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Completing the links between UNFCCC reporting categories and SEEA AFF Air Emission Accounts. An application to the Italian case.¹

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1. Introduction

Greenhouse Gas (GHG) emissions are estimated by countries and international organizations (FAO as far as Agriculture, Forestry and Other Land Use – AFOLU are concerned) following the IPCC (Inter-Governmental Panel on Climate Change) guidelines. These do not refer to the classification of human activities (industries, households consumption) used in national accounting but to technological *processes*, which are not always typical of specific economic activities but may be carried out in several different economic activities. Conversely the SEEA-CF Air Emission Accounts establish first the economic activities (industries, households' consumption) generating emissions and then assess which of the processes causing the emissions are actually carried out in the activities, in order to split the emissions between those activities. This is very often the data flow process followed in most Annex I Parties (developed countries, mostly OECD members) of the UN Framework Convention on Climate Change (UNFCCC) when reporting their National Greenhouse Gas Inventories (NGHGI).

Notwithstanding the wide experience gained in Annex I Parties mapping UNFCCC NGHGI to SEEA Air Emissions Accounts, this exercise has to date excluded emissions falling under the IPCC Land Use, Land Use Change and Forestry (LULUCF) category. Only recently the mapping of the latter and the underlying ISIC² A (“Agriculture, forestry and fishing”) activities has been completed, specifically under the SEEA Agriculture Forestry and Fisheries (SEEA AFF) framework.

This paper explores a first tentative allocation of all processes relevant to ISIC A activities mapping relevant emissions data presented in the Agriculture and LULUCF reporting tables of Italy, an Annex I Party, to table 4.5 of the SEEA AFF. While establishing all the links by referring the most disaggregate level of the Common Reporting Format (CRF), we also adopt some approximations that allow mapping the emissions into SEEA tables in a resource efficient way.

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² ISIC: International Standard Industrial Classification of All Economic Activities, Revision 4 (2008).

2. Table 4.5 SEEA AFF and our exercise

The SEEA AFF introduces a table for the description of the air emissions – and in particular of greenhouse gases (GHG) emissions generated by the activities of ISIC section A.

This table provides important details on which actions or “processes” carried out in AFF activities contribute to these emissions, including them in columns with labels clearly related to IPCC. This highly facilitates the data mapping exercise. Emission categories included in the scope of SEEA AFF air emission account are: synthetic fertilizers, manure applied to soils, burning biomass, crop residues left on soil, manure left on pasture, enteric fermentation, manure management, rice cultivation, cultivation of drained organic soils, other cropland and grassland activities, forest land management, and fuel combustion in ISIC A01, A02 and A03 categories.

In accordance with UNFCCC decisions for Annex I Parties, the emissions to be included in the table are reported, in Common Reporting Format Tables (CRF; see associated IPCC guidelines)³, under items “1. Energy”, “3. Agriculture” and “4. Land use, land use change and forestry (LULUCF)”. As for the first item, only emissions from fuel combustion in AFF activities have to be included in the table, such as diesel oil, gasoline, liquefied petroleum gases (LPG), residual fuel oil, natural gas, biomass and other fuels used in stationary engines, in off-road vehicles, in other mechanized processes (such as sawing, harvesting, irrigation and drying) and in fishing. As for LULUCF, not only emissions but also removals can be included in the table. It is important to note that – as we will show in detail in the next section – not all LULUCF emissions are attributable to AFF activities, while all of those under item “3. Agriculture” fall within the table’s domain.

Very interestingly from an environmental accounts’ methodology point of view, in the SEEA AFF physical flows are related, as much as possible, to the individual products resulting from AFF activities. In table 4.5, like in other tables of the SEEA AFF concerning physical flows, the products are specified in the rows. This introduction of the “products” dimension in SEEA Air Emission Accounts is an important enrichment of our understanding of how air emissions – and physical flows in general – relate to production and consumption. Indeed, it may greatly enhance the usefulness of physical environmental accounts, for its implications concerning the use of these accounts in Life Cycle Analysis and IO applications. It may also provide results that are easier to communicate to a public that is generally not familiar with the concept of “industry”.

The attention to the “product” dimension has led, as for table 4.5, to attentively consider how to deal with certain emissions from Land Use and Land Use Change, which cannot be put in relation to any specific current product nor to current production in general, and to include additional rows dedicated to the assets involved. Indeed, in these cases the emissions are not due to the current use of the asset in production, but the management of the asset considered

³ CFR items are: “1. Energy”, “2. Industrial processes and product use”, “3. Agriculture”, “4. LULUCF”, “5. Waste”, “6. Indirect emissions of N₂O and CO₂” (data of item 6 are not included in the “Total national emissions and removals” of CFR communication but they are reported in a “memorandum items”).

per se, or to past operations related to a long-run stream of products, so that attributing these emissions to current products would be misleading with respect to the actual pressure exerted on the atmosphere by current operations. Often, the emissions are clearly related to AFF activity, and must therefore be recorded under the ISIC A columns, but this is not always the case. Sometimes, they are relevant for AFF activities, in the sense that the land involved was or will be in use by the ISIC A industry, but derive from other industries' operations. Examples of such activities/industries are: Drainage of agricultural and forest land (which in the European Classification of Economic Activities NACE rev.2 belongs to 43.12 - Site preparation); Drainage and management of peatland for peat production (NACE 09.90 - Support activities for other mining and quarrying); Preparation of paddy fields (also 43.12); Changes in the hydrologic regime (NACE 42.9).

The following paragraph discusses how the emissions reported by an Annex 1 Party, like Italy, can be allocated in the cells of table 4.5 of the AFF. This application, which we hope helps clarify some theoretical issues, is done with reference to a table where we consider in the columns the economic activities (plus households) that cause atmospheric emissions, classified according to ISIC, and in the rows the dimensions "Substance type" (separately for GHG and "Other Air Pollutants") and "Product/Asset".

The columns are structured as follows:

- ISIC A - AGRICULTURE FORESTRY AND FISHING
 - ❖ ISIC A01 - Crop and animal production, hunting and related service activities
 - SF: Syntetic Fertilizers
 - MAS: Manure Applied to Soil
 - BB: Burning Biomass
 - CRLS: Crop Residues left on soils
 - MLP: Manure left on Pasture
 - EF: Enteric Fermentation
 - MM: Manure Management
 - RC: Rice Cultivation
 - CDOS: Cultivation of Drained Organic Soils
 - OCCA: Other Cropland and Grassland Activities
 - FCAg Fuel Combustion (in Agriculture)
 - ❖ ISIC A02 - Forestry and logging
 - FLM: Forest Land Management
 - FCFo: Fuel Combustion (in Forestry)
 - ❖ ISIC A03 - Fishing and aquaculture
 - FCFi: Fuel Combustion (in Fishing)
 - OFi: Other (in Fishing)
- ALL OTHER ISIC AND HOUSEHOLDS (AO&H)

while the rows are structured as follows:

- Emissions by SUBSTANCE TYPE
 - ❖ Greenhouse Gases (expressed in kton of CO2 equivalents)
 - carbon dioxide (CO2)
 - methane (CH4)
 - nitrous oxide (N2O)
 - hydrofluorocarbons (HFCs)
 - perfluorocarbons (PFCs)
 - sulphur hexafluoride (SF6)
 - nitrogen trifluoride (NF3)
 - ❖ Other Air Pollutants (expressed in kton)
 - oxides of nitrogen (NOx)
 - carbon monoxide (CO)
 - non-methane volatile organic compounds (NMVOC)
 - sulphur dioxide (SO2)
- GHG emissions by PRODUCT/ASSET⁴ (expressed in kton of CO2 equivalents)
 - ❖ Crops Primary: Products of agriculture, horticulture and market gardening (CPC⁵ 01):
 - Cereals
 - Pulses
 - Fodder Crops
 - Other crops
 - ❖ Livestock: Live animals and animal products (excluding meat) (CPC 02):
 - Cattle and Buffaloes
 - Sheep and Goats
 - Camels, Horses, Mules and Asses
 - Swine
 - Poultry
 - Other livestock
 - ❖ Forestry and logging products (CPC 03) and Forest trees (CPA 02.10.03)⁶
 - Forestry and logging products (CPC 03)⁷
 - Forest trees (CPA 02.10.03)
 - ❖ Fish and other fishing products (CPC 04)

⁴ A feature of the SEEA AFF is flexibility with regard to the products included in these tables (though of course at least the main products should be included).

