Method for determining CO_2 equivalent emissions reductions

Type of project:

CO_2-emission reduction through increase in groundwater levels in peatland areas (Paying for Peat)

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Contents

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001	First publication after adoption by Green Deal National Carbon Market	December 20 2018
002	Update: - Adjustment for application in raised bogs - Adjustment following November 2019 trial validation – checking consistency	February 14 2020

1. Introduction

Lowering the water level in peat meadow areas ensures, among other things, that large quantities of peat oxidize. As a result of this, each year, 7 million tonnes of CO_2[1] are released in the Netherlands. Most of this CO_2 is released in the provinces of Friesland (24% of these annual emissions), Drenthe (22%) and South Holland (15%) because of the large areas of peatland combined with intensive land use in these provinces [Statistics Netherlands, 2017]. In addition to the active lowering of water levels in agricultural peat areas, there is also drying in existing natural peat areas resulting from lower groundwater levels and oxidation of peat.

Reducing CO_2 emissions in peatland areas is currently not an obligation in the Netherlands. It is, however, part of the Paris Climate Agreement in a broader context. Agreements have been made under the heading *land use, land use change and forestry* (LULUCF)[2]. This EU regulation states that each country should ensure that emissions from these activities do not lead to a net increase in CO_2 emissions. In the case of an increase in CO_2 emissions from LULUCF activities, there should at least be carbon offset compensation. Each country has the freedom to take specific measures for this at national level. An agreement has also been made at EU level to report these emissions from 2021. This EU policy therefore encourages a reduction of emissions from peat oxidation and an increase in the amount of carbon captured by peat growth.

[1] According to Statistics Netherlands, this corresponds to the CO_2 emissions of more than half a million households [Statistics Netherlands, 2017].

[2] See also https://ec.europa.eu/clima/lulucf_en

2. Description of the project type

In the project type Paying for Peat (Valuta van Veen, VvV), CO_2 emissions are reduced by raising the water level in peat areas - whether or not they are in agricultural use - so that oxidation of the peat and thus CO_2 emissions are avoided. This method applies to peat meadow areas with a sufficiently thick peat layer ('raw peat') and for the conservation and development of new nature areas (nature restoration and expansion in peat areas). The meaning of 'sufficiently thick' is a peat layer that is at least as thick as the groundwater level prior to the water level increase. For example, if the groundwater level is 90 cm below ground level, the peat layer should also have a minimum thickness of 90 cm. If the peat layer is less thick - for example 70 cm - then the starting situation is not a groundwater level of 90 cm, but instead, a groundwater level that starts in the peat layer (in this example, at 70 cm) is used. For areas where the soil layer consists of clay on peat, an adapted approach based on this method is used.

An important principle of Paying for Peat is that increasing the water level is undertaken on a voluntary basis. When several landowners are involved in the project, they can jointly determine how much the level will be increased compared to the prescribed baseline (see Section 5). This is then laid down for a certain period of time under a private agreement. If only one landowner is involved, such an agreement is not necessary. In the most far-reaching application, a landowner can raise the water level above ground level. In that case wet crops will be grown, paludiculture will be practiced, or the area will maintain or acquire its function as a natural wetland.

As far as is known, this type of project has not yet been applied in agricultural areas in the Netherlands or elsewhere. Known applications in other countries with the use of CO_2 certificates concern conversion of agricultural areas into nature, for example Moorfutures[3] in Germany, or restoration of peatland areas like Peatland code projects[4] in England. With regard to wet crops, various field trials are under way in the Netherlands and a start is being made on the commercial cultivation of cranberries in peat meadow areas. Nature management organizations in the Netherlands are also faced with the challenge of preserving the peat that still exists but is threatened by desiccation.

Three approaches to 'Paying for Peat'

This project type can be implemented in three different ways:

1. Paying for Peat with continuation of agricultural meadow function: The water level in the peat meadow area is raised, but the area continues its agricultural function for growing grass. This includes the extensification of agriculture, in combination with forms of agricultural nature management with an elevated water level, including the change of agricultural areas into nature reserves. For the time being, plots with underwater drainage and pressure drainage[5] are excluded from this project type. The reason for this is that this approach to raise water levels, and the influence this has on CO_2 emissions, are still under investigation. No reliable measurement data are currently available to determine the level of CO_2 reduction on plots where underwater drainage and pressure drainage are used. As soon as these data become available, it should be determined whether and how they should be included in the method.
2. Paying for Peat in combination with wet cultivation (paludiculture): The water level in this application is set so high that the area is made suitable for growing crops other than grass, especially crops that thrive particularly well at higher water levels (bulrush or reedmace, cranberries, etc.). Here too, the area retains its agricultural function.
3. Paying for Peat with nature development: With this project type, the function of the area is changed to nature by raising the water level to such an extent that nature benefits optimally, within the preconditions of the required nature management. This category also includes efforts by nature management organizations to conserve or expand existing but threatened low-lying or raised peat areas.

[3] See www.moorfutures.de

[4] See www.iucn-uk-peatlandprogramme.org/peatland-code

[5] With pressure drainage, the drainage pipes are connected to an above-ground water storage facility. This allows the water level to be accurately regulated over the entire plot - also in times of drought.

The basis for these three approaches is the same. Here and there, additional elements are required for one of the three approaches, which is explained in more detail in the following chapters. The operation of the project type is explained in more detail in Box 1.

Box 1. How does peat oxidation work?

Under wet, anaerobic (oxygen-free) conditions, dead vegetation does not completely decompose, but accumulates in the form of peat. This has resulted in peat layers many metres thick in parts of the Netherlands. Peat grows in this way by a few millimetres per year. Peat degradation occurs in a similar way, but about 10 times faster. As soon as peat comes into contact with oxygen in the air, the peat decomposes through the oxidation process. What has built up over a century is thus broken down in 10 years. During this process, the carbon, which is stored in the organic matter and peat, is released again in the form of CO_2.

