GREENPEACE
BACKGROUND PAPER

Temporary sinks do not cause permanent climatic benefits.

Achieving short-term emission reduction targets at the future's expense.

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1 Introduction

Stabilising greenhouse gas concentrations at safe levels is the ultimate goal of the Climate Change Convention. The Kyoto emission reduction targets were adopted as a first step towards this common objective. Included in the Protocol are LULUCF[1] provisions which permit Annex B Parties to add to their allowed emissions of fossil fuel and other industrial gases.

In this context, it is often suggested that establishing forests or deferring deforestation for some period of time would be an effective tool to address climate change and should therefore be accounted under the Kyoto Protocol. This is often based on the assumption that *temporary*[2] carbon storage lowers temperature-levels and damages "at each point in time"[3] in the future.

Unfortunately, this assumption is wrong since it does not take account of the carbon cycle. Although causing climatic benefits in the near-term, *temporary* carbon storage will in the long-term increase CO_2-concentrations and temperature-levels. Consequently, higher climate change related damages could be expected in the future.

In relation to the accounting of LULUCF-activities inside the Kyoto Protocol Framework, there is concern that accounting of biotic carbon storage will lead to higher CO_2-concentrations and temperatures. Accounting of sinks under Article 3.3 and 3.4 and project activities under Article 12 would allow a large additional amount of fossils fuels to be added to the atmosphere. These emissions would be additional to those that would have occurred in the absence of credits for LULUCF activities. A large proportion of these sinks might not be additional or permanent.

This paper explores this issue and examines concerns about the climatic effect of temporary carbon storage accounted within the Kyoto Protocol.

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www.greenpeace.org > campaigns > climate > documents.

[1] Land Use, Land-Use Change and Forestry
[2] Temporary carbon storage is here defined as 'not permanent' or 'permanent but not additional over all time'.
[3] See for example the paper "Evaluating carbon offsets from forestry and energy projects: how do they compare?" by Ken Chomitz from the Development Research Group, Worldbank, (2000, p.12), which was widely distributed at SB-12 and the current SB-13.

2 Effect on CO_2-concentrations

The science behind this counterintuitive phenomenon - that the temporary carbon storage as a seeming climate mitigation policy increases long-term CO_2-concentrations - is rather simple. The following four steps explain briefly the science.

2.1 Firstly, the effect of CO_2-emissions on atmospheric CO_2-concentrations has to be understood. One tonne of CO_2 emitted into the atmosphere results in the atmospheric CO_2 content being initially one tonne higher. This additional tonne of CO_2 in the atmosphere then enters the carbon cycle where ocean uptake and CO_2 fertilisation play a role. Higher CO_2-concentrations cause increased CO_2-fertilisation and increased CO_2-uptake by the oceans. The fraction of the CO_2-emission in the atmosphere decreases with time so that about 40-50% is left after hundred years. Therefore, the atmospheric CO_2-content is increased by "only" 400to 500 kg, one hundred years after a one tonne CO_2 emission occurs. How much carbon is left in the atmosphere depends mainly on the background CO_2-emissions. The higher CO_2-background-concentrations there are in the atmosphere, the higher will be the remaining fraction of each

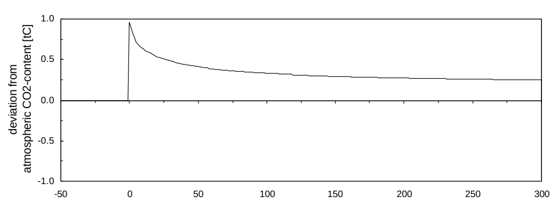

Figure 1 - Change in atmospheric CO2-content due to a CO2-emission

single CO_2-emission over time. If overall emissions follow a high emission scenario such as the IS92a each tonne of CO2 that is emitted today will lead to approximately 700 kg more atmospheric CO_2 in the year 2300. Under a low-emission scenario, such as the WorldScanA1-550EA, the atmospheric CO_2 content in 2300 is increased by 'only' 300kg[4]. This is because CO_2-uptake by oceans and the terrestrial biosphere is ultimately limited.

