset of the activity is on 1 January 1990 or later and would exclude any RV before 1990. In this case, the RV activity since 1 January 1990 and in 1990 (or in any other base year) defines the area to be accounted under RV for the base year. The 2013 IPCC KP Supplement advises to establish the base year inventory for RV in an analogous manner to that for the Cropland Management base year estimation[23]. This includes *historical data on land use and management practices in 1990 (or the appropriate year(s)) and in years prior to 1990 for the 1990 base year net emissions and removals of soil carbon from Cropland Management*.[24] However, also in the case of CM, this applies only to the CM area in the base year and not to any CM area in the transition period before.

2.7.2 Interpretations of Revegetation reporting in the base year by Iceland, Japan Romania and UNFCCC reviewers

The IPCC (2003) GPG obviously have been interpreted differently by Iceland, Japan Romania and UNFCCC reviewers in terms of what land and what past management need to be taken into account when calculating the base year´s net emissions and removals for RV activities.

The following interpretations of the key questions that need to be addressed are set out below:

1. Are areas on which RV has occurred between 1971 and the base year included in the base year or not?
   - Iceland: yes
   - Japan: no
   - Romania: yes

It is the common understanding of the project team and the Joint Research Centre of the Commission (JRC) that the areas on which RV has occurred prior to 1990 should not be included in the base year. Including these areas is likely to lead to a conservative net-net accounting, which will not cause any derogations.

2. Are GHG emissions and removals on areas on which RV has occurred between 1970 and the base year included in the base year GHG emissions and removals for accounting or not?
   - Iceland: no, because the pre-1990 stratum was excluded from the accounting.
   - Japan: no
   - Romania: yes

[22] IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003), p. 4.37.
[23] IPCC Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2013), p. 200.
[24] IPCC Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2013), p. 176.

UNFCCC reviewers have accepted the interpretations of Iceland and Japan, but have also recommended the inclusion of areas and GHG emissions and removals in the case of Romania. The project team notes that Romania currently seems to report in a conservative way beyond the commonly understood requirements for the base year.

2.7.3 Interpretation of Revegetation reporting for implementing EU Decision 529/2013/EU

The project team and JRC agree in their interpretation of the clarifications made in the 2013 IPCC KP Supplement, chapter 2.11 about base year reporting. The following procedure is suggested for implementing EU Decision 529/2013/EU:

- RV activities since 1990 should be reported and accounted, but not those having started before 1990.
- Historical information (since 1971) about land-use, management and C stocks in mineral soils may be needed on land subject to RV since 1990 in case areas subject to RV were subject to land use and/or management changes in the previous 20 years and therefore the C stock changes relating to the mineral soil C pool have lagged behind and the equilibrium C stock has not been reached by the time RV starts.

2.8 Guidance for Revegetation Reporting

This section provides information on how to source activity data and calculate emission factors for RV.

2.8.1 Activity data

Existing national data sources are likely to contain useful spatial information on potential RV land. Some examples of these, which have been mentioned as relevant by Member States are listed here:

- Land-use maps often contain tree lines, hedgerows or shelterbelts as polygons or linear elements depending on width criteria. Linear elements can be transformed into area data if the width is known or can be estimated.
- Long time series of high-quality, high-resolution orthophotos are often available from the military or land surveying offices.
- Trees outside forests are included in the NFI in some Member States.
- Urban tree cadastres exist for many cities and can include information on species, age, breast height diameter, tree height etc. Sometimes only large trees are included, which would underestimate the sink strength.
- LIDAR[25] data are available in many Member States and have been used for digital elevation mapping. They also allow the crown cover and tree height of urban trees or trees outside forests to be estimated.

[25] 'LIght Detection And Ranging' or 'Laser Imaging, Detection and Ranging' technology. LIDAR is a remote sensing method. It measures distance by sending a laser beam on a target and analyzing the reflected light. It is typically used for altimetry measurements.

2.8.2 Emission factors and methodologies

- Germany and Romania report C stocks for hedgerows or shelterbelts and Denmark is improving its inventory for hedgerows. These Member States have collected, or are collecting, data on volume and C stocks in hedgerows. Detailed guidance is provided in the Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU, Chapter 6.
- Growth functions can be derived from existing data in urban tree cadastres and botanical gardens which also may have data for exotic urban tree species.

2.8.3 Data sources for emission factors for woody biomass

There is no general data source for emission factors for woody biomass. Therefore, the profiles are organised according to the type of woody biomass rather than by data source.

Woody biomass in CM and GM has been subject to research in many Member States. There is likely to be dispersed data available from research projects and institutions, breeding centres and agricultural schools in many Member States as well. Some Member States have data included in their national forest inventories. Given the diversity of types of woody biomass and management practices among Member States, it is recommended to coordinate the development and dissemination of data for woody biomass at European level. This could be organised by a tender or a COST[26] action.

Perennial crops

The area of perennial crops and type of perennial crops are available in agricultural statistics, e.g. from EUROSTAT.

Some national statistics are much more detailed regarding type of perennial crops, number and age of fruit trees.

Carbon stocks in woody biomass of perennial crops (t C ha^{-1}) can be derived from data collected by agricultural schools and breeding centres which regularly collect biomass, tree density etc. by crop type and cultivar. This data can be used statistically or be converted into growth functions, which are then applied to statistical data of number and age of trees. Biomass to carbon conversions are similar to the methods used for forest trees.

Carbon in harvested biomass by pruning can be derived from the same sources. It is generally assumed according to common practice that pruning equals growth.

Some Member States have performed, or are planning, research projects about woody biomass in perennial crops. The German NIR presents detailed carbon stocks derived from an unpublished PhD thesis for orchards and vineyards. The background data can be transferred to a wider range of Member State conditions in cooperation with the data owners.

[26] European Cooperation in Science and Technology – www.cost.eu

Agroforestry

The term 'agroforestry' is broadly defined and implemented among Member States. This makes it difficult to transfer knowledge among Member States. There is no common, nor any clearly documented approach to agroforestry. It may be practical to start with data on bioenergy or raw material from coppices and derive area, carbon stocks and carbon stock changes from production and national data sources.

Agroforestry as coppice system is widespread in Italy and growing in UK and Northern Member States for fuelwood and bioenergy.

Hedgerows, shelterbelts

Specific national data is available in Romania, Germany and Denmark (in progress). Other Member States have data included in the national forest inventory.

The length and width of hedgerows and EFs of hedges and shrubland or woody pastures excluded from the national forest definition could, e.g., be found in inventories of high nature value areas or nature conservation areas (RV).

Some Member States have included hedgerows, shelter belts and other trees outside forest in their national forest inventory. Field data include classical forestry metrics so that the results can be directly taken for area, C stocks and C stock changes. Given the wealth of experience in all Member States with forest inventories it is worth exploring whether other Member States would expand their national forest inventories to areas with trees outside forest as well.

Urban trees

There are plenty of unexplored dispersed data sources which require joint efforts to be mobilized for improving LULUCF reporting.

Activity data: Urban tree cadastres are available for many cities. They contain data about location and number of trees, tree species, age, sometimes also tree breast height diameter and tree height. Often trees are protected above certain thresholds of breast height diameter, age or height and are monitored over time at local level.