In general, the lower the groundwater level, the more peat oxidizes and the more CO_2 is released. At high groundwater levels, however, more methane (CH_4) is released (CH_4 is a greenhouse gas 28 times stronger than CO_2). There may also be nitrous oxide (N_2O) emissions (N_2O is a greenhouse gas 265 times stronger than CO_2). We always calculate the total greenhouse gases that are emitted or measured, in units known as CO_2 equivalents, i.e. the relevant greenhouse gas is converted into units of CO_2. A total of three greenhouse gases are included: CO_2, CH_4 and N_2O. This is done in order to compare the quantities with each other, since each greenhouse gas has a different strength of greenhouse effect. Other factors that influence CO_2 emissions are fertilizing and working the land (ploughing). The relationship between groundwater level and greenhouse gas emissions (CO_2, CH_4 and N_2O) is shown below [Jurasinski et al, 2016].

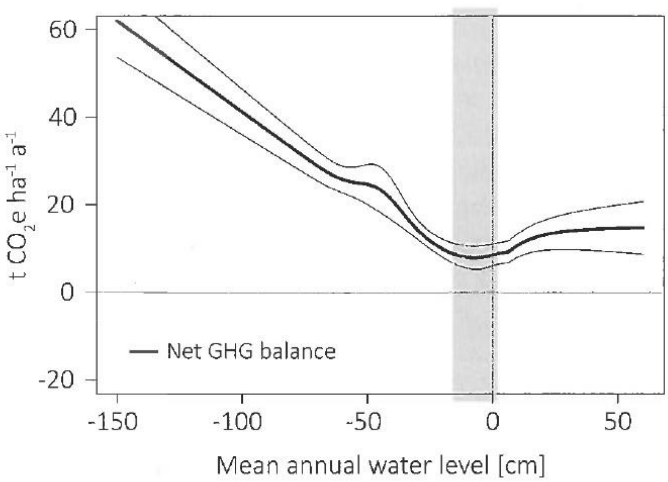

Figure 1. Relationship between groundwater level and greenhouse gas emissions (CO2-equivalent)

The relationship between groundwater level and CO_2 emissions alone is shown below [Fritz, C. et al. 2017]. (Note: CH_4 and N_2O emission not included, these are shown in Table 1)

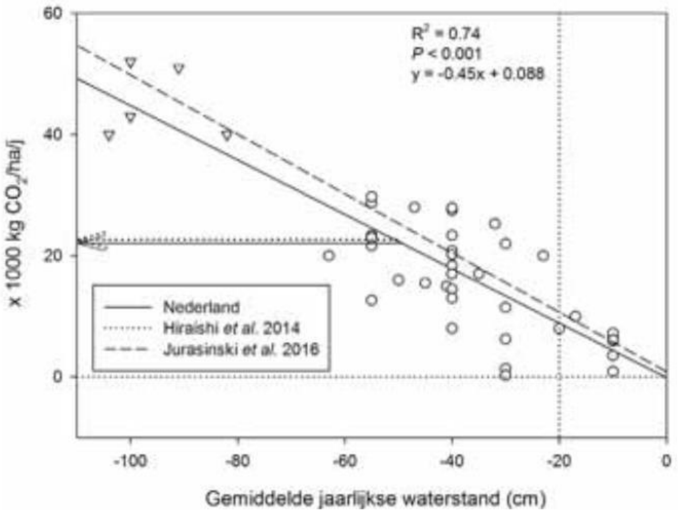

Figure 2. Relationship between groundwater level (x-axis) and CO_2-emissions (y-axis)

3. Determination of additionality of emission reduction

The Dutch national Climate Agreement (June 2019)[6] contains no obligation to reduce CO_2 emissions from peat areas. There will be funding for a number of pilot projects, but no generic subsidy scheme. The measure is also included in the Paris Climate Agreement (2015), but only with the option of not increasing net land use emissions. As long as politics does not impose an obligation to prevent peat oxidation, Paying for Peat can be used as a measure to generate additional emission reductions (and thus carbon certificates). Should the (partial) reduction of CO_2 emissions from peatland areas become mandatory in due course, the Paying for Peat approach can anticipate this by increasing the ambition; that is, a project will raise the groundwater level higher than required by policy. Paying for Peat can then be applied for that additional part. For the rule on additionality, reference is made to the Rulebook item **Additionality of emission reductions** of the National Carbon Market Foundation[7].

Additionality of Paying for Peat with retention of agricultural meadow function

The lowering of water levels occurs in all peat meadow areas that are in agricultural use in the Netherlands. The degree to which the water level has been lowered in relation to the ground level, however, differs between provinces and areas. Without additional measures the lowering of water levels will remain in place.

In the agricultural sector, the water levels have been lowered so that farmers can access the fields earlier and later in the season and thus enjoy bigger and longer harvests. Yields are also assumed to be higher at lower water levels. Water level increases therefore lead to a loss of income for the farmers. While other crops may be able to replace income from growing grass, or in some cases be more financially attractive, there is still a financial risk attached to growing wet crops. This can be seen in the very diverse calculations of financial yields per hectare, the uncertain sales market and the high start-up investments. The income from Paying for Peat can act as a financial incentive to the transition to wet crops. This also fits with the idea of voluntary CO_2 certificates, and contributes to the transition to a more sustainable society.

Paying for Peat, while retaining the meadow function, can be combined with agricultural nature management. The land user then receives an agricultural nature management subsidy based on the CAP[8]. A combination with Paying for Peat is only possible if the soil is made wetter than is necessary for an agricultural nature objective. Only then is the increased water level considered to show additionality. In peat meadow areas, this often involves the use of policy instruments for meadow birds.