2.2 Secondly, the effect of a permanent emission reduction is just the reverse of an emission. 100 years after a 'one tonne emission reduction' the CO_2-concentrations are lower, but less than one tonne lower. One hundred years later, CO_2-concentrations are about 400 to 500kg lower – depending on the saturation of sinks.

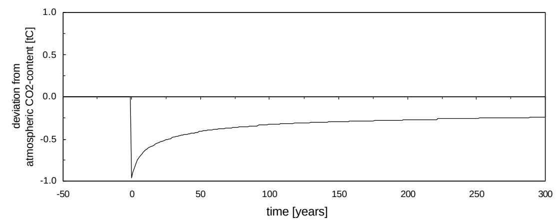

Figure 2 - Change in atmospheric CO2-content due to a CO2-emission reduction or permanent carbon storage

A permanent emission reduction is either a fossil fuel emission reduction or a permanent carbon storage that is additional over all time. However, permanent carbon storage in the terrestrial biosphere can not be guaranteed.

2.3 Thirdly, the effect of temporary carbon storage outside the Kyoto Protocol is just the superposition of an emission reduction (2.2), followed by an emission (2.1). Decreased CO_2-concentrations during the time that the carbon is being stored in a sink-project lowers the CO_2-fertilisation of the terrestrial biosphere and ocean

[4] The remaining fractions of CO2 over time were obtained from parameterisation of the BERN-SAR model, which is used in the Second IPCC Assessment Report (1995). Figures 1-4 were calculated with stabilised CO2-concentrations at 364ppmv. , which is a simplification that is often used by equivalence-based accounting-proposals (see e.g. Moura Costa, P. and C. Wisson (1999). "An equivalence factor between CO2 avoided emissions and sequestration - description and applications in forestry." Mitigation and Adaptation Strategies for Global Change 5(1): 51-60.).

uptake of CO_2. Therefore, if one tonne of carbon is stored in a sink-project, the atmospheric CO_2-content is not equivalently lower by one tonne C over all time. The re-emission of the sequestered tonne of carbon leads then to higher CO_2-concentrations, although the net-CO_2-emissions are zero (see "peak" in figure 3).

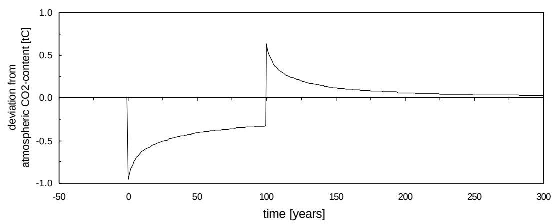

Figure 3 - Change in atmospheric CO2-content due to temporary carbon storage of 100 years.

2.4 Finally, the effect of temporary carbon storage inside the Kyoto Protocol differs substantially from a temporary carbon storage project outside the framework of the Kyoto Protocol.

If carbon storage is accounted for under the Kyoto Protocol, each accounted tonne will allow one further tonne of fossil fuel emissions. Accordingly, the effect of temporary carbon storage is illustrated by the superposition of 'temporary carbon storage outside the Kyoto Protocol' (2.3) with an emission (2.1), that accrues from credits given to the carbon storage project.

Thereby, the following analysis assumes that an equivalence-based accounting approach is chosen for crediting sink-projects under the CDM, so that no debits are given for the re-emission of temporarily stored carbon. Similar in its effects on the atmosphere could be temporary carbon storage under a stock-change accounting system. Even if future generations are fully debited for re-emissions, these re-emissions might not be truly offset because future emission reduction targets might be set lower in anticipation of potential re-emissions from carbon-storage-projects.

The fundamental assumption of the following section is that the Kyoto Protocol emission reduction targets are meant as *permanent* emission reductions in order to be a first step to the common objective of stabilising GHG-concentrations at 'safe levels'. Since the Kyoto targets are already fixed, they are seen as *part of the baseline*. Consequently, the effect of current decisions of how these targets are met (e.g. renewable energy versus sinks under the CDM), is illustrated by setting a permanent emission reduction as baseline and displaying the effect of credited temporary carbon storage in relation to this baseline.

