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# Assessment of UNCCD report for The Netherlands

Authors:

Saskia Keesstra[1], Gerard Hazeu[1], Peter Kuikman[1], Jan de Leeuw[2]

Reviewer: Saskia Visser[1]

[1]Wageningen Environmental Research
[2]ISRIC

# Contents

# 1 SUMMARY

This report provides a review of the UNCCD ('*Performance Review and Assessment of Implementation System, Seventh reporting process, report of The Netherlands')* report. The UNCCD report follows the Tier-1 approach outlined in the guidelines. The data provided in the sheets are based on satellite imagery derived land use change, the ISRIC soil grids and NDVI (Normalized Difference Vegetation Index) data.

The estimated reported land use change seems to overestimate the conversion from agriculture into artificial surfaces compared to tier 2 data available for The Netherlands. In addition, the rotational use of non-peat soils for arable land and grassland is not taken into account.

The Land Productivity dynamics estimations based on NDVI data, clearly has little relationship with the actual NPP in The Netherlands as evidenced by CBS.

On the issue of data and whether these represent soils in the Netherlands, we conclude that on the SOC stocks the numbers are high compared to other estimates and measures of Soil Organic Carbon (SOC) in Dutch agricultural and natural soils such as provided in the LSK. Furthermore, peatlands and the loss of C through land subsidence is not taken into account.

We recommend to consider completing the requested information sheets based on a Tier-2 or -3 methodology. The advantage is a better and more accurate representation of the Dutch situation. In the Netherlands, data are available from other reporting requirements such as reporting on soil C dynamics in relation to LULUCF as required and mandatory under the climate agreements to the UNFCCC. The benefit would also be that reporting on soil C changes in the Netherlands to different UN fora and for different reasons is coherent and consistent.

# 2 INTRODUCTION

This short report was made in commission of the Ministry of Agriculture, Nature and Fishery (LNV) to validate the UNCCD report from The Netherlands. The research questions were:

- How does the definition used in the report relate to other definitions that are reported elsewhere?
- Validate the quantitative data in the provided report.
- Provide, were possible, answers to the bio-physical open questions in the PDF form: '*Performance Review and Assessment of Implementation System, Seventh reporting process, report of The Netherlands'* provided by the UNCCD.

Overview of the UNCCD report:
The UNCCD report comprises of an assessment of the land degradation state of The Netherlands based on European and Worldwide databases.
The UNCCD Strategic Framework has five strategic objectives (SO's):

1. To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality
2. To improve the living conditions of affected populations
3. To mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems
4. To generate global benefits through effective implementation
5. To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level

In this report we mainly reflect on the first strategic objective '*To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality*' The UNCCD uses the following indicators to assess Land Degradation Neutrality:

1. Land cover
2. Land productivity dynamics
3. Soil Organic Carbon stocks

For the other objectives, only a short reflection is given.

This assessment report starts with an explanation of the definitions relevant for understanding the assessment of the UNCCD report. Secondly, we provide a reflection on the sub-indicators used to assess the state of land degradation in order to evaluate strategic objective 1. Alternative quantitative data and limitations of the currently used methodologies are reflected on.
Finally, recommendations are given for future development for land degradation neutrality assessments for the Dutch context.

# 3 DEFINITIONS OF LAND DEGRADATION AND GUIDELINES

The UNCCD is one organization having defined land degradation and have agreed with countries that reporting on Land Degradation is required and provided a guidelings report on this. Other views on Land Degradation may exist. The guidelines offers a Tiered approach. Tier -1 methodology is provided and should allow all to complete the reporting relatively simple and in cases where data are missing. The guidelines offer alternative (tier2 or tier3) approaches should countries have more specific and better reflections of national situation and condition.

The UNCCD defines land degradation as:

*'The reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or rangeland, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation' (UNCCD 1994)[1'].*

The UNCCD initially mainly focused on drylands. Nowadays the UNCCD spread its reposiblity and aims to make a lasting global contribution to the achievement of sustainable land management in all ecosystems globally. Vogt et al. (2011)[2] highlighted the need to have an agreed definition for monitoring and assessing land degradation.

Several definitions of land degradation can be found in influential reports:

- The Millennium Ecosystem Assessment (2005)[3],
- A book on land degradation, desertification and climate change by (Reed & Stringer 2016)[4], which was endorsed by the UNCCD,
- The Status of the World's Soil Resources Report from the Intergovernmental Technical Panel on Soils (FAO 2015)[5],
- The Thematic Assessment on land Degradation and Restoration of the IPBES[6]
- The IPCC special report for 2018, and the JRC report on Land productivity dynamics in Europe (Cherlet et al. 2013)[7].

This shows ones again there is no generally accepted definition of land degradation in environmental science and policy. One of the problems with defining land degradation is that what one group of people might view as degradation, others might view as a benefit or opportunity. The policy report with scenarios for the UNCCD's Global Land Outlook by (Van der Esch et al. 2017)[8] therefore makes an explicit choice to not directly quantify 'land

[1] UNCCD, 1994. *Article 2 of the Text of the United Nations Convention to Combat Desertification.*

[2] Vogt, J. V. et al., 2011. Monitoring and assessment of land degradation and desertification: Towards new conceptual and integrated approaches. , 22(2), pp.150–165

[3] Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington, DC.

[4] Reed, M.S. & Stringer, L.C., 2016. *Land Degradation, Desertification and Climate Change: Anticipating, assessing and adapting to future change (Climate and Development)*, Routledge. Available at: https://www.amazon.com/Land-Degradation-Desertification-Climate-Change/dp/1849712719.

[5] FAO, 2015b. *Status of the World ' s Soil Resources Main Report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils*, Rome.

[6] IPBES, 2015. *SCOPING FOR A THEMATIC ASSESSMENT OF LAND DEGRADATION AND RESTORATION*, Available at: https://www.ipbes.net/sites/default/files/downloads/pdf/decision_ipbes-3-1_annex_viii_advance_scoping_ldr.pdf [Accessed August 16, 2017].

[7] Cherlet, M. et al., 2013. *Land Productivity Dynamics in Europe Towards Valuation of Land Degradation in the EU*

[8] Van der Esch, S. et al., 2017. *Exploring future changes in land use and land condition and the impacts on food, water, climate change and biodiversity Scenarios for the UNCCD Global Land Outlook Policy Report*, The Hague. Available at: http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2017-exploring-future-changes-in-land-use-and-land-condition-2076.pdf

degradation' because of the differences among definitions and the subjectivity of the term itself. Instead, the study assessed changes in land condition and ecosystem functions relative to the natural or undisturbed state to determine human impact.

However, some common elements in the definitions can be identified: declining land functions, threatened or declining soil functions and declining ecosystem functions or ecosystem services.

