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Editorial: Carbon dioxide removal: perspectives from the social sciences and humanities

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Editorial on the Research Topic

Carbon dioxide removal: Perspectives from the social sciences and humanities

Introduction

In recent years, carbon dioxide removal (CDR) methods have been increasingly recognized as crucial in climate policy and scientific contexts (Abegg et al.). According to the latest Intergovernmental Panel on Climate Change reports, the 1.5-degree target is unattainable without rapid and substantial investments in CDR. These methods are also crucial to counteract emissions overshoot and residual emissions. Currently, integrated assessment models (IAMs) and techno-economic research dominate the interpretive space for understanding and deliberating the future of CDR methods and translating these understandings into policy and political action (Hansson et al., 2021). A criticism of this dominance is that many important perspectives on technical development, socio-ecological challenges, local political contexts, and other complexities are relegated to a marginal role. If large-scale CDR is portrayed as achievable through its incorporation into mitigation scenarios and climate policies, this might justify less focus on crucial short-term challenges.

Against this backdrop, we aimed to invite theoretical and empirical contributions from the social sciences and humanities about CDR-related policy design or analyses of recent policy developments, construction of knowledge in scientific discourses, historical and contemporary experiences of CDR in different contexts, and political and public debates over CDR. The Research Topic has gathered contributions that provide puzzle pieces that nuance, deepen, or challenge previous research through empirical case studies, theoretical engagement, literature reviews, policy and governance analysis, or analyses of perspectives from the public, experts, or industry. Specifically, the contributions approach this by asking questions like: how does the adoption of a “net” framing reconstruct the goals, processes, and mechanisms of climate

policies (McLaren and Carver)? What is the industry's view on residual emissions assumed to be compensated for in the future (Brad et al.)? What could a research agenda capable of supporting a more responsible evaluation of CDR methods look like (Healey et al.)? How is foresight knowledge produced and used among policymakers with the help of emission scenarios (Andersson)? What are the gaps and barriers for a specific CDR method to be integrated into a national policy regime (Cortinovis et al.)?

Carbon dioxide removal policy from sub-national to international levels of governance

Since the early 2020s, there has been a surge in research on policies to incentivize CDR deployment, a trend also reflected in this Research Topic. Focusing on the UK, Healey et al. report on stakeholders' views of CDR, which, despite a tendency toward negative opinions, do not rule out any CDR options. Stakeholders request further research and deployment to gain experience. Two policy pathways emerge from their analysis: contracts for difference and producer responsibility obligations. However, Healey et al. underscore the importance of developing appropriate incentive structures from the bottom up, "built one at a time, jurisdiction by jurisdiction." They caution that even well-regarded CDR methods could be rejected if paired with unfavorable financial incentives. Top-down policy analysis requires complementary bottom-up analysis to ensure feasibility, or policies risk backfiring.

Bottom-up analysis of policy instruments may be cumbersome but beneficial. Incorporating multiple perspectives can lead to more robust policy by identifying potential trade-offs between diverse objectives. Günther and Ekardt emphasize this, showing how CDR policy is subordinate to emissions reductions in international climate law, while conservation measures are paramount in international biodiversity law. They argue that safeguarding biodiversity should take precedence if trade-offs are identified. Policymakers must address both climate change and biodiversity loss through coordinated land-use strategies, considering the negative impacts of large-scale land-based CDR on ecosystems and food security.

This is no simple feat. The shrinking solution space necessitates CDR to avoid costly loss, damage, or extreme adaptation measures, including risky solar radiation management. Policymakers must also juggle sector-specific interests involving powerful lobby groups like chemical, steel, cement, and fuel producers. Brad et al. show how trade associations largely support the EU's climate goals, including CDR integration. However, the EU's net targets for 2030 and 2050 leave room for residual emissions from unspecified sources. Trade associations make vague claims to residual shares and highlight CDR's technical potential to argue against the need for rapid emissions reductions. Brad et al. work similarly to Healey et al. by assembling industry claims to reveal a bigger picture where the equation does not compute. Their analysis highlights the challenges in designing CDR policy that is effective, overcomes trade-offs, and avoids promoting overstated future CDR potentials that can be used to delay necessary emissions reductions.

Construction of scientific knowledge and communication of carbon dioxide removal

IAMs are pivotal in the scientific and policy debates on CDR methods. Their quantitative analyses of emissions scenarios form the foundation of IPCC assessments of mitigation options, placing CDR at the forefront of global discussions on achieving net-zero targets. Therefore, it is important to examine, from a critical social scientific perspective, the roles that modeling frameworks like IAMs play in shaping scientific knowledge on CDR and broader climate policy. Andersson and Wilson contribute significantly to this endeavor.

Andersson examines how model-based scenario analyses inform foresight knowledge relevant to Swedish climate policy. These simulations, despite their deep uncertainties and long-term outlooks, guide policy decisions by defining common problems and suggesting cost-effective mitigation pathways. However, Andersson highlights that focusing solely on economic efficiency may limit policy effectiveness by neglecting transformative changes in cultural norms and behaviors.