⁵ CPC: Central Product Classification, version 2.1 (2013).

⁶ CPA 02.10.03 (Forest trees) doesn't have a corresponding item in CPC.

⁷ This is mainly wood in rough, including timber stock in permanent woody cropland.

- ❖ Other products
- ❖ Produced and Non-Produced Environmental Assets:
 - Relevant for AFF activities
 - of which: growth of standing timber in non-cultivated forests
 - Not relevant for AFF activities

Total emissions by "product/assets" categories is equal to the total GHG emissions in CO₂eq reported by product.

The allocation to the products and assets of the data found in the communication for a generic reference year⁸ is described below, following a column-wise order, i.e. - for each kind of IPCC process specified in the column's heading, we list the non-empty cells in the column, giving, under each of them, the exact reference to where the figures, to be included in the cell, can be found in the communication file.

3. The correspondences established

In this paragraph we report as data of Italian CFR communication are allocated in the cells of table 4.5, structured as shown in the previous paragraph.

ISIC A01 - Crop and animal production, hunting and related service activities

SF - Synthetic fertilizers column

We include in this column emissions of nitrous oxide gas (N₂O) from synthetic fertilizers (containing nitrogen) additions to managed soil. NO_x emissions also occur.

Nitrous oxide (N₂O) row

- Table3.D, row 9 ("1. Inorganic N fertilizers"), column E (N₂O): direct N₂O emissions from N input from application of inorganic fertilizers to cropland and grassland;
- part of Table3.D, row 19 ("b. Indirect N₂O Emissions from managed soils"), column E (N₂O): indirect N₂O emissions from agricultural soils (i.e. "volatilized N from agricultural inputs of N" and "N from fertilizers and other agricultural inputs that is lost through leaching and run-off"); only the part referable to "Inorganic N fertilizers" has to be considered in this point and this part is calculated assuming the indirect emissions proportional to the direct ones (share is obtained by dividing the emission of "Inorganic N fertilizers" to the total of "Direct N₂O emissions from agricultural soils");

⁸ Communications are done yearly for the entire series of reference years from 1990 to the year T-2, T being the year in which the communication takes place. For each reference year, an excel file with 95 data sheets is included in the communication. In our exercise we used the data communicated in 2016 for reference year 2014, as these were the most recent data available at the time of constructing the numerical example. Italy's latest UNFCCC communication according to the CRF format is available at the following address:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/ita-2017-crf-11apr17.zip.

- part of Table4(IV), rows 8+9 (“1. Atmospheric deposition” + “2. Nitrogen leaching and run-off”), column E (N2O): indirect N2O emissions from managed soils, other than cropland and grassland (i.e. “volatilized N from managed soils from inputs of N” and “N from fertilizers and other that is lost through leaching and run-off from managed soils”)⁹; only the part referable to “Inorganic fertilizers” has to be considered in this point (the remaining part is attributed to organic N fertilizers).

Oxides of nitrogen (NOx) row

- part of Table3s2, row 8 (“D. Agricultural soils”), column E (NOx): only the part referable to “Inorganic fertilizers” has to be considered in this point and this part is calculated assuming the NOx emissions proportional to the N2O ones (using the same percentages with which the N2O emissions from Table 3.D are divided into the various emission categories).

Crops Primary (total) row

All the same emissions as in the Nitrous oxide (N2O) row. Pro-quota allocation to specific crops would require further investigation of auxiliary data. This could not be done in the framework of the present experimentation, but use of synthetic fertilizers by crop may be available from agricultural input statistics.

MAS - Manure applied to soil column

We include in this column GHG (N2O and CO2) emissions from organic fertilizers (manure) additions to managed agricultural soils. NOx emissions also occur.

Nitrous oxide (N2O) row

- Table3.D, row 10 (“2. Organic N fertilizers”), column E (N2O): direct N2O emissions from N input from organic N fertilizers (animal manure, sewage sludge and/or other organic fertilizers applied to soils) to cropland and grassland;
- part concerning “Organic N fertilizer” of Table3.D, row 19 (“b. Indirect N2O Emissions from managed soils”), column E (N2O): indirect N2O emissions from agricultural soils (cropland and grassland); this part is calculated assuming the indirect N2O emissions proportional to the direct ones (share is obtained by dividing the emission of “Organic N fertilizers” to the total of “Direct N2O emissions from agricultural soils”);
- part concerning “Organic N fertilizer” of Table4(IV), rows 8+9 (“1. Atmospheric deposition” + “2. Nitrogen leaching and run-off”), column E (N2O): indirect N2O emissions from managed soils, other than cropland and grassland.

Carbon dioxide (CO2) row

- Table3s2, row 12 (“H. Urea application”), column B (CO2);
- Table3s2 - row 13 (“I. Other carbon-containing fertilizers”), column B (CO2).

⁹ Report atmospheric deposition and leaching and runoff of N from the following sources of N inputs: synthetic and organic N fertilizer from land use categories, other than cropland and grassland (these emissions are reported in the agriculture sector), and N mineralization associated with loss of soil organic matter resulting from change of land use or management on mineral soils in all land use categories except for cropland remaining cropland.

Oxides of nitrogen (NO_x) row

- part of Table3s2, row 8 (“D. Agricultural soils”), column E (NO_x): only the part referable to “Organic N fertilizer” has to be considered in this point and this part is calculated assuming the NO_x emissions proportional to the N₂O ones (using the same percentages with which the N₂O emissions from Table 3.D are divided into the various emission categories).

Crops Primary (total) row

Sum of all emissions of nitrous oxide (N₂O) and carbon dioxide (CO₂). Pro-quota allocation to specific crops would require further investigation of auxiliary data.

BB - Burning biomass column

We include in this column GHG emissions (but there are also NO_x, CO and NMVOC emissions) produced by controlled burning¹⁰ of biomass (mainly crop residues) on-site¹¹.

Methane (CH₄) and Nitrous oxide (N₂O) rows

- Table3.E, row 9 (“Grassland”), columns I/J (CH₄/N₂O): prescribed burning of savannas;
- Table3s2, row 10 (“F. Field burning of agricultural residues”), columns C/D (CH₄/N₂O);
- Table4(V), rows 18+21+25+28 (“B. Cropland: Controlled burning” + “C. Grassland: Controlled burning”), columns J/K (CH₄/N₂O).

Carbon dioxide (CO₂) row

- Table4(V), rows 18+21+25+28 (“B. Cropland: Controlled burning” + “C. Grassland: Controlled burning”), column I (CO₂).

Oxides of nitrogen (NO_x), Carbon monoxide (CO) and Non-methane volatile organic compounds (NMVOC) rows

- part of Table3s2, row 9 (“E. Prescribed burning of savannas”), columns E/F/G (NO_x/CO/NMVOC): only the part referable to “Grassland” has to be considered in this point and this part is calculated on the bases of data of “Table3.E - Prescribed burning of savannas” (the remaining part is attributed to forest land);
- Table3s2, row 10 (“F. Field burning of agricultural residues”), columns E/F/G (NO_x/CO/NMVOC).

¹⁰ Emissions produced by wildfires of cropland and grassland are included in “All Other ISIC and Households” column as it is assumed that they are not caused by ISIC A01.

