



The policy discourse on negative emissions, land-based technologies, and the Global South

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ABSTRACT

Negative emissions are increasingly seen as a policy option to limit climate change. However, the most readily available technologies that could deliver negative emissions require, if deployed at scale, large amounts of land, with huge risks for livelihoods and the environment. This land is often assumed to be in the Global South. This article analyzes the nascent policy discourse on negative emissions by assessing 116 policy documents by 97 organizations with a focus on land-based technologies (afforestation and reforestation, bioenergy with carbon capture and storage, biochar, soil carbon sequestration). We conclude that this policy discourse is largely centered in the Global North (mostly in the United States, the United Kingdom, and Germany), with only five organizations directly linked to the Global South. 61% of the organizations in our sample, however, somehow refer to the Global South in their contributions, with nongovernmental organizations being most strongly focused on the role of the Global South and in particular the risks for vulnerable countries. While the earlier policy discourse on negative emissions was linked to a more general “geoengineering” discourse, this link has loosened in the last years. Overall, in the documents that we studied, negative emissions technologies seem to become more accepted, and parts of the discourse shift towards deployment. Bioenergy with carbon capture and storage seems more often associated with risks if compared to other land-based negative emissions technologies, especially with a view to the Global South.

1. Introduction

The remaining carbon budget for limiting global warming to well below 2 °C is shrinking rapidly (IPCC, 2021). Should emissions continue at current levels, the carbon budget would be depleted in less than two decades (SRU, 2020). Yet global climate policy seems to fall short of achieving decarbonization of our economies within such a short timeframe. Due to this lack of resolute action, negative emissions technologies are increasingly discussed as possible part of a solution. Negative emissions are defined as “intentional human efforts to remove CO₂ emissions from the atmosphere” (Minx et al., 2018, p. 3). In integrated assessment models, negative emissions allow for an extension of current carbon budgets (van Vuuren et al., 2016). Negative emissions have entered the mainstream debate on climate change mitigation following

the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (Beck and Mahony, 2018). In this report, most pathways that could limit global warming to 2 °C include some negative emissions (Clarke et al., 2014). In the IPCC’s subsequent Special Report on Global Warming of 1.5 °C, all modeled pathways that could limit warming to 1.5 °C include negative emissions (Rogelj et al., 2018). Yet, the topic is not new in expert discourse, where negative emissions—often known as carbon dioxide removal—have been discussed for long, often jointly with solar radiation management as part of geoengineering, that is, “the deliberate large-scale intervention in the Earth’s climate system, in order to moderate global warming” (Shepherd, 2009, ix). While negative emissions are not well integrated into national climate targets until now (Rogelj et al., 2021), there are steps towards policy integration in several countries (Schenuit et al., 2021).

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In theory, numerous technologies could remove carbon dioxide from the atmosphere. Every technology faces its own specific challenges, although some challenges apply to several options. Challenges include immaturity, limited potentials, reversibility, resource requirements, and possible socio-economic and environmental side effects (Fuss et al., 2018). Currently, two negative emissions technologies are well integrated in integrated assessment models: first, afforestation and reforestation, and second, bioenergy combined with carbon capture and storage (BECCS) (Clarke et al., 2014). More recent literature, however, moves towards a broader portfolio of technologies (Hilaire et al., 2019). Both afforestation and reforestation as well as BECCS belong to a subset of negative emissions technologies that inevitably require large amounts of land (Fuss et al., 2018). Other frequently discussed land-based negative emissions technologies are biochar and soil carbon sequestration. Soil carbon sequestration as well as afforestation and reforestation have already been studied scientifically in the 1990s, while scholarly discussions on BECCS started in the 2000s (Minx et al., 2018). Biochar gained momentum only from 2010 onwards and is still discussed in comparatively fewer studies (Minx et al., 2018); however, it is related to the concept of *Terra Preta*, which has been discussed since the 1980s (Bezerra et al., 2017).

Land-based negative emissions technologies at a scale that is anticipated in the IPCC reports for the second half of the 21st century would consume 320–970 million hectare (through afforestation and reforestation) and 380–700 million hectare (through BECCS) of the planet's land area (Smith et al., 2016). One estimate for BECCS alone suggests use of land that would equal one to two times the size of India (Anderson and Peters, 2016). Fajardy and Mac Dowell (2017) showed that the way BECCS is implemented is decisive for land and resource requirements. For an analysis using miscanthus and switchgrass as biomass, the upper and lower boundary for land requirement differed by a factor of more than six for a given carbon removal target. Soil carbon sequestration, however, would not necessarily lead to additional land requirements, and neither would biochar addition to land. Nevertheless, biochar is produced from biomass, so large-scale production of biochar would also require dedicated biomass cultivation and, thus, additional use of land (Smith, 2016). Reallocating large areas to negative emissions technologies would bring huge trade-offs for both people and nature (Fuss et al., 2018; Babin et al., 2021). Not the least, the question would arise where such large land areas might be available.

The (largely implicit) answer to this question in many studies is the Global South. Both afforestation and reforestation and bioenergy production for BECCS are expected to be deployed to a significant extent in countries of the Global South. As for BECCS, Clarke et al. (2014, p. 448) state that “[m]odels universally project that the majority of biomass supply for bioenergy and bioenergy consumption will occur in developing and transitional economies”, and they expect similar distributions for afforestation and reforestation and other land-based technologies. Many countries of the Global South are in tropical climatic zones (Food and Agriculture Organization, 2016), and these zones generally have higher net primary productivity of vegetation (Kicklighter et al., 1999). Consequently, models assume that the majority of biomass for bioenergy will be produced in developing countries (Rose et al., 2014; Haberl et al., 2011). Even in cases where the geographical distribution is not specified, the assumed biomass yield may imply deployment in tropical and subtropical areas (as Creutzig et al. (2021) pointed out regarding Hanssen et al. (2020)). Currently, however, the British biomass power plant Drax, which is the world's largest and has a pilot project on BECCS, sources 80% of its biomass from North America (Drax Group, n.d.). Large-scale biomass cultivation for biochar would face similar geographic considerations as BECCS.