Additionality of Paying for Peat with nature development or nature conservation

Nature development or nature conservation are only considered to show additionality if more has been done than is required from the nature objective (comparable to what has been described above about agricultural nature management). After all, a management subsidy is already provided for these purposes. The water level specified for the prescribed management subsidy is then the baseline. Everything that is done above that is considered to be additional, and is eligible for CO_2 certificates. All nature restoration that is done in addition to the obligations of the Nature Network of the Netherlands (NNN), whereby CO_2 emissions from peat are prevented and CO_2 is possibly stored (in the form of carbon), is eligible for financing with CO_2 certificates. After all, an additional effort has been made to prevent CO_2 emissions. This applies both to the creation of nature areas outside the boundaries of the NNN, and to a management type in which the water level is set at a higher level than that required for the nature target type, but that is authorized by the competent authority.

[6] Climate Agreement, The Hague, June 28, 2019, https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/national-climate-agreement-the-netherlands

[7] https://nationaleco2markt.nl/wp-content/uploads/2019/12/Beleidsadditionaliteit-2.0.pdf

[8] CAP; EU Common Agricultural Policy.

Conclusions:

- In peat meadow areas that are in agricultural use, a low water level is commonplace;
- As long as no obligation is imposed on farmers to raise the water level, a voluntary water level increase is considered to be additional;
- Paying for Peat can be combined with agricultural nature management, the conversion of agricultural land into nature, and the development or conservation of nature areas. These measures are considered to be additional when there are higher water levels than are required by the nature subsidy, or when/insofar as there is no government subsidy.

4. Determining the project boundary

The project boundary is determined by the agricultural or nature area in which the water level will be raised for the benefit of Paying for Peat. Such an area is part of the peat meadow area in the Netherlands, or is one of the remaining natural low or raised peat areas in the country. An area where Paying for Peat is applied should be a single unit from a water management point of view, so that the increase in the level can actually be realized. Or the water level in the area should be independently adjustable by the landowner.

The calculation takes into account greenhouse gas emissions other than CO_2 (in this case methane and nitrous oxide). The unit tonne of CO_2 equivalents per hectare per year are taken into account (see also Box 1).

For the total CO_2 balance, it is important to know whether a Paying for Peat project within or outside the project area has other effects. If such effects occur and these are a result of the actions of the landowners/users themselves, this should be included in the CO_2 emission reduction calculations. Possible effects that can occur are:

➢ Number of cows

Extensifying the agricultural business (in part) as a result of applying Paying for Peat could possibly have an effect on the number of cows - and related methane emissions - on farms or elsewhere.

The stocking density and the associated manure standards are based on phosphate rights and land area. A large part of the Dutch dairy herd is permanently kept indoors. The basic premise is that farmers will retain their livestock and possibly supply roughage from elsewhere if the peat pasture areas are moderately wet. Then there is no impact on emissions from livestock. However, the additional CO_2 emissions as a result of the supply of roughage will have to be included in the calculation (see also 'crop yield' below).

In case of further water level increases and possible reductions in livestock numbers, farmers will sell phosphate rights, resulting in an increase of livestock elsewhere, but emissions from dairy cows will not change nationally. There are no phosphate rights for beef cattle; a reduction in the beef herd does not therefore lead to growth elsewhere in the Netherlands, but this is difficult to determine.

On the whole, we do not expect an increase or decrease in greenhouse gases in peat pasture areas caused by a changing number of cows. This is therefore not included in the calculations.

➢ Crop yield

A higher water level reduces the crop yield. This is especially true for the protein-rich first cut when growing grass. However, according to some experts, drought damage occurs in dry summers. A higher water level in summer helps to combat this drought damage. If a higher water level leads to a lower yield, feed from elsewhere will have to be purchased or the production of animal feed on the farm needs to be increased. In the total CO_2 balance, the CO_2 emissions caused by these activities (more transport movements/higher feed production on farms) are discounted (see chapter 6 "Determining project emissions"). An exception to this is the situation where the project area is used by a SKAL certified organic farmer, because he cannot use alternatives that lead to higher CO_2 emissions elsewhere, including on roads, to compensate for lower animal feed production, as explained below (‘dewatering of peat soil elsewhere’ and 'management'). The flat-rate deduction of CO_2 emissions as explained in Chapter 6 therefore does not apply to organic farmers. Proof of SKAL certification should be included with the project plan by organic farmers.

➢ Dewatering of peat soil elsewhere

If agricultural production cannot take place, or is reduced, because the peat meadow area in question is used for CO_2 emission reduction/storage, or for cultivation of wet crops, agricultural production can be increased elsewhere. Within the area boundaries of the project, other areas of land that have not previously been used may be used. This land can then be dewatered and additional peat can oxidize. The same intensification can also take place far beyond the planning area. If this occurs on peat soil by additional level reduction, the CO_2 emission reduction will on balance be less or even cancelled out. If this is done by the choices and actions of the landowner himself, this should be taken into account in the calculation of the CO_2 emission reduction by the project.

As far as the displacement of CO_2 emissions within the Netherlands is concerned, there is no danger of peatland being reclaimed for agricultural use. All peat soil is in use, either for agriculture, or as protected nature reserves. In the Netherlands, the water level is also fixed in these areas. There are no indications, nor does it seem realistic to assume that peat areas with a natural function will be taken into agricultural production or that existing peat pasture areas in agricultural use will be strongly intensified in the Netherlands[9]. It is conceivable, however, that the choice for high water levels in the context of agricultural nature management will revert to 'pure' agricultural use with old, lower levels after a period of six years (the duration of agricultural nature management subsidy contracts). In this case, the agricultural nature conservation subsidy will stop and it will be possible to compensate for the entire water level increase through CO_2 certificates.

It is also possible that other (peat) plots become more intensively fertilized and managed within an agricultural company, as a result of which the CO_2 emissions from these plots increase in the calculations (see chapter 7 "Calculation of emission reduction"). A fixed value of 0.4 tonnes of CO_2 eq./ha is used in this situation, which is always applied to the entire area (with the exception of organic farmers where this factor is not applied at all).