**Combined this shows the deterioration of benefits humans derive from terrestrial ecosystems.**

To show the diversity of definitions found elsewhere in literature we made a brief and non-exhaustive overview:

- Reed et al., 2015: "*Land degradation: i) is a phenomenon caused by human activities and exacerbated by certain climate and topographic characteristics; ii) is characterized by changes in ecosystem processes and levels of natural capital that affect the flow of ecosystem services to society; iii) causes an effectively permanent decrease in the capacity of the land system as managed to meet its user demands; and iv) is a threat to the long-term biological and/or economic resilience and adaptive capacity of the ecosystem and the populations who depend on it*."
- EEA, 8/2016*: "In Europe land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. ....In the context of productivity, land degradation results from a mismatch between land quality and land use*."
- IPBES 2015: *"'…degraded land' is defined as land in a state that results from persistent decline or loss of biodiversity and ecosystem functions and services that cannot fully recover unaided within decadal time scales.*
- *'Land degradation', in turn, refers to the many processes that drive the decline or loss of biodiversity, ecosystem functions or services and includes the degradation of all terrestrial ecosystems.*
- *'Restoration' is defined as any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state."*

The choice which definition to follow is not an easy one and should be made in good agreement. For the assessment report it is however logical to follow the definition the UNCCD used for their report.

The guidelines require to report on:

4. Land cover
5. Land productivity dynamics
6. Soil Organic Carbon stocks
7. Land degradation (neutrality)

Apart from the term Land Degradation the term *Land degradation Neutrality* is also important to clarify. This last term originates from SDG 15 "Life on Land" and specifically SDG target 15.3 which states: '*By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.*' The United Nations Convention to Combat Desertification (UNCCD), the author of the report under assessment, is the agency in charge of monitoring SDG indicator 15.3.1 ("*Proportion of land that is degraded over total land area").* This indicator was proposed by the Inter-Agency and Expert Group on SDG indicators (IAEG-SDGs) and adopted by the United Nations Statistical Commission (UNSC) in March 2017 to monitor progress towards achieving SDG target 15.3.

[Accessed August 8, 2017].

The SDG indicator 15.3.1 is reported in a simple binary way: degraded/not degraded. This is in principle based on comparable and standardized national official data sources. The SDG indicator 15.3.1 ("the indicator") assesses changes in i) land cover, ii) land productivity and iii) carbon stocks ("the sub-indicators"), which need to be validated and reported by national authorities.

SDG indicator 15.3.1 makes use of geospatial information and digital data from national, regional and global sources. The indicator consists of three sub-indicators: Trends in Land Cover, Land Productivity and Carbon Stocks. The method of computation for this indicator follows the "One Out, All Out" statistical principle. Furthermore, it is based on the baseline assessment (in this case the year 2000) and evaluation of change in the sub-indicators to determine the extent of land that is degraded over total land area.

# 4 EVALUATION OF SO1-1: LAND COVER

In this chapter we describe the evaluation of the first sub indicator, land cover. We discuss the validation of the quantitative data provided by the UNCCD. Subsequently we discuss the chosen parameter itself.

**Validation of the quantitative data provided by the UNCCD**

The data provided in the report of the UNCCD is based on large-scale data (1-km$^2$ grids of the European Space Agency). To validate this, we compared this data set with several tier 1 and 2 data[9] available at WR. In addition, it was compared to an existing WOT study done for the UNFCCC (Arets et al., 2019)[10], which contains similar data.

For the first quick scan comparison the following sources have been consulted

1. CORINE Land Cover (CLC2000, 2006, 2012 and 2018); Topographical data (Top10NL) which is continuously being updated
2. Bestand Bodemgebruik (BBG) with reference years 1993, 1996, 2000, 2003, 2006, 2008, 2010, 2012, 2015)
3. Basiskaart Natuur (BKN1990, 2004, 2009, 2013 and 2017)
4. Landelijk Grondgebruik Nederland (LGN1-7) with reference years 1986, 1994, 1997, 2000, 2004, 2008, 2012)

All datasets have own definitions regarding land cover classes, spatial detail and temporal frequency. Corine Land Cover (CLC) is a European wide harmonised dataset where the level of spatial detail is restricted compared to the other datasets. The CLC datasets are based on national expertise and interpretation, harmonised and managed by the EEA.

The Landelijk Grondgebruik Nederland) LGN datasets has been produced on basis of the datasets under 2-4. Those datasets are integrated, and additional information is added. This assessment will focus on the data coming from the LGN and CLC datasets.

The results of the assessment are shown in Annex 1. We can conclude that large deviations exist between UNCCD LC data and data coming from two data sources (LGN and CLC). “Artificial surface” are occupying far more land in LGN and CLC. The trend in UNCCD and LGN/CLC is the same although the order of magnitude of the increase in surface area in UNCCD is more than 2 times as high. The area “Cropland” shows in UNCCD and LGN/CLC the same trend, i.e. a decrease in surface area but the order of magnitude of the decrease in surface area in UNCCD is more than 2 times as high. Furthermore “Cropland” is largely overestimated in the UNCCD report. For some specific classes trends between UNCCD and LGN/CLC are contradictory, i.e. “Wetlands” and “Other land”. For “Grasslands” absolute figures and the trend in time shows a diverse image for the 3 datasets. Probably due to differences in nomenclatures and aggregation to the UNCCD classes.
Aggregation of LGN and CLC nomenclatures to the UNCCD classes is proofs to be difficult. The classes greenhouses, heathlands, dune areas and grassland in urban areas are e.g. difficult to aggregate to UNCCD classes. Another difficulty in comparing data is the incompatible sea mask used between the three datasets UNCCD, CLC and LGN.

[9] ● Tier 1 (default method): Global/regional earth observation, geospatial information and modelling; ● Tier 2: National statistics based on data acquired for administrative or natural reference units (e.g. watersheds) and national earth observation; ● Tier 3 (most detailed method): Field surveys, assessments and ground measurements.

10 Arets, E.J.M.M., J.W.H van der Kolk, G.M. Hengeveld, J.P. Lesschen, H. Kramer, P.J. Kuikman & M.J. Schelhaas (2019). Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological *background, update 2019*. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), Wageningen. WOt-technical 146 108 p

Next to this quick scan we also compared the data to the document that was made for the report of the UNFCCC (Arets et al., 2017 and 2019)[11][12]. The 2019 version of the report is this date [11-02-2019] still under evaluation, but will be published by the 1st of April 2019. The land use conversion tables are shown in Annex 2, which gives a detailed description of the land use change. The full report is available on this link: http://edepot.wur.nl/418559.

The data in the UNFCCC report originate from the land use/cover classifications of the national topographic maps (Section 3.2), TOP25, TOP10Vector and TOP10NL. The resolution used for this analysis was 25 x 25 m. Therefore, can be considered more reliable compaerd to the assessment done in the report provided by the UNCCD.