Regarding afforestation and reforestation, the expected high contribution of the Global South draws also on two complex, but opposing effects. On the one hand, trees take up carbon dioxide from the air and store it in living biomass, which means that afforestation brings a cooling effect. On the other hand, land-use change by afforestation and

reforestation will increase the albedo, which has a warming effect (South et al., 2013). Thus, many studies suggest that because of these effects, afforestation and reforestation in boreal (Northern) regions would cause a net warming of the earth, while afforestation and reforestation in tropical regions would cause a net cooling (South et al., 2013; Bala et al., 2007). The net effect of afforestation and reforestation in temperate regions, such as Europe or most of the United States, is unclear (Bala et al., 2007; South et al., 2013).

The potential for land-based negative emissions technologies seems hence unequally distributed across the planet, which leads some studies to suggest a possibly larger role of countries in the tropics. This would, however, add to existing global injustices around climate change and beyond. The Global North is responsible for most historical greenhouse gas emissions, yet it is the vulnerable countries in the Global South that are expected to suffer the greatest negative impacts of climate change (Preston, 2012). The growing focus on negative emissions now shifts the responsibility for preventing disastrous climate change further to those countries least responsible for atmospheric greenhouse gas concentrations. Indeed, some Northern countries may not even be able to generate sufficient land-based negative emissions within their borders to get to net zero (Healey et al., 2021). At the same time, countries in the Global North still struggle with reducing their high fossil fuel consumption (Climate Transparency, 2019), which might make the deployment of negative emission technologies in tropical countries possibly very attractive as an easy transition approach. For these reasons, and with reference to the uncertainties in the feasibility of large-scale deployment of negative emissions technologies, Anderson and Peters (2016) call negative emissions “an unjust and high-stakes gamble” (p. 183) and point to the risks for vulnerable communities that are least responsible for climate change if negative emissions technologies fail to deliver. Others have taken slightly more positive views. Healey et al. (2021) emphasized the need for strong global governance and capacity building to enable and safeguard benefits for Southern countries and local communities. Some negative emissions technologies, such as soil carbon sequestration, are also expected to bring some direct benefits for the Global South, particularly for rural communities, by improving local soil quality (Smith et al., 2019).

The considerations above may explain why scholars have emphasized the scarcity of social science research on negative emissions (Minx et al., 2017; Moe and Røttereng, 2018; Buck, 2016). Numerous methods from the social sciences could be useful to study negative emissions technologies, including discourse analysis. This is hence the focus of our study on discourses on negative emissions.

Numerous studies have investigated discourses around the more general concept of geoengineering, yet only few specifically on discourses or stakeholder perspectives of negative emissions (Cox et al., 2020; Haikola et al., 2019; Haikola et al., 2018; Bezerra et al., 2017; Fridahl, 2017; Pidgeon and Spence, 2017; Buck, 2018; Bellamy et al., 2021; Rodriguez et al., 2021; Christiansen and Carton, 2021; Forster et al., 2020; Clery et al., 2021). Moreover, most discourse analyses on negative emissions and geoengineering focus on European or North American contributions to such discourses. The Global South so far has a minor role in both the discourses and the discourse analyses (Huttunen et al., 2015). Some exceptions to this trend include the analysis of discursive networks and the Global South by Biermann and Möller (2019); interviews with Indian policymakers and experts by Mathur and Roy (2019); and interviews with vulnerable populations by Carr and Yung (2018). In addition, Winickoff et al. (2015) performed an engagement process with mostly Southern environmental leaders; Delina (2021) surveyed Southeast Asian stakeholders; the Solar Radiation Management Governance Initiative held several workshops in the Global South (African Academy of Sciences et al., 2013); and the surveys by Sugiyama et al. (2016) and Visschers et al. (2017) included comparisons of perceptions in countries from the Global North and the Global South. Our study adds new insights to this literature.

We focus our study on the policy sphere, and this for two reasons.

First, the deployment of negative emissions technologies will ultimately depend on decisions of policymakers because most negative emissions technologies are costly (Fuss et al., 2018) and could not be deployed at scale without sufficient incentives. Second, negative emissions are still largely absent from the mainstream climate policy debate despite their current critical role in integrated assessment models (Haikola et al., 2018). In this article we therefore seek to answer three interrelated research questions:

- (1) how is the policy discourse on negative emissions currently structured?
- (2) how are different land-based negative emissions technologies seen in this policy discourse?
- (3) how is the Global South represented in the discourse?

Regarding the third research question, we analyze representation in two ways. First, we study the extent to which organizations from the Global South take part in the policy discourse. Second, we analyze the degree to which organizations that are not based in the South refer to the Global South in their discourse.

2. Methods

Discourse analysis is a broad research field that shares a common interest in language patterns and the embeddedness of these patterns in a societal context (Paltridge, 2012). The field comprises numerous theoretical notions of the term “discourse” along with many research foci (Keller, 2011). Originating from linguistics, discourse analysis has become an important research approach across the social sciences and humanities. The study of discourse is important as discourse is performative (Paltridge, 2012) and its analysis may allow for a better understanding of policy change (Schmidt, 2002, 2008; Schmidt and Radaelli, 2004), not the least in a critical, transformative perspective. Combining Hajer’s (2002, p. 63) definition of discourse with Sharp and Richardson’s (2001, p. 195) definition of policy discourse, we define policy discourse here as “an ensemble of ideas, concepts, and categories through which meaning is given to phenomena of a particular policy-making process or debate”.

