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ANALYSIS

How social movements contribute to staying within the global carbon budget: Evidence from a qualitative meta-analysis of case studies

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ABSTRACT

Despite renewed efforts to combat climate change, it remains uncertain how economies will achieve emission reduction by 2050. Among different decarbonisation strategies, knowledge about the potential role and contributions of social movements to curbing carbon emissions has been limited. This study aims to shed light on the diverse contributions of social movements to staying within the global carbon budget, as well as on the specific outcomes and strategies employed in protests against hydrocarbon activities. For this purpose, we conduct a systematic literature review of 57 empirical cases of social movements contesting fossil fuel projects in 29 countries. Based on an exploratory approach, we identify a series of different movement strategies and a range of qualitative contributions that support staying within the carbon budget. These include raising awareness of risks and strategies, enhancing corporate responsibility, being informed about policy changes, laws and regulations, fostering just energy transitions, energy democracy, divestment, alternative market solutions, and forcing the postponement or cancellation of targeted hydrocarbon activities. While the institutional means are widely used and seem to support policy change and regulation, these strategies are not used to deliver awareness or postponement outcomes. Similarly, while movements tend to rely on civil disobedience to stop hydrocarbon projects in the short term, they rely on multiple strategies to cancel them in the longer term. Our study also indicates significant knowledge gaps in the literature, particularly, cases in Africa and Central Asia, women's participation in these movements, in addition to more quantitative assessments of the actual emissions reduced by social movements.

1. Introduction: social mobilisation towards decarbonisation

The levels of carbon dioxide (CO_2) concentration in the atmosphere continue to grow, despite a worldwide commitment to the Paris Agreement (Friedlingstein et al., 2020). Even with emerging climate policies, regulations, and carbon-capture technologies, reaching the Paris Agreement goal remains a challenge. Concurrently, climate activists and environmental justice organisations continue to protest against extracting and processing fossil fuels as a strategy to achieve climate change mitigation (Temper et al., 2020; Villamayor-Tomas and García-López, 2018). As a result, activism towards decarbonisation is becoming a potentially effective force for reducing CO_2 emissions (Klein, 2015). Movements such as 'Blockadia' that mobilise to stop the extraction of fossil fuels and other minerals have become important actors for the transition to a more socially and environmentally just society (Martinez-Alier et al., 2016).

This study aims to improve the understanding of the role that activism against hydrocarbon activities can play in climate change mitigation. The increased attention to social movements contesting fossil fuel use has resulted in a well-defined body of conceptual and empirical studies examining these movements' success and failure against hydrocarbon activities (Owen et al., 2018; Temper et al., 2020). However, these studies are scattered across different disciplines, using different focuses and approaches. Thus, there is a lack of systematic and generalised knowledge linking social movements to limiting or reducing carbon emissions as a decarbonisation strategy.

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The establishment of carbon budgets has become a key strategy in combatting climate change. A carbon budget refers to the aggregate amount of carbon dioxide (CO_2) emissions permissible between 1817 and 2050 to hold global temperature increases to within 2 °C above the pre-industrial level (IPCC, 2014). According to the Intergovernmental Panel on Climate Change (IPCC), there is a 66% probability of limiting total human-induced warming (accounting for both CO_2 and other human influences on climate) to less than 2 °C relative to the period 1850 to 1900. To stay well below 2 °C, it would require total anthropogenic CO_2 emissions since 1870 to be limited to approximately 2900 gigatons of CO_2 (Gt CO_2) at 66% probability and 2250 Gt CO_2 of CO_2 for 1.5 °C (IPCC, 2021; IPCC, 2018; IPCC, 2014). According to estimated emissions for 2011 to 2017, only 118 Gt CO_2 would remain from the beginning of 2018 to limit global warming to 1.5 °C (Hausfather, 2018). The British Petroleum (BP) Statistical Review of World Energy (2018) assessment of reserves indicates that the extensive production of refined oil, gas, and coal reserves would produce respectively 630, 365, and 2037 Gt CO_2 (3029 Gt CO_2 in sum) (British Petroleum Company, 2018). These figures show that world carbon reserves are higher (of about 25 times for 1.5 °C and 15 times for 2 °C) than the combustible amount suggested by the carbon budget allowed to control the rise in global temperatures, even with international efforts to stay within the limit. Both activists and scientists claim for 'Leaving Fossil Fuels Underground' (LFFU), which would be needed for most reserves. In a recent article in Nature, Welsby et al. (2021) found that to allow for a 50% probability of limiting warming to 1.5 °C, by 2050, nearly 60% of oil and fossil methane gas and 90% of coal must remain unextracted. Then, there is an urgent need for alternative strategies for limiting carbon emissions. The carbon budget concept creates a pathway for linking sustainability science with climate mitigation policymakers and grassroots movements. It enables to quantify the amount of carbon emitted in the atmosphere before the global temperature rises (Lahn, 2020). The target can, in turn, motivate grassroots environmental justice and resistance movements against fossil fuels to promote just and sustainable decarbonisation pathways. However, while many studies analyse the effect of technologies, market mechanisms, and top-down policies to staying within the global carbon budget, there is a lack of systematic knowledge of the contributions of social movements to climate change mitigation.

