German Environment Agency

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Funding climate-friendly soil management – key issues

Setting Baselines[1]

1 Background

Definition: In the context of climate mitigation, the "baseline" is the level of emissions and removals against which the mitigation impact is determined – the benchmark. Mitigation is calculated as the difference between the baseline GHG fluxes or carbon stock changes and those following mitigation actions. In most cases, the baseline is set as a counterfactual scenario, i.e. the emissions and removals occurring without the policy intervention. Baselines can also be performance-based, setting a minimum standard.

Importance: Baselines are important for the robust quantification of emission reductions or increased removals. If baselines are overestimated, this undermines environmental integrity (i.e. recognised removals/emissions reductions are larger than the real mitigation) and lowers cost-effectiveness (Böttcher et al. 2022).

Relevance: Baselines are relevant for all types of soil carbon mitigation: removals (e.g. to calculate change in soil carbon stocks resulting from improved crop rotation) and emission reductions / avoided emissions (i.e. to quantify the mitigation impact of avoiding soil degradation from reduced compaction). Baselines are used for all results-based financing, including offsetting mechanisms[2].

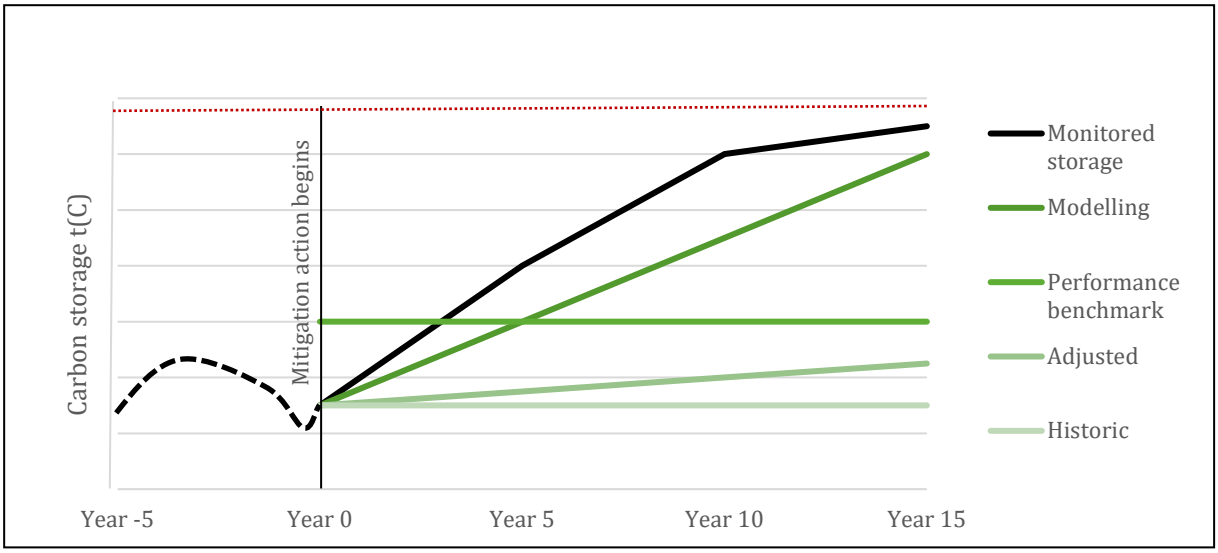
2 Key issues

Different baseline approaches: Baselines represent an emissions or removal level against which mitigation activities are measured. This level can be defined in different ways, with different implications for what can be accounted for as beyond the baselines. The table on the following page describes different approaches to baselines (see figure below) and their strengths/weaknesses (McDonald et al. 2021).

[1] This factsheet was also published as part of the UBA report "Funding climate-friendly soil management", available at http://www.umweltbundesamt.de/publikationen/Funding-climate-friendly-soil-management.

[2] Under offsetting approaches, the buyer is using the certificates for mitigation outcomes as a substitute for within value chain abatement or mitigation activities in their own sphere and counts it towards their own (voluntary) climate target.