Settlement area is monitored in cadastres, topographic surveys or other land surveys in great detail regarding urban functions. Settlement functions are also often laid down in regional and urban planning and development plans. The stratification by function could serve as proxy for fractional cover of sealed and unsealed area, and fractional cover of green space and trees. Land-use maps often identify urban park areas and other urban green areas. These can also be taken from high resolution remote sensing.

Carbon stocks, carbon stock changes: Land-use planners and landscape architects have detailed knowledge about growth and shape of urban trees, which could be collected and transferred to carbon stocks. Some arboreta and botanical gardens have collected growth and shape information, e.g. tree height and crown diameter with age. This information can be used to develop allometric functions and growth functions so that urban trees can be monitored with a similar approach to forests.

Latvia and Sweden have included urban areas in their national forest inventory. Field data include classical forestry metrics so that the results can be directly taken for area, C stocks and C stock changes. Given the wealth of experience in all Member States with forest inventories it is worth exploring whether other Member States would expand their national forest inventories to urban areas as well.

2.9 Addressing organisational and operational issues

2.9.1 Exploring and including the national expertise

Useful spatial activity data or other information such as that listed in Section 2.7 often exists in Member States for other purposes than LULUCF reporting. It is worth engaging with those authorities and researchers dealing with issues such as biodiversity, bioenergy, urban planning and topographic mapping in order to identify and use these data. Sometimes data are available at the local level and in these cases they often need to be harmonised to create a consistent national data set.

Botanical gardens have collected data on exotic tree species and have sometimes monitored tree growth as well.

Urban planners have information about the suitability, height and growth forms of trees, which can support the derivation of C stock estimates and of tree species distributions.

Pruning material from hedgerows is increasingly used for bioenergy so that yield estimates may be available from the bioenergy plants allow C stocks and growth to be calculated per pruning interval.

2.9.2 International co-operation

Methodological development and data collection, e.g. for allometric functions, exotic trees or volume to biomass ratios of hedgerows, is likely to be most resource-efficient when carried out through international research co-operation. While data is most likely to be unevenly distributed and difficult to find in some cases, the resulting methods and emission factors are applicable across borders as they relate to biophysical properties of trees and shrubs.

Data from other Member States reporting C stocks in biomass in settlements could also serve as a starting point.

2.9.3 Resources and cost effective approaches

Some promising solutions which are simple and cost-effective have been found by some Member States. These provide useful illustrations of the sort of solutions that could be adopted elsewhere as well. A couple of examples are provided below.

Activity data and biomass for trees outside forests: The NFI in many Member States includes an analysis of aerial photography or high-resolution remote sensing data in the entire country to classify land-use categories. This analysis could provide data sources, or

additional data on shrub cover, crown cover, number of trees outside forests in the survey areas. The NFI field survey in some Member States goes beyond forests and includes trees outside forests. As the NFI methodology is well established and there are well-trained experts available, it may be relatively straightforward to expand the NFI to trees outside forests in other Member States as well.

C stocks and C stock changes in hedgerows: Research projects have been carried out which weighed the biomass removed by hedge pruning as a means of estimating C stocks in hedgerows per unit area or unit hedge length. In addition, the pruning rotation cycle was estimated. This allows C stocks and C stock changes in hedgerows to be estimated. If the pruning cycle is short (<20 years) the data also allow equilibrium C stocks to be estimated that are representative for pruning rotations. In this case, information on age-class distribution is not needed.

3 Wetland Drainage and Rewetting

3.1 Introduction

The UNFCCC/KP definition of Wetland Drainage and Rewetting (WDR) is as follows: *'a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined above, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage'.* (Decision 2/CMP.7 (Land use, land-use change and forestry) contained in FCCC/KP/CMP/2011/10/Add.1, p.13)

WDR is a new elective activity under KP and is restricted to organic soils. It was introduced to the UNFCCC negotiations to emphasise the significant role of drained organic soils as a source of GHG emissions and to give credit to activities for peatland rewetting and restoration.

WDR refers to organic soils under any land-use category, not to the land-use category Wetlands.

WDR is last in the hierarchy of elective activities. This means that under EU Decision 529/2013/EU WDR is restricted to organic soils not reported under AR/D, FM, CM, GM and – if elected – RV. This hierarchy restricts WDR in many cases to former or active peat extraction areas, degraded near-natural areas or otherwise abandoned organic soils. Most of these areas are classified as Wetlands (managed or unmanaged) or Other Lands (unmanaged) in the GHG inventory.

3.2 Useful IPCC Guidance

Member States have a lot of experience in working with the IPCC guidelines, so the content of the IPCC guidelines is not repeated here. There are, however, two new IPCC documents, which supersede previous guidance and are mandatory for WDR reporting. These are:

- the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, also known as 2013 IPCC KP Supplement (IPCC, 2014a); and
- the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, also known as the 2013 IPCC Wetlands Supplement (IPCC, 2014b)

Member States may not yet be completely familiar with these documents. Specific guidance on WDR can be found in various parts of these new IPCC documents. This section provides a guide about where relevant guidance for WDR reporting can be found in these IPCC documents, focusing on new or particularly critical issues for reporting.

3.2.1 2013 IPCC KP Supplement

The 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2013 IPCC KP Supplement, IPCC (2014a)) provides supplementary methods

and good practice guidance for estimating and reporting anthropogenic greenhouse gas (GHG) emissions and removals resulting from LULUCF activities under Article 3.3 and Article 3.4 of the Kyoto Protocol for the second commitment period, 2013-2020. This includes AR/D, FM, CM, GM, RV, and WDR.

Guidance on WDR is provided in chapter 2.12 of the 2013 IPCC KP Supplement. The structure and contents of the WDR guidance is summarised below.

Chapter 2.12.1 Definitional issues and reporting requirements
This chapter provides an overview of definitions and reporting requirements and shows the links to relevant guidance in other IPCC documents. It demonstrates how WDR is distinguished from AR/D, FM, CM, GM and RV. It gives examples of measures accountable under WDR.

WDR definition: '*According to Decision 2/CMP.7 'Wetland Drainage and Rewetting' is a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage'* (2013 IPCC KP Supplement, Chapter 2.12.1).

- WDR is the last activity in the hierarchy of AR/D, FM, CM, GM and RV. Therefore, not all drainage and rewetting activities are accounted under WDR, only those that are not accounted elsewhere.
- WDR can only be carried out on organic soils, but under any land-use category[27].
- Guidance on the definition on organic soils can be found in Annex 3A.5, Chapter 3, Volume 4 of the 2006 IPCC Guidelines and country specific definitions in chapter 1 of the 2013 IPCC Wetlands Supplement.
- Methodological guidance for drained and partially rewetted organic soils is provided in chapter 2 and for organic soil having been totally rewetted to near-natural water table levels in chapter 3 of the 2013 IPCC Wetlands Supplement.
- *Practices of drainage and rewetting of organic soils may occur under any other activity under Articles 3.3 or 3.4 and would be reported under these mandatory or elected activities accordingly.* An example box provides an overview for how to report emissions and removals from drained or rewetted organic soils under various KP LULUCF activities[28].