To identify the documents for our study, we used two main sources, together with additional internet research. The first source is the website Climate Engineering News, which is operated by the Kiel Earth Institute. It has a section to which policy papers on geoengineering are regularly added (Kiel Earth Institute, n.d.). We selected this repository as it provided a readily available collection of discourse contributions. The second source is the Carbon Dioxide Removal Google Group, an online forum mainly of scientists (Carbon Dioxide Removal Google Group, n.d.). The Carbon Dioxide Removal Google Group focuses on carbon dioxide removal more broadly and not only on policy issues. We thus scanned all posts in this group for relevant links and for mentions of policy documents or organizations. We selected this second source because it provided a transparent forum of knowledgeable researchers in the field. Therefore, we expected them to also discuss the relevant contributions to the policy discourse. Further internet research helped us to complement these sources, using Google and the search terms carbon dioxide removal, negative emissions, negative emissions technologies, BECCS, afforestation, reforestation, biochar, soil carbon sequestration, nature-based solutions, blue carbon, climate repair, and climate restoration. As the Google search yielded a very large number of results, we chose a pragmatic approach and limited our search to the first five pages of search results for each term. In addition to the English terms, we also translated the prominent terms to German and French to add non-English language documents. (We chose these two additional languages, both spoken by us, because a certain competence in a language is necessary for the subsequent analysis, which advises against using additional languages that we do not speak sufficiently.).

We included only studies that matched our definitions above and

offered a discussion of negative emissions beyond the mere mentioning of the terms, even though we did not require a dominant focus on negative emissions. Lastly, we included only documents published since 2013. In 2013, the first working group report of the IPCC’s Fifth Assessment Report was published, and the Assessment Report strongly stimulated the debate on negative emissions. Our search for new documents ended in early October 2019, when we started to analyze data. The data gathering strategy is summarized in Fig. 1, and the list of policy documents is provided in Supplementary Material D.

We used NVivo, a computer-assisted software for qualitative data analysis, to process and analyze the documents, following an approach of inductive category-based content analysis (Leifeld, 2011). As previous research on geoengineering discourses has often focused either more generally on geoengineering or more specifically on only solar radiation management, we were not able to rely on an available catalogue of categories for our analysis. Thus, the inductive approach was the obvious choice. All policy documents were imported in NVivo and subsequently read and coded. A procedure with two iterations was applied, which is summarized in Fig. 2.

In the coding process, we read only those parts of the documents that treated negative emissions. For very extensive documents, only the summary was coded if it was available and had sufficient detail. Categories were developed both for negative emissions in general, and for four land-based negative emissions technologies: afforestation and reforestation, BECCS, biochar, and soil carbon sequestration (i.e., those technologies considered in Minx et al. (2018) that capture carbon on land via photosynthesis).

To analyze the representation of the Global South, we coded statements on the Global South separately. While the term Global South has multiple definitions and connotations (Mahler, 2017), like other terms such as *Third World*, *developing countries*, the *non-Western world* or the *Periphery*, it generally refers to countries of Latin America, Africa, and large parts of Asia and Oceania (Rigg, 2015; Dados and Connell, 2012; Ming’ate, 2015). We use here the term Global South because it usually addresses power relations and socioeconomic differences (Boatcă, 2015; Dados and Connell, 2012) without invoking notions of culture or development. Further details on coding and classification are included in Supplementary Material C.

The discourse fragments that we analyzed were published by single or multiple organizations. The organizations contributing to the discourse we classified by five types of organizations: nongovernmental organizations, think tanks, academia, governmental organizations (hereafter referred to as governments), and businesses and business sector organizations (hereafter referred to as businesses). Furthermore, we assigned the organizations to countries according to the location of their headquarters. An exception were intergovernmental organizations and consortia of organizations, which we classified as *international* unless their members were (almost) exclusively located in one country. Because many organizations operate at the EU-level, the European Union was categorized as a separate entity.

Regarding our concrete analytical steps, we first assessed the results of the coding. We extracted contingency tables from NVivo for the frequencies of categories across organizational types, years, and countries. Subsequently, we imported these tables to Microsoft Excel and analyzed them for striking features. This work was supported by calculating relative frequencies and color coding in Excel. The tables are included in Supplementary Material B. Secondly, we analyzed the statements on the Global South qualitatively, followed by an analysis of the contingency tables for those categories.

3. Results and discussion

We identified 26 recurring statements in the discourse on negative emissions along with further statements in the discourses on four specific land-based negative emissions technologies. Discourse participants most often emphasize that integrated assessment models show the need

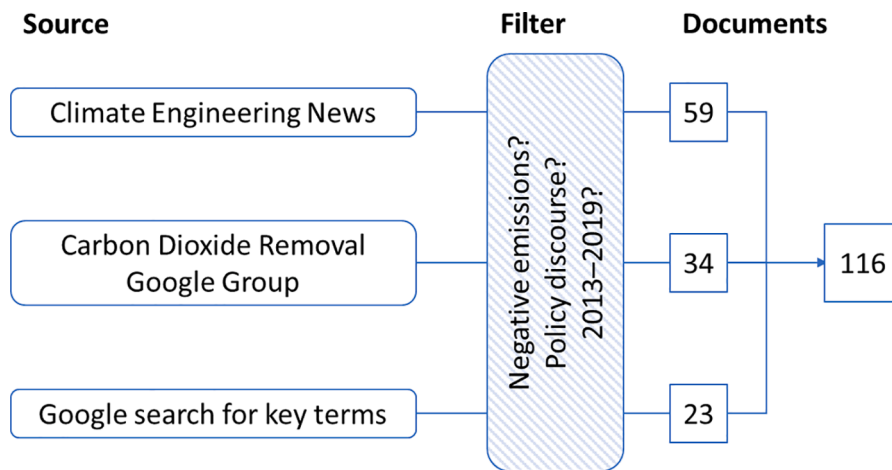


Fig. 1. Summary of the data gathering strategy (own depiction).