Because the periods over which land use change has been calculated are not the same, the outcomes cannot be compared one on one. The Tier 2 data also shows a large increase in urbanized areas. However, the extend of the increase of 'artificial surfaces' is much smaller than indicated in the report of the UNCCD: over the period 1990-2013 on average 4.7%, and when calculated over the period 2004-2013 0.94%. Furthermore, it is clear that the cropland areas and grass land areas are in a rotational system (except for the peatland grasslands). Therefore, in the matrixes there is for every timeslot they identified a similar number of pixels being converted to cropland into grassland and visa versa. However, this cannot be seen as a degrading or restoring trend as it is part of the agricultural system that is used.

Our overall conclusion is that the main land conversion in The Netherlands consists of the conversion from arable land (grassland + cropland) into artificial surfaces and natural areas.

We advise not to use a new data set for the evaluation of Land Degradations. But be consistent and use the same one for both studies (for UNFCCC and UNCCD). One drawback however of this data source is the lack of yearly land cover data.

**Considerations on the methodology**

Discussion points about the land cover and land cover change classification as was done by the UNCCD:

1. Satellite data: In the past satellite data has proved not to be suitable for the assessment of land cover in the Netherlands due to the fragmented character of the Dutch landscape. Especially forest cover is overestimated by satellite imagery by 10-15% due to overhanging crowns at the borders of these parcels. In addition, the large pixel size fails to capture the characteristics of the mosaic of the landscape.
2. Peatland meadows (Veenweide): this particular land use type is most likely classified as grass land in the UNCCD report (which is not possible to verify at this moment). However, 10-15% of these areas are permanent wetlands. This is not taken into account.
3. Floodplains: It is unclear how the floodplain areas have been classified: as wetland or as grassland.
4. Rotational grassland/cropland: In the UNCCD the conversion of grassland into cropland is classified as degradation. However, in Dutch agriculture, all grassland that is not on peatland (veenweides) are under rotational cropping, which means all cropland is sometimes grassland and visa versa. It is not clear how this has been incorporated in this report.

In the document on page 5 hotspot/brightspots areas need to be identified. For this section areas like large 'Vinex' projects (Leidse Rijn, Almere etc.) could be mentioned. As an example of restoration the area in Tiengemeenten can be mentioned where an agricultural landscape was given back to nature and now it is grassland with encroaching forest.

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[11] Arets et al., 2017. Greenhouse gas reporting for the LULUCF sector in the Netherlands Methodological background, update 2017, WOt technical report 95, pp92

[12] Arets, E.J.M.M., J.W.H van der Kolk, G.M. Hengeveld, J.P. Lesschen, H. Kramer, P.J. Kuikman & M.J. Schelhaas (2019). *Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological background, update 2019*. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), Wageningen. WOt-technical 146 108 p

# 5 EVALUATION OF SO1-2: LAND PRODUCTIVITY DYNAMICS

The second sub-indicator is 'Land productivity dynamics'. This the biological productive capacity of the land, the principle source of the food, fibre and fuel that sustains humans. It points to long-term changes in the health and productive capacity of the land and reflects the net effects of changes in ecosystem functioning on plant and biomass growth. This can be measured at local to global scales using satellite remote sensing and image transformations that are sensitive to changes in plant productivity and are correlated with the Annual Net Primary Production (ANPP) of vegetation.

The assessment of land productivity in this GPG uses three metrics calculated from remotely sensed estimates of land productivity:

1. Trend, which represents the trajectory of productivity over time,
2. State, which compares the current productivity level in a given area to historical observations of productivity in that same area
3. Performance, which measures local productivity relative to other similar vegetation types in similar land cover types and bioclimatic regions.

These three metrics are combined into a qualification of each pixel to be Declining, moderately declining, Stressed, Stable or Increasing. After which these five classes are again lumped into two classes: degrading (declining, moderately declining or stressed) or not degrading (stable of increasing).

**Validation of the quantitative data provided by the UNCCD**

The first table on page 6 of the report shows that the land productivity dynamics in the Netherlands are mostly positive. Only 1766 km2 are categorized as degrading, less than 5% of the total area of The Netherlands, in all the rest the situation is stable of increasing. Especially the category 'increasing' takes up a very large part of the statistics (58%). This information can doubted, as the meteorological have not been taken into account. Any data series of National Primary Production (NPP) has a large annual variation. If by chance a very favourable meteorological condition caused very high production in a year close to the end of the time series and a year with low production and the beginning, the resulting trend will be very positive. However, when these particular would be just outside the time series the trend would be completely different. This shows that the NPP is for a large part (at least for the Netherlands) driven by meteorological conditions and not by land degradation. It is possible to eliminate the variation of the meteorological conditions with a method (RESTTREND) that has been used by ISRIC World Soil Information .

When looking at the second table on page 6, which shows the change in productivity dynamics for the conversion of one land use into another. It is surprising to see the high numbers in the 'increasing' class for areas that are changing from cropland, grassland or tree-covered areas into artificial surfaces, as you would expect productivity numbers to decline with increasing surface sealing. After careful considerations of these quantitative data, this could be due to the different data sources used for sub-indicator 1 (land cover) and 2 (NVDI) on the places that have been indicated as converted to artificial surface, do not show this conversion in the NVDI data that was used in sub-indicator 2. From the provided guidelines on how this was report was made, this cannot be derived.

**Considerations on the methodology**

There are several issues that specifically relate to this sub-indicator.

1. The conversion of land into greenhouses. It is not clear how greenhouses are classified. This sub-indictor (based on NDVI data) will give a decline, while the production will have increased.
2. The table of NPP trends per land cover type is sensitive to errors in the land cover classification. A more robust assessment could be done when using national land cover data (instead of the default) for this analysis.
3. The NPP trend analysis is sensitive to the influence of variation in weather conditions. Several approaches available in Trends.Earth could be used to eliminate or reduce the influence of weather conditions on the NPP trend analysis. It is advised to use these options to reanalyze the SO1.2 data for the Netherlands.
4. Currently there is no indication for the decline in NPP is for The Netherlands from other sources (CBS, reference to be provided). Therefore, the methodology using NDVI data is not suitable for the Dutch setting.

# 6 EVALUATION OF SO1-3: SOIL ORGANIC CARBON STOCKS

The third sub-indicator is the soil organic carbon stocks. The carbon stock defined as the amount of carbon in above- and below-ground biomass, dead organic matter, and soil organic carbon. The IPCC (2006[13]) report contains the most relevant definitions.