¹¹ Emission from burning biomass depend mainly from burning of agriculture residues (which vary by country, crop, and management system) and savannah burning (which occurs mostly in tropical and sub-tropical regions; however, grassy and woody formations elsewhere in the world can also be subject to fire, mainly as a result of management practices). Non-CO₂ emissions (particularly CH₄, CO, NO_x and N₂O) are reported; CO₂ emissions from biomass burning do not have to be reported, since:

- cropland: the carbon released during the combustion process is assumed to be reabsorbed by the vegetation during the next growing season;
- grassland: CO₂ emissions from biomass burning are largely balanced by the CO₂ that is reincorporated back into biomass via photosynthetic activity, within weeks to few years after burning.

Crops Primary (total) row

- Table3s2, row 10 ("F. Field burning of agricultural residues"), columns C+D (CH₄ + N₂O). The allocation to specific crops is possible as follows:
 - *Cereals row*: Table3.F, row 8 ("1. Cereals"), columns H+I (CH₄ + N₂O);
 - *Pulses row*: Table3.F, row 17 ("2. Pulses"), columns H+I (CH₄ + N₂O);
 - *Other crops row*: Table3.F, rows 22+25+26 ("3. Tubers and roots" + "4. Sugar cane" + "5. Other"), columns H+I (CH₄ + N₂O).
- Table4(V), rows 18+21 ("B. Cropland: Controlled burning"), column I+J+K (CO₂ + CH₄ + N₂O).

Environmental Assets relevant for AFF activities row

- Table3.E, row 9 ("Grassland"), columns I+J (CH₄ + N₂O): prescribed burning of savannas;
- Table4(V), rows 25+28 ("C. Grassland: Controlled burning"), columns I+J+K (CO₂ + CH₄ + N₂O).

CRLS - Crop residues left on soil column

We include in this column emissions of nitrous oxide gas (N₂O) produced by decomposition of nitrogen in crop residues on managed soils. NO_x emissions also occur.

Nitrous oxide (N₂O) row

- Table3.D, row 15 ("4. Crop residues"), column E (N₂O): direct N₂O emissions from N in crop residues returned to soils;
- part concerning "Crop residues" of Table3.D, row 19 ("b. Indirect N₂O Emissions from managed soils"), column E (N₂O): indirect N₂O emissions from agricultural soils (cropland and grassland); this part is calculated assuming the indirect N₂O emissions proportional to the direct ones (share is obtained by dividing the emission of "Crop residues" to the total of "Direct N₂O emissions from agricultural soils").

Oxides of nitrogen (NO_x) row

- part of Table3s2, row 8 ("D. Agricultural soils"), column E (NO_x): only the part referable to "Crop residues" has to be considered in this point and this part is calculated assuming the NO_x emissions proportional to the N₂O ones (using the same percentages with which the N₂O emissions from Table 3.D are divided into the various emission categories).

Environmental Assets relevant for AFF activities row

All the same emissions as in the Nitrous oxide (N₂O) row. Crop residues are functional not for current year's production, but for soil improvement for future years.

MLP - Manure left on pasture column

We include in this column emissions of nitrous oxide gas (N₂O) from nitrogen additions to managed soils from grazing livestock. Specifically N₂O is produced by microbial processes of nitrification and de-nitrification taking place on the decomposition site (direct emissions), and after volatilization/re-deposition and leaching processes (indirect emissions). NO_x emissions also occur.

Nitrous oxide (N₂O) row

- Table 3.D, row 14 (“3. Urine and dung deposited by grazing animals”), column E (N₂O): direct N₂O emissions from N excretion on pasture, range and paddock;
- part concerning “Urine and dung deposited by grazing animals” of Table 3.D, row 19 (“b. Indirect N₂O Emissions from managed soils”), column E (N₂O): indirect N₂O emissions from agricultural soils (cropland and grassland); this part is calculated assuming the indirect N₂O emissions proportional to the direct ones (share is obtained by dividing the emission of “Urine and dung deposited by grazing animals” to the total of “Direct N₂O emissions from agricultural soils”).

Oxides of nitrogen (NO_x) row

- part of Table 3s2, row 8 (“D. Agricultural soils”), column E (NO_x): only the part referable to “Urine and dung deposited by grazing animals” has to be considered in this point and this part is calculated assuming the NO_x emissions proportional to the N₂O ones (using the same percentages with which the N₂O emissions from Table 3.D are divided into the various emission categories).

Environmental Assets relevant for AFF activities row

All the same emissions as in the Nitrous oxide (N₂O) row.

EF - Enteric fermentation column

We include in this column emissions of methane (CH₄) produced in digestive systems of ruminants (enteric fermentation) and to a lesser extent of non-ruminants.

Methane (CH₄) row

- Table 3s1, row 9 (“A. Enteric fermentation”), column C (CH₄).

Livestock (total) row

- Table 3s1, row 9 (“A. Enteric fermentation”), column C (CH₄). The allocation to specific animals is possible as follows:
 - *Cattle and Buffaloes row*: Table 3s1, rows 10+23 (“1. Cattle” + “Buffalo”), column C (CH₄);
 - *Sheep and Goats row*: Table 3s1, row 20+24 (“2. Sheep” + “Goat”), column C (CH₄);
 - *Camels, Horses, Mules and Asses row*: Table 3s1, row 25+26 (“Mules and Asses” + “Horse”), column C (CH₄);
 - *Swine row*: Table 3s1, row 21 (“3. Swine”), column C (CH₄);
 - *Other livestock row*: Table 3s1, row 29 (“Rabbit”), column C (CH₄).

MM - Manure management column

We include in this column air emissions (CH₄, N₂O and NMVOC) from the decomposition of manure under low oxygen or anaerobic conditions (these conditions often occur when manure is stored in large piles or disposed of in lagoons and other types of manure management systems).

Methane (CH₄) row

- Table 3s1, row 31 (“B. Manure management”), column C (CH₄).

Nitrous oxide (N2O) row

- Table3s1, rows 31 (“B. Manure management”), column D (N2O).

Non-methane volatile organic compounds (NMVOC) row

- Table3s1, row 31 (“B. Manure management”), column G (NMVOC).

Other products row

Sum of emissions of methane (CH₄) and nitrous oxide (N₂O). Air emissions are related to the production of manure (CPC 34654 - “Excreta of animals useful for manure/fertilizer and fuel preparation”; ISIC 01).

RC - Rice cultivation column

We include in this column emissions of methane (CH₄) from the anaerobic decomposition of organic matter in paddy fields. NMVOC emissions may also be possible.

Methane (CH₄) row

- Table3s2, row 7 (“C. Rice cultivation”), column C (CH₄).

Non-methane volatile organic compounds (NMVOC) row

- Table3s2, row 7 (“C. Rice cultivation”), column G (NMVOC).

Crops (total) row

- Table3s2, row 7 (“C. Rice cultivation”), column C (CH₄). Emissions are entirely attributed to *Cereals* row.

CDOS - Cultivation of drained organic soils column

We include in this column GHG (CO₂ and N₂O) emissions from organic soils drained for use in AFF activities. NO_x emissions also occur.

Carbon dioxide (CO₂) row

- Table4.B, row 13 (“annual crops”), column R (net CO₂ emissions/removals)¹².

Nitrous oxide (N2O) row

- Table3.D, row 17 (“6. Cultivation of organic soils”), column E (N₂O): direct N₂O emissions from area of cultivated organic soils;
- part concerning “Cultivation of organic soils” of Table3.D, row 19 (“b. Indirect N₂O Emissions from managed soils”), column E (N₂O): indirect N₂O emissions from agricultural soils (cropland and grassland); this part is calculated assuming the indirect N₂O emissions proportional to the direct ones (share is obtained by dividing the emission of “Cultivation of organic soils” to the total of “Direct N₂O emissions from agricultural soils”);

¹² CO₂ emissions are reported in this column (“Cultivation of drained organic soils”) as Table 4.B shows that for Italy CO₂ emissions from “annual crops” depend on carbon stock change (losses) in organic soils. If Table 4.B had shown carbon stock change (gains/losses) in mineral soils, the emissions/removals would be reported in the column “Other Cropland and Grassland Activities”.