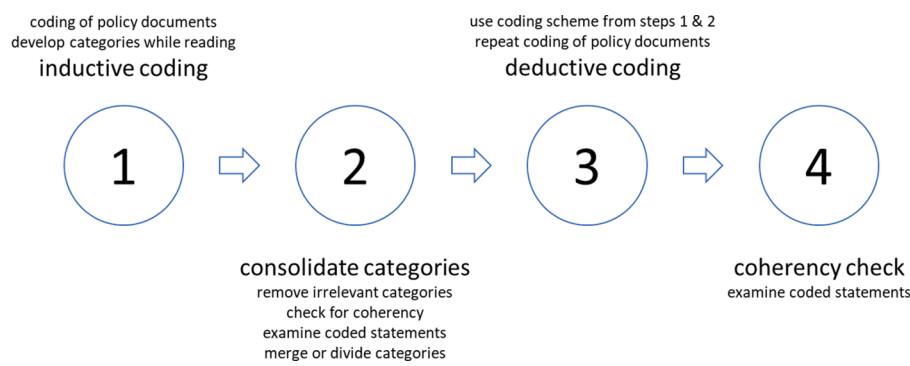


Fig. 2. Summary of the four-step coding process (own depiction).

for negative emissions. The second most common statement, however, relates to risks and uncertainties of carbon dioxide removal. Further abundant statements are calls for governance of negative emissions, calls for more research, and calls for a deployment of negative emissions technologies alongside conventional mitigation. We include the full lists of recurring statements on negative emissions and on the individual technologies, as well as information on their abundance in the discourse in [Supplementary Material A](#).

We structure this section along our main findings and finish with a

reflection on the limitations of our research and the need for further research.

3.1. Accelerating policy discourse on negative emissions

First, it is striking that the number of documents in this field has strongly increased over the years. While there were only five documents each in 2013 and 2014, this number went up to 36 documents in 2018. (The 28 documents in the following year, 2019, do not reflect the full

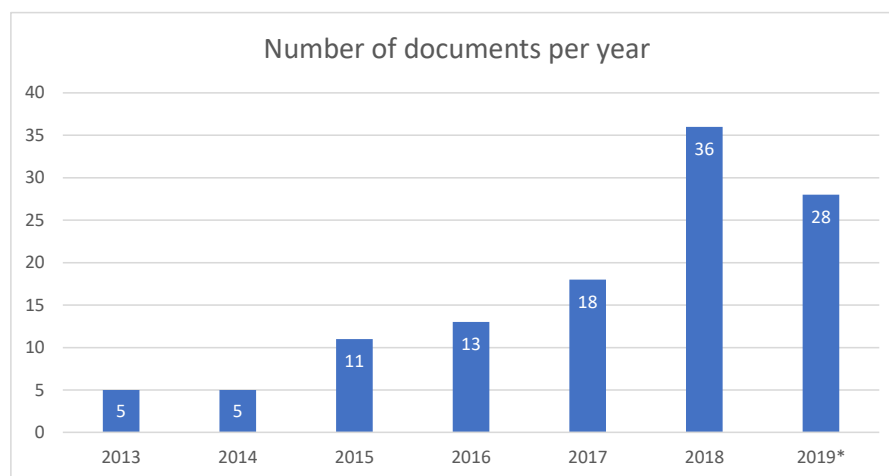


Fig. 3. Number of policy documents per year (own depiction). *Note that the number of policy documents in 2019 does not reflect the full year as no new documents were included after October 2019.

twelve months of that year because no new documents were included after October 2019). Fig. 3 displays the temporal distribution of the documents. This is in line with Minx et al. (2018), who showed an increase in scientific publications. Within this development, the scholarly discussions on negative emissions started to grow earlier than the policy discourse.

In total, 97 organizations contributed to the discourse. Fig. 4 shows the distribution of the organizations across actor types and the number of documents that these organizations have contributed to. The number of organizations from academia, governments, nongovernmental organizations, and think tanks is rather similar. Think tanks, however, have produced considerably more documents than the other types of organizations. Businesses are least active. While most organizations have contributed only one document to the discourse, some have published multiple documents, up to nine documents from one organization.

3.2. Limited participation of Southern actors

Interestingly, from a total of over 190 countries, only eleven countries and the European Union have contributed to the discourse, along with international actors (see Fig. 5). Except for two Australian and one South African organization, all actors in the discourse are from Europe or North America. At the level of individual countries, we see a heavy dominance of only three countries: the United States, Germany, and the United Kingdom.