As illustrated in figure 4, the effect on atmospheric CO_2-concentrations by temporary carbon storage inside the Kyoto Protocol is 'neutral' for the time the carbon keeps being additionally stored. After the release – assumed here to be in the year 100 – the effect is equivalent to an extra CO_2-emission.

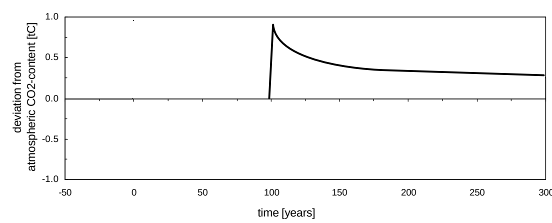

Figure 4 - Change in atmospheric CO2-content due to temporary carbon storage under the Kyoto Protocol.Note that the baseline for the deviation of atmospheric CO2 concentrations *includes* the effect of a unit reduction of fossil fuel emissions under the Kyoto Protocol. The curve is therefore the *net*-effect of an additional release of one tonne of carbon *and* storage of one tonne, followed by the release of this tonne at year 100.

Some accounting proposals suggest that credits are only given to a certain proportion of sequestered carbon. Although this would lead to a near-term climate benefit by lowering the CO2-concentrations more than a fossil fuel emission reduction would have done, there are still higher temperature-levels to be expected in the long-term, as long as the debits given to a re-emission are lower or equal to the credits given for the sequestration.

3 Effect on temperature-levels

Having shown the effect on *CO_2-concentrations* of the three climate mitigation policies, 'reducing emissions', 'establishing temporary sinks' and 'establishing temporary sinks under the Kyoto Protocol', the following paragraphs sketch the effect on global mean air temperature. Global mean temperature is likely to be a better indicator for climate change related damages than CO_2-concentrations.

3.1 The climatic effect of activities OUTSIDE the Kyoto Protocol

The temperature-effect of reducing fossil fuel emissions and establishing temporary sinks is generically different. Considering the effect of temporary carbon storage OUTSIDE the Kyoto Protocol framework, the following conclusions can be drawn.

> **Reducing fossil fuel emissions** leads to *decreased* temperature-levels in the long-term (see solid line in figure 5).
>
> **Temporary carbon storage** leads to extra warming after the release of the sequestered carbon (see dashed line in figure 5). Temporary carbon storage is therefore not useful to mitigate long-term climate change, although it decreases CO_2-concentrations and temperature-levels in the near-term. Of course *permanent* carbon storage that is additional over all time would have the same effect as reduced fossil fuel emissions but as mentioned earlier this is an unlikely situation.

Temporary carbon storage outside the Kyoto Protocol might have beneficial effects in terms of reducing the *rate of change* of temperature. A policy, however, that implies a trade-off between decreasing the *rate of change* in the short-term and decreasing the *magnitude of change* is dubious since effective climate change mitigation has to address both.

Sometimes put forward as a beneficial effect of temporary sinks is "shaving the peak of emissions". This argument suggests that by using temporary carbon storage we decrease peak-levels of climate change by postponing emissions into the future, when temperature or CO_2-concentrations are lower. However only the most aggressive policies could lead to a return to current CO_2-concentration and temperature levels over the next centuries. This would entail an almost complete phase-out of fossil fuels over the next 100 years.

Figure 5 shows the effect on the climate that is caused by activities, which are undertaken additional, and outside the Kyoto Protocol framework. The baseline (straight line at 0 in figure 5) could basically be any emission path - here the calculation was done with a 550-stabilisation scenario[5].

After an equal reduction of the atmospheric CO_2-content and temperatures by carbon storage and emission reductions, the temperatures are increasing over baselines levels in the case of temporary carbon storage when the sequestered carbon is re-emitted.

In this illustrative example, the carbon is assumed to be *re-emitted* or not *additionally* stored any more after 100 years. A storage duration of hundred years would reflect the case that the carbon is *additionally* stored about 70 years longer than the average project-lifetime of current AIJ-LULUCF-activities[6]. For example, future demand for agricultural land might cause the re-emission of carbon sequestered in forests, in

[5] The WorldScanA1-550EA scenario as given in Morita and Lee (1998) is here taken as a 550ppmv-stabilisation scenario. See Morita, T. and H.-C. Lee, 1998 "IPCC SRES database, version 0.1, Emission Scenario Database prepared for the IPCC Special Report on Emission Scenarios", available at www-cger.nies.go.jp/cger-e/db/ipcc.html

[6] LULUCF activities under the Pilot Phase as Acitivities Implemented Jointly (AIJ)

which case the carbon storage is not permanent. Equivalently, natural re-vegetation might have caused the re-growth of a forest without the LULUCF-project within 100 years, in which case the carbon storage is not additional over all time.