Meanwhile, Wilson explores the challenges of measuring CDR technology effectiveness, particularly in California's forest offset program. He critiques current measurement practices reliant on baseline projections, which often overestimate carbon removals due to inaccurate representations of carbon dynamics. Wilson advocates for alternative measurement targets less dependent on counterfactual scenarios to ensure genuine long-term carbon reductions.

Both Andersson and Wilson underscore how scientific knowledge construction through modeling and measurement shapes CDR policy discourses, while also warning against systemic biases and exaggerated promises in climate mitigation strategies. In contrast, Bellamy and Raimi highlight communication challenges surrounding CDR strategies, emphasizing the need for responsible communication that addresses public awareness gaps and frames CDR in broader social and policy contexts. They argue for inclusive communication strategies that consider diverse implementation scenarios to enhance public understanding and support for CDR technologies.

Historical and contemporary experiences of carbon dioxide removal

Cortinovis et al. highlight the IPCC's general lack of inclusion of national characteristics such as financial, technological, social, and political acceptance in their scenarios. They address this gap by analyzing emerging policy frameworks for Direct Air Carbon Dioxide Capture and Storage (DACCS) in Canada, identifying policy deficiencies and proposing tailored strategies to integrate them with existing frameworks and support technology scaling. They emphasize the challenge of short-term national energy policies in Canada, focused on local needs and strengthening current energy systems through investments in Carbon Dioxide Capture and Storage (CCS). The authors argue that while DACCS holds promise, political efforts are needed to effectively integrate it into energy and climate policies as it appears the dominant

interests use the promise of DACCS to justify only marginal energy transition.

Hilser et al. similarly examine national contexts, focusing on empirical observations from the Dominican Republic, a small island developing state. They conduct an in-depth study at a field trial site relevant to understanding CDR, cautioning against bioenergy and afforestation projects that may lead to land grabs and exacerbate climate vulnerabilities. They stress the importance of climate justice in CDR interventions, advocating for participatory approaches that include vulnerable groups and build trusting relationships. In contrast, Fink and Ratter study local attitudes toward CDR in Germany, a developed country without ongoing implementation projects. While justice perspectives are less prominent in their analysis, they underscore the importance of transparency, inclusion, and co-creation of knowledge in shaping local perceptions and strategies for implementing CDR technologies. These studies collectively underscore the necessity of considering national contexts and justice perspectives in CDR implementation, whether in policy frameworks, empirical studies, or local community engagements.

Contested carbon dioxide removal framings and discourses

One key theme in the Research Topic is the contentious public and political debates surrounding the role of carbon dioxide removal and storage in climate policy. Authors in this Research Topic emphasize that analyzing these debates is crucial because dominant framings, concepts, and discourses actively shape the goals, processes, and mechanisms of CDR development and governance.

McLaren and Carver illustrate how the concept of “net-zero” has reshaped climate policy by framing it as a balance between emissions sources and carbon sinks. This framing has entrenched the idea of “residual” emissions requiring CDR, reinforcing the inevitability of CDR in international climate governance. They argue that the turn to net policies reflects a broader neoliberal perspective, emphasizing quantification, commodification of the environment, and economic justifications for policy solutions, promoting notions of economic freedom and green growth. Beyond critiquing neoliberal impacts on CDR, McLaren and Carver draw lessons from historical net policy effects. They advocate for shifting away from market-driven narratives and propose principles for fairer and sustainable CDR policies.

Similarly, Rodriguez explores framings in scientific literature on carbon dioxide enhanced oil recovery (EOR) in the North Sea, identifying contrasting views. One framing presents EOR as a bridging strategy facilitating carbon storage, while another views it as incompatible with climate mitigation, exacerbating fossil fuel use and carbon emissions. The analysis reveals conflicts between EOR and point-source or atmospheric carbon capture and storage (CCS) for climate mitigation, emphasizing the dominance of economic interests in EOR discourse. Rodriguez suggests policy solutions to prevent carbon lock-in, such as promoting alternative carbon storage methods without EOR, restricting EOR use, and mandating transparent knowledge sharing on monitoring and safety.

These studies underscore the importance of dissecting framing effects in shaping CDR and climate policy discourses, advocating

for policies that navigate conflicts and promote sustainable, equitable approaches to climate mitigation.

Conclusions

The Research Topic has underscored the importance of fostering diversity in scientific and political processes to comprehend CDR's societal role. Despite empirical and theoretical differences among studies, temporal aspects at the systemic level have emerged as crucial for further investigation. For instance, how do CDR methods influence the speed of climate transition and the preservation of existing structures?

Aligned with Bellamy and Raimi's argument advocating for a broader or more comprehensive discourse, we hope this Research Topic can enrich the public debate on the role of these methods in societal transformations.

Author contributions

AH: Writing – original draft, Writing – review & editing, Conceptualization. SA: Writing – original draft, Writing – review & editing, Conceptualization. MB: Writing – original draft, Writing – review & editing, Conceptualization. MF: Writing – original draft, Writing – review & editing, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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