Organizations from developing countries—more than 130 countries in total—did not contribute any document to this discourse. The only organization from the Global South is ActionAid, an international nongovernmental organization that has been founded in the United Kingdom but had its headquarters relocated to South Africa in 2004, which made it at that time the first major international nongovernmental organization to move its headquarters to the Global South (Campolina, 2015). Besides ActionAid, four consortia of nongovernmental organizations have direct ties to the Global South through membership of organizations from Southern countries: the Global Forest Coalition, the Geoengineering Monitor, the Climate Land Ambition and Rights Alliance, and Hands Off Mother Earth. The Global Forest Coalition consists of indigenous peoples' organizations and other nongovernmental organizations and includes many organizations from the Global South (Global Forest Coalition, n.d.). Furthermore, it is part of the Geoengineering Monitor along with three organizations from the

Global North (Geoengineering Monitor, n.d.). The Geoengineering Monitor also hosted the *Hands Off Mother Earth!* Manifesto, in which civil society organizations, including many organizations from the Global South, call for an end of all geoengineering activities (Hands Off Mother Earth, 2018). Finally, the Climate Land Ambition and Rights Alliance includes both ActionAid and the Global Forest Coalition, along with further actors from the Global South and the Global North (CLARA, n.d.). These consortia include organizations from all inhabited continents. In particular, many organizations of indigenous peoples are members of these consortia. However, none of them can be seen as a purely Southern voice as all four also include actors from the Global North. The five organizations with direct ties to the Global South have produced seven discourse contributions in total.

This small sample can hardly speak for the Global South as such and must hence be interpreted with caution. In terms of causality, we note that these five organizations are both critical towards negative emissions and (consortia mainly of) nongovernmental organizations. Given that nongovernmental organizations are generally critical towards negative emissions (see below), it remains unclear whether it is the ties to the Global South that explain the critical attitude of these organizations, or their general background as nongovernmental organizations.

In the general discourse on negative emissions, the Southern organizations more often frame negative emissions as geoengineering and more often consider the results of integrated assessment models to be questionable. Regarding individual technologies, there is a tendency towards emphasizing negative aspects more strongly, particularly for BECCS and biochar. For afforestation and reforestation, this is more ambiguous. Only one of those organizations discusses soil carbon sequestration.

The poor representation of the Global South in the discourse is unsurprising. Previous research has shown the dominance of a small group of Northern countries in the geoengineering discourse (Huttunen et al., 2015; Biermann and Möller, 2019). Our results confirm that this pattern is also true for the discourse on negative emissions. We believe that this pattern is highly problematic, especially as land-based negative emissions could be deployed to a significant extent in the Global South.

Therefore, measures must be taken to increase Southern participation in the discourse. Because we have analyzed here global discourses in a non-formalized setting, there are no formal procedural rules that could be changed to strengthen Global South participation. Such procedural rules will be more relevant, however, when it comes to

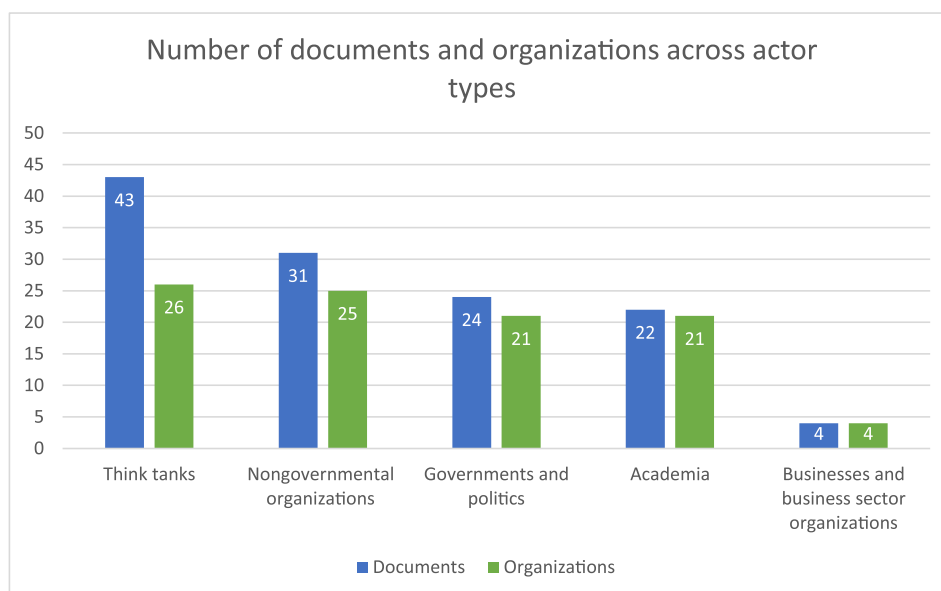


Fig. 4. Number of documents and number of organizations across actor types (own depiction).

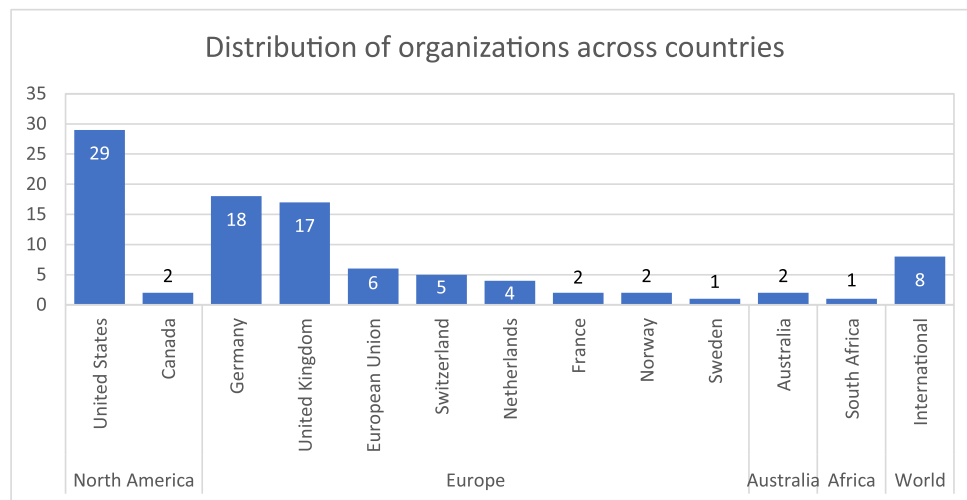


Fig. 5. Distribution of organizations across countries according to the location of their headquarters (own depiction).