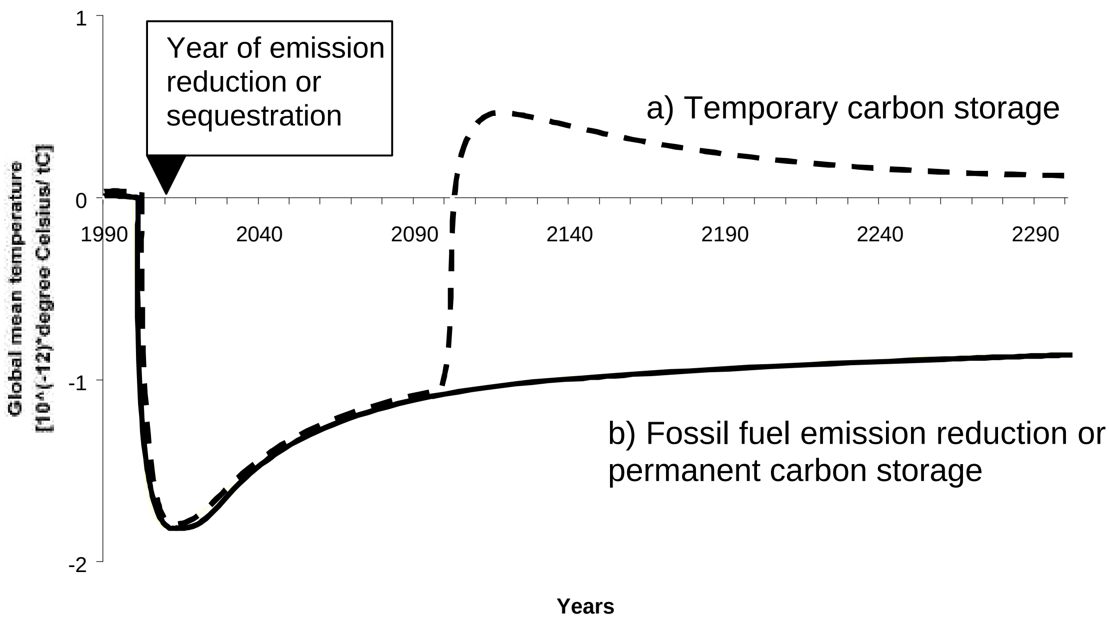

Figure 5 – Effect on global mean temperatures by a) 100 year-long temporary carbon storage (dashed line) and b) a permanent emission reduction (solid line) that are undertaken *outside* the Kyoto Protocol.

Model used: MAGICC 2.4; Background-emission scenario: WorldScanA1_550EA; climate sensitivity: 2.5°C;

3.2 The climatic effect of activities INSIDE the Kyoto Protocol

Applying equivalent assumptions as under section 2.4 in terms of baselines and accounting, the following section highlights briefly the effect of temporary carbon storage on temperature-levels.

Accounted temporary carbon storage has an equally 'neutral' effect as a permanent emission reduction until the re-emission occurs. After the re-emission of sequestered carbon temperature-levels rise significantly over the baseline (cp. Figure 6). For each point in time after the re-emission, the temperature-levels are higher, just as if an additional fossil fuel emission has taken place in 2100.

Having shown in the previous section that temporary carbon storage outside the Kyoto Protocol may not be useful for long-term climate change mitigation, the climatic effects are likely to be even worse if temporary sinks are included in the Kyoto Protocol, since each accounted 'sink'-tonne is a licence for emitting more fossil fuels.