Since the Green Deal National Carbon Market is a system for a voluntary national carbon market, developments outside the Netherlands are not taken into account

Management

A wetter peat meadow area has different management from a conventional deeply drained area. With a higher water level, a farmer can often not enter the land in the spring and autumn. It is also assumed that crop production is lower, so that mowing is less frequent. This reduces the CO_2 emissions of agricultural machines. On the other hand, land use could become more intensive during the months that a farmer can enter the land. The extent to which this happens is further substantiated in Chapter 7 (Calculation of emission reductions).

When converting to wet crops, marshes or nature with a water level above ground level, the formation of methane and nitrous oxide plays a role in the total emissions of greenhouse gases. The formation of these gases is taken into account in the total CO_2 balance (see also Box 1 and Chapter 6 on "Project emissions").

➢ Removal of peat-rich material

When the function of peat meadows changes to nature, it may happen that the peat-rich top layer is removed and disposed of outside the project area. If this peat is exposed to the air, this will lead to increased CO_2 emissions outside the project area. If this happens, these emissions must be included in the total CO_2 balance of the project (see also chapter 6).

Conclusions:

- The project boundary is the area where the water level is raised;
- The calculation of the total avoided CO_2 emissions only includes those effects that the landowner/user can influence himself;
- The following effects should be included in the calculation, if applicable: the supply of extra cattle feed from elsewhere, the more intensive use of other peat meadow parcels within the company, and a different management and the removal of peat soil outside the project area; and
- The following effects are not included within the project boundary: an increase in the number of livestock within the company and/or elsewhere and/or the conversion of peat meadow areas for intensive agricultural use.

[9] For peat areas that are in agricultural use, these peat areas are already being used very intensively or the water levels cannot be lowered further due to the applicable water level policy.

5. Determination of the baseline

Peat meadow areas with retention of agricultural function

The water level of drainage ditches is known in the peat meadow areas[10], because it has been established in water level decisions. This is often based on a provincial policy. The average (established) water level of drainage ditches is known for each Province/Water Board. The water level of drainage ditches that is most commonly used in a Water Board can be seen as the usual practice in this part of the peat meadow area: for this project type, this current water level of drainage ditches becomes the baseline. Since the current water level of drainage ditches is different in every Province/Water Board, the baseline must be substantiated in every Water Board/Province.

A water level below this baseline is not eligible for CO_2 certificates, because the emission reduction by a project is only considered additional if it exceeds the reduction already resulting from other policies (see chapter 2 "Determining additionality of emission reduction"). In addition, it regularly happens in practice that the water level is higher than what is necessary according to a legal water level decision. Since we want to compensate the actual CO_2 emission reduction with CO_2 certificates, it is important to know what the actual water level was before it was raised. In other words: if the water level in an area is on average higher than the water level decision, the actual average water level becomes the baseline. The latter is determined by measuring the water level on a comparable neighbouring plot or determining the average ground and water level of drainage ditches before the intervention takes place on the basis of previous measurement data (see also chapter 8 "Monitoring").

If there is a subsidy from ANLb (Subsidy Scheme for Agricultural Nature and Landscape Management), the baseline is the water level that applies to the nature target type concerned. Only level increases above this level and outside the period during which the mandatory level from the subsidy must be raised, are eligible for CO_2 certificates.

The emissions are determined annually on the basis of the relationship between CO_2-eq emissions and average groundwater levels. The relationship of groundwater level/CO_2 emissions from Fritz et al, (2017), as shown in Figure 3 is used for this purpose.

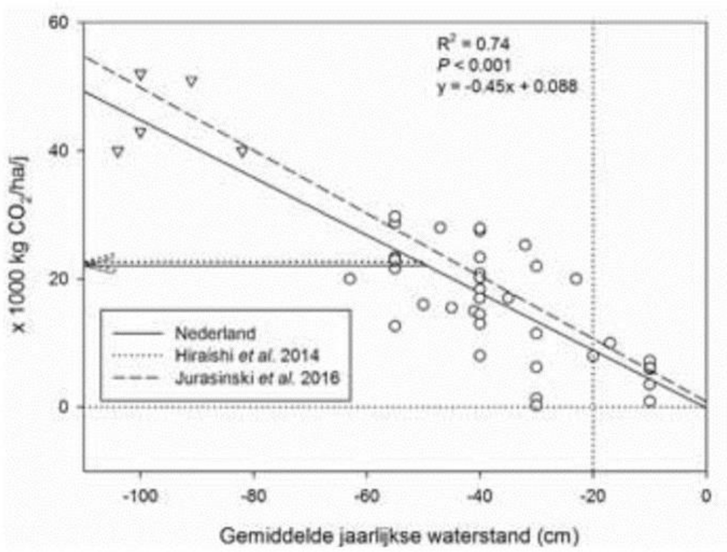

Figure 3. Relationship between CO_2 emissions per ha/yr (x-axis) at groundwater levels between ground level and below (y-axis) for Dutch peat meadow areas (solid line) and elsewhere (Jurasinski et al. 2016) [Fritz et al., 2017]. (Note: CH_4 and N_2O emission not included, these are shown in Table 1)

[10] The term 'water level' refers to the ground water level **and** the water level in drainage ditches. In other cases it is specified whether ground water level **or** water level in drainage ditches is meant.

It should be noted that the CO_2 emissions in Figure 3 have been calculated conservatively. The emissions in the graph apply to extensively used peat pastures. With more intensive use (more fertilization and tillage), CO_2 emissions increase. By assuming more extensively used soils in the graph, the emissions are lower than would be expected for intensively used peat pastures. In that sense, the calculated emission reduction due to water level increase is on the conservative side [oral statements by researcher C. Fritz]. This reduces the risk of an overestimation of expected payments.