Chapter 2.12.2 Base year
Results of drainage and rewetting practices '*are only considered, as far as practices have taken place since 1990. The practices of drainage and rewetting result in immediate changes of GHG emissions and removals so that there may be less need to establish a land-use history prior to 1990 for Tier 1 methods'* (2013 IPCC KP Supplement, Chapter 2.12.2).

Pre-1990 land-use history is less of an issue for WDR than for CM and GM because GHG emissions from organic soils after land-use change are immediately reported with the emission factor of the new land-use category. It does not matter, therefore, for Tier 1 and

[27] IPCC 2014, 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland, p. 2.164.
[28] See box 2.12.1 on page 2.165.

Tier 2 methodologies when the land use or the management present in 1990 was established.

Chapter 2.12.3 Choice of methods for identifying lands
'As drainage or rewetting of organic soils may also occur under other accounted land-use activities, the WDR activity will always concern only a subset of the total area of organic soil in the country. The activity WDR can only be applied to organic soils that are drained or rewetted since 1990 and that are not included under any other mandatory or elected KP activity' (2013 IPCC KP Supplement, Chapter 2.12.3).

- A decision tree is provided for identifying land under KP Article 3.4 activities (figure 2.12.1, see box for Chapter 2.12.3 above). Organic soils have to be allocated to the mandatory and elected KP activities. Only those that do not fall in any other KP activity are eligible for WDR.
- Box 2.12.2 of 2013 IPCC Wetlands Supplement, (chapter 2.12.3) WDR areas in 1990 and the commitment period (net-net accounting)
- With respect to the minimum area of 1 ha to which WDR applies, criteria can be defined as to the minimum width. Then the minimum length of the area follows from the combination of width and the prescribed minimum area of 1 ha. For example, with a minimum width of 20 m, a rectangle of minimum width has to be at least 500 m long to meet the 1 ha size requirement[29].
- Specific guidance for identifying areas suitable for WDR is based on the generic guidance on reporting methods and approaches in section 2.2 (e.g. decision tree in figure 2.2.2) of the 2013 IPCC Wetlands Supplement and section 3.3.1, Chapter 3, Volume 4 of the 2006 IPCC Guidelines. WDR land can be identified in two ways. The first option is to use a broad comparison of the state of organic soils between 1990 and the commitment period, comparable to the approach for FM, CM and GM. The second option is to track measures and projects, comparable to the approach for AR/D and RV and estimates the change in organic soil drainage status on these areas of land compared to 1990.
- Chapter 2.12.3 guides the stratification of WDR land into sub-categories for reporting. The land is subdivided into the land-use category, climate zone and the status of the organic soils, in particular drained and undrained, with eventual further stratification by drainage class and nutrient status.

Chapter 2.12.4 Choice of methods for estimating GHG emissions and removals
'Guidance on methodologies for estimating carbon stock changes, CO_2 emissions and removals and non-CO_2 GHG emissions on land subject to WDR is given in the 2006 IPCC Guidelines supplemented by the 2013 IPCC Wetlands Supplement' (2013 IPCC KP Supplement, Chapter 2.12.4).

The 2013 IPCC KP Supplement does not contain any guidance or obligations for estimating GHG emissions and removals on WDR land beyond some generic guidance about the choice of methods (Section 2.3.6) and WDR key category analysis (decision trees in Figures 1.2 and 1.3 in Chapter 1, Volume 4 of the 2006 IPCC Guidelines). It summarises where to find

[29] IPCC 2014, 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland, p. 2.164.
[29] See box 2.12.1 on page 2.168.

detailed guidance on reporting C pools and other GHG emissions. Although the chapter contains many links to the 2006 IPCC Guidelines it should be remembered that the 2013 IPCC Wetlands Supplement supersedes the 2006 IPCC Guidelines for estimating GHG emissions and removals from the organic soil pool. WDR reporting must follow the 2013 IPCC Wetlands Supplement.

3.2.2 2013 IPCC Wetlands Supplement

The 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (2013 IPCC Wetlands Supplement, IPCC 2014b) extends the content of the 2006 IPCC Guidelines. The 2013 IPCC Wetlands Supplement provides guidance on:

- estimating emissions and removals on land with drained and rewetted organic soils (Chapters 2, 3 and 4); and
- general issues on wetlands (Chapters 1 and 7).

The 2013 IPCC Wetlands Supplement goes far beyond the scope of WDR. Table 3 provides an overview of the chapters in which important guidance for WDR reporting can be found.

Table 3 Overview of the 2013 IPCC Wetlands Supplement by soil type, GHG, land-use category and region.

TABLE 1.1
LOOK-UP TABLE FOR *WETLANDS SUPPLEMENT* BY LAND-USE CATEGORIES, SOIL TYPE AND CONDITION AND INLAND OR COASTAL LOCATION

Soil Type		Gas	Forest land		Cropland		Grassland		Wetlands		Settlements		Other Land	
			Inland	Coastal	Inland	Coastal	Inland	Coastal	Inland	Coastal	Inland	Coastal	Inland	Coastal
Mineral	Mineral Dry	CO_2	Refer to the 2006 IPCC Guidelines											
		CH_4												
		N_2O												
	Mineral Drained[3],	CO_2	5	4	5	4	5	4	5	4	5	4	5	4
		CH_4	5	4	5	4	5	4	5	4	5	4	5	4
		N_2O		4		4		4		4		4		4
	Mineral Wet	CO_2	5	4	5	4	5	4	5	4	5	4	5	4
		CH_4	5	4	5	4	5	4	5	4	5	4	5	4
		N_2O	5	4	5	4	5	4	5	4	5	4	5	4
Organic	Organic wet	CO_2	3	4	3	4	3	4	3	4	3	4	3	4
		CH_4	3	4	3	4	3	4	3	4	3	4	3	4
		N_2O	3	4	3	4	3	4	3	4	3	4	3	4
	Organic Drained	CO_2	2	4	2	4	2	4	2	4	2	4	2	4
		CH_4	2		2		2		2		2		2	
		N_2O	2		2		2		2		2		2	
	Constructed and Natural Wetlands for Wastewater treatment		The emission sources discussed in the *Wetlands Supplement* Chapter 6 provide guidance for the Waste Sector and do not impact on estimates of emissions and removals within AFOLU. However, the area of constructed wetlands should be reported as Wetlands, Settlements, or other land-use categories as appropriate and the impact on biomass, soil carbon and other pools may be considered. Care is required to avoid double-counting of emissions.											
	Emissions due to burning of organic soils		Chapter 2 in the *Wetlands Supplement* provides guidance for estimation of greenhouse gas emissions due to burning of organic soils. This guidance can be applied across all land use categories as appropriate where burning is reported as occurring.											
	DOC, DIC, PIC, POC		Chapter 2 in the *Wetlands Supplement* provides a discussion and some guidance on carbon loss from organic soils through water pathways. The information is relevant to all land use categories.											

NB: The red box highlights the land-use category Wetlands and the green box the organic soils. The chapters indicated in the boxes are relevant for WDR reporting.[30]

As shown in Table 3, Chapter 2 provides guidance for drained inland organic soils, Chapter 3 for rewetted and wet inland organic soils and Chapter 4 for drained and wet coastal organic

[30] IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland, p. 1.14.

soils. It is good practice to estimate and report GHG emissions from drained organic soils (Chapter 2) and from rewetted organic soils (Chapter 3) under WDR separately.