It may also occur that CO₂ emission depends on carbon stock change in both kind of soils: in this case it is possible to consistently relocate the emissions between the columns.

- part of Table4(III), row 14 (“2. Lands converted to cropland”), column D (N2O): direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to cropland¹³); only the part referable to "organic soils" has to be considered in this point (the remaining part is attributed to “mineral soils”).

Oxides of nitrogen (NOx) row

- part of Table3s2, row 8 (“D. Agricultural soils”), column E (NOx): only the part referable to "Cultivation of organic soils" has to be considered in this point and this part is calculated assuming the NOx emissions proportional to the N2O ones (using the same percentages with which the N2O emissions from Table 3.D are divided into the various emission categories).

Crops (total) row

All the same emissions/removals as in the Carbon dioxide (CO2) row¹⁴. Pro-quota allocation to specific crops would require further investigation of auxiliary data.

Environmental Assets relevant for AFF activities row

All the same emissions as in the Nitrous oxide (N2O) row.

OCGA - Other cropland and grassland activities column

The main elements of this column are:

- main emissions/removals: CO2 removals from land converted to grassland and from woody biomass and CO2 emissions associated with carbon losses from perennial wood crops¹⁵ due to harvest or gathering or disturbance in cropland remaining cropland¹⁶;
- major product grouping: Forestry and logging products and Forest trees;
- assets involved: land and soil.

Carbon dioxide (CO2) row

- part concerning “Agriculture” (the remaining part is “Forestry”) of Table3s2, row 11 (“G. Liming”), column B (CO2);
- Table3s2, row 14 (“J. Other”), column B (CO2);
- Table4.B, rows 12 (“perennial woody crops”), column R (net CO2 emissions/removals);

¹³ N2O emissions from “cropland remaining cropland” are included in previous points.

¹⁴ See previous note 12.

¹⁵ The change in biomass is only estimated for perennial woody crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks and therefore no CO2 emissions/removals.

¹⁶ Assumptions are: all carbon in perennial woody biomass removed (e.g.: biomass cleared and replanted with a different crop) is emitted in the year of removal; and perennial woody crops accumulate carbon for an amount of time equal to a nominal harvest/maturity cycle. The latter assumption implies that perennial woody crops accumulate biomass for a finite period until they are removed through harvest or reach a steady state where there is no net accumulation of carbon in biomass because growth rates have slowed and incremental gains from growth are offset by losses from natural mortality, pruning or other losses.

- Table4.B, row 14 (“2. Land converted to cropland”), column R (net CO₂ emissions/removals);
- Table4.C, row 10 (“C. Total grassland”), column R (net CO₂ emissions/removals);

Methane (CH₄) row

- Table3s2, row 14 (“J. Other”), column C (CH₄);

Nitrous oxide (N₂O) row

- Table3s2, row 14 (“J. Other”), column D (N₂O);
- Table3.D, row 16 (“5. Mineralization/immobilization associated with loss/gain of soil organic matter”), column E (N₂O): direct N₂O emissions from N in mineral soils that is mineralized in association with loss of soil C;
- Table3.D, rows 18 (“7. Other”), column E (N₂O): other direct N₂O emissions not elsewhere considered;
- part concerning “Mineralization/immobilization associated with loss/gain of soil organic matter” and “Other” of Table3.D, row 19 (“b. Indirect N₂O Emissions from managed soils”), column E (N₂O): indirect N₂O emissions from agricultural soils (cropland and grassland); this part is calculated assuming the indirect N₂O emissions proportional to the direct ones (share is obtained by dividing the emission of “Mineralization/immobilization associated with loss/gain of soil organic matter” plus emission of “Other” to the total of “Direct N₂O emissions from agricultural soils);
- part of Table4(III), row 14 (“2. Lands converted to cropland”), column D (N₂O): direct N₂O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to cropland¹⁷); only the part referable to “mineral soils” has to be considered in this point (the remaining part is attributed to “organic soils”);
- Table4(III), row 15 (“C. Grasslands”), column D (N₂O): direct N₂O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to grasslands) or management of mineral soils (grassland remaining grassland);

Oxides of nitrogen (NO_x) row

- part of Table3s2, row 8 (“D. Agricultural soils”), column E (NO_x): only the part referable to “Mineralization/immobilization associated with loss/gain of soil organic matter” and “Other emissions from agricultural soils” has to be considered in this point and this part is calculated assuming the NO_x emissions proportional to the N₂O ones (using the same percentages with which the N₂O emissions from Table 3.D are divided into the various emission categories);
- Table3s2, rows 14 (“J. Other”), column E (NO_x);
- Summary1.As2, rows 21+22 (“B. Cropland” + “C. Grassland”), column J (NO_x).

¹⁷ N₂O emissions from “cropland remaining cropland” are included in previous points.

Carbon monoxide (CO) and Non-methane volatile organic compounds (NMVOC) rows

- Table3s2, row 14 ("J. Other"), columns F/G (CO/NMVOC)
- Summary1.As2, rows 21+22 ("B. Cropland" + "C. Grassland"), columns K/L (CO/NMVOC).

Sulphur dioxide (SO2) row

- Summary1.As2, row 18 ("J. Other"), column M (SO2).

Livestock (total) row

- Table4.C, row 12 ("grazing lands"), column R (net CO2 emissions/removals); pro-quota allocation to specific animals requires further investigation of auxiliary data.

Forestry and logging products row

- Table4.B, rows 12 ("perennial woody crops"), column R (net CO2 emissions/removals): wood in the rough.

Forest trees row

- Table4.C, row 13 ("other wooded lands"), column R (net CO2 emissions/removals): growth of the woody component in woody perennial biomass (removals)¹⁸.

Environmental Assets relevant for AFF activities row

Sum of all emissions of methane (CH4) and nitrous oxide (N2O) plus the following CO2 emissions:

- part concerning agriculture (the remaining part is forestry) of Table3s2, row 11 ("G. Liming"), column B (CO2);
- Table3s2, row 14 ("J. Other"), column B (CO2);
- Table4.B, row 14 ("2. Land converted to cropland"), column R (net CO2 emissions/removals);
- Table4.C, row 14 ("2. Land converted to grassland"), column R (net CO2 emissions/removals);

FCAg - Fuel combustion (in Agriculture) column

We include in this column air emissions (CO2, CH4, N2O, NOx, CO, NMVOC, SO2) from fuel combustion for all kind of use in agricultural activities: transportation, heating, electricity production.

Carbon dioxide (CO2), Methane (CH4) and Nitrous oxide (N2O) rows

- part of Table1.A(a)s4, rows from 52 to 57 ("i. Stationary") plus rows from 59 to 65 ("ii. Off-road vehicles and other machinery"), columns G/H/I (CO2/CH4/N2O): only the part concerning "Agriculture" has to be considered in this point (the remaining part is "Forestry").

¹⁸ If carbon losses are higher than gains (i.e. harvest of woody biomass is major than growth of woody biomass) then the data is reported in "Forestry and logging products" row.

Oxides of nitrogen (NO_x), Carbon monoxide (CO), Non-methane volatile organic compounds (NMVOC) and Sulphur dioxide (SO₂) rows

- part of Table1s2, row 10 ("c. Agriculture/forestry/fishing"), columns E/F/G/H (NO_x/CO/NMVOC/SO₂): only the part concerning "Agriculture" has to be considered in this point (the remaining part is to be split between "Forestry" and "Fishing").

Crops Primary, Livestock and Forestry and logging products rows

Further investigation of auxiliary data is needed to allocate GHG emissions (CO₂, CH₄ and N₂O) between "Crops Primary" (allocated pro-quota to specific crops), "Livestock" (allocated pro-quota to specific animals) and "Forestry and logging products".