The UNCCD uses the soil organic carbon (SOC) stock as an indicator of overall soil quality associated with nutrient cycling and its aggregate stability and structure with direct implications for water infiltration, soil biodiversity, vulnerability to erosion, and ultimately the productivity of vegetation, and in agricultural contexts, yields. SOC stocks reflect the balance between organic matter gains, dependent on plant productivity and management practices, and losses due to decomposition through the action of soil organisms and physical export through leaching and erosion. The change in carbon stock is derived from a combined table on the average amount of carbon in a specific land use type with the Land Use change as shown in sub-indicator 3. In a table provided by the UNCCD each conversion type is classified as being a decrease, stable or increase in carbon stock.

**Validation of the quantitative data provided by the UNCCD**

The table provided on page 8 of the report shows a decrease of SOC for all six cover types. The reason for this decrease has not been clarified. In the second table on page 8 the effects of the land use for the carbon stocks is given. Furthermore, the quantitative data provided for each soil type are rather high compared to the carbon stocks used for the assessment for the UNFCCC. This could be due to the use of average data for specific landuses, which are also based on data points outside of The Netherlands.

Because the quantitative data provided are a result of the multiplication of the land use change as derived in sub-indicator 1 and the table with average amounts of SOC under a specific land use the table is simple to understand. However, as indicated in the section on sub-indicator 1 the quantitative data here are subject to the same doubts as we had there.

It is not clear why in the table provided there are only four land conversions listed, and the other land conversion that have taken place are not in the table.

**Considerations of the methodology**

There are several issues that specifically relate to this sub-indicator.

- Because this sub-indicator is directly linked to sub-indicator 1, an overestimation of a negative trend in sub-indicator 1 will have a direct effect on this sub-indicator.
- The decrease in SOC when any land use type is converted to 'artifcial surface' is debatable. The SOC does not actually change when the surface is sealed. It is true that the location is no longer not providing any other ecosystem service, but the Organic Carbon is still in the soil (or has been transported elsewhere). In the 2006 IPCC guidelines (IPCC 2006) state the following for land converted to Settlements for the soil carbon pool: '*Default stock change factors for land use after conversion (Settlements) are not needed for the Tier 1 method for Settlements Remaining Settlements because the default assumption is that inputs equal outputs and therefore no net change in soil carbon stocks occur once the settlement is established.'*

[13] IPCC. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Agriculture, Forestry and Other Land Use*. IPCC National Greenhouse Gas Inventories Programme. Published by the Institute for Global Environmental Strategies (IGES), Kanagawa, Japan.

- Most importantly, this assessment does not make the distinction between mineral and organic soils. In the Netherlands SOC is lost in peatlands by peat oxidation due to drainage of these peatlands for agricultural use. Cultivated organic soils are an important source of GHG emissions in the Netherlands. About 290,000 ha (or 6% of the total land area) of The Netherlands are covered by peat soils. About 223,000 ha of this total peat area are under agricultural land use, mainly as permanent pastures for dairy farming. This land degradation process is not taken into account by the assessment of the UNCCD. However, in the WOt reports (Arets, 2017[14], 2018[15]) these dynamics are incorporated in the assessment.
- Originally the largest part of the forested area in the Netherlands was planted for wood production using regular spacing and just one or two species in even-aged stands. Nowadays this is changing towards multi-purpose forests (e.g. nature, recreation). Therefore, most of the forested areas (both established as wel as newly planted) in the Netherlands are now managed according to Sustainable Forest Management principles. These new management strategies have an impact on the amount of carbon in the soil, litter and vegetation.

[14] Arets, E.J.M.M., J.W.H van der Kolk, G.M. Hengeveld, J.P. Lesschen, H. Kramer, P.J. Kuikman & M.J. Schelhaas (2017). Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological background, update 2017. Wageningen, Statutory Research Tasks Unit for Nature & the Environment, WUR. Wot-technical 95. 89 p;

[15] Arets, E. J. M. M., J. W. H. van der Kolk, G. M. Hengeveld, J. P. Lesschen, H. Kramer, P. J. Kuikman and M. J. Schelhaas. (2019). Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological background, update 2019. WOt Technical report 146. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), Wageningen UR, Wageningen, The Netherlands.

# 7 SDG 15.3.1.: LAND DEGRADATION NEUTRALITY

The method used by the UNCCD to assess SDG indicator 15.3.1 is reported in a simple binary way: degraded/not degraded. The indicator consists of three sub-indicators: Trends in Land Cover, Land Productivity and Carbon Stocks. The method of computation for this indicator follows the "One Out, All Out" statistical principle. So, if any of the three sub-indicators described above is classified as 'degraded' than the pixel in question is classified as 'degraded'. SDG indicator 15.3.1 makes use of geospatial information and digital data from national, regional and global sources. Furthermore, it is based on the baseline assessment (in this case the year 2000) and evaluation of change in the sub-indicators to determine the extent of land that is degraded over total land area.

In the provided report on page 10 the lumped number of 3313 $km^2$, which calculates into 9.7% of the area of The Netherlands is given. This lumped estimate seems very unlikely to be correct. However, based on the descriptions provided by the UNCCD in their document explaining the methodology it is not possible to reproduce this number based on the data listed in their report.

# 8 SUITABILITY OF CHOSEN INDICATORS FOR SO1 FOR THE DUTCH LAND DEGRADATION ASSESSMENT

The indicators used for SO1 by the UNCCD are based on the Tier 1 methodology. This is different from the system used for the reports made for LULUCF for the UNFCCC. For that report Tier 2 and for some indicators even Tier 3 information is used. The chosen indicators as well as the chosen methodology will lead to different outcomes of the analysis, as is shown also by the information given in the sections above.

Currently, there are no official indicators defined for the Netherlands in addition to the three indicators listed by the UNCCD. There are, however, several indicators that would be useful to take into account if an accurate assessment of the current state and trend of Land Degradation. The current set of indicators only comprise of land use change, land productivity change and change of soil organic carbon stocks. However, in the Netherlands other land degradation processes like soil compaction, soil subsidence, salinization and soil pollution are issues that should not be ignored if a full scope of land degradation is needed.

The 7 soil threats as indicated by the European Commission[16] could be an option to formulate a more comprehensive and complete set of land degradation indicators.

This shows that the lumped outcome number of 9.7% is unlikely to be correct. The indicators that were taken into account have been overestimated according to our quick assessment described above, but as other relevant threats to the state of land have not been taken into consideration the total degradation state is unknown at this moment.

In this report the standard indicators have been used: Land use change, land productivity dynamics and soil organic carbon stocks. These indicators are insufficient to depict the land degradation state in the Netherlands. We would argue to use separate indicators for all soil threats:

Soil threats/land degradation that have been overlooked by this report: (i) Soil Compaction, (ii) Soil subsidence (mainly organic soils) due to compaction and oxidation of organic material (Peat oxidation); (iii) Pollution: both point and diffuse pollution and (iv) Salinization.