CHAPTER 2—DRAINED INLAND ORGANIC SOILS
'Chapter 2 provides an updated summary of emission factors and supplementary guidance to Volume 4 of the 2006 IPCC Guidelines on estimating greenhouse gas emissions and removals from drained inland organic soils for all land-use categories across climate zones: Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land' (2013 IPCC Wetlands Supplement, p. 1.12). The complete chapter is relevant for WDR.

- All CO_2 and N_2O EFs for organic soils are updated from the 2006 IPCC Guidance (except off-site emissions from harvested peat).
- New GHG sources are included in Tier 1 guidance:
  - off-site CO_2 emissions from carbon loss as dissolved organic carbon (DOC);
  - CH_4 emissions from drained land and drainage ditches; and
  - CO_2, CH_4 and CO emissions from peat fires (both wildfires on drained peatlands and managed fires).
- Additional Tier 1 guidance is given to include the impact of drainage depth (water-table level) and nutrient status on CO_2, CH_4 and N_2O emissions.
- Default EF units are t CO_2-C ha^{-1} yr^{-1}, kg CH_4 ha^{-1} yr^{-1}, and kg N_2O-N ha^{-1} yr^{-1}.
- Chapter 2 guidance also applies to partly rewetted conditions where the water table has been raised but has not reached the near-natural status.
- Annexes describe the methodological background for deriving the EFs. The EF tables contain the references of the measurements used for the default EFs so that they can be traced back to check to what extent they are representative of national conditions.

CHAPTER 3—REWETTED INLAND ORGANIC SOILS
'Chapter 3 provides guidance and emission factors for organic soils that had been drained for forestry, crop production, grazing, peat extraction or other purposes, and subsequently have been rewetted to re-establish water saturation' (2013 IPCC Wetlands Supplement, p. 1.13). This guidance is completely new and fully relevant for WDR.

- Tier 1 guidance is provided on the ideal case of organic soils having been rewetted to near-natural status. Generic guidance for higher Tier methods also considers less ideal rewetting through flooding or raising the water table beyond the natural water table.
- Tier 1 methodologies are provided for assessing CO_2, CH_4 and N_2O emissions and removals from rewetted organic soils by climate region and general guidance for utilizing higher tier methodologies.
- Default EF units are t CO_2-C ha^{-1} yr^{-1} and kg CH_4-C ha^{-1} yr^{-1} (different from Chapter 2) and the default EF for N_2O is zero.

Annexes describe the methodological background for deriving the EFs. The EF tables contain the references of the measurements used for the default EFs so that they can be traced back to check to what extent they are representative of national conditions.

CHAPTER 4—COASTAL WETLANDS

'Chapter 4 provides guidance on estimating emission and removals of greenhouse gases (CO_2, CH_4 and N_2O) associated with specific activities on managed coastal wetlands, which may or may not result in a land use change. Coastal wetlands are wetlands near the coast that are influenced by tidal and/or saline or brackish water. They may consist of mangrove, tidal marsh and seagrass vegetation and can have organic and mineral soils. Management practices included in the guidance are aquaculture, salt production, extraction, drainage, rewetting, revegetation and creation, and forest management practice in mangroves. (2013 IPCC Wetlands Supplement, p. 1.13). This guidance is completely new and goes beyond WDR.

Coastal wetlands differ from land ecosystems because they have highly dynamic matter exchange in both horizontal and vertical directions, which can originate from natural or anthropogenic processes or – most commonly – a mixture of both. Chapter 4 provides methodologies to estimate how human activities, management practices and land uses affect emissions, e.g. how the restoration, creation, and recovery of wetlands affects carbon sequestration and GHG emissions.

Most of the activities described in Chapter 4 are not directly related to WDR. Coastal wetlands, however, may have organic soils so that they may be included in WDR under specific circumstances.

3.3 Activities with potential for WDR and reporting challenges

WDR requires the tracking of changes in water table on organic soils by drainage and of rewetting measures compared to 1990. WDR has to include all areas where drainage has changed since 1990, i.e., drainage has become deeper or shallower. It is not sufficient to track only peatland restoration, rewetting and nature conservation projects where GHG emissions have been reduced. Organic soils have to be monitored in a comprehensive way so that drainage measures are tracked as well.

Activities with potential for including as WDR include:

- All stages of peat extraction that lead to GHG emissions or removals (land preparation, extraction, abandonment, restoration). Peat extraction can be tracked in cooperation with the peat industry and through extraction permits and controls. The extracted peat falls under WDR as well.
- Water table management for nature conservation. Degraded peatlands have become secondary habitats for endangered species which has led to the water table being managed, for example, for bird protection. This can have partial benefits for GHG mitigation. Water table management can be tracked by target water levels or target species.
- Peatland restoration. Restoration does not always require, or lead to, changes in the water table, but is sometimes restricted to mowing or tree removal. Peatland restoration has usually happened for nature conservation purposes. Such projects often have synergies with GHG mitigation. Project documentation and monitoring may provide detailed data on vegetation types, their development, historical and/or present elevation and in some cases water table.

- Water management activities by water boards or other local agencies responsible for water table regulation. Detailed target data of water table and water table monitoring data is most likely to be found in local and regional water-related agencies.

Potential challenges and barriers in reporting WDR activities include:

- Finding robust data to reconstruct 1990 water table levels, e.g. by vegetation or land-use proxies;
- Estimating GHG emissions, e.g. by reconstructing subsidence (since 1990);
- Finding activity data with comparable quality for drainage and rewetting measures and the water table status in general.

Organic soils have to be defined according to the IPCC Guidelines. The IPCC Guidelines use a wide definition of organic soils, which goes beyond most national and international classifications of peat soils. In consequence, soils with shallow peat layers and with peat layers mixed with mineral material qualify as organic soils. These soil types are not necessarily included in national definitions of peat soils. This definitional issue is, however, not restricted to WDR but has to be resolved for reporting under UNFCCC and for reporting AR/D, FM, CM and GM under EU Decision 529/2013/EU as well.

Fine-grained land-use data are needed to document that WDR activities happen on a minimum area of 1 hectare. This may be a challenge for land-use reporting in 1990.

3.4 Current Reporting of organic soils and Wetlands

As WDR is a newly introduced activity for the 2nd Kyoto commitment period there is no expertise yet on activity-based reporting. This section gives an overview of the current state of reporting on drained organic soils and the land-use category Wetlands (land-based reporting) under the UNFCCC taken from the national submissions in 2014 and Member State responses to the Member State survey carried out for this study in summer 2014.

3.4.1 Definition and area of organic soils

Many Member States are aware of the fact that the IPCC definition of organic soils is broader than most national soil classifications. Member States with significant areas of organic soils have found solutions for applying a definition, which matches the IPCC definition. The Netherlands, for example, includes a detailed description of how the national definition of organic soils matches the IPCC definition in the background documentation of the NIR.