ISIC A02 - Forestry and logging

FLM - Forest land management column

We include in this column all emissions concerning forestry, with the exception of fuel combustion in forestry activities. Main data regard CO₂ absorption from forest trees in "forest land remaining forest land".

Carbon dioxide (CO₂) row

- part concerning "Forestry" (the remaining part is "Agriculture") of Table3s2, row 11 ("G. Liming"), column B (CO₂);
- Table4.A, row 10 ("A. Total forest land"), column T (net CO₂ emissions/removals);
- Table4(V), rows 11+14 ("A. Forest land: Controlled burning"), column I (CO₂).

Methane (CH₄) row

- Table3.E, row 8 ("Forest land"), column I (CH₄): prescribed burning of savannas;
- Table4(V), rows 11+14 ("A. Forest land: Controlled burning"), column J (CH₄).

Nitrous oxide (N₂O) row

- Table3.E, row 8 ("Forest land"), column J (N₂O): prescribed burning of savannas;
- Table4(I), row 9 ("A. Forest land"), column D (N₂O): direct N₂O emissions from nitrogen inputs to forest soils;
- Table4(III), row 10 ("A. Forest land"), column D (N₂O): direct N₂O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to forest land) or management of mineral soils (forest land remaining forest land);
- Table4(V), rows 11+14 ("A. Forest land: Controlled burning"), column K (N₂O).

Oxides of nitrogen (NO_x), Carbon monoxide (CO) and Non-methane volatile organic compounds (NMVOC) rows

- part of Table3s2, row 9 ("E. Prescribed burning of savannas"), columns E/F/G (NO_x/CO/NMVOC): only the part referable to "Forest land" has to be considered in this point and this part is calculated on the bases of data of "Table3.E - Prescribed burning of savannas" (the remaining part is attributed to grassland and reported in "Burning biomass" column);

- Summary1.As2, row 20 (“A. Forest land”), columns J/K/L (NO_x/CO/NMVOC).

Forest trees row

- Table4.A, row 10 (“A. Total forest land”), column T (net CO₂ emissions/removals): forestry biomass growth (removals);
- Table4(V), rows 11+14 (“A. Forest land: Controlled burning¹⁹”), columns I+J+K (CO₂ + CH₄ + N₂O).

Environmental Assets relevant for AFF activities row

- part concerning “Forestry” (the remaining part is “Agriculture”) of Table3s2, row 11 (“G. Liming”), column B (CO₂);
- Table3.E, row 8 (“Forest land”), columns I+J (CH₄ + N₂O): prescribed burning of savannas;
- Table4(I), row 9 (“A. Forest land”), column D (N₂O): direct N₂O emissions from nitrogen inputs to forest soils;
- Table4(III), row 10 (“A. Forest land”), column D (N₂O): direct N₂O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to forest land) or management of mineral soils (forest land remaining forest land).

FCFo - Fuel combustion (in Forestry) column

We include in this column air emissions (CO₂, CH₄, N₂O, NO_x, CO, NMVOC, SO₂) from fuel combustion for all kind of use in forestry activities: transportation, heating, electricity production.

Carbon dioxide (CO₂), Methane (CH₄) and Nitrous oxide (N₂O) rows

- part of Table1.A(a)s4, rows from 52 to 57 (“i. Stationary”) plus rows from 59 to 65 (“ii. Off-road vehicles and other machinery”), columns G/H/I (CO₂/CH₄/N₂O): only the part concerning “Forestry” has to be considered in this point (the remaining part is “Agriculture”).

Oxides of nitrogen (NO_x), Carbon monoxide (CO), Non-methane volatile organic compounds (NMVOC) and Sulphur dioxide (SO₂) rows

- part of Table1s2, row 10 (“c. Agriculture/forestry/fishing”), columns E/F/G/H (NO_x/CO/NMVOC/SO₂): only the part concerning “Forestry” has to be considered in this point (the remaining part is to be split between “Agriculture” and “Fishing”).

Forest trees row

Sum of all GHG emissions (CO₂, CH₄ and N₂O).

¹⁹ Emissions produced by wildfires of forest land are included in “All Other ISIC and Households” column as it is assumed that they are not caused by ISIC A02.

ISIC A03 - Fishing and aquaculture

FCFi - Fuel combustion (in Fishing) column

We include in this column air emissions (CO₂, CH₄, N₂O, NO_x, CO, NMVOC, SO₂) from fuel combustion for all kind of use in fishing activities: transportation, heating, electricity production.

Carbon dioxide (CO₂), Methane (CH₄) and Nitrous oxide (N₂O) rows

- Table1.A(a)s4, rows from 67 to 73 (“iii. Fishing”), columns G/H/I (CO₂/CH₄/N₂O).

Oxides of nitrogen (NO_x), Carbon monoxide (CO), Non-methane volatile organic compounds (NMVOC) and Sulphur dioxide (SO₂) rows

- part of Table1s2, row 10 (“c. Agriculture/forestry/fishing”), columns E/F/G/H (NO_x/CO/NMVOC/SO₂): only the part concerning “Fishing” has to be considered in this point (the remaining part is to be split between “Agriculture” and “Forestry”).

Fish and other fishing products row

Sum of all GHG emissions (CO₂, CH₄ and N₂O).

OFi - Other(in Fishing) column

We may include in this column all emissions concerning fishing, with the exception of fuel combustion in fishing activities. No emissions is currently included in this column.

AO&H - All other ISIC activities and Households

All other emissions of the national economy are reported in this column; i.e. with reference to the CFR Tables, the emissions to be included in the column are reported under items “1. Energy” (all emissions with the exception of fuel combustion in AFF activities), “2. Industrial processes and product use” (all emissions), “4. LULUCF” (all emissions that have not already been attributed to AFF activities), “5. Waste” (all emissions).

Emissions reported in this column make up the difference between UNFCCC totals, adjusted in order to comply, as required by SEEA, with the residence principle (which has no implication for emissions from the ISIC A industry) and AFF activities’ emissions.

It is interesting to point out here where these emissions are reported in the CRF, and especially to explicit, among these, the emissions of the remaining LULUCF components, i.e. from LULUCF processes not allocated to AFF activities:

Carbon dioxide (CO₂) row

- part of Table1s1, row 7 (“Total Energy”), column B (CO₂): deduct CO₂ emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), column B (CO₂);
- Table4.D, row 10 (“D. Total wetlands”), column R (net CO₂ emissions/removals);
- Table4.E, row 10 (“E. Total settlements”), column R (net CO₂ emissions/removals);
- Table4.F, row 10 (“F. Total other land”), column R (net CO₂ emissions/removals);

- Table4(II), row 8 (“Total for all land use categories”), column G (CO₂): CO₂ emissions/removals from drainage/rewetting and other management of organic and mineral soils;
- Table4(V), rows 12+15+19+22+26+29 (“A. Forest land: wildfires” + “B. Cropland: Wildfires” + “C. Grassland: Wildfires”)²⁰, column I (CO₂);
- Table4(V), rows 30+37+38+39 (“D. Wetlands” + “E. Settlements” + “F. Other land” + “H. Other”), column I (CO₂): biomass burning (controlled burning and wildfires) on land other than cropland, grassland and forest land;
- Table5, row 7 (“Total waste”), column B (CO₂);
- Summary1.As2, row 26 (“G. Harvested wood products”), column B (CO₂);

Methane (CH₄) row

- part of Table1s1, row 7 (“Total Energy”), column C (CH₄): deduct CH₄ emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), column C (CH₄);
- Table4(II), row 8 (“Total for all land use categories”), column I (CH₄): CH₄ emissions from drainage/rewetting and other management of organic and mineral soils;
- Table4(V), rows 12+15+19+22+26+29 (“A. Forest land: wildfires” + “B. Cropland: Wildfires” + “C. Grassland: Wildfires”), column J (CH₄);
- Table4(V), rows 30+37+38+39 (“D. Wetlands” + “E. Settlements” + “F. Other land” + “H. Other”), column J (CH₄): biomass burning (controlled burning and wildfires) on land other than cropland, grassland and forest land;
- Table5, row 7 (“Total waste”), column C (CH₄).