The Netherlands does not have a specific policy targeting land degradation or monitoring action on Land Degradation Neutrality. However, the Netherlands is monitoring SDG progress and monitors yield developments. But in terms of LDN there is only reference to the prevention of access N and P pools in the environment. However, recently, initiatives have been launched in The Netherlands regarding concerns about the general soil quality and is challenging the sector to actively and specifically contribute to maintain and enhance soil quality. This soil strategy (reference to Kamerbrief Bodemstrategie van May 2018[17]) encompasses emissions and climate issues (carbon stocks) and soil biodiversity.

In the Netherlands, economic activities and growing population require more infrastructure and housing as well as economic activities. Several activities in agriculture are transformed into horticultural greenhouses. As such land is under pressure.

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[16] European Commission. 2006. *Communication from the Commission to the Council, the European Parliament, The European Economic and Social* Committee of the regions. Thematic Strategy for Soil Protection. Commission of the European Communities, Brussels. COM (2006) 231 final.

17file:///C:/Users/Saskia%20Keesstra/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/kamerbrief-over-bodemstrategie%20(3).pdf

# 9 MOVING INTO THE FUTURE: STRATEGIC OBJECTIVES 2, 3, 4 AND 5

The other 4 strategic objectives in the document are not taken into account in this report.

Strategic objective 2: To improve the living conditions of affected populations. This strategic objective has indicators related to poverty, income inequality and access to drinking water. We did not have any information about these topics to our disposal.

Strategic objective 3: To mitigate, adapt to and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems. This strategic objective is very interesting to think about. We would think any management strategy that will enhance the SOC for instance will be useful to increase the resilience. Possibly plans made for mitigating and adapting to climate change and plans for protecting and restoring biodiversity can be useful to reach this objective. Possibly the three related conventions may be merged into one policy and related managed plan (e.g. climate smart agriculture, agricultural practices related to soil subsidence mitigation).

Strategic objective 4: To generate global environmental benefits through effective implementation of the UNCCD. This strategic objectives has indicators related to the abundance and distribution of selected (Red List) species. Unfortunately, we did not have sufficient information to our disposal to be able to make any suggestions on how to fill this part of the form, nor which further indicators would be useful.

Strategic objective 5: To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level. Unfortunately, we have not been able to provide any feedback on this part of the report.

# 10 CONCLUSIONS AND RECOMMENDATIONS:

Our recommendations fall apart into three main issues:

1. The methodology used by the UNCCD is currently not transparent. Therefore, we recommend asking the UNCCD to provide the sources of data and describe methodologies. It is currently not clear how the UNCCD comes to the conclusion of an area of total degraded land of 3313km$^2$
2. The current reporting does not or insufficiently reflect the condition and situation in the Netherlands. The country does indeed have better and more detailed information on the status of its soils that the informatoin used sofar in the reporting.
3. We recommend to bring together better quantitative data than now are listed, based on at least tier 2 type of data. The datasets used for the data in Annex 1 and in the reports by Arets et al., (2017, 2019, Annex 2) can be combined to bring forwards a comprehensive dataset that will reflect the true degradation state of Dutch land. However, it is important to realise that every other data set that would be used as the basis of a land use change assessment would give different results because of difference in definition of the land use classes, differences in resolution, differences in the characterisation of the classes.
4. We conclude this report is currently not reflecting the situation of land degradation in the Netherlands. The parameters evaluated in the report are overestimated by as much as 50% as we can see in our fast evaluation. However, there are other land degradation processes that are currently not taken into account in this report, which are very relevant for The Netherlands to monitor, such as soil compaction, land subsidence, soil salinization and soil pollution.

Therefore, we would recommend to make a more detailed study of the current situation and make an assessment of the relevant land degradation processes and their indicators linked to the soil threats as they have been described by the European Commission. We recommend to design the way forwards in collaboration with existing Land Degradation Neutrality initiatives that are already running in The Netherlands.

# ANNEX 1: COMPARING AND IMPROVING UNCCD DATA WITH CORINE/TOP10NL/BBG/BKN/LGN

**Datasets available:**
The following relevant Land Cover datasets covering the entire dealing Netherlands exist:

1. CORINE Land Cover (CLC2000, 2006, 2012 and 2018)
2. Topographical data (Top10NL) which is continuously being updated
3. Bestand Bodemgebruik (BBG) with reference years 1993, 1996, 2000, 2003, 2006, 2008, 2010, 2012, 2015)
4. Basiskaart Natuur (BKN1990, 2004, 2009, 2013 and 2017)
5. Landelijk Grondgebruik Nederland (LGN1-7) with reference years 1986, 1994, 1997, 2000, 2004, 2008, 2012)

All datasets have their peculiarities regarding land cover classes, spatial detail and temporal frequency. Corine Land Cover (CLC) is a European wide harmonised dataset where the level of spatial detail is restricted compared to the other datasets. The CLC datasets are based on national expertise and interpretation, harmonised and managed by the EEA. The Landelijk Grondgebruik Nederland) LGN datasets has been produced on basis of the datasets under 2-4. Those datasets are integrated and additional information is added. This assessments will focus on the data coming from the LGN and CLC datasets.

**Land Cover classes:**
The look-up table (Table 1) shows how the LGN classes are aggregated into the UNCCD land cover classes. Sometimes it is not clear for a LGN class to which UNCCD class it belongs. **Questionable classes** are e.g. greenhouses, forest in built-up areas, grass in built-up areas, heathlands etc. Greenhouses are now grouped under cropland while you could also opt for artificial land. Grass in built-up areas is now grouped under artificial land while you could also opt for grasslands. Forest in built-up areas is however grouped under tree covered areas. Tree nurseries are now seen as cropland. Making another aggregation to the UNCDD class will affect the figures in Table 3.

Table 2 shows the look-up table for the CLC dataset. It presents how LEAC level 2 classes from CLC are aggregated into UNCCD land cover classes. The CLC data used in this assessment are coming from the European Environment Agency (EEA) and are part of the Copernicus Land programme.

**Frequency:**
Since 1990 the LGN dataset is produced at a regular interval of 3-5 years. In this analysis only the LGN versions 5, 6 and 7 are taken into account. LGN4 is not used as between LGN4 and LGN5 there is trend break due to methodological changes in the production of the dataset. LGN8 with reference year 2018 is in production.

At the moment no information is available for the years in between the reference years of LGN. Information can be produced for the in-between years if digital topographical data is existing for those years. A quantitative land cover change analysis will be more difficult (i.e. land cover matrix with changes from one land cover class to the other).

CORINE Land Cover (CLC) data are existing for the years 1990, 2000, 2006, 2012 and 2018. The data are available at three thematic levels and at level 3 there exist 44 land cover classes.