The calculation is based on an annual average CO_2 emission. Fluctuations resulting from, for example, changes in temperature or fertilization have been taken into account.

Where necessary, adjustments should be made for methane and nitrous oxide emissions (in CO_2 eq.) in relation to the groundwater level (see Table 1 for these emissions). At groundwater levels above ground level, these total CO_2 eq emissions from methane and nitrous oxide are derived from Jurasinski et al. (2016) (see also Box 1). It should also be mentioned that the emission of nitrous oxide can vary as a result of the fertilization regime. For practical reasons, it was decided to use one value per groundwater level for this.

Table 1. CO2-eq emissions of CH_4 and N_2O emissions during peat breakdown, based on average groundwater level, derived from Jurasinki et al, 2016. (Note: these figures do not *include CO2-eq figures from carbon dioxide, these are shown in Fig. 2 and 3)*

Average groundwater level [cm]	CH_4- and N_2O-emissions [tonne CO_2-eq/ha/jaar]	Total CO_2-eq emissions [tonne CO_2-eq/ha/jaar]
50		14,9
40		14,6
30		14,3
20		13,5
10		10,8
0	8,9	
-10	4,0	
-20	1,9	
-30	2,6	
-40	4,4	
-50	4,5	
-60	1,8	
-70	0,2	
-80	0,0	
-90	0,0	
-100	0,0	

Figure 3 and Table 1 show what the emissions are at certain water levels. Based on the increase of that water level it can then be determined which emissions have bee n avoided.

Procedure for revision of the Paying for Peat baseline while retaining the agricultural meadow function

It is conceivable that a higher water level will be made mandatory for agricultural areas in the future. In that case, the baseline should be adjusted for new but also ongoing projects. After all, CO_2 certificates can only be issued if the CO_2 emission reduction is more than that based on other policy or law (see also Chapter 3 on additionality). A balance is sought between accurate determination of additional emission reductions on the one hand, and the need of investors for reasonable investment security on the other. That is why in this method, this project type has been chosen for a period of 10 years for current projects, for which additionality and baseline are determined. After the 10-year period, the additionality and baseline will be re-established for a subsequent 10-year period. If a policy change takes place in the course of a period, for example after 8 years, it will only be incorporated into the project plan of an ongoing project during the revision after 10 years. The 10-year period is used in accordance with other similar projects and programmes, such as the Verra certification system (formerly the Verified Carbon Standard (VCS)).

Moreover, this is a period in which nature has the opportunity to develop. New information, however, as incorporated in the updated method document, will immediately be applied to new projects.

Paying for Peat in combination with the growing of wet crops

For the application of Paying for Peat for wet crops, the water level is almost raised to the maximum level. The same baseline applies as for Paying for Peat with agricultural use as peat pasturage. In addition, other crops also store additional carbon in the soil by leaving behind root residues. This should be compared to the number of kilogrammes of dry matter normally captured in a grassland mat. The latter becomes part of the baseline.

Here too, the policy can change over the years. It is therefore logical not to let the period up to the first evaluation point be too long, in order to be able to adjust the baseline to what is required by law. Here too, a first term of 10 years has been chosen.

Paying for Peat with nature development or nature conservation

In areas that will have a natural function after the water level increase (= nature development) or when the level increase is implemented in existing nature areas, the project duration is assumed to be a much longer project period, namely 50 years. The reason is that (new) nature reserves may be based on a stable long-term situation because the status of nature reserves is laid down by law or planning regulations. As a rule, nature management organizations have no reason to change the function again. If that is insufficiently laid down in statutes or other documents - for example for private nature managers - this can still be recorded by a notarial document. It is also important that nature in these peat areas has the opportunity to recover. The same period is also used for Moorfutures[11], which is a project with a similar design. If the nature reserve is eligible for a subsidy from SNL (Subsidy Scheme for Nature and Landscape), the baseline that applies is the water level that is stipulated for the nature target type concerned. Only additional water level increases are eligible for CO_2 certificates. The summer half of the year is especially important because this is when peat oxidation processes are most active.

Considering the values for the emissions of the other greenhouse gases, it can be assumed that no nitrous oxide emissions will occur if no fertilization takes place.

Although natural areas may assume a project duration of 50 years, here too the baseline should be periodically evaluated. For areas that will have a new nature function, or that will retain this function (through adapted management), a frequency of 10 years should be assumed, after which the baseline will be evaluated and adjusted if necessary if there are changed insights. If a nature management organization can then rely on new management subsidies, the income from CO_2 certificates is no longer necessary. In any case, there should be no wrongful collection of this income from subsidies.

Conclusions:

- A standard water level for the Province/Water Board is chosen as the baseline. The baseline may differ by Province/Water Board. Certificates can only be claimed for water levels from the baseline and above;
- The actual level of the groundwater in the initial situation is determined by prior monitoring or on a control plot;
- If a combination is made with agricultural nature management - ANLb - a baseline is used that belongs to the relevant nature target type;
- For nature - if there is a subsidy from SNL - a baseline is chosen that belongs to the SNL nature target type;
- The CO_2 emissions at the baseline level (or a higher groundwater level as used before the level was raised for the Paying for Peat project) are scientifically substantiated (Fritz et al., 2017 and Jurasinski et al., 2016);
- A project duration of at least 10 years is maintained for areas with an agricultural function, and 50 years for areas with a nature function. In each case, an evaluation should be made after 10 years of whether the baseline should be adjusted due to changed circumstances or insights.

[11] See footnote 3.

6. Determining project emissions

Paying for peat with retention of agricultural function

The quantity of CO_2 released in a peat meadow area depends on the groundwater level and the management of the soil[12]. This quantity is calculated by monitoring the groundwater level, which is continuously measured. The CO_2 emissions at that groundwater level are calculated on the basis of these measurements. In addition, CO_2 emissions are calculated as a result of, among other things, the supply of additional animal feed from elsewhere (negligible) and a different management (0.4 tonnes of CO_2 eq/ha; see Chapter 4, Project limit). Together, these elements produce the emissions as they will be after the realization of the project. As explained in Chapter 4, this flat-rate deduction always applies to the entire project area, but not to organic farmers.