Studies on environmental justice movements that contest hydrocarbon activities claim that such actions are crucial for a sustainable and just transformation of energy systems (Bradshaw, 2015; Martinez-Alier et al., 2014; Pearse, 2016; Piggot, 2018; Roy and Schaffartzik, 2021; Temper et al., 2020). An empirical study using several hundred cases of place-based energy-related mobilisations listed in the Environmental Justice Atlas (EJAtlas.org) – the world largest inventory of environmental conflicts-found that, for 25% of the observations, conflictive projects were either stopped or delayed (Temper et al., 2020). The surge in climate and environmental justice movements is frequently led by local environmental organisations, women in the Global South, and indigenous people who replant trees, chase away loggers, or block mining linked to the extraction of fossil fuels (Federici, 2011; Temper et al., 2018; Villamayor-Tomás and García Lopez, 2021).

According to Pierrehumbert (Pierrehumbert, 2019; Pierrehumbert, 2016), the global carbon budget target can be achieved by: 1) social mobilisation towards decarbonisation, 2) reducing carbon footprints through market-oriented policies and regulations, and 3) alternative energy technologies such as nuclear or carbon capture and storage. The success of the second and the third strategies are contingent on a broad spectrum of social and institutional change. In contrast, social mobilisation towards decarbonisation can be achieved by collective resistance and proactive participation of local communities and civil society actors (Temper et al., 2018). While the climate-mitigation instruments reported in the IPCC Fifth Assessment Report address the general role of NGOs as advocates, the specific actions and perspectives of grassroots movements are not addressed. This contrasts with growing evidence about the emergence of social mobilisations against hydrocarbon extraction and processing projects and the capacity of grassroots movements to jeopardise the economic returns of extractive industries (Franks et al., 2014), and, at times, to delay or completely stop the projects (Klein, 2015; Temper et al., 2020).

In light of the knowledge gap concerning collective mobilisations and climate change mitigation, this paper aims to address two research questions: 1) What are the specific contributions of social movements to staying within the carbon budget? 2) Which kind of strategies do movements employ to achieve different outcomes in protests against hydrocarbon activities? This paper systematically reviews academic research papers and book chapters on social movements contesting fossil fuel projects to answer these questions. A qualitative meta-analysis of 57 empirical cases was undertaken after conducting an intensive review and filtering process. The scope of the analysis was limited to understanding the outcomes of social movements against specific hydrocarbon projects at the supply side, particularly against the extraction, processing, and transportation of fossil fuels by states and companies. Studies focusing on movements targeting citizens to achieve demand-side changes, such as low carbon lifestyle movements and community-based energy consumption reforms initiatives and their contributions to emission reduction, are not considered here (see, for example, Biglan et al., 2020; Büchs et al., 2015; Landholm et al., 2019). Based on an exploratory approach, the paper identifies different movement strategies and diverse qualitative contributions relevant for supporting emissions reduction processes. The associations of different movement strategies with the diverse qualitative outcome variables observed in the study sample were evaluated using Pearson Chi-squared tests of independence.

Section 2 discusses the conceptual framework, exploring social movements against fossil fuel activities and strategies to achieve the global carbon budget. Section 3 explains the methodology. Section 4 analyses the results and discusses how social mobilisations against fossil fuels can limit the global carbon budget. Section 5 concludes the analysis and proposes a future research agenda.