Table 1. Aggregation of LGN classes to UNCCD classes.

| | | UNCCD classes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | LGN classes | Tree cover | Grassland | Cropland | Wetland | Artificial | Other | Water |
| 1 | pasture | | X | | | | | |
| 2 | maize | | | X | | | | |
| 3 | potatoes | | | X | | | | |
| 4 | sugar beet | | | X | | | | |
| 5 | cereals | | | X | | | | |
| 6 | other agricultural crops | | | X | | | | |
| 61 | tree nurseries | | | X | | | | |
| 62 | fruit cultivation | | | X | | | | |
| 8 | greenhouses | | | X | | | | |
| 9 | orchards | | | X | | | | |
| 10 | flower bulbs | | | X | | | | |
| 26 | built-up areas outside urban areas | | | | | X | | |
| 11 | deciduous forest | X | | | | | | |
| 12 | coniferous forest | X | | | | | | |
| 16 | fresh water | | | | | | | X |
| 17 | salt water | | | | | | | X |
| 18 | urban built-up areas | | | | | X | | |
| 19 | semi urban built-up areas | | | | | X | | |
| 20 | forest in built-up areas/deciduous | X | | | | | | |
| 21 | coniferous forest in urban area | X | | | | | | |
| 22 | forest in semi built-up areas/built- | X | | | | | | |
| 23 | grass in built-up areas | | | | | X | | |
| 24 | bare soil in built-up areas | | | | | X | | |
| 28 | grass in semi built-up areas | | | | | X | | |
| 25 | main roads & railways | | | | | X | | |
| 30 | salt marshes | | | | X | | | |
| 31 | coastal sands | | | | | | X | |
| 32 | dune areas with low vegetation | | X | | | | | |
| 33 | dune areas with high vegetation | | X | | | | | |
| 34 | heathland in coastal areas | | X | | | | | |
| 35 | drifting sands / river sandbanks | | | | | | X | |
| 36 | heathland | | X | | | | | |
| 37 | grassy heathland | | X | | | | | |
| 38 | very grassy heathland | | X | | | | | |
| 39 | raised bogs | | | | X | | | |
| 40 | forest in raised bogs | | | | X | | | |
| 41 | other swamp vegetation | | | | X | | | |
| 42 | reeds | | | | X | | | |
| 43 | forest in swamp areas | | | | X | | | |
| 44 | swampy pastures in peat areas | | X | | | | | |
| 45 | natural grasslands | | X | | | | | |
| 46 | bare soil in natural areas | | | | | | X | |

Table 2. Aggregation of EAC level 2 CLC classes to UNCCD classes.

| LEAC level 2 classes | Tree cover | Grassland | Cropland | Wetland | Artificial | Other | Water |
|---|---|---|---|---|---|---|---|
| Arable land & permanent crops | | | X | | | | |
| Standing Forest | X | | | | | | |
| Pastures | | X | | | | | |
| Artificial surfaces | | | | | X | | |
| Water Bodies | | | | | | | X |
| Wetlands | | | | X | | | |
| Natural grasslands, heathland, sclerophylous vegetation | | X | | | | | |
| Transitional woodland shrub | X | | | | | | |
| Mosaic farmland | | | X | | | | |
| Open spaces with little or no vegetation | | | | | | X | |

**Land cover trends:**

Comparing the figures from Table 3 with those from the UNCCD shows **large deviations** in surface area for the classes "Artificial surfaces", "Cropland" and "Grassland". "Artificial surfaces" and "Grassland" surface areas are much higher in LGN then in UNCCD, while "Cropland" is occupying far less surface area in LGN then in UNCCD. Not including LGN greenhouses in "Croplands" will further reduce the area for "Croplands". Excluding LGN's grassland in urban areas from "Artificial surfaces" will decrease the area of "Artificial surfaces" but increasing the area of "Grassland". Not including all heathland and dune area classes in the "Grassland" class will reduce the surface area for this class but grouping them under "Tree covered areas" or "Others" will increase those classes (and becoming less comparable with the surface areas under UNCCD).

Trends in land cover according LGN are a decrease in "Cropland" and to a lesser extent in "Tree Covered area". The UNCCD data shows an increase in "Tree covered area" since 2004 (+3 km2) vs a decrease of 48km2 (LGN) (period 2004-2012) and a much smaller decrease in "Cropland" in the period 2004-2012 (-71km2) vs a decrease of 593 km2 according to LGN. UNCCD shows smaller increases in "Grassland" 106 vs 19km2 and for "Artificial land" 399 vs 64 km2 (LGN vs UNCDD, respectively). The largest decreases/increases in area for specific land cover classes are taking place in the period 2000-2004 according to the UNCCD data. After 2004 land cover classes are more or less stable in surface area.

Table 3. Areas for UNCCD land cover classes derived from Landelijk Grondgebruik Nederland database (LGN) (in km2).

| UNCCD classes | LGN7 (2012) | LGN6 (2008) | LGN5* (2004) | LGN7-LGN5* |
|---|---|---|---|---|
| Tree cover | 3832 | 3870 | 3880 | -48 |
| Grassland | 13385 | 13231 | 13278 | 106 |
| Cropland | 9201 | 9694 | 9793 | -593 |
| Wetland | 616 | 596 | 595 | 21 |
| Artificial | 6293 | 6034 | 5894 | 399 |
| Other | 121 | 119 | 116 | 4 |
| Water | 8102 | 7984 | 7970 | 132 |
| Total area* | 41549 | 41527 | 41527 | |

*The total area deviates from UNCCD figures due to the fact that a buffer area (sea) around The Netherlands is included.

For the periods 2004-2008 and 2008-2012 the type and area of land cover changes could be derived from the LGN datasets (Table 5 and 6). For the entire period 2004-2012 the type and area could also in principle being derived. However these change matrices do not match exactly with the UNCCD classes.

The absolute figures for the UNCCD LC classes are higher for the "Tree covered areas" and "Grassland" and much lower for the "Wetland" and "Artificial surfaces" classes. "Artificial surfaces" are like in LGN far higher than the figures coming from UNCCD. The higher figures for "Wetland" compared to LGN are due to the fact that in CLC part of the water is classified as intertidal flats which are aggregated to the class "Wetlands". "Cropland" in LGN is far less in surface area compared to CLC as mosaic farmland is aggregated to "Cropland" in CLC while it is partly also grassland.

Table 4. Areas for UNCCD land cover classes derived from CORINE Land Cover (CLC) (in km2).

| UNCCD\CLC | 2000 | 2006 | 2012 | 2018 | 2000-2018 | 2000-2012 |
|---|---|---|---|---|---|---|
| Tree cover | 3209 | 3210 | 3197 | 3200 | -9 | -12 |
| Grassland | 11082 | 10949 | 10911 | 10889 | -193 | -171 |
| Cropland | 14421 | 14161 | 13962 | 13872 | -549 | -459 |
| Wetland | 2916 | 2934 | 2958 | 2988 | 72 | 42 |
| Artificial | 4855 | 5209 | 5422 | 5485 | 630 | 567 |
| Other | 138 | 138 | 149 | 151 | 13 | 11 |
| Water | 3497 | 3517 | 3519 | 3533 | 36 | 22 |
| Total | 40118 | 40118 | 40118 | 40118 | | |

Large deviations in LC trends between UNCCD and CLC are for the classes "Artificial surfaces" and "Cropland", i.e. a much higher increase respectively decrease in UNCCD surface area for the reporting period. "Tree covered area" is decreasing more in UNCCD then in CLC. The trend for "Wetlands" is in contradiction between UNCCD and CLC.