Nitrous oxide (N₂O) row

- part of Table1s1, row 7 (“Total Energy”), column D (N₂O): deduct N₂O emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), column D (N₂O);
- Table4(I), row 16+23+30 (“D. Wetlands” + “E. Settlements” + “H. Other”), column D (N₂O): direct N₂O emissions from nitrogen inputs to soils other than forest land;
- Table4(II), row 8 (“Total for all land use categories”), column H (N₂O): N₂O emissions from drainage/rewetting and other management of organic and mineral soils;
- Table4(III), rows 18+21+24 (“D. Wetlands” + “E. Settlements” + “F. Other land”), column D (N₂O): direct N₂O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to wetlands or to settlements) or management of mineral soils (wetlands remaining wetlands or settlements remaining settlements);
- Table4(V), rows 12+15+19+22+26+29 (“A. Forest land: wildfires” + “B. Cropland: Wildfires” + “C. Grassland: Wildfires”), column K (N₂O);

²⁰ Air emissions produced by controlled burning in cropland, grassland and forest land are included in ISIC A01 and ISIC A02.

- Table4(V), rows 30+37+38+39 (“D. Wetlands” + “E. Settlements” + “F. Other land” + “H. Other”), column K (N₂O): biomass burning (controlled burning and wildfires) on land other than cropland, grassland and forest land;
- Table5, row 7 (“Total waste”), column D (N₂O);

Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF₆) and Nitrogen trifluoride (NF₃) rows

- Table2(I)s1, row 7 (“Total industrial processes”), columns E/F/H/I (HFCs/PFCs/SF₆/NF₃).

Oxides of nitrogen (NO_x), Carbon monoxide (CO) and Non-methane volatile organic compounds (NMVOC) rows

- part of Table1s1, row 7 (“Total Energy”), columns E/F/G (NO_x/CO/NMVOC): deduct NO_x/CO/NMVOC emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), columns J/K/L (NO_x/CO/NMVOC);
- Table5, row 7 (“Total waste”), columns E/F/G (NO_x/CO/NMVOC);
- Summary1.As2, rows 23+24+25+27 (“D. Wetlands” + “E. Settlements” + “F. Other land” + “H. Other”), columns J/K/L (NO_x/CO/NMVOC).

Sulphur dioxide (SO₂) row

- part of Table1s1, row 7 (“Total Energy”), column H (SO₂): deduct SO₂ emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), column M (SO₂);
- Table5, row 7 (“Total waste”), column H (SO₂);
- Summary1.As2, row 27 (“H. Other”), column M (SO₂).

Other products row

- part of Table1s1, row 7 (“Total Energy”), columns B+C+D (CO₂ + CH₄ + N₂O): deduct GHG emissions related to fuel combustion in AFF activities (already included in ISIC A);
- Table2(I)s1, row 7 (“Total industrial processes”), columns B+C+D+E+F+H+I (CO₂ + CH₄ + N₂O + HFCs + PFCs + SF₆ + NF₃);
- Summary1.As2, row 26 (“G. Harvested wood products”)²¹, column B (CO₂);
- Table5, row 7 (“Total waste”), columns B+C+D (CO₂ + CH₄ + N₂O);

Environmental Assets relevant for AFF activities row

- Table4(V), rows 12+15+19+22+26+29 (“A. Forest land: wildfires” + “B. Cropland: Wildfires” + “C. Grassland: Wildfires”), columns I+J+K (CO₂ + CH₄ + N₂O).

Environmental Assets not relevant for AFF activities row

- Table4.D, row 10 (“D. Total wetlands”), column R (net CO₂ emissions/removals);
- Table4.E, row 10 (“E. Total settlements”), column R (net CO₂ emissions/removals);
- Table4.F, row 10 (“F. Total other land”), column R (net CO₂ emissions/removals);

²¹ HWP includes all wood material (including bark) that leaves harvest sites.

- Table4(I), row 16+23+30 (“D. Wetlands” + “E. Settlements” + “H. Other”), column D (N2O): direct N2O emissions from nitrogen inputs to soils other than forest land;
- Table4(II), row 8 (“Total for all land use categories”), columns G+H+I (CO2 + CH4 + N2O): GHG emissions/removals from drainage/rewetting and other management of organic and mineral soils;
- Table4(III), rows 18+21+24 (“D. Wetlands” + “E. Settlements” + “F. Other land”), column D (N2O): direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use (lands converted to wetlands or to settlements) or management of mineral soils (wetlands remaining wetlands or settlements remaining settlements);
- Table4(V), rows 30+37+38+39 (“D. Wetlands” + “E. Settlements” + “F. Other land” + “H. Other”), column I+J+K (CO2 + CH4 + N2O): biomass burning (controlled burning and wildfires) on land other than cropland, grassland and forest land.

4. Results

In this paragraph we report (Figure 1) the results of the exercise carried out for Italy, referring to the year 2014 and based on 2016 communication's CRF file.

In Figure 1 we include all the emissions reported by 2016 communication's CRF, allocated in the manner previously described²².

²² Total emission of Italian Table 4.5 (Figure 1) corresponds to the “Total national emissions and removals” of CFR communication (Summary1.As1 of CRF) and therefore it does not include data of Table6 of CRF (Indirect emissions of N2O and CO2), that in CRF are reported as a memo items).

If we also want to consider Table 6, the proposed allocations are:

➤ *Other cropland and grassland activities (OCGA) column*

Crops (total) row

- Table6, rows 11 (“3. Agriculture”), column G (CO2): indirect emissions of CO2

Environmental Assets relevant for AFF activities row

- Table6, rows 12 (“4. LULUC”), columns G+H (CO2 + N2O): indirect emissions of CO2 and N2O

➤ *All other ISIC activities and Households (AO&H) column*

Other products row

- Table6, rows 9+10+13+14 (“1. Energy” + “2. Industrial processes and product use” + “5. Waste” + “6. Other”); columns G+H (CO2 + N2O): indirect emissions of CO2 and N2O not relating to “Agriculture” and “LULUCF”

and the result is:

Data of “6. Indirect emissions of N2O and CO2” item of CRF allocated in Table 4.5 - Italy, year 2014

	OCGA	AO&H	TOTAL
Greenhouse Gases (in kton CO2 eq.)	16		
CO2 (in kton CO2 eq.)			
N2O (in kton CO2 eq.)	16	1.148	1.164
GHG by Product/Asset (in kton CO2eq.)	16	1.148	1.164
<i>Crops Primary: Products of agriculture, horticulture and market gardening (CPC 01)</i>			
<i>Other products</i>		1.148	1.148
<i>Environmental Assets Relevant for AFF activities</i>	16		16

Figure 1: Table 4.5 SEEA AFF (Air Emissions Accounts), Italy - year 2014(based on 2016 communication's CRF file)

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL			
	Crop and animal production, hunting and related service activities (ISIC A01)										Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)		Total AFF					
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi				OFi		
Type of Substance																				
Greenhouse Gases (in kton CO2 eq.)																				
CO2	411										905	-5.387 (b)	6.823 (c)	-34.036 (f)	(g)	475	-30.809	345.942	315.134	
CH4	15										13.762	3.071	1.599			(g)	1	18.491	25.096	43.587
N2O	3.154	3.852	4	1.156	1.039	2.136		133 (a)	(e)	674 (c)			(g)	3	12.166	8.326	19.328			
HFCs																		11.978	11.978	
PFCs																		1.564	1.564	
SF6																		354	354	
NF3																		28	28	
Total GHG	3.154	4.263	19	1.156	1.039	13.762	5.207	1.599	1.038 (a)	-5.387 (b) (e)	7.540 (c)	-34.036 (f)	(g)	478	-152	392.140	391.972			
Other Air Pollutants (in kton)																				
NOx	9	11	0,5	3	3			0,4	8	59 (d)	0,1		(g)	(h)	93	709	803			
CO	12												161	49 (d)	199	(g)	(h)	420	2.276	2.697
NMVOC	1										1		6	13 (d)	8	(g)	(h)	28	835	863
SO2													0 (d)	(g)		(h)	0	132	132	