Most Member States use a static area of organic soils in their inventory. Drained organic soils undergo continuous degradation. In consequence, shallow organic soils drop out of the IPCC definition at some point so that in reality the area of organic soils may shrink in some Member States. Denmark, for instance, has included a dynamic area of organic soils in its inventory, taking the loss of organic soils into account. The loss rate can be large. Rough estimates suggest that 30% of shallow organic soils have turned to mineral soils in the last decades.

3.4.2 Stratification by drainage status

The Netherlands has developed maps with spatially explicit information on peat type, nutrient status, water table and land-use on organic soils (Kuikman, 2005). This allows a spatially explicit stratification of these soils by drainage status. So far the data have been presented in a temporally static way but observations have continued so that there is the potential to develop a time series of drainage status for organic soils. Details about the methodology are described in the section on organic soils in the 'Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU'.

Germany has developed a methodology for estimating the drainage status of organic soils based on dip-well data, climate, land-use, peat properties and topographic position. The methodology has been applied to derive a map of drainage status with quantitative uncertainties at 25m resolution for the organic soils of Germany (Bechtold *et al*. 2014). Details are described in the open access publication by Bechtold *et al*. (2014). The map was used to derive area-weighted average emission factors per land-use category, which will be used in Germany´s NIR submission for 2015.

Water table data is most likely to be the greatest challenge for Member States. This challenge is not restricted to WDR but also arises for AR/D, FM, CM and GM (less for RV, which will rarely take place on organic soils). Monitoring data from ditches, dip wells etc. are likely to be available in Member States, but often not in digital format or harmonised and may well be hidden within local water boards or water management agencies. While the efforts to find and mobilise old data can be significant, past data have enormous value for other purposes beyond GHG reporting, so the effort to source this information is likely to be worth it for many reasons.

3.4.3 Wetlands Reporting

It is assumed here that WDR will mainly address the land-use category Wetlands under EU Decision 529/2013/EU. Therefore, the focus here is on providing an overview of current reporting on the land-use category Wetlands only, to give a rough assessment of the information available for potential WDR reporting.

The area of the land-use category Wetlands is reported by many Member States with approach 2 or 3, often in a spatially explicit way. Reporting quality at the level of the broad land-use category is almost as good as for Cropland and Grassland. This is a good starting point for WDR reporting.

11 Member States report organic soils in the Wetlands category and the others report 'NO', (not occurring) 'NE' (not estimated) or 'NA' (not applicable). This is logical because organic soils are most widespread in the north and north-west of Europe and organic soils do not occur in all Member States. Data sources usually come from national soil maps and, in some cases, have been updated or improved by research projects.

6 Member States report sub-categories for Wetlands. This usually means that water bodies and peat extraction are distinguished where relevant. The UK additionally stratifies by region and reports separately the on-site CO_2 emissions from peat extraction areas and off-

site CO_2 emissions from horticultural peat. The past structure of the reporting tables has not encouraged the reporting of sub-categories. The new common reporting tables, however, contain much more detail and have at least three sub-categories for Wetlands:

- Water bodies;
- Peat extraction areas; and
- Other Wetlands on mineral and organic soils.

There is little information on Wetlands management in most NIRs. Few Member States report management on Wetlands at all. The organic soils in the Netherlands were stratified into types of peat and organic matter content (mixed or overlain with clay or sand or not), nutrient status (poor – medium – rich), ditch water level or groundwater (8 classes from groundwater table map). Germany has introduced information on the water table (Bechtold et al. 2014) into the 2015 submission of the NIR.

The past reporting of C pools has been slightly less complete than for Cropland and Grassland:

- Four Member States report Wetlands remaining Wetlands as a key category.
- 25 Member States report aboveground biomass in Wetlands remaining Wetlands, but only 4 use country-specific EFs. Biomass is not a significant pool of Wetlands remaining Wetlands in any Member State.
- Only three Member States report mineral soils in Wetlands remaining Wetlands. Mineral soils are not a significant pool of Wetlands remaining Wetlands in any Member State.
- Eleven Member States report organic soils in Wetlands remaining Wetlands, 5 of them with Tier 2. Organic soils are a significant pool of Wetlands remaining Wetlands in 4 Member States. Three of them report organic soils with country-specific EFs. EFs for organic soils originate mainly from research projects, models or expert judgement.

The 2013 IPCC Wetlands Supplement contains in-depth guidance and many new emission sources, sub-categories and reporting items, in particular for drained and rewetted organic soils. The guidance in the 2013 IPCC Wetlands Supplement is mandatory for WDR reporting. This means in practice that the past reporting of all Member State is incomplete and not detailed enough to meet the requirements for WDR reporting. The new requirements are described in Section 3.5.

3.5 Qualitative assessment of mitigation potential related to WDR in EU Member States

This section provides a Tier 1 assessment of the potential relevance of greenhouse gas emissions mitigation by WDR in EU Member States. It serves as a rough orientation of the potential relevance of WDR in different parts of the EU and could help Member States in their decision on whether or not to consider electing WDR.

It should be borne in mind that this assessment uses rough assumptions and tries to determine the upper limit of the possible mitigation. More detailed assessments by Member State are likely to result in a lesser degree of relevance because a substantial fraction of the potential WDR area is unmanaged.

The first two sections describe the methodology and results of assessing the upper boundary of potential WDR implementation under Decision 529/2013/EU. The third section lists policies and measures that could be used to support WDR. Electing WDR may be considered a way of providing an additional rationale for public resources spent for peatland restoration even if the contribution to national GHG mitigation is small.

3.5.1 Methodology for estimating WDR mitigation potential

The total area of organic soils and of organic soils under forest, cropland or grassland was taken from the national NIRs. Missing data and data for peat extraction areas were taken from a European research synthesis (Byrne *et al.* 2004). The potential WDR area was estimated as the area of organic soils not managed as forest, cropland or grassland. This potential area comprises natural peatlands, peat extraction, other unspecified wetlands and settlements. Where available, the area under peat extraction was determined and analysed separately as well. A substantial fraction of this potential area, however, is covered by unmanaged and natural peatlands where WDR is not relevant. This fraction of irrelevant peat area substantially limits the theoretical potential relevance calculated here.

GHG emissions from the potential WDR area were estimated by applying the EFs for shallow-drained grasslands in temperate zones from the 2013 IPCC Wetlands Supplement, chapter 2. This is a rough assumption but probably the best way to account for the fact that the potential WDR area is extensively used and often not drained to more than 30 cm below the surface. An aggregated EF for CO_2, CH_4 and N_2O was constructed, assuming that 1.3% of the area is covered by ditches. The ditch area was taken from the latest unpublished German NIR (submission 2015), derived from land-use maps. This led to an aggregated EF for the potential WDR area of 16 (8 – 24) t CO_2-equivalents ha^{-1} yr^{-1} (CO_2: 14; CH_4: 1.0; N_2O: 0.7 t CO_2-equivalents ha^{-1} yr^{-1}).

The aggregated default EF for ‘shallow-drained grassland in the temperate climate zone’ was multiplied with the potential WDR area as a baseline emission. GHG emissions do not return to zero when peatlands are rewetted. The 2013 IPCC Wetland Supplement, chapter 3, gives an aggregated default EF of 3 t CO_2-equivalents ha^{-1} yr^{-1} for nutrient-poor peatlands and 10 t CO_2-equivalents ha^{-1} yr^{-1} for nutrient-rich peatlands. This means that the mitigation potential achievable by WDR is only the difference between the baseline and the ideal rewetted status. The EF for nutrient-poor peatlands was applied in the boreal zone and the EF for nutrient-rich peatlands in the temperate climate zone.