formalized assessments, the workings of official and semi-official global commissions, or institutionalized global science and policy networks, where the input of the Global South must be ensured through clear and adequate structural mechanisms that ensure a balance of views. For example, should an independent intergovernmental organization be established to oversee negative emissions (Healey et al. 2021), procedural rules to ensure an equitable and effective participation of Global South actors are imperative. Engagement exercises bringing together a variety of Southern stakeholders can also foster South-South cooperation and support knowledge formation (e.g., Winickoff et al., 2015; Delina, 2020). To empower Southern actors to structurally better participate in the global discourse, also increased international research funding for Global South institutions would be an important enabling factor to ensure a stronger voice of the academic community of the Global South, including through support to scientific institutions and academies in the South. Support should be aimed at different actor types and at organizations in various countries of the Global South, particularly in Least Developed Countries, which would increase the discourse contributions of Southern actors and ensure the breadth of Southern contributions to reflect a variety of positions.

3.3. Decoupling of the discourse on negative emissions from the broader geoengineering discourse

At the start of the period of our investigation, negative emissions were typically discussed as part of geoengineering. In those cases, carbon dioxide removal was usually named as one of two approaches to geoengineering, next to solar radiation management. We found that this approach to discussing negative emissions was most pronounced among nongovernmental organizations, but common also among other types of organizations. German organizations were more likely than organizations from the other dominant countries (United Kingdom and United States) to approach negative emissions from the broader geoengineering perspective. Over time, however, the discursive link between geoengineering and negative emissions loosened, and the share of documents that considered carbon dioxide removal as a form of geoengineering has sharply decreased in the last years.

Less often, some organizations (mostly think tanks) also explicitly stated that they did not see carbon dioxide removal as part of geoengineering or that they believed that they should not be discussed together. A few organizations framed negative emissions also as a form of climate change mitigation, trying thus to further cut the link to geoengineering approaches that are often seen as more risky or undesirable, notably solar radiation management.

The decoupling of the carbon dioxide removal and geoengineering

discourses can also be seen in the decline of related discourse statements: For instance, in the early years, organizations more often emphasized that carbon dioxide removal only has slow effects. This argument was usually proposed when comparing carbon dioxide removal to solar radiation management. The latter is assumed to yield effects more rapidly, because incoming solar radiation is directly reflected, while carbon dioxide removal has a slower mechanism through the carbon cycle. More recently, the slowness of carbon dioxide removal has been brought up much less often. Similarly, in the early discourse, it was more often put forward that negative emissions address the cause of climate change. Again, this statement must be seen in comparison to solar radiation management, which leaves greenhouse gas concentrations unchanged, while carbon dioxide removal reduces atmospheric concentrations. The absence of these statements in the more recent discourse shows that negative emissions are increasingly regarded as a separate and stand-alone topic.

We believe that this decoupling of the discourses on negative emissions and solar radiation management could be the result of both a sophistication of the discourse and an active framing. On the one hand, as the discourse on negative emissions moves more towards deployment, a discussion that links this conceptually with solar radiation management may not be practical anymore. On the other hand, solar radiation management is often perceived as sensational but also negatively as a form of hubris with especially high risks, geopolitical conflict potential, and uncertainties. Therefore, actively loosening the connection to solar radiation management may be seen by some actors as beneficial for the growing acceptance of negative emissions technologies.

3.4. Discursive shift towards the necessity of negative emissions

Throughout the period of our study, documents referred to the IPCC reports and integrated assessment models more generally and stated that these modeling exercises show a need for negative emissions. Policy documents therefore overwhelmingly rely on the IPCC reports as a justification for talking about negative emissions. Indeed, this is the most common statement in the discourse overall. This expands the results by Gupta and Möller (2019), who found that the IPCC's Fifth Assessment Report became a major point of legitimacy for geoengineering research projects. A further and related point of reference are climate goals (often explicitly: the Paris Agreement). Organizations often state that climate goals cannot be achieved without negative emissions. Implicitly, this may also refer to the IPCC reports and integrated assessment models. More recently, however, these models were also criticized for their assumptions, mainly by academia and nongovernmental organizations. Nevertheless, IPCC reports and climate models

remain a strong discursive argument suggesting a necessity of negative emissions.

Throughout the discourse, also some positive effects of deploying negative emissions technologies have been suggested, notably that negative emissions technologies could compensate for residual emissions or for an emissions “overshoot,” along with possible co-benefits. In the last years, these effects have been emphasized more often. While the idea of compensating for an “overshoot” is more often discussed within academia and by think tanks, the potential of negative emissions to compensate for residual emissions is more widely debated. Nongovernmental organizations, on their part, rarely suggest any possible advantages of negative emissions.

Negative effects, however, notably risks, uncertainties, and moral hazard, are brought up consistently. Nongovernmental organizations dominate here the debate on negative effects, in particular regarding moral hazard, that is, that the expected future availability of negative emissions technologies delays or reduces incentives for rapid decarbonization. They also often bring up more general risks and uncertainties, but so do other organizational types as well. Comparing the three dominant countries in these discourses, German organizations are slightly more critical towards negative emissions and emphasize risks and moral hazard more often, and co-benefits less often.