For projects in which the agricultural function is maintained (Paying for Peat with continuation of agricultural meadow function, Paying for Peat in agriculture, in nature, and in combination with the cultivation of wet crops), there is a risk that a project will lead to more CO_2 emissions, for example by extra fertilizing and ploughing of grassland elsewhere in the peat meadow area. In connection with these risks, a fixed percentage of 10% is deducted from the emission reduction calculated in Chapter 7 (calculation of emission reduction). For Paying for Peat with nature development (see below), these risks are not expected and no deductions will be made.

Paying for Peat in combination with wet crops

The cultivation of wet crops, and of bulrush in particular, is relatively unfavorable with regard to the emission of methane and nitrous oxide. Because the stem is a long pipe, methane can readily escape through it. In addition, methane is mainly released as gas bubbles from the soil when the cultivation is under water. By periodically dropping the water level to produce temporary ‘dry’ conditions for the crops during the growing season, this methane source can largely be avoided. This should therefore be the standard cultivation practice.

The methane and nitrous oxide emissions from wet crops, expressed in the form of CO_2-eq., are taken into account in the total amount of avoided CO_2 emissions. Emissions at ground level are approximately 8.9 tonnes of CO_2eq/ha/yr (see Table 1). This roughly corresponds to “Landschap Noord-Holland's” (North-Holland Land management body) estimate of 10 tonnes of CO_2eq/ha/yr for bulrush cultivation [Landschap Noord-Holland, 2014]. Correction for methane and nitrous oxide emissions is made using Table 1.

If turf is removed during flooding, this reduces the emission of methane. It is not known what level of methane emissions can be avoided in this way. As long as there is no reliable data for this, it is assumed that the turf has not been removed and that there will be methane emissions.

Paying for Peat with nature development

Methane can also be released during conversion to or preservation of the nature function (depending on the groundwater level and nature type). These quantities are taken into account when calculating the total CO_2 emissions.

As described above for wet crops, additional methane emissions occur when the existing turf is flooded. In this case, compensation should be paid (see Table 1 above). This can be prevented or reduced by cutting the turf. It is not known what level of methane emissions can be avoided in this way. As long as no reliable data are available, no correction is made for this. It is known from practical experience that turf cutting, in combination with the excavation of the top 30 centimetres, reduces methane emissions to zero [oral statements by C. Fritz]. In that case, there is no need to correct for methane emissions.

If the soil is cut as turf and applied in such a way that it comes into contact with air, this causes additional CO_2 emissions. In this case, it must be made clear how much peat this oxidizes and how much CO_2 is released annually and for what period this applies. These extra emissions are then included in the calculation of the total CO_2 balance.

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[12] In addition to the water level, tillage (preparation and sowing of the grassland, ploughing) and fertilization (number of applications of fertilizer and type of manure) have an impact on CO_2 emissions.

7. Calculation of emission reductions

Paying for Peat with retention of agricultural meadow function

Chapters 5 and 6 explain how the baseline for a project and the emissions from the project scenario are calculated. The emission reduction is the difference between the emissions in the baseline and the emissions after an increase in the groundwater level. In addition, if necessary, in accordance with Chapter 6, emissions that are caused by the actions of the landowner as a result of the project are calculated.

The calculation of the total annual emission reduction is then:

CO_2-eq emission reduction per hectare in year t = CO_2-eq emission/ha $_{\text{baseline, t}}$ – (CO_2-eq emission/ha $_{\text{project, t}}$ + 0.4 t CO_2- eq/ha $_{\text{fixed deduction in case of non-organic farmer}}$) – 10% $_{\text{risk adjustment, t}}$[13]

Example of water level increase in peat meadow:

The sum of CO_2 eq. emissions at t = 0 (start of the project) is 40 tonnes of CO_2 eq./year/ha. By carrying out the project, this is reduced during a year (t = 1) to 20 tonnes of CO_2 eq./ha. In addition, if the project does not involve an organic farmer, it is assumed that 0.4 tonnes of CO_2 eq./ha were emitted as a result of changes in management.[14] The total emissions per hectare avoided in a year are thus 40 - (20 + 0. 4) = 19.6 tonnes of CO_2 eq./ha. Minus the uncertainty margin, 17.6 tonnes of CO_2 eq./ha/year are avoided for which certificates can be applied for.

Paying for Peat in combination with the growing of wet crops

The emission reduction for wet crops is calculated in the same way as above. For these crops, the carbon sequestration in permanently remaining root residues in the soil is also included in the CO_2 calculation. The emission reduction here is the difference between the carbon sequestration that took place in the turf during the production of grass (see baseline) and the permanent sequestration in the specific wet cultivation (eg bulrush root mat). For bulrush, in practice (one-off) an average of 20 tonnes of CO_2/ha is stored underground compared to grass cultivation (oral statement by researchers C. Fritz and J. Geurts, Radboud University).

In addition, it depends on the type of crop whether the carbon content of the foliage is stored for a long time or is released almost immediately (long versus short cycle). This is only relevant for climate policy (long-cycle sequestration) when there are crops with a long lifespan. Even if this is the case, it is not included in this method because it is up to the customer whether or not the crops are processed in such a way that the carbon is fixed on a long cycle (processing in building material) or short-cycle (processing into fodder). The grower of these crops has no say in this.

Calculation example: emission reductions by cultivation of bulrush:

The sum of CO_2 eq. emissions at t = 0 (start of the project) amounts to 40 tonnes CO_2 eq./ha/year. By carrying out the project, this will be reduced during a year (t = 1) to 10.8 tonnes of CO_2 eq./ha/year (based on a groundwater level 10 cm above ground level, see Table 1). Approximately 20 tonnes of CO_2 eq./ha are also recorded as root material on a one-off basis. If this is spread over a period of 10 years, it amounts to approximately 2 tonnes of CO_2 eq./ha/year which is additionally recorded.