2. Conceptual framework: social movements as forces for sustainability

From the Kyoto Protocol to the Paris Agreement, various approaches have been advanced to reduce fossil fuels. Well-known examples are the development of low-carbon technologies, the establishment of carbon pricing and markets, and the promotion of lifestyle changes. Many of the strategies favoured by governments target the demand side (Lazarus et al., 2015; Somanathan et al., 2014). However, the initiatives pursued have been insufficient to limit fossil fuel consumption to stay within the global carbon budget (Covert et al., 2016; Erickson et al., 2018; Godinho, 2020; Piggot, 2018). Therefore, supply-side strategies are also needed to help reach the emissions target. These strategies can be implemented through national and sub-national climate mitigation policy instruments to limit fossil fuel supplies through economic instruments, regulatory approaches, government provision of goods and services, information measures, and voluntary actions (Somanathan et al., 2014). In this context, Piggot (2018) has explicitly argued for exploring the role that activism and social mobilisations against hydrocarbon projects may have in influencing policies that constrain fossil fuel supply.

The multiple ways through which social movements influence social transformations are complex. Social movements, referring broadly to the diverse sets of actors engaging in processes of rational and purposeful collective actions or resistance, may emerge for manifold reasons, for example, in reaction to an authoritative transformation in a society, or over the conflicting interest of resources, values, and cultures (Della Porta and Diani, 2006; Tilly, 2004). Mobilisations tend to differ across geographical, social and political contexts. There can be broad alliances among different stakeholder groups, such as between environmental justice organisations, local communities, indigenous people, minorities

and women's groups (Tarrow, 2011) or coalitions of actors across sectors, such as local governments, non-governmental organisations and civil society (Bond and Dorsey, 2010), or a combination of strategies known as "Repertoires of actions" (Tilly, 2004; Tarrow, 2011). Consequently, the motivations, framing, forms of protest, and effectiveness can vary across cases (Benford and Snow, 2000; Tilly, 2004). In this study, we focus the systematic literature review on identifying specific movement strategies and their combinations, as reported in the empirical literature in relation to specific outcomes.

The idea that social mobilisations may play an essential role in addressing environmental concerns and enhancing sustainability has been conceptualized in the growing literature on *ecological distribution conflicts* (for an overview, see Scheidel et al., 2018). This idea can be traced back and related to various concepts discussing the struggles of grassroots collectives for more just, and sustainable resource uses: *environmental justice movements* (Bullard, 1994); *ecosystem people* (Gadgiil and Guha, 1995), *ecological resistance movements* (Taylor, 1995), *eco-political movements* (Goldman, 1996), the *environmentalism of the poor* (Martinez-Alier, 2002), *livelihood movements* (Robbins, 2004), or *politics from below* (Borras and Franco, 2013). A common denominator in all these terms is the emphasis given to marginal grassroots groups that fight against environmentally destructive activities that threaten their cultural values and livelihoods. They are primarily concerned about natural resources and ecosystem services rather than monetary matters delivered by the modern economic system (Martinez-Alier, 2002). Given the increasing frequency of environmental protests globally and their interconnection via networks, Martinez-Alier et al. (2016) label this grassroots environmental activism as a "*global movement for environmental justice*". Many civil society organisations, such as Global Witness (Global Witness, 2020) and, recently, also the United Nations Environmental Programme (UNEP, 2018), refer to environmental activists and movements as *environmental defenders*. Their contentious actions that frequently arise out of environmental conflicts in which they oppose environmentally destructive and socially unjust projects have made significant contributions to the promotion of environmental sustainability and social justice regarding natural resource use and management (see, e.g. Escobar, 1998; Lemos and Agrawal, 2006; Scheidel et al., 2018; UN, 2019; Villamayor-Tomas and García-López, 2018; Watts and Peets, 2004). The specific question that we explore in this paper is how and through which contributions, grassroots movements may also promote and pave alternative paths for climate mitigation.

In studies of ecological distribution conflicts, the struggles of environmental justice movements are observed at different stages of commodity chains, including the extraction, transportation, production of goods, and waste disposal stages (Martinez-Alier et al., 2010; O'Connor and Martinez-Alier, 1998). The increase of environmental justice struggles is related to the growth in the social metabolism, that is, the global economy's growing demand for materials and energy that have far-reaching social and ecological consequences, including climate change and environmental injustice (Muradian et al., 2012). Furthermore, even though industrialised countries have developed policies and regulations for reducing carbon emissions domestically, energy and emission-intensive activities are frequently outsourced to other countries, a process known as 'leakage' (Jakob et al., 2013; Lazarus et al., 2015; Somanathan et al., 2014). Therefore, understanding how and with what outcomes resistance to energy-intensive activities occurs across the different stages of commodity chains may provide essential insights for understanding their potential to shape carbon emissions (Martínez-Alier and Muradian, 2015). In this paper, we build on the hypothesis that social movements that contest fossil fuels across different commodity chain stages contribute to reducing, constraining, and politicising carbon emissions.