Figure 1: Different benchmarking approaches



Source: Authors' own elaboration

Table 1: Different baseline approaches, strengths and weaknesses, and examples

Baseline type	Strength/weakness	Example: Improved crop rotation	Example: Silvoarable agroforestry
Historic baselines are established using historic data, e.g. the previous year's soil carbon stock, or an average of multiple previous years of data. These can be **adjusted** (e.g. set 10% below historic levels) or incorporate trends (e.g. decline 5% per year).	- Depend on reliable historic data - Can involve high uncertainty + Simple approach	Baseline based upon previous cropping practices and soil carbon stocks, e.g. average of past three years.	Baseline based on previous level of woody biomass (e.g. hedgerows); potentially zero. Baseline should also cover existing carbon stocks (e.g. soils) and other GHG gases.
Monitoring: Baselines are set by monitoring current activity or taking measurements (e.g. of soil carbon stocks).	- Can be expensive, acting as a transaction cost that reduces incentives to participate + Can have high certainty	Baseline set by sampling current soil carbon stocks.	Baseline set by sampling current soil carbon stocks and site-based measurements of existing woody biomass.
Modelling: Baselines that are established through modelling approaches. These can simulate management practices and their impacts alongside external factors including policies and climate change.	- Complex (and potentially costly and time-consuming to develop). - Can have high uncertainty. + Can reflect policy developments and other exogenous factors	Future baseline (e.g. for next ten years) modelled using historic data and expected policy (e.g. CAP crop rotation standards).	Future baseline modelled based upon historic data and expected policy (e.g. CAP cross-compliance requirement for retainment of natural features).
Performance benchmark: Baselines can be performance-based, set at a level of emissions or removals using data from similar types of actors (e.g. a sector-level average of field vehicle traffic/soil compaction), or a **reference technology**.	- Adverse selection risk, where actors who are already better than the benchmark participate and are recognised for removals/emissions reductions without additional action. - Complex and costly to develop - Challenging to identify relevant benchmark + Once available, low costs for activity owners.	Baseline set at average soil carbon stocks of leading farms (e.g. top 20%) in a similar region and sector.	Baseline set at a minimum width and length of hedgerows on similar farm types in the region (and associated removals).
Reference area: Baseline is set by monitoring what occurs in a separate, similar area, where the mitigation action does not occur.	- Only appropriate to set baselines for smaller, project-based scales (not for larger scales e.g. jurisdictions). - Hard to identify sufficiently "similar" area. - Additionality difficult to assess due to differences in area properties + Can reflect increasing policy developments and other exogenous factors	Baseline set by measuring soil carbon stocks on a similar, untreated reference area (e.g. neighbouring field or neighbouring farm).	Baseline set by monitoring agroforestry coverage (and sequestration) on a similar farm. This should also consider soil carbon stocks and other gas flows.

Source: Authors' own elaboration, based upon McDonald et al. (2021).

Baseline uncertainty: Baselines are always uncertain because they are an attempt to represent a counterfactual that is unknowable: it is not known how the future will develop or how actors would respond without the policy intervention. In addition, baseline estimation is subject to the same challenges as any monitoring, reporting and verification of nature-based solutions, such as high levels of data and quantification uncertainty. Baseline uncertainty can pose a fundamental challenge to certification when too high, i.e. if the uncertainty range is larger than the expected mitigation (when the 'signal' is smaller than the 'noise', Schneider et al. 2014).