In a first rough estimate based on IPCC default EFs of the 2013 IPCC Wetland Supplement, WDR on peatlands outside forest, cropland and grassland could achieve a net GHG mitigation of -13 t CO_2-equivalents ha^{-1} yr^{-1} and -6 t CO_2-equivalents ha^{-1} yr^{-1} in the temperate zone.

3.5.2 Upper boundary of the GHG mitigation by WDR under the Decision 529/2013/EU

Since a majority of the EU member states hold only marginal peatland areas that are not managed for forest, cropland or grassland, WDR mitigation potential is relatively small (Table 4). For 20 Member States the mitigation potential is near zero. For 8 Member States (Sweden, Latvia, Finland, Estonia, Ireland, Slovenia, Hungary and Denmark) a marginal

mitigation potential was estimated. The potential for them lies between 0.1 and 1.48 % of the national GHG emissions. This includes Latvia which already had a net GHG sink in its total GHG emissions total including LULUCF in 2012, which could be increased by WDR.

Table 4 Tier 1 estimate of the upper limit of WDR relevance by Member State

Member State	Tier 1 upper limit of the GHG mitigation potential by WDR	WDR potential as % of 2012 total GHG emissions
	Gg CO_2-equivalents ha^{-1} yr^{-1}	%
Sweden	32,753	1.4763
Finland	29,930	0.8524
Estonia	5,380	0.3121
Ireland	4,205	0.0759
United Kingdom	2,470	0.0043
Poland	1,727	0.0047
Latvia	1,244	-0.9407 *
Germany	806	0.0009
Denmark	372	0.0072
Hungary	293	0.0051
Slovenia	283	0.0195
Italy	212	0.0005
France	142	0.0003
Spain	100	0.0003
Belgium	87	0.0008
Netherlands	56	0.0003
Portugal	48	0.0009
Austria	47	0.0006
Czech Republic	22	0.0002
Slovakia	20	0.0006
Bulgaria	17	0.0003
Greece	8	0.0001
Luxembourg	4	0.0004
Cyprus	0	0
Malta	0	0
Croatia	0	0
Romania	0	0
Lithuania	0	0

* Latvia: Negative sign means increase of the national net GHG sink.

WDR may be most relevant in the Scandinavian countries, the UK, Ireland and some Baltic states. The WDR potential estimated in Table 4, however, substantially overestimates the likely real potential.

***Sweden*:** Approximately half of Swedish organic soils under Wetlands and Other Land are in a natural or near-natural state (unmanaged) and only a small area is used for peat extraction (Vasander *et al*. 2003). Most peatland areas are quite small individually, but cover a large

area in total in the flatter parts of the more elevated areas in northern Sweden. Sweden has the largest potential area. The Tier 1 assessment indicated the largest WDR potential of all Member States. The majority of the potential area, however, is likely to be unmanaged so that the real WDR potential is much smaller.

Finland: With peatlands covering 30 percent of its area, Finland is one of the most important peatland countries in the world[31]. Many types of mire have been irreversibly drained for forestry, agriculture and peat extraction. The potential area for WDR covers approximately one quarter of the total area (26.03 percent)[32]. Consequently in Finland emissions in the wetland category were a significant source, of which emissions from peat extraction were 97 percent[33]. WDR may be relevant in Finland.

Latvia: Near-natural Wetlands cover 4.9% of Latvia[34]. Wetlands are one of the priorities for the further development of the GHG inventory for the LULUCF sector in Latvia.[35] The area for WDR was calculated to be approximately 14% of peatlands, although the impact on GHG emissions is likely to be marginal, given that most of this area is unmanaged.

Estonia: Wetlands cover 11% of Estonia´s territory.[36] About 70 percent of all Estonian peatlands have been drained or influenced by drainage or other activities.[37] In Estonia, peat is the third most-important indigenous fuel after oil shale and wood. The potential area for WDR was calculated to be approximately 42%, indicating that WDR does have some potential relevance.

Ireland: The area of WDR was calculated to be approximately 23% of peatlands, indicating the potential relevance of WDR.

Although the restoration of peat extraction areas and other drained organic soils has a high GHG mitigation potential per hectare, the majority of former wetlands has been drained and is used mainly for agriculture and forestry. WDR may offer some potential in Member States with historical or ongoing peat extraction. The organic soils drained for forestry, cropland and grassland accounted for under FM, CM and GM have a much larger GHG mitigation potential than the remaining organic soil areas for WDR. Nevertheless, the land-use pressure on abandoned peat extraction areas and degraded near-natural peatlands is much lower than on areas under agriculture and forestry so that WDR may offer cost-effective GHG mitigation options that are also easy to mobilise.

3.5.3 Policies and legislation with synergies for WDR

Near-natural peatlands harbour rare endangered species and are often protected under the Habitats directive or national law. The Habitats directive obliges Member States to improve

[31] Lindholm, T. & Heikkilä, R. (eds.)(2012): Mires from Pole to Pole. The Finnish Environment 38: 1-420. Papers from the 2006 IMCG Field Symposium and Congress in Finland, p14
[32] Own calculation
[33] NIR Finland 2014, p. 267
[34] http://www.norbalwet.org/our-wetlands/latvia/
[35] NIR Latvia 2014, p326
[36] NIR Estonia 2014, p321
[37] Vasander, H. et al 'Status and restoration of peatlands in northern Europe', *Wetlands Ecology and Management* 11: 51–63, 2003, p52

degraded peatland vegetation. This will often require water management and rewetting measures. The emission reductions associated with these measures can be accounted for under WDR.

Many Member States have peatland restoration programmes. Most of them are focussed on biodiversity conservation but have increasingly been using GHG mitigation as additional or even main argument for carrying out the restoration measures. In some Member States the peat industry has an obligation to restore and rewet abandoned peat extraction sites, at least those abandoned in recent years or in the future. Peatland restoration effectively reduces GHG emissions and can be accounted under WDR.

Some Member State or regions have strong water boards managing the groundwater table. They have target values for seasonal groundwater levels, which not only provide excellent activity data for WDR but can also serve as WDR measures by raising the target values for some or all seasons. This could be reported as partial rewetting provided that the target values represent the actual water table and not the maximum or minimum allowed value.

3.6 Guidance for WDR Reporting

GHG emissions from undrained, natural organic soils are considered natural and are accounted as zero. Anthropogenic GHG emissions result from the drainage of undrained organic soils, the alteration of drainage (deeper or shallower), and the rewetting of drained organic soils.

WDR reporting requires national data for the area and status of organic soils and the application of Tier 2 or Tier 3 methods combined with land identification by Reporting Method 2 or a detailed Reporting Method 1, as spatially explicit as possible (see 2013 IPCC KP Supplement, section 2.2.4).

Net-net accounting against 1990 emissions and removals implies that the quality of data and methodologies for 1990 reporting should be as good those for reporting in the commitment period.