3. Methodology: a qualitative meta-analysis

The study employs a qualitative meta-analysis of case studies following protocols used in similar studies (Villamayor-Tomas and García-López, 2018). Data collection and analysis included three stages. In stage 1, we ran an exploratory review of case studies. These case study designs are helpful when there is little theory on the studied phenomenon, such as the connection between social movements and carbon emissions (McDonough and McDonough, 1997; Yin, 1984). For example, the highest contributing factor to rising global temperatures are the emissions caused by burning coal, oil, and gas for power generation in different sectors (Le Quéré et al., 2012).[1] Thus, the most relevant cases to study in this context are the environmental justice movements around these fossil fuel commodities. Therefore, we explored and screened studies broadly associated with social movements and hydrocarbon-related projects, searching for an appropriate initial list of 'contribution' variables. The search was carried out in Scopus and Google Scholar, and studies were selected based on relevance, i.e., the connection with our research questions. The operational questions used were: "What was the outcome of the case?" "What were the strategies used by the movement to achieve a specific outcome?" and "How often does a type of outcome repeat across all reviewed studies?". In the process of screening the studies, we also paid attention to 'auxiliary' variables, i.e., variables that, although not directly connected with our research questions, could be useful for contextualisation purposes (e.g., country, type of project). As a result of this non-systematic exploratory review, we produced a 'coding book', including an initial list of variables and their definitions (See Table 1, and a series of keywords used in the second stage.

In the second stage, we carried out a more systematic search and screening of studies in Scopus and Google Scholar through the combination of keywords. We combined pairs of words from two groups: one related to the hydrocarbon resource ('emission' 'fossil fuels' 'extraction' 'procession' and 'transportation') and the other concerning social movements ('social movement', 'environmental justice movement' and 'climate justice movement'). The publications displayed in the Scopus search from the keyword combinations resulted in 1697 hits with overlapping publications from each combination. We made selections based on relevance to our research questions to filter this initial batch of publications into a manageable set. First, we selected empirical studies published in English as academic journal articles and book chapters. We then screened the content of the studies and selected: 1) studies of social movements that focused on at least one process of hydrocarbon extraction, processing, or transportation (mining, fracking, refineries, coal-fired power plant, pipelines, terminals and shipping) but did not include end-user consumption, to narrow the scope of research; *and* 2) studies that contained information about the actors that participated in the mobilisation, and explained both the strategies and the outcomes of the mobilisation. Overall, the screening filtered down the initial list to 78 publications.

In the third stage, we proceeded with extracting the data from the studies, i.e., through the coding process. Again, some studies were discarded here due to a lack of relevant information. Finally, we coded 45 studies, including 57 cases (some articles contained multiple cases), covering 2010 to 2020. The list of publications used is reported in Table C1 (Appendix C). Table 1 shows the variables set up for the studies and their coding criteria. The coding book, outlined in the

[1] The CO_2 budget components include the CO_2 emissions from fossil fuel combustion, land-use change and forestry; the growth rate of CO_2 in the atmosphere; and the uptake of CO_2 by the 'CO_2 sinks"'in both ocean and land. The emission from fossil fuels is calculated from fossil fuel combustion, which includes gas flaring and cement production. Such data are gathered from energy data on hydrocarbon fossil fuels archived by several organisations (Andres et al., 2012, Le Quéré et al., 2012). Even though the carbon budget does not include gas flaring from coal mining, oil extraction, gas extraction and distribution (Le Quéré et al., 2012), we examined activism against these extractive activities since they still limit the supply of fossil fuels.

Table 1
Initial variable list for coding.