In this context, accounting proposals for sinks under the CDM miss the point when saying that longer biotic carbon storage should be given higher credits than shorter storage. In other words, some proposals suggest the option that longer biotic carbon storage could be accounted for as if it were offsetting more fossil fuel emissions than shorter projects, which is the idea behind the category of *equivalence-based accounting* approaches (e.g. *yearly tonne-year crediting*). Since only permanent carbon storage (storage over all time), which is *as well* additional *over all time* (which seems to be a rather rare case) could truly offset fossil fuel emission reductions, any temporary storage should not be awarded any credits at all. Even *stock change accounting* that would theoretically reflect "what the atmosphere sees" (full debiting for re-emissions so that the net-credits of temporary carbon storage are zero), simply creates a new burden of additional emission reduction efforts for future generations.

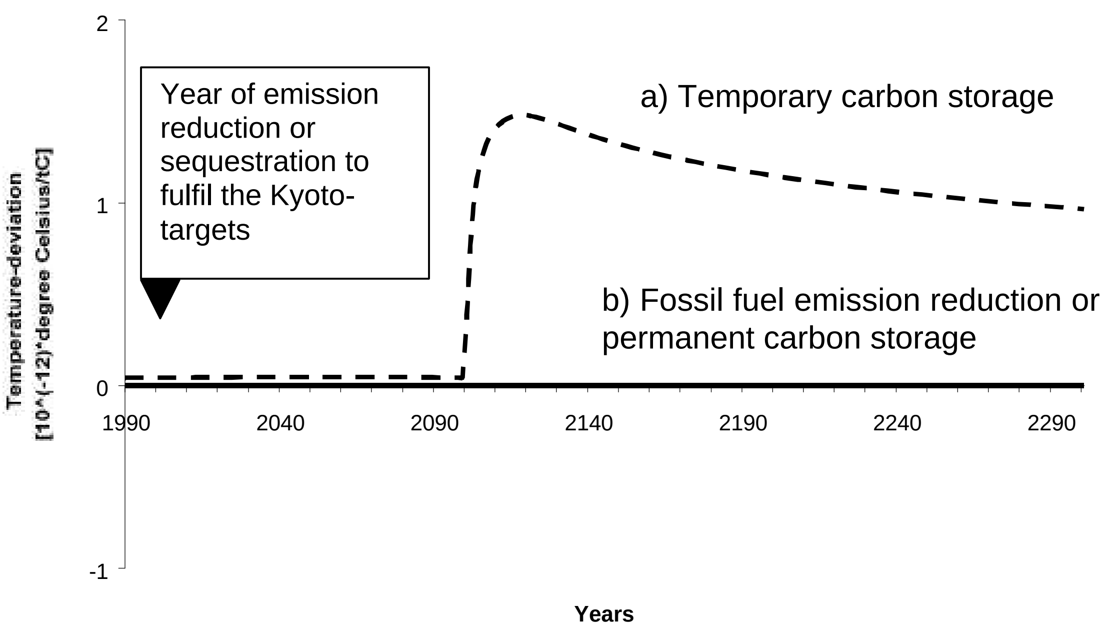

Figure 6 – Effect on global mean temperatures by a) 100 year-long temporary carbon storage (dashed line) and b) a permanent emission reduction (solid line) that are undertaken 'inside the Kyoto Protocol'.
Model used: MAGICC 2.4; Background-emission scenario: WorldScanA1_550EA; climate sensitivity: 2.5°C;

Conclusion

Carbon storage in the terrestrial biosphere that is (a) permanent *and* (b) additional over all time is theoretically possible, but highly unlikely. LULUCF-projects, which are often designed to generate maximal carbon credits for the investor in the near future, are likely to be either reversed after the project-lifetime or not truly additional.

Similarly, "additional" activities under article 3.4 are likely *not* to be additional, or at least there is no way to guarantee this. This uncertainty is compounded by the very real risk of counting natural effects and CO2 fertilisation. Symmetrical considerations apply to Article 3.3 and sinks under Art. 12.

The problematic of increased future temperature levels arising from temporary carbon storage accounted under the Kyoto Protocol. Accounting for business as usual activities and CO2-fertilisation effects would further undermine the objective of the Climate Change Convention to stabilise GHG-concentrations at 'safe levels' (Art. 2 of the Convention).