As WDR election is voluntary and GHG mitigation strongly depends on the magnitude of the GHG source from drained organic soils in 1990, reviewers will be quite critical about:

- the quality of the data for the 1990 base line;
- the balance between drainage and rewetting; and
- the accuracy of activity data and EFs.

Data quality for 1990 may be the most challenging issue for most Member States. A reference to a later base year, e.g. 2005, would make WDR reporting easier but would omit any accounting for GHG mitigation measures having taken place before 2005.

3.6.1 Activity data

Area and properties of organic soils

The area of organic soils is usually taken from national soil maps. Data on nutrient status and soil properties or area data at a good resolution are sometimes available from peat

inventories established to determine peat deposits for peat extraction. Such data are often collected in local and regional peatland cadastres and geological surveys and are not necessarily connected with soil maps.

The 2006 IPCC Guidelines (Section 7.2.1.1, Chapter 7, Volume 4) provide guidance on how to distinguish between nutrient-rich and nutrient-poor organic soils.

Land-use information on organic soils is required at a high resolution. Land identification must prove that it can detect activities of 1 ha minimum area. This means that no activities smaller than 1 hectare are accountable under WDR and land identification must be as precise as 1 hectare. Grid-based land-use inventories with sample points of 1 hectare in size or smaller fulfill the reporting requirements, even if the original land-use information has a coarser resolution.

Land under WDR can be identified via two different methods called 'options'. These options are loosely linked to the 'reporting methods' and 'approaches' for land identification in the 2006 IPCC Guidelines, but have a different meaning. The different options end up with the same result, with option 1 zooming downwards from potential WDR land, and option 2 adding up the actual WDR projects. Land identification option considers all organic soils and compares the drainage status in the reporting year with 1990. Option 1 is consistent with the methodologies for the land-use matrix used for the UNFCCC inventory and for land identification under AR/D, FM, CM and GM.

Land identification option 2 considers organic soils on which drainage and rewetting measures have taken place since 1990. Option 2 tracks areas independent of the methodologies used for land identification under AR/D, FM, CM and GM. If this option is taken, care must be taken to avoid double counting, gaps and inconsistencies. If Member State report with option 2 they need to provide evidence that drainage and rewetting projects are considered in a balanced, unbiased way. Measures include any action to lower or raise the water table, such as the regular deepening of ditch bases. As many of these measures are carried out by private entities or are regulated at local levels, information about past activities is difficult to access and often very heterogeneous or incomplete. The quality of past data may make option 2 inapplicable in most Member States.

Drainage status of organic soils

The 2013 IPCC Wetlands Supplement, page 2.10 distinguishes between undrained, shallow drained and deep drained status and gives guidance on how to stratify drainage status based on national data (chapter 2 of 2013 IPCC Wetlands Supplement). National data to stratify drainage status of organic soils could be available from:

- Wetness attributes in cadastres, land-use or vegetation maps;
- Water management plans and water monitoring (e.g. Kuikman *et al.* 2005);
- Time series of dip well data combined with land-use and vegetation classes (e.g. Bechtold *et al*. 2014).

Data sources for water monitoring data could comprise:

- Water monitoring in dip wells or ditches: water table is monitored at specific permanent sample plots, either continuously, or on plots that are revisited on a regular basis. It should be documented that the water data represent the water table in the organic soil under a particular land-use and drainage stratum and that the data cover a representative period, which represents a multi-year mean annual water table.
- For drained and wet organic soils, the drainage levels (e.g. from water management plans), status of nature conservation areas (e.g. indicated by the percentage of FFH habitats in good/reasonable/bad condition), water protection zone maps, well data from water management authorities, regulations in peat extraction concessions about water table management etc.
- Water management plans, documentation from water management installations

Additional options and guidance on how to combine data are described in the 2013 IPCC Wetlands Supplement, chapter 2.

Germany (Bechtold *et al.* 2014) and the Netherlands (Kuikman *et al.* 2005) have developed national methodologies for estimating drainage status, which may be adapted for other Member States.

Vegetation could serve as a proxy for the drainage status of organic soils (Couwenberg *et al*. 2011) provided that there is adequate spatial and temporal detail and a nationally calibrated relation between vegetation and drainage status, which proves the robustness of the vegetation proxies over the full range of drainage conditions present in the country. Land-use or vegetation classes can serve as rough estimates of drainage status. Vegetation proxies are relatively cheap and accurate indicators of drainage status in near natural conditions but lose their indicator function in drained and managed conditions. National vegetation proxies could be derived from detailed high resolution land-use and vegetation maps, e.g. from colour infrared imagery, which can allow land-use sub-categories to be classified via combined vegetation and wetness attributes.

Emission factors of GHG emissions from drained and rewetted organic soils

WDR reporting should rely on country-specific EFs or need to provide proof that the default EFs are appropriate for national circumstances, through a comparison with national measurements. Information about national circumstances includes climate, organic soil type, drainage level, vegetation cover and management activities. Any country-specific EF must be accompanied by appropriate national or regional land-use/management activity and environmental data relevant for WDR.

The most significant GHG emissions for WDR are on-site CO_2 emissions and CH_4 emissions. On-site CO_2 emissions are the dominant GHG source from drained organic soils relevant for WDR. In rewetted conditions, on-site CO_2 emissions are highly variable and remain significant for WDR reporting regarding emission level, trend and uncertainty. CH_4 emissions are significant in rewetted organic soils under WDR regarding emission level, trend and uncertainty. In specific situations, GHG emissions from peat fires and N_2O emissions may also be significant.

Flux-based methods for on-site CO_2 emissions from organic soil: Most Member States with significant areas of drained and rewetted organic soils have supported intensive research on GHG emissions, driving factors and management options. Although research usually has used well-established and largely standardised measurement techniques by eddy covariance and flux chambers, the observations generally produce CO_2 emissions for the ecosystem or soil, but do not separate the peat soil C source from other C sources, such as biomass and litter. The fluxes measured originally therefore need to be corrected to avoid double-counting or omissions of CO_2 emissions with litter and biomass derived CO_2 fluxes. The methodology for deriving the correct CO_2 emissions from organic soils is described in Annex 2A.1 of chapter 2 of the 2013 IPCC Wetlands Supplement.

Subsidence measurements for on-site CO_2 emissions from organic soil: These measurements rely on measuring the height loss of the peat surface by poles over several years with additional measurements of the bulk density and carbon content in the profile to distinguish between soil compaction and oxidation (Schothorst, 1977). The peat loss by oxidation is approximately the CO_2 flux. It should be corrected for the C loss as dissolved organic carbon and CH_4 if relevant (see Annex 2A.1 of chapter 2 of the 2013 IPCC Wetlands Supplement). Subsidence measurements are a good means of monitoring and should be combined with measurements of the groundwater table. They are cheap and relatively easy so they can also serve for upscaling CO_2 flux measurements in space and time.

The average soil subsidence can be calculated from elevation measurements of the surface in the past and more recent altimetry. Repeated high-resolution elevation measurements (ground-based or by Laserscan), combined with additional measurements of the bulk density and carbon content in the profile at reference points have been tested successfully in the German federal state of Baden-Württemberg. They allow robust estimates of peat subsidence at decadal time scales. They allow a fully spatially explicit and complete assessment of peat subsidence at regional to national scale.