Cost-benefit considerations: It can be complex and costly to define baselines. This is particularly true when **specific baselines** are established individually for each actor. While individual baselines can be more accurate and certain, developing them is costly, and the cost of establishing robust baselines (direct financial costs as well as indirect time costs) can act as a barrier to individuals taking up mitigation activities and reduce the net benefit to society. There is also the risk of inconsistencies between such individual baselines in case of different underlying information. Moreover, the risk of baseline inflation (overestimation) is higher with individual baselines. An alternative is to use **standardised baselines**, where a common baseline is used for every actor within a sector and/or geographic region (sometimes slightly adapted based on individual characteristics). These can reduce participant transaction costs and increase transparency and objectivity; however, these can involve high upfront development costs, can lead to adverse selection in voluntary results-based mechanisms, and may be inappropriate for complex, highly variable sectors (Schneider et al. 2012). The land sector, with its high variability in climate, precipitation, soil types, land management etc., poses a particular challenge for standardised baselines.

3 Example

The table on the previous page describes how the different types of baselines could be defined for two example solutions, improved crop rotation and silvoarable agroforestry.

4 Relevance for the EU

LULUCF Regulation (EU/2018/841) revisions: The EU Commission's proposed revisions to the LULUCF regulation[3] include a number of references to EU and Member State baselines:

- "No-debit rule": The EU is committed to LULUCF removals being at least equal to emissions from 2021-2025. This effectively forms a baseline that consists of different elements, including historic reference (in the case of cropland, grassland and wetland accounting), a projected reference level (in the case of forest accounting, see also below) and "gross-net" accounting (i.e. the baseline is zero in the case of other land use categories).
- 2026-2030 net removal targets: The Commission amendments set a baseline level of net LULUCF removals of 310 Mt CO_2e, which is broken down to the Member State level.[4] These national-level LULUCF baselines will be updated in 2025, based on data of net removals in 2021, 2022 and 2023. The baseline of -310 was derived from a policy scenario calculated using economic modelling. It can thus be interpreted as a projected modelled baseline.
- "Forest reference level": for the period 2021-2025 Member States have submitted projected trends of the forest net sink development. It is a projection of business as usual assuming the historic management intensity observed in 2000-2009.

[3] COM (2021) 554 final, https://ec.europa.eu/info/sites/default/files/revision-regulation-ghg-land-use-forestry_with-annex_en.pdf

[4] See Annex II

Common Agricultural Policy (CAP): The CAP has cross-compliance requirements that include soil management baselines; even though these do not consider carbon storage, they set implicit baselines for many CAP-regulated farmers. Additional CAP measures also impact soil carbon and GHG fluxes, and therefore must also be considered when setting baselines.

EU voluntary certification mechanisms: Many existing voluntary carbon markets in Europe rely on baselines to calculate additional removals/emissions reductions, e.g. MoorFutures, Label bas Carbone agroforestry, Woodland Carbon Code, etc. (McDonald et al. 2021).

5 Addressing challenges

Uncertainty may be managed using two common approaches:

- **Conservative baselines:** Baselines should be set "conservatively", i.e. assuming a low level of baseline emissions (or high level of baseline removals).
- **Updating baselines:** Baselines need to be updated at regular intervals (e.g. every five years). This enables erroneous baselines to be corrected, increases accuracy based on additional information, and enables the reflection of increasing climate ambition and other changing drivers.

However, due to the identified challenges, some degree of uncertainty is unavoidable. High baseline uncertainty is a particular problem for avoided emissions (e.g. avoided deforestation, avoided wetland drainage), which make these less suitable for crediting (Böttcher et al 2022).

Baseline setting also poses political challenges, as it implicitly identifies a standard or minimum requirement. This can create 'winners' (i.e. those who can easily and at low cost meet and exceed the baseline) and 'losers'. An example of a potential 'loser' would be an actor who has always maintained their soil carbon, meaning their baseline is at or close to the maximum ('saturated') level of carbon storage that can be achieved on their land and, depending on the reward mechanism, could mean they have little opportunity to be rewarded. These political challenges should be addressed by carefully considering the implications of different types of baselines for different actors and through transparent communication.

6 Relevant literature

Böttcher, H.; Schneider, L.; Urrutia, U.; Siemons, A.; Fallasch, F. (2022): Land use as a sector for market mechanisms under Article 6 of the Paris Agreement. UBA Climate Change, UBA, Dessau-Roßlau.

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