**Land cover change matrices:**

The land cover change matrix LGN7 vs LGN6 (Table 5) shows that main conversion between 2008-2012 were from arable land (grassland and cropland) into urban area and nature areas (and to lesser extent into water bodies and forest). Another important conversion is from forest into nature areas. Also some forest is converted to arable land and water into urban areas.

Table 5. Land cover change matrix LGN7 vs LGN6 (km2) for 8 monitoring classes.

| | | | | | LGN7 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Arable land | Greenhouses | Orchards | Forest | Water | Urban Area | Infrastructure | Nature | Total |
| | Arable land | 3.2 | 6.2 | 5.1 | 15.9 | 16.5 | 110.2 | 7.1 | 34.2 | 198.3 |
| | Greenhouses | 4.9 | 0.8 | 0.0 | 0.0 | 0.1 | 2.0 | 0.1 | 0.0 | 7.9 |
| | Orchards | 5.0 | 0.3 | 0.3 | 0.2 | 0.1 | 1.6 | 0.0 | 0.0 | 7.5 |
| | Forest | 11.6 | 0.0 | 0.0 | 1.1 | 1.2 | 3.6 | 0.5 | 19.7 | 37.9 |
| LGN6 | Water | 0.1 | 0.0 | 0.0 | 0.1 | 1.0 | 10.9 | 0.2 | 2.8 | 15.1 |
| | Urban Area | 1.2 | 0.2 | 0.0 | 0.8 | 4.4 | 10.5 | 1.4 | 1.5 | 20.0 |
| | Infrastructure | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 2.1 | 0.1 | 2.6 |
| | Nature | 0.4 | 0.0 | 0.0 | 4.3 | 4.9 | 1.9 | 0.1 | 17.4 | 29.0 |
| | Total | 26.6 | 7.6 | 5.4 | 22.4 | 28.2 | 140.8 | 11.6 | 75.7 | 318.4 |

The land cover change matrix LGN6 vs LGN5 (Table 6) shows that main conversion between 2004-2008 were from arable land (grassland and cropland) into urban area. Also quite important is the conversion of arable land into nature areas, water bodies and greenhouses. Furthermore, greenhouses and forest were converted into urban areas. All other conversions are below 3 km2.

Table 6. Land cover change matrix LGN6 vs LGN5 (km2) for 8 monitoring classes.

| | | | | | LGN6 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Arable land | Greenhouses | Orchards | Forest | Water | Urban Area | Infrastructure | Nature | Total |
| | Arable land | 1.6 | 12.9 | 0.3 | 4.6 | 13.1 | 126.5 | 5.3 | 29.3 | 193.5 |
| | Greenhouses | 2.9 | 2.2 | 0.0 | 0.0 | 0.1 | 3.6 | 0.1 | 0.0 | 8.8 |
| | Orchards | 2.3 | 0.2 | 0.0 | 0.0 | 0.0 | 2.3 | 0.1 | 0.2 | 5.1 |
| | Forest | 2.0 | 0.0 | 0.0 | 0.2 | 0.2 | 3.5 | 0.6 | 7.5 | 14.0 |
| LGN5 | Water | 0.0 | 0.1 | 0.0 | 0.0 | 0.8 | 0.8 | 0.0 | 0.6 | 2.3 |
| | Urban Area | 0.3 | 0.3 | 0.0 | 0.7 | 1.3 | 21.4 | 1.0 | 0.5 | 25.6 |
| | Infrastructure | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 1.9 | 3.7 | 0.2 | 6.2 |
| | Nature | 0.1 | 0.0 | 0.0 | 0.3 | 1.1 | 1.6 | 0.0 | 0.4 | 3.6 |
| | Total | 9.4 | 15.8 | 0.4 | 5.8 | 16.6 | 161.6 | 10.9 | 38.7 | 259.1 |

Main processes in the Netherlands according to the CLC data for the period 2000-2018 are related to urbanisation and the conversion from farmland into natural land and/or forested land (see Table 7).

Table 7. Land cover flows 2000-2018 based on CLC2000-2018 (EEA preliminary data).

| Land cover flows 2000-2018 | km2 |
|---|---|
| urban land management | 171 |
| urban residential sprawl | 175 |
| sprawl of economic sites & infrastructure | 453 |
| agriculture internal conversions | 36 |
| conversions from forested and natural land to agriculture | 22 |
| withdrawal of farming | 231 |
| forest creation and management | 54 |
| water bodies creation and management | 46 |
| changes of land cover due to natural and multiple causes | 73 |
| No Change | 38857 |
| total | 40118 |

**References:**

UNCCD report
LGN5, LGN6 and LGN7 reports, G.W. Hazeu 2005, 2010 and 2014.
Land accounts for Europe 1990-2000 – Towards an integrated land and ecosystem accounting, EEA 2006.

# ANNEX 2: LAND USE CHANGE MATRIXES BASED ON LULUCF ASSESSMENT FOR UNFCCC

The following tables originate from the report:

Arets, E.J.M.M., J.W.H van der Kolk, G.M. Hengeveld, J.P. Lesschen, H. Kramer, P.J. Kuikman & M.J. Schelhaas (2017). Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological background, update 2017. Wageningen, Statutory Research Tasks Unit for Nature & the Environment, WUR. Wot-technical 95. 89 p; 10 Figs; 30 Tabs; 46 Refs. 3 Annexes.