In total, 40 - 10.8 + 2 = 31.2 tonnes of CO_2 eq./ha were avoided in one year. Minus the uncertainty margin, 28.1 tonnes of CO_2 eq./ha/year are avoided for which certificates can be applied for.

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[13] This 10% deduction does not apply to Paying for Peat with nature development.

[14] According to the Agricultural Economic Institute (LEI), a first indicative calculation shows that a higher water level leads to less nitrogen mineralization. This mineralization is compensated for by adding extra nitrogen in the form of fertilizer. Compensation for the reduced mineralization by fertilizer nitrogen corresponds to an additional emission of 100 kg N/ha * 3.6 kg CO_2/kg N = 360 kg CO_2/ha. Rounded off, this is 0.4 tonnes of CO_2/ha. This includes the CO_2 emissions released during the production of fertilizers.

Paying for Peat with nature development

The effect of an increase in water level is calculated in the same way as with Paying for Peat while retaining an agricultural meadow function (see above) in the event of a change in function to nature or in the event of an increase in water level in existing nature areas (for example, when combatting dessication). When the water level rises above ground level, a correction is required for the emission of methane (see Table 1 above).

In nature, additional carbon can also be stored in the form of peat (growth of peat moss), swamp (or swamp forest) or vegetation. This additional carbon sequestration can be included in the total emission reduction insofar as the CO_2 is stored for a long time (long-cyclically) and this should be substantiated in the project plan.

Also, the biomass released from these soils during mowing or cyclic management may be kept out of the carbon cycle for long periods, depending on the type of management. The same applies here as with paludiculture: the certificate rights for this lie in principle with the processor of these raw materials (unless these rights are transferred/given/sold to the supplier, i.e. the nature manager) and are therefore <u>not</u> included in the emission reduction calculation.

Example: nature development:

The sum of CO_2-eq. emissions at t = 0 (start of the project) amounts to 40 tonnes CO_2 eq./ha/year. By carrying out the project, this will be reduced during one year (t = 1) to 8.9 tonnes CO_2 eq./ha (groundwater level at ground level, see Table 1). Due to vegetation development, 2 tonnes of CO_2 eq./ha/year are permanently stored as plant material. A total of 40 - 8.9 + 2 = 33.1 tonnes of CO_2 eq./ha was thus avoided in one year.

Ex-post versus *ex-ante* issue of certificates

Combatting peat oxidation by raising the water level is drastic for the farmers' business operations (both while retaining the existing agricultural function and during the transition to wet crops). For example, the harvest will decrease or a new crop with completely different needs will be required. It also requires initial investments such as the purchase and installation of monitoring wells and hydrological measures. Since the Paying for Peat approach is voluntary, there should be a clear incentive for farmers to participate, but also a means of applying pressure so they do not abandon the project.

Functional change to nature has its own characteristics. In many cases, the site has yet to be purchased (with additional costs for the required hydrological measures). Once the change in function has been implemented (and likewise with the preservation of the nature area's function), an expected long-term situation will arise. After all, the (in some cases private) nature manager has no interest in changing the nature function again. If this is not clear from the articles of association or other documents, this can be recorded by a notary.

In order to be able to offer an appealing perspective to farmers and nature managers, among others, it is important to offer the most attractive possible alternative to current practices that are causing the peat to oxidize at a rapid rate. This has led to a system with partial *ex-ante* certification, but under clear conditions with regard to periodic monitoring, and a reserve buffer with withheld certificates. This system, including determination of the size of the buffer, is included in the document ***'Ex-post* versus *ex-ante* issue of certificates for projects in peat meadow areas'**, which is available via the website www.nationaleCO2markt.nl as a Rulebook item: ***Ex ante* versus *ex post* issue of certificates (only available in Dutch)**.

Conclusions

- The emission reduction of the project is determined as the difference between the emissions (in CO_2 eq.) before the increase in the water level (baseline), and the emissions after the increase;
- In the case of nature development and conservation of nature and wet crops, the carbon fixation in the roots and growth of plant material may also be included;
- Paying for Peat with continuation of meadow function, and Paying for Peat in combination with wet crops, have a risk percentage of 10 percent. These risks are not expected and this percentage is set to zero with Paying for Peat with nature development and nature conservation.
- *Ex ante* certification is possible under certain conditions over a period of five years during the life of a project. At the start of a five-year period, 85% of the estimated emission reduction for that period is made available in the form of certificates. 15% of the certificates are withheld as a buffer, and made available after the end of the five-year period if the monitoring and verification show that this emission reduction has actually been achieved.

8. Plan for monitoring of project progress

Since - for cost and practical reasons - CO_2 emissions are not measured directly, the groundwater level is measured. After all, there is a scientifically substantiated relationship between the groundwater level and the emission of CO_2 from peat areas (see Figure 3 and Table 1). For this, the groundwater level will have to be monitored during the duration of the project. This is done by means of a system of various monitoring wells that measure the groundwater level in real time at the location concerned. A monitoring well is placed in the middle of each plot. The average groundwater level for this plot is calculated using Waternet's GGOR tool[15]. Alternative measuring methods are allowed, if approved by the Water Board or a knowledge institution. The opinion of the Water Board or knowledge institution, as an independent party, must be communicated in writing, as an appendix to the project plan.

The data from these monitoring wells is regularly read. Placing the monitoring wells and storing and processing the data is done by an independent, specialized organization, i.e. an organization that has no direct (financial) interest in raising the water level, and that observes the *Handboek meten van grondwaterstanden in peilbuizen* (STOWA, 2012). Next to measuring the results, this also enables verifying the measuring line and, if desired, of the raw data during verification of the emission reductions.