In the last years, organizations more frequently called for concrete measures regarding carbon dioxide removal, ranging from more control and governance to more investment and research. While such calls to action have become more widespread, nongovernmental organizations were comparatively silent on these matters, except for some calls for governance. German organizations were much more likely to call for a public debate on negative emissions, while organizations in the United States were more likely to call for investment in supporting negative emissions.

Overall, these findings indicate a discursive shift: even though challenges remain and the assumptions in integrated assessment models may be overly optimistic, calls for action have become more frequent with more emphasis on assumed advantages of deploying negative emissions technologies. This supports the findings by Haikola et al. (2019), who observed a shift in the discourse on BECCS towards a reluctant acceptance. One type of organizations, however, resists this discursive shift. Nongovernmental organizations rarely call for action on carbon dioxide removal except for the need for governance and control. Furthermore, nongovernmental organizations strongly emphasize the moral hazard that carbon dioxide removal could entail and center their discourse on risks. If the overall discursive shift among academics, think tanks or government actors continues, nongovernmental organizations might thus face increasing challenges to maintain their opposition, especially should the policy discourse accelerate. While

nongovernmental organizations will likely continue to criticize negative emissions, they might also reluctantly accept a possible deployment of some technologies in order to influence the conditions of such deployment. However, there is also a temporal trade-off for nongovernmental organizations and other critical actors: while these organizations might wish to influence an increasingly likely deployment of some negative emissions technologies sooner rather than later, such (too) early engagement might put at risk any strong decarbonization policies.

3.5. The discourse on BECCS is more strongly focused on risks compared to other land-based negative emissions technologies

In addition to the general discourse on negative emissions, we studied the specific discourses of four land-based negative emissions technologies: BECCS, afforestation and reforestation, biochar, and soil carbon sequestration. The discourses are distinct in volume and in their foci. The discourses on BECCS and afforestation and reforestation are more prevalent, while biochar and soil carbon sequestration are more marginal (Fig. 6). This comes with no surprise as BECCS and afforestation and reforestation are best integrated into integrated assessment models (Clarke et al., 2014) and are therefore at the heart of the carbon dioxide removal debate. Overall, the relative number of documents discussing the four negative emissions technologies resembles the distribution of scientific publications on these technologies in Minx et al. (2018), except for soil carbon sequestration, which is less represented in the policy discourse compared to scholarly publications.

Risks and co-benefits are important talking points in the discourses, yet with strong differences between the land-based negative emissions technologies. Regarding BECCS, risks are brought up more than any other issue, followed by land and biomass requirements which are closely linked to risks. Co-benefits are discussed much less. On the contrary, soil carbon sequestration is overwhelmingly assumed to have co-benefits, which is the most-often discussed issue by far. Risks are rarely mentioned. The discourses on the two remaining technologies, afforestation and reforestation as well as biochar, appear more balanced in terms of risks and co-benefits. Regarding afforestation and reforestation, the most-often discussed aspects are risks, followed by co-benefits; for biochar, it is the other way round.

Fridahl (2017) identified a critical attitude of nongovernmental organizations towards BECCS. This is supported by our analysis, but we also find that the discourse on BECCS is in general strongly dominated by a perception of risks, not only in the discourse contributions of nongovernmental organizations. More recently, risks of BECCS have been pointed out slightly less often overall, which can be seen as further evidence of the discursive shift we identified above.

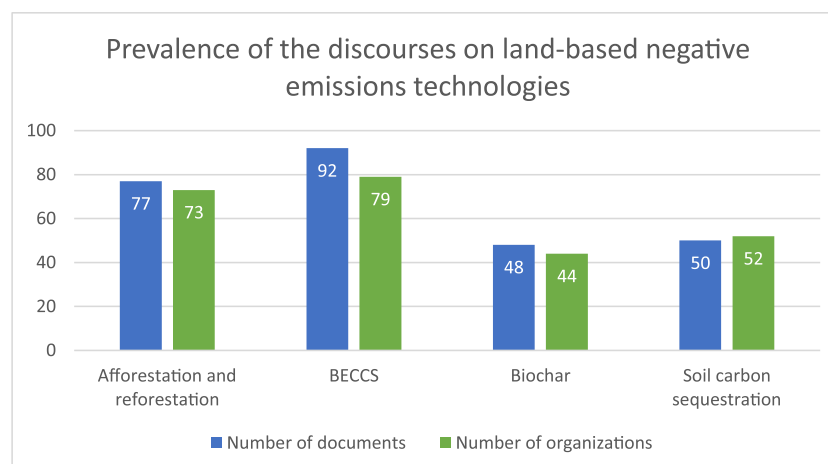


Fig. 6. Number of documents and number of organizations employing statements on specific land-based negative emissions technologies (own depiction).

3.6. Majority of contributions discusses the role of the Global South, in particular risks

In total, 61% of all organizations in the discourse that we analyzed refer to the Global South in at least one of their contributions; hence, 39% of all organizations seem to publish policy papers on negative emissions technologies without any special reference to the Global South. Here, organizations in the United States mention the Global South much less often than organizations in Germany and the United Kingdom. Also more generally, governments less frequently mention the Global South, with nongovernmental organizations referring to the Global South most frequently. All organizations with direct ties to the Global South relate to the Global South in their discourse contributions.

In the general discourse on negative emissions, risks and uncertainties are most prevalent with regards to the Global South. In particular, land grabbing is mentioned as a threat for communities. A second recurring issue relates to the governance of negative emissions with reflections on how to include Southern stakeholders in future governance.

As for individual negative emissions technologies, the discourses are distinct and differ in size. For BECCS, afforestation and reforestation, and biochar, the frequency is not too different from the general discourse, with the Global South being mentioned by 37–41% of the organizations that refer to these technologies. Soil carbon sequestration, however, is put into the context of the Global South only by 17% of the organizations that discuss this technology.