(continue Figure 1)

(continue Figure 1)

(continued from page 2)

	ISIC A - AGRICULTURE FORESTRY AND FISHING																AO&H	TOTAL
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)		Total AFF		
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi			
GHG by Product/Asset (in kton CO2eq.)	3.154	4.263	19	1.156	1.039	13.762	5.207	1.599	1.038 (a)	-5.387 (b) (e)	7.540 (c)	-34.036 (f)	(g)	478	-152	392.140	391.972	
Crops Primary: Products of agriculture, horticulture and market gardening (CPC 01)	3.154	4.263	19					1.599	905		7.540 (c)				17.480		17.480	
Cereals			19					1.599							1.618		1.618	
Pulses																		
Fodder Crops																		
Other crops																		
Livestock: Live animals and animal products (excluding meat) (CPC 02)						13.762				7					13.769		13.769	
Cattle and Buffaloes						11.662									11.662		11.662	
Sheep and Goats						1.550									1.550		1.550	
Camels, Horses, Mules and Asses						193									193		193	
Swine						325									325		325	
Poultry																		
Other livestock						32									32		32	
Forestry and logging products (CPC 03) and Forest trees (CPA 02.10.03) *										255		-34.036	(g)		-33.781		-33.781	
Forestry and logging products (CPC 03)										2.238					2.238		2.238	
Forest trees (CPA 02.10.03)										-1.984		-34.036	(g)		-36.020		-36.020	
Fish and other fishing products (CPC 04)														478	478		478	
Other products						5.207									5.207	380.423	395.630	
Produced and Non-Produced Environmental Assets				1.156	1.039				133 (a)	-5.649 (b) (e)		(f)			-3.305	11.717	8.412	
Relevant for AFF activities				1.156	1.039				133 (a)	-5.649 (b) (e)		(f)			-3.305	1.489	-1.816	
of which: growth of standing timber in non-cultivated forests																		
Not relevant for AFF activities																10.228	10.228	

* CPA 02.10.03 (Forest trees) doesn't have a corresponding item in CPC

(a) It includes also the part (of direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from lands converted to cropland) referable to “mineral soils”, which should be correctly allocated in the OCGA column; (b) It includes also the part of “Liming” concerning “Forestry”; (c) It includes also the part of “Fuel combustion” concerning “Forestry”; (d) It includes also the part of “Fuel combustion” concerning “Forestry” and “Fishing”; (e) The part (of direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from lands converted to cropland) referable to “mineral soils” is included in "organic soils" (CDOS column); (f) The part of “Liming” concerning “Forestry” is included in "Agriculture"; (g) The part of “Fuel combustion” concerning “Forestry” is included in "Agriculture"; (h) The part of “Fuel combustion” concerning “Fishing” is included in "Agriculture".

Figure 2: part of Table 4.5 referring to “3. Agriculture” item of CRF - Italy, year 2014

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL			
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)				Total AFF		
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi					
Type of Substance																				
Greenhouse Gases (in kton CO2 eq.)																				
CO2	411											12 (b)		(f)			423		423	
CH4	15											13.762		3.071	1.599			18.447		18.447
N2O	3.154	3.852	4	1.156	1.039	2.136		127							11.468		11.468			
HFCs																				
PFCs																				
SF6																				
NF3																				
Total GHG	3.154	4.263	19	1.156	1.039	13.762	5.207	1.599	127	12 (b)		(f)			30.338		30.338			
Other Air Pollutants (in kton)																				
NOx	9	11	0,5	3	3				0,4						26		26			
CO	12																12		12	
NMVOC	1											1					1		1	
SO2																				

(continue Figure 2)

(continue Figure 2)

(continued from Figure 2)

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL	
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)				Total AFF
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi			
GHG by Product/Asset (in kton CO2eq.)	3.154	4.263	19	1.156	1.039	13.762	5.207	1.599	127	12 (b)		(f)				30.338		30.338
Crops Primary: Products of agriculture, horticulture and market gardening (CPC 01)	3.154	4.263	19					1.599								9.035		9.035
Cereals			19					1.599								1.618		1.618
Pulses																		
Fodder Crops																		
Other crops																		
Livestock: Live animals and animal products (excluding meat) (CPC 02)						13.762										13.762		13.762
Cattle and Buffaloes						11.662										11.662		11.662
Sheep and Goats						1.550										1.550		1.550
Camels, Horses, Mules and Asses						193										193		193
Swine						325										325		325
Poultry																		
Other livestock						32										32		32
Forestry and logging products (CPC 03) and Forest trees (CPA 02.10.03) *																		
Forestry and logging products (CPC 03)																		
Forest trees (CPA 02.10.03)																		
Fish and other fishing products (CPC 04)																		
Other products						5.207										5.207		5.207
Produced and Non-Produced Environmental Assets				1.156	1.039				127	12 (b)		(f)				2.333		2.333
Relevant for AFF activities				1.156	1.039				127	12 (b)		(f)				2.333		2.333
of which: growth of standing timber in non-cultivated forests																		
Not relevant for AFF activities																		

* CPA 02.10.03 (Forest trees) doesn't have a corresponding item in CPC

(b) It includes also the part of "Liming" concerning "Forestry";

(f) The part of "Liming" concerning "Forestry" is included in "Agriculture".

Figure 3: part of Table 4.5 referring to “4. LULUCF” item of CRF - Italy, year 2014

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL			
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)				Total AFF		
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi					
Type of Substance																				
Greenhouse Gases (in kton CO2 eq.)																				
CO2	905											-5.398		-34.036				-38.529	10.836	-27.693
CH4																		0	335	335
N2O	6 (a)											(e)						22	737	743
HFCs																				
PFCs																				
SF6																				
NF3																				
Total GHG	911 (a)											-5.398 (e)		-34.036				-38.507	11.909	-26.615
Other Air Pollutants (in kton)																				
NOx	8													0				8		8
CO	161													199				359		359
NMVOC	6													8				14		14
SO2																			1	1

(continue Figure 3)

(continue Figure 3)

Continued Figure 3

	ISIC A - AGRICULTURE FORESTRY AND FISHING																AO&H	TOTAL
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)		Total AFF		
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi			
GHG by Product/Asset (in kton CO2eq.)	911 (a) -5.398 (e)											-34.036				-38.507	11.909	-26.615
Crops Primary: Products of agriculture, horticulture and market gardening (CPC 01)	905															905		905
Cereals																		
Pulses																		
Fodder Crops																		
Other crops																		
Livestock: Live animals and animal products (excluding meat) (CPC 02)	7															7		7
Cattle and Buffaloes																		
Sheep and Goats																		
Camels, Horses, Mules and Asses																		
Swine																		
Poultry																		
Other livestock																		
Forestry and logging products (CPC 03) and Forest trees (CPA 02.10.03) *	255											-34.036				-33.781		-33.781
Forestry and logging products (CPC 03)	2.238															2.238		2.238
Forest trees (CPA 02.10.03)	-1.984											-34.036				-36.020		-36.020
Fish and other fishing products (CPC 04)																		
Other products																	191	191
Produced and Non-Produced Environmental Assets	6 (a) -5.660 (e)															-5.639	11.717	6.062
Relevant for AFF activities	6 (a) -5.660 (e)															-5.639	1.489	-4.166
of which: growth of standing timber in non-cultivated forests																		
Not relevant for AFF activities																	10.228	10.228

* CPA 02.10.03 (Forest trees) doesn't have a corresponding item in CPC

(a) It includes also the part (of direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from lands converted to cropland) referable to "mineral soils", which should be correctly allocated in the OCGA column;

(e) The part (of direct N2O emissions from N mineralization/immobilization associated with loss/gain of soil organic matter resulting from lands converted to cropland) referable to "mineral soils" is included in "organic soils" (CDOS column).