As explained in Chapter 5, to get a good idea of the water level in the baseline scenario (before raising the water level):

- the groundwater level is measured one year before the level change is implemented; or
- this measurement takes place in a comparable, representative (comparable in distance to ditches) neighbouring plot.

Paying for Peat with continuation of agricultural meadow function

One monitoring well will be placed in the middle of the plot (at half the width of the plot measured from ditch edge to ditch edge). A monitoring well is placed in each plot and a network of monitoring wells is thus formed, together with the monitoring well in the control plot. The monitoring well is preferably placed below ground level and equipped with a data logger so that the water level can be continuously measured. It is also possible to use existing monitoring wells in the country. The independent organization determines whether or not the existing monitoring wells can be used. Alternative measuring methods are allowed, if approved by the Water Board. The approval of the Water Board, as an independent party, must be communicated in writing, as an appendix to the project plan.

When visiting the site or via Google maps, it is important to check in the interim whether arable crops may be grown (see also risk analysis in chapter 8).

Paying for Peat in combination with growing wet crops

For wet crops where the water level is above ground level, the water level can easily be read visually. No monitoring wells need to be used for this. For wet crops where the water level is below ground level, a monitoring well can be used, just as with the monitoring of Paying for Peat in peat meadow areas while retaining an agricultural function.

In addition, an annual sample of the root residues is taken for these wet crops and it is determined how high the dry matter content is, or a fixed value can be included on the basis of existing research. The annual growth of these root residues is included as carbon sequestration in the calculation of total avoided CO_2-eq emissions.

Paying for Peat with nature development and conservation

At a water level below ground level, the method is maintained while maintaining the agricultural meadow function (with monitoring wells and by using Table 1). For water levels at or above ground level, the method of growing wet crops is followed (including the correction for methane). Furthermore, a substantiated estimate is

[15] A user-friendly version of this GGOR tool, called Python, is under development at Waternet (executive organization of Water Board Amstel, Gooi and Vecht (Amsterdam region) www.waternet.nl/en).

made of the carbon that is stored in vegetable material that remains in the area.
All monitoring results and the resulting calculations are verified by an external party.

Conclusions:

- The amount of avoided CO_2 emissions is monitored by measuring the groundwater level;
- Based on the actual groundwater levels, the amount of CO_2 emissions of the project is calculated based on Table 1 and Figure 3;
- These data are compared with the measurements taken at a neighboring and comparable control plot or with the measurement prior to the level increase;
- For water levels above ground level, a visual inspection of the water level and the determination of the captured carbon in plant material remaining in the area will suffice.

9. Risks

With Paying for Peat there are a number of risk factors that may prevent the intended emission reduction from being achieved during the project. These vary in nature, sometimes being general, in others more project-specific. Furthermore, the importance of each risk factor - and how to deal with it - strongly depends on the method of certification: *ex-post* or *ex-ante*. With *ex-post* certification, some risk factors have an immediate effect on the measurement results and thus on the number of certificates subsequently determined. Then a correction is not necessary (although there is a disadvantage for the climate). With *ex-ante* certification, the number of risk factors is greater and it is also more important to be able to correct for them. Partly for this reason, a backup buffer is used for this. This creates an incentive for the manager/farmer to prevent water levels from dropping as much as possible.

General

Extensive and long-lasting drought

Due to climate change, it is very likely that long-term drought will occur increasingly frequently. As a result, the water level in the project area drops and more peat oxidises than was calculated. This can be prevented by letting in additional water during periods in which there is sufficient water to keep the water level high for longer in periods of extreme drought. These extremes must be kept up to give a good substantiation of the emission reduction. This is also done by measuring the water level in real time (see Chapter 8, Monitoring).

The farmer quits at an early stage

When selling or for any other reason, a farmer could stop using the higher water levels. Also the yield can be disappointing when growing wet crops, and the farmer may wish to stop the project. This is prevented by contractual agreements with the farmer concerned, which include consequences for non-compliance with the contract. The annual payment to the farmer works as an incentive to the farmer to keep the agreements. There is also the option to have a note for the relevant plot of the higher level placed in the register of the Land Registry. The Water Board can also be requested to take a new watering decision for the parcel in question, which will establish this. If a farmer stops, the issuing of certificates will lapse with *ex-post* certification.

Ex-ante certification is only possible if a farmer has contractually agreed in advance for the period for which this form of certification applies.

Paying for Peat with continuation of agricultural meadow function

Grasland is temporarily being used for other crops

Intensively used grassland is regularly ploughed and re-sown. As a result, the grassland remains highly productive and/or another crop is used in the meantime (eg maize cultivation). The ploughing of grassland and, in particular, the use of arable crops such as the cultivation of maize increases the CO_2 emissions. Even though the water level remains elevated from the initial situation. One of the conditions is included with the landowners to prevent the use of arable farming or maize cultivation on the plots where Paying for Peat is applied. It is important to continue to check this, which can easily be done (see Chapter 8, Monitoring). In this way, this risk is sufficiently covered for both *ex-post* and *ex-ante* certification.

Relocation of dairy farming to other peat areas

This is also referred to as passing on (or *leakage*). Due to a higher water level, the grass yield and also the milk yield of the farmer concerned can decrease. As a result, in theory, the milk/grass yield in other peat areas elsewhere (e.g. elsewhere in Europe) or within one's own company could be increased by lowering the water level (and increasing CO_2 emissions). This can be ruled out because the groundwater levels in the Dutch peat meadow areas are fixed (through water level decisions). A further reduction in these areas is unlikely to take place.

As far as is known, there are no other peat areas in the Netherlands that are nominated to be 'developed' for (intensive) dairy farming. Since the Green Deal National Carbon Market looks at the situation within the Netherlands, there is no consideration of possible relocation across the border.

10. Literature

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