Table 3.3

*Land Use and Land Use Change Matrix for 1990-2004 aggregated to the six UNFCCC land use categories (in ha)*

| | **BN 1990** | | | | | | |
|---|---|---|---|---|---|---|---|
| **BN 2004** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | 350,751 | 14,560 | 22,540 | 1,217 | 2,530 | 651 | 392,248 |
| Cropland | 1,605 | 739,190 | 196,595 | 596 | 1,623 | 8 | 939,617 |
| Grassland | 17,902 | 176,797 | 1,190,740 | 9,092 | 10,987 | 2,547 | 1,408,064 |
| Wetland | 1,822 | 6,821 | 18,641 | 776,007 | 1,390 | 2,583 | 807,265 |
| Settlement | 10,019 | 81,783 | 78,259 | 2,836 | 392,805 | 630 | 566,332 |
| Other land | 809 | 201 | 907 | 2,791 | 122 | 33,144 | 37,974 |
| *Total* | *382,907* | *1,019,353* | *1,507,682* | *792,539* | *409,457* | *39,563* | *4,151,500* |

| | **BN 2004** | | | | | | |
|---|---|---|---|---|---|---|---|
| **BN 2009** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | 377,584 | 2,304 | 8,827 | 466 | 6,155 | 238 | 395,573 |
| Cropland | 487 | 813,282 | 106,547 | 177 | 4,367 | 2 | 924,863 |
| Grassland | 6,417 | 108,480 | 1,243,329 | 9,633 | 23,123 | 506 | 1,391,488 |
| Wetland | 829 | 1,794 | 10,610 | 794,785 | 3,033 | 890 | 811,941 |
| Settlement | 6,694 | 13,729 | 37,705 | 1,441 | 529,417 | 137 | 589,123 |
| Other land | 238 | 27 | 1,047 | 762 | 237 | 36,200 | 38,512 |
| *Total* | *392,248* | *939,617* | *1,408,064* | *807,265* | *566,332* | *37,974* | *4,151,500* |

Table 3.5

*Land Use and Land Use Change Matrix for 2009-2013 aggregated to the six UNFCCC land use categories (in ha)*

| | **BN 2009** | | | | | | |
|---|---|---|---|---|---|---|---|
| **BN 2013** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | 380,255 | 2,791 | 9,672 | 763 | 3,346 | 494 | 397,320 |
| Cropland | 1,535 | 793,892 | 145,410 | 304 | 3,198 | 1 | 944,340 |
| Grassland | 7,778 | 116,002 | 1,194,126 | 6,180 | 20,653 | 970 | 1,345,709 |
| Wetland | 863 | 1,410 | 10,849 | 801,539 | 4,477 | 1,825 | 820,962 |
| Settlement | 4,907 | 10,740 | 30,915 | 1,311 | 557,312 | 328 | 605,512 |
| Other land | 235 | 28 | 516 | 1,846 | 135 | 34,897 | 37,657 |
| *Total* | *395,573* | *924,863* | *1,391,488* | *811,941* | *589,121* | *38,515* | *4,151,500* |

Table 3.6

*Annual changes in land us for the period 1990-2004 aggregated to the six UNFCCC land use categories (in ha $yr^{-1}$).*

| | **From** | | | | | | |
|---|---|---|---|---|---|---|---|
| **To** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | | 1,040 | 1,610 | 87 | 181 | 47 | 2,964 |
| Cropland | 115 | | 14,043 | 43 | 116 | 1 | 14,316 |
| Grassland | 1,279 | 12,628 | | 649 | 785 | 182 | 15,523 |
| Wetland | 130 | 487 | 1,332 | | 99 | 185 | 2,233 |
| Settlement | 716 | 5,842 | 5,590 | 203 | | 45 | 12,395 |
| Other land | 58 | 14 | 65 | 199 | 9 | | 345 |
| *Total* | *2,297* | *20,012* | *22,639* | *1,181* | *1,189* | *459* | *47,776* |

Table 3.7

*Annual changes in land us for the period 2004-2009 aggregated to the six UNFCCC land use categories (in ha $yr^{-1}$).*

| | **From** | | | | | | |
|---|---|---|---|---|---|---|---|
| **To** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | | 461 | 1,765 | 93 | 1,231 | 48 | 3,598 |
| Cropland | 97 | | 21,309 | 35 | 873 | 0 | 22,316 |
| Grassland | 1,283 | 21,696 | | 1,927 | 4,625 | 101 | 29,632 |
| Wetland | 166 | 359 | 2,122 | | 607 | 178 | 3,431 |
| Settlement | 1,339 | 2,746 | 7,541 | 288 | | 27 | 11,941 |
| Other land | 48 | 5 | 209 | 152 | 47 | | 462 |
| *Total* | 2,933 | 25,267 | 32,947 | 2,496 | 7,383 | 355 | 71,380 |

Table 3.8

*Annual changes in land us for the period 2009-2013 aggregated to the six UNFCCC land use categories (in ha $yr^{-1}$).*

| | **From** | | | | | | |
|---|---|---|---|---|---|---|---|
| **To** | Forest land | Cropland | Grassland | Wetland | Settlement | Other land | Total |
| Forest land | | 698 | 2,418 | 191 | 837 | 124 | 4,267 |
| Cropland | 384 | | 36,353 | 76 | 800 | 0 | 37,612 |
| Grassland | 1,945 | 29,001 | | 1,545 | 5,163 | 243 | 37,896 |
| Wetland | 216 | 353 | 2,712 | | 1,119 | 456 | 4,856 |
| Settlement | 1,227 | 2,685 | 7,729 | 328 | | 82 | 12,050 |
| Other land | 59 | 7 | 129 | 462 | 34 | | 690 |
| *Total* | 3,830 | 32,743 | 49,341 | 2,601 | 7,952 | 905 | 97,371 |

Recently a new report was made (not officially published yet at this moment)

Arets, E.J.M.M., J.W.H van der Kolk, G.M. Hengeveld, J.P. Lesschen, H. Kramer, P.J. Kuikman & M.J. Schelhaas (2019). Greenhouse gas reporting of the LULUCF sector in the Netherlands. Methodological background, update 2019. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), Wageningen. WOt-technical report @. 108 p

In this report the latest years were also analysed.

The change matrix that came out of this analysis is shown below:

Table 3.7

*Land Use and Land Use Change Matrix for 2013-2017 aggregated to the six UNFCCC land-use categories (in ha) with Grassland (GL) divided in GL non-TOF and Trees outside Forest (TOF).*

| | **BN 2017** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **BN 2013** | FL | CL | GL (non-TOF) | TOF | WL | Sett | OL | Total |
| Forest land | 356,633 | 1,662 | 9,345 | 2,012 | 804 | 4,886 | 404 | 375,744 |
| Cropland | 902 | 762,447 | 170,184 | 245 | 1,674 | 8,865 | 24 | 944,340 |
| Grassland (non-TOF) | 4,816 | 103,116 | 1,197,036 | 1,500 | 9,185 | 28,661 | 1,394 | 1,345,709 |
| Trees outside forest | 1,143 | 205 | 1,658 | 16,549 | 146 | 1,834 | 41 | 21,576 |
| Wetland | 837 | 291 | 6,711 | 191 | 805,948 | 4,306 | 2,678 | 820,962 |
| Settlement | 1,034 | 2,582 | 21,372 | 710 | 1,559 | 578,065 | 191 | 605,512 |
| Other land | 215 | 7 | 736 | 34 | 1,399 | 429 | 34,838 | 37,657 |
| *Total* | 365,579 | 870,310 | 1,407,040 | 21,240 | 820,715 | 627,046 | 39,570 | 4,151,500 |