The debate on BECCS and the Global South is heavily dominated by risks; most often mentioned are land grabbing, food security and the risk of direct or indirect land-use change of tropical forests. A much smaller set of organizations also discusses advantages of BECCS in the Global South.

Afforestation and reforestation are also strongly discussed with respect to risks for the Global South. Risks for indigenous people are most often highlighted, followed by land grabbing and the clearance of tropical forests. However, because afforestation and reforestation could be counterproductive if done at higher latitudes because of the albedo effect, some papers also emphasize a special suitability of tropical countries for afforestation and reforestation, supported by other organizations that suggest high potentials for afforestation and reforestation in the Global South. A few organizations also mention co-benefits for the Global South.

Biochar is often put in the context of Terra Preta, which is of South American origin; we consider such references hence as relating to the Global South. While such references are mostly used as a positive reference to the origins of biochar, some organizations also state that biochar is not Terra Preta or are ambiguous about this. Risks are considered by some organizations, again with land grabbing being the most common issue. Some also consider co-benefits such as higher crop yields for Southern farmers.

Soil carbon sequestration, on its part, is rarely discussed with respect to the Global South. Risks are not discussed in this context at all, and the only recurring issue is the potential for co-benefits in the Global South.

Overall, we see a debate on negative emissions and the Global South focused on risks, in particular for BECCS, but also for other technologies except for soil carbon sequestration. Land grabbing is of particular concern to many organizations. Nongovernmental organizations most often discuss risks for the Global South. Besides risks, we find some technology-specific discussions (e.g., albedo or Terra Preta) as well as smaller debates on several issues including co-benefits and potentials.

3.7. Limitations and further research

Several limitations should be considered when interpreting the results of this research.

First, our data gathering strategy could not identify all potentially relevant documents. For one, our results are biased as we included only

documents in English, German, and French. Policy contributions in other languages that are official or common in many Southern countries were thus excluded from the analysis by definition. Notably, we did not include any Spanish language contributions, which creates a bias against South American discourse contributions and possibly against negative emissions technologies more relevant to this context. However, contributions aimed at the international negative emissions discourse are often published in English and are hence covered by our approach. We thus believe that we have captured a relevant sample of discourse contributions. A further limitation to our data gathering strategy are the chosen repositories. As the Climate Engineering News website is operated by German researchers (in English and German) and the Carbon Dioxide Removal Google Group was initiated by North American researchers, our sample might have a bias towards more German and North American contributions. This could explain why organizations based in Germany and the United States represent the highest share of organizations in our sample, along with those based in the United Kingdom. Moreover, our data gathering strategy is also limited by our focus on written documents, which excluded for instance conference presentations, videos, webinars and the like.

Second, also the way we coded statements has its limitations. While it allowed for a good overview of the policy discourse, we may have missed nuances. For example, our analysis did not distinguish between texts that mentioned an issue only once and texts that more specifically focused on it.

Lastly, also this article is another piece of research on geoengineering by Northern researchers that adds to the imbalance in global geoengineering research, even though our findings in the end clearly expose some of the current disbalances in the discourse and show the need for structural reforms that would give actors from the Global South a much stronger voice. Our positionality might also have caused a bias in our results, for example due to our limitation to English, French and German contributions as discussed above.

Future research could further scrutinize some details of the discourse on negative emissions. The broad categories of statements could be disaggregated. For example, while we coded a variety of risks and uncertainties to the same category, disaggregating such risks into risks for natural systems and risks for social systems could add to the results of this article. Furthermore, we only analyzed the discourse in one arena, namely the policy sphere. A comparison of the policy discourse with other discourse arenas might prove fruitful. Including documents from more languages, especially languages spoken in the Global South, could improve the geographic balance of the analysis.

4. Conclusion

The policy discourse on negative emissions is accelerating. Its development can be understood by scrutinizing the temporal, organizational and regional distribution of the statements structuring this discourse. Five aspects stand out.

First, while the discourse on negative emissions originates from the broader geoengineering discourse, *a decoupling can be observed*. Statements that link these two discursive strands are becoming much less frequent over time, while statements that discursively separate the strands became dominant. Negative emissions are increasingly viewed as a standalone topic.

Second, we observe *a discursive shift towards deployment*. At the same time, possible advantages of negative emissions are emphasized more often. Some nongovernmental organizations, however, appear to resist this trend, with their discourse remaining more strongly centered around risks and moral hazard.

Third, *some negative emissions technologies are framed more positively than others*. Soil carbon sequestration, in particular, is discussed mostly in terms of co-benefits, while BECCS is usually seen in the light of its risks. For afforestation and reforestation and biochar, both risks and benefits are considered.

Fourth, 61% of the organizations active in this discourse refer to the Global South in at least one of their discourse contributions. Nongovernmental organizations often speak about the role of the Global South regarding negative emissions, in particular relating to risks. BECCS is most often associated with risks for the Global South.

Fifth and most importantly, *only very few organizations from the Global South participate in the discourse*. Of all organizations contributing to this discourse, only one organization and members of four consortia of nongovernmental organizations have their headquarters in the Global South. Therefore, in total, *only 5 out of 97 organizations active in this discourse have direct ties to the Global South*. These few organizations lean towards a more critical stance in the discourse.

Given that land-based negative emissions technologies are expected to be deployed to a significant extent in the Global South, the scarcity of Southern voices in the discourse is highly problematic. It requires urgent action, in particular through targeted international financial support for independent research and assessment in the Global South.

CRedit authorship contribution statement

Gregor Jaschke: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Frank Biermann:** Conceptualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gloenvcha.2022.102550>.

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