CH_4 emissions: Rewetting increases CH_4 emissions, which have to be accounted as anthropogenic sources. CH_4 emissions can be quite substantial and go far beyond typical emission rates from natural peatlands if nutrient-rich peatlands are rewetted (Tuittila *et al.*, 2000; Drösler, 2005; Hendriks *et al.,* 2007; Wilson *et al*., 2008), if rewetting leads to permanent flooding and nutrient-rich organic sediment forms at the bottom of the newly formed lake (Hahn-Schöfl *et al*. 2011), and generally if the water table is near the surface and vegetation is maladapted to wet conditions. Country-specific EFs for CH_4 from rewetted organic soils need to cover not only the mean conditions of rewetting but also extremes to avoid an underestimation of CH_4 emissions. Representative EFs could be derived as area-weighted means of rewetting methods, fraction of flooded area and nutrient status of the flooded fraction.

Non-significant carbon pools and arguments for 'not a source'

Changes in woody biomass, litter and dead wood are generally minor unless land-use changes occur after drainage and rewetting. They can be estimated with Tier 1 methodologies. If Tier 1 assumes zero changes, additional arguments are needed as to why the carbon pool is not a source.

Developing country-specific EFs for woody biomass:

- Peatland conservation and restoration projects have often carried out vegetation monitoring, which can serve as a basis for estimating biomass carbon stocks by vegetation type.
- Studies of the vegetation types used for stratification or as proxies of water table (see above) may contain biomass data that can be converted to mean carbon stocks per vegetation type.

Studies with GHG flux measurements often determine biomass and changes in biomass on experimental sites and could also be used to collect data on litter and dead wood, or prove the non-existence of these pools. These data can serve as basis for arguments about why woody biomass, litter and dead wood are not a source of GHG emissions. Data and arguments can also be taken from neighbouring countries with similar conditions.

3.6.2 Exploring and including the national expertise

National institutions in administration and research and stakeholder groups involved in biodiversity and nature conservation, water management or peat extraction have expertise in the management of organic soils and all have networks and historical data or project documentation that could help improve WDR reporting. It is likely to be extremely worthwhile to carry out a broad review of existing national institutional expertise on WDR, including of geological and soil survey staff, soil and biodiversity research institutions, statistical offices, units dealing with land use/cover, stakeholder organisations on peat use and nature conservation as well as major peat production enterprises. This would help to identify the full range of relevant information available as well as develop links and build networks to enable joined-up, and therefore more cost-effective, projects to be commissioned to derive the activity data and emission factors required. The networks should involve the environmental (climate change, soil and biodiversity related), land-use, and scientific units and funding institutions who have funded drainage and rewetting. Networking with the national expertise also raises awareness of stakeholders and transparency at from the very start of any mitigation plans. Past experiences have shown that transparency and participation are also the key to successful peatland restoration.

Involving a range of institutions and government departments in such discussions requires considerable communication efforts at several levels and a broad national identification in the institutions with the reporting requirements. Institutions not focussed on LULUCF reporting and accounting will be busy and may be reluctant to take on additional commitments, so the benefits of coordinating efforts and sharing information need to be set out clearly beforehand to facilitate such collaboration. Successful collaboration with relevant institutions therefore requires good preparation, time and thorough and regular communication, ideally also at a strategic level. It may take some time until the benefits are recognised and full cooperation is established, so it will be important to prioritise the information and inputs required with efforts made to source the highest priority data first. Co-funding of the collaboration, e.g. via staff time for coordination and for critical first tasks, or by offering additional temporary resources considerably helps in speeding up the process and deciding about priorities.

It is very critical for WDR to establish a robust detailed 1990 baseline for organic soils that potentially fall under WDR because the reporting requires a balanced consideration of the same land area in 1990 and in the reporting year. It is therefore not enough to collect data about past projects but general data on the status of organic soils in 1990 is needed so that areas being drained or rewetted in the future can be considered with adequate methods and data in the base year.

A parallel effort needs to find ways to successfully bind the institutions to the reporting system for reporting in the future. Contractual or even legal arrangements with a perspective for longer involvement may facilitate such collaboration.

3.6.3 International co-operation

WDR is a new activity under the Kyoto Protocol. There are countries inside and outside the EU who have expressed an interest in electing WDR and who may have started research and development for WDR reporting. It may be worth joining efforts or exchanging experiences among countries who consider electing, or have elected WDR. Member States should have submitted their decisions about elective activities under Art. 3.4 of the Kyoto Protocol in the 2nd commitment period to the European Commission by 15 January 2015. The European Commission and JRC could facilitate contacts among interested countries.

Most Member States with significant areas of organic soils have had, have ongoing, or are planning research and development projects for GHG measurements and deriving functional relations as basis for country-specific EFs or for GHG mitigation. Coordination of these activities at the European level would offer significant potential for a resource-efficient improvement, capacity building and exchange of methodologies and data. Due to the complexity of the measurements and the diversity of data, it would be important to involve the original researcher in any such venture. A purely centralised stock-taking and data collection exercise would not add value particularly and risks producing results that are not robust. However, a cooperative research project under Horizon 2020 or ERA-NET may offer a more appropriate format.

Various funding opportunities are available from the European Commission which may also be considered for support to establish and improve WDR reporting and accounting. In particular, the LIFE 2014-2020 Programme and the European Regional Development Fund are worth highlighting. Both programmes have a strong focus on implementation and dissemination measures. More details about these programmes can be found in the Guidance on reporting and accounting for cropland and grassland management in accordance with Article 3(2) of EU Decision 529/2013/EU, chapter 7.2.

3.6.4 Resources and cost effective approaches

WDR can be reported in a resource and cost effective way if historic activity data is available that is of adequate quality and that can be mobilised, e.g. from archives, local or regional institutions, stakeholder groups etc. Nationally coordinated criteria and regulations for the monitoring and documentation of drainage status and vegetation could be implemented for

measures related to water management, drainage and rewetting on organic soils. National or regional authorities involved in water management or authorisations for drainage and rewetting measures could act in networking, data collection and quality control for activity data used in WDR reporting.

While the development of country-specific EFs and of a robust 1990 baseline is a one-off activity, cost-effective approaches for monitoring and documentation will determine the resource efficiency of WDR implementation in the future.

A decision on whether or not to report on WDR should not only consider the mitigation potential but also the challenges in reporting. Despite the fact that WDR is a new activity which requires extra efforts to establish reporting that is sufficiently robust to meet MRV requirements, Member States should keep in mind that WDR is restricted to organic soils outside managed forests, croplands and grasslands, which are accounted under AR/D, FM, CM, GM and maybe RV. The WDR areas consist of land under former or active peat extraction and to some extent under nature conservation, although it is not necessarily in a natural state. These areas usually have a much lower land-use pressure than elsewhere and rewetting measures can be implemented with fewer of the typical conflicts with land owners and stakeholders on intensively used land areas. Many of these areas may also be in public ownership. So despite the small area and maybe less difference in GHG emissions than for measures happening on deep-drained organic soils, WDR measures offer a cheap, easy and effective approach to GHG mitigation. They may also act as the forerunner areas for rewetting organic soils on more intensively used land.

Annex: Reference materials

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