Codes	Coding values and criteria
Projects & movements	
Types of Fossil Fuel: coal, oil and gas	1: The case study reports on the actions of a movement against fossil fuels, such as coal, oil or gas, respectively. It can be all '1's when the case does not mention a particular type but generally refers to all fossil fuel types. 0: The study does not report on a fossil fuel-related case. The variable should not be all '0's.
Commodity chain: extraction, processing and transportation	1: The case study examines a movement centred around a particular commodity chain stage, such as extraction, processing or transportation 0: The research does not focus on a specific fossil fuel commodity-chain stage but refers to general protests against fossil fuels.
Type of activity: mining, fracking, coal-fired power plant (CFPP), refinery, pipelines and shipping	1: The case study examines an activity related to fossil fuel extraction, processing and transportation, such as mining, fracking, coal-fired power plant (CFPP), refinery, pipelines and shipping, When the movement concerns reducing carbon emissions in general and reducing hydrocarbon/fossil fuels, however, it does not specify the type of activity, the coder selects all the criteria as '1'. 0: The case study does not report any activity related to fossil fuels, such as mining, fracking, CFPP, refinery, pipelines and shipping.
The scale of the movement	Local: The movement's actions unfold at the provincial, state, city or town level Regional: the movement's actions unfold across provinces National: the movement's actions unfold nation-wide International: the movement's actions unfold across countries
The number of protest events	Single: One protest event is mentioned in the study Multiple: the exact number of protest events is not mentioned, but it is more than one.
Contributions	<open text> Explain if the case study provides information about the movement's outcome contributing to climate change mitigation and carbon emission reduction. There can be multiple contributions in one movement case. Other outcomes that do not contribute as positive contributions are also added as 'other outcomes'.
Actors and network	<open text>: If the case study provides information about the participation of different actors, continue to code its participation. There can be multiple participation of actors in a single case of social movement. "Unclear": The case does not provide clear information on its network and other participants (but can still be coded).
Strategies	<open text>: If the case study provides information about the movement's mobilisation strategies towards reducing carbon emission, continue to code the strategies. There can be multiple strategies in one movement case. "Unclear": The case does not provide a clear strategy (but can still be coded).

Source: Authors.

supplementary material, provides a detailed explanation of the process.

Finally, the cases are examined using a combination of qualitative and quantitative analyses. First, we ran frequency tables that explore the geographical distributions of the codified social movement cases. Second, we used frequency tables to analyse patterns of outcomes across movement strategies. Thirdly, Chi-squared and Fisher's exact tests are used to determine non-random associations between two categorical variables.[2] A valid Chi-squared test should fulfil two assumptions: i) the observations are categorised into mutually exclusive variables, and ii) the calculated expected values should be greater than 5 in at least 80% of the cells. We examined Fisher's exact test for more reliable results in cases where expected values are less than 5, possibly due to a low frequency of a particular strategy and outcome pair in the sample. Subsequently, we analyse the combinations that were statistically significant to identify the strongest associations between strategies and outcomes.

The analysed sample has some inherent characteristics and limitations that should be considered when interpreting the results. First, the reviewed empirical literature is composed of diverse case studies, which may include *typical* cases that exemplify more common movement dynamics, as well as *extreme* or *unique* cases that include key events such as important movement successes (e.g. winning a case) or failures (e.g. killing of activists) (Bryman, 2012). Results on the frequency of observed outcomes, therefore, reflects only the findings in the available literature, which is a limitation that applies more generally to systematic reviews of case studies. By adopting a qualitative exploratory approach to said outcomes (e.g., identification and classification of "contributions" and "strategies"), we aimed to cover the diversity of outcomes unveiled in the literature. Second, our sample covers only English academic papers and book chapters indexed in Google Scholar and Scopus but does not cover 'grey literature' or studies published in other languages. Thus, our systematic review reflects state-of-the-art knowledge available in English academic literature but not cases of resistance to fossil fuels that remain undocumented in the academic literature or are only documented in languages other than English.

4. Results and discussion: the strategies, actors and contributions of social movements to climate mitigation

First, this section presents an overview of the results regarding resistances to fossil fuels across stages of the commodity chain and their geographical coverage. Second, the contributions of social movements to climate change mitigation and their strategies are reported and discussed based on the systematic literature review. Third, a discussion that draws on the results of our study to answer our research question on how social movements contribute to staying within the global carbon budget is presented.

4.1. Overview of results regarding resistance to fossil fuels

Fig. 1 illustrates the geographical coverage of the literature about contestation against coal, oil and gas across different stages in the commodity chain. The extraction cases are under-represented in Asia and Africa (Map A). Most are concentrated in North and South America, South Africa, Europe and Australia. Within Asia, only India, the Philippines and Indonesia are covered. The only cases from Africa correspond to the extraction stage. Most of the processing stage cases are concentrated in western countries; hence coverage is lacking for African countries (Map B). However, unlike other stages, we see a limited representation from China in the sample. Regarding the transportation

[2] The Fisher's exact test is appropriate when the sample size is too small and can give more reliable results (Macdonald, 2014).