Figure 4: part of Table 4.5 NOT related to “3. Agriculture” and “4. LULUCF” items of CRF - Italy, year 2014

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL		
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)				Total AFF	
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi				
Type of Substance																			
Greenhouse Gases																			
CO2	6.823 (c)											(g)		475	7.298	335.106	342.404		
CH4	43 (c)											(g)		1	44	24.761	24.805		
N2O	674 (c)											(g)		3	676	6.440	7.117		
HFCs																11.978	11.978		
PFCs																1.564	1.564		
SF6																354	354		
NF3																28	28		
Total GHG (in kton CO2 eq.)	7.540 (c)											(g)		478	8.018	380.231	388.250		
Other Air Pollutants (in kton)																			
NOx	59 (d)											(g)		(h)	59	709	768		
CO	49 (d)											(g)		(h)	49	2.276	2.325		
NMVOC	13 (d)											(g)		(h)	13	835	847		
SO2	0,03 (d)											(g)		(h)	0	131	131		

(continue Figure 4)

(continue Figure 4)

Continued Figure 1

	ISIC A - AGRICULTURE FORESTRY AND FISHING															AO&H	TOTAL	
	Crop and animal production, hunting and related service activities (ISIC A01)											Forestry and logging (ISIC A02)		Fishing and aquaculture (ISIC A03)				Total AFF
	SF	MAS	BB	CRLS	MLP	EF	MM	RC	CDOS	OCGA	FCAg	FLM	FCFo	FCFi	OFi			
GHG by Product/Asset (in kton CO2eq.)	7.540 (c)											(g)		478		8.018	380.231	388.250
Crops Primary: Products of agriculture, horticulture and market gardening (CPC 01)	7.540 (c)															7.540		7.540
Cereals																		
Pulses																		
Fodder Crops																		
Other crops																		
Livestock: Live animals and animal products (excluding meat) (CPC 02)																		
Cattle and Buffaloes																		
Sheep and Goats																		
Camels, Horses, Mules and Asses																		
Swine																		
Poultry																		
Other livestock																		
Forestry and logging products (CPC 03) and Forest trees (CPA 02.10.03) *												(g)						
Forestry and logging products (CPC 03)																		
Forest trees (CPA 02.10.03)												(g)						
Fish and other fishing products (CPC 04)														478		478		478
Other products																	380.231	380.231
Produced and Non-Produced Environmental Assets																		
Relevant for AFF activities																		
of which: growth of standing timber in non-cultivated forests																		
Not relevant for AFF activities																		

* CPA 02.10.03 (Forest trees) doesn't have a corresponding item in CPC

(c) It includes also the part of "Fuel combustion" concerning "Forestry";

(d) It includes also the part of "Fuel combustion" concerning "Forestry" and "Fishing";

(g) The part of "Fuel combustion" concerning "Forestry" is included in "Agriculture";

(h) The part of "Fuel combustion" concerning "Fishing" is included in "Agriculture".

5. Final remarks and questions to the London Group

As for tables 4.B and 4.C of the CRF (reporting emissions from change in use of cropland and grassland), we tackled only the cases that are significant for Italy (meaning: for which data are reported). This is due to the fact that these tables include cases for which it is necessary to carry out the reasoning, necessary to decide about the allocation of the emissions, at a quite high level of detail, varying according to the factors that determine the emissions and not just to the type of change in the use of the land (whether it is the biomass stock, or the carbon in the soil...).

Setting the exercise up costed 15 full days of one very skilled researcher's time. It could be repeated at quite low cost, using any edition and reference year of most Annex 1 party communication.

We do not feel we can say we dealt with all the conceptual aspects in a satisfactory way, and established all the correct connections. The list of associations that we give in this paper should therefore be seen more as a starting point and as working tool, to be corrected and further refined through use, also by other countries, rather than as a finished and self-standing piece of work.

It is clearly beyond the scope of a working session of the London Group to analyze and verify in detail the meaningfulness of the allocation of emissions that we propose in this paper. Therefore, the questions we would like to get an answer to from the London Group are therefore rather of a general nature.

Indeed, the exercise has an important conceptual component, consisting in understanding whether a certain emissions and carbon removal can be assigned to a specific product or should rather be connected to some environmental assets, namely the asset from which the matter dispersed in the atmosphere comes from or the asset which benefits from the activity generating the gaseous flows accounted for in air emission inventories. These emissions are mostly related to the "land" asset. Since not all emissions from LU and LUC are due to AFF activities, part of the emissions under the IPCC item "4. LULUCF" will have to be included in final column of SEEA AFF table 4.5, which is devoted to "all other activities".

There are several borderline cases which would deserve a more thorough discussion than we could carry out above. It all has to do with the application of a National Accounting logic to the phenomena causing emissions or removals. The latter often are - by their very nature - not easy to deal with by using the classifications use in Supply/Use tables. E.g. let us consider the emissions from manure, when used as fertilizer or left on pastures. Should they be assigned to the animals seen as assets, to their current flow of products or to the improvement of the asset "land"? Although the industry to which these emissions are connected is ISIC 01 in all cases, the way we solve this issue has an impact on the quantity of emissions allocated to current production, i.e. that can be correctly put in relation to production, value added and other outcomes of economic activity. In general, a confirmation of the intuition underlying SEEA AFF's table 4.5, that some air emission flows should directly be connected to assets,

being the result of operations done on assets, i.e. of changes in some assets that affect (also) future production potential, and that therefore these emissions should be connected to the assets' degradation or improvement, rather than to current production, seems to us an important outcome of our exercise.

Some open questions concern the correct identification of the connections with products and the proposed allocation to economic activities. The following are some examples²³:

- Is it ok to allocate air emissions from Wildfires to “Other ISIC and Households”? Are these emissions connected to current production or should they remain with the reduction in the volume of the “living plants” asset?
- Crop residues left on soil emit this year, but they provide a fertilisation service to the following years' production. How should we deal with this in terms of the rows of the table?
- Emissions from manure management: is it correct to attribute them to the product “manure” (included under “other products”)?
- Emissions from “Harvested wood products”, dealt with in ch. 12 of the IPCC guidelines, have been provisionally allocated, in our exercise, to “Other ISIC and Households”, as we considered them deriving from the use of these products, which mainly occurs outside AFF activities. Is this correct?

A second type of question concerns the possibility of generalizing (in particular, to non-Annex 1 Countries) this kind of work:

- Is it granted that the Annex-1 countries reporting tool (CRF) is based on a (complete) description/classification of the biophysical processes underlying GHG emissions from AFF activities, to which all IPCC-compliant estimates can be referred, even if they articulate this description/classification at lower levels of detail?
- Is it granted that the CRF level of detail is high enough to be well suited for the establishment of (at least) “qualitative” correspondences with economic activities and products (use of auxiliary information sources is needed for pro-quota allocation)?
- Is it granted that the theoretical (qualitative) correspondences between IPCC categories can in principle be established at this level of detail, without much regard to how emissions and absorptions are calculated, as far as these calculations are based on the same classification of biophysical processes, even if used at a higher level of aggregation?
- Can the connections proposed in this paper be the basis for a set of guidelines for the transformation of UNFCCC communication data into table 4.5 of the SEEA AFF? Which adaptations are required to allow exploitation of existing national and international databases?

²³ The reader interested in knowing which solutions we adopted can look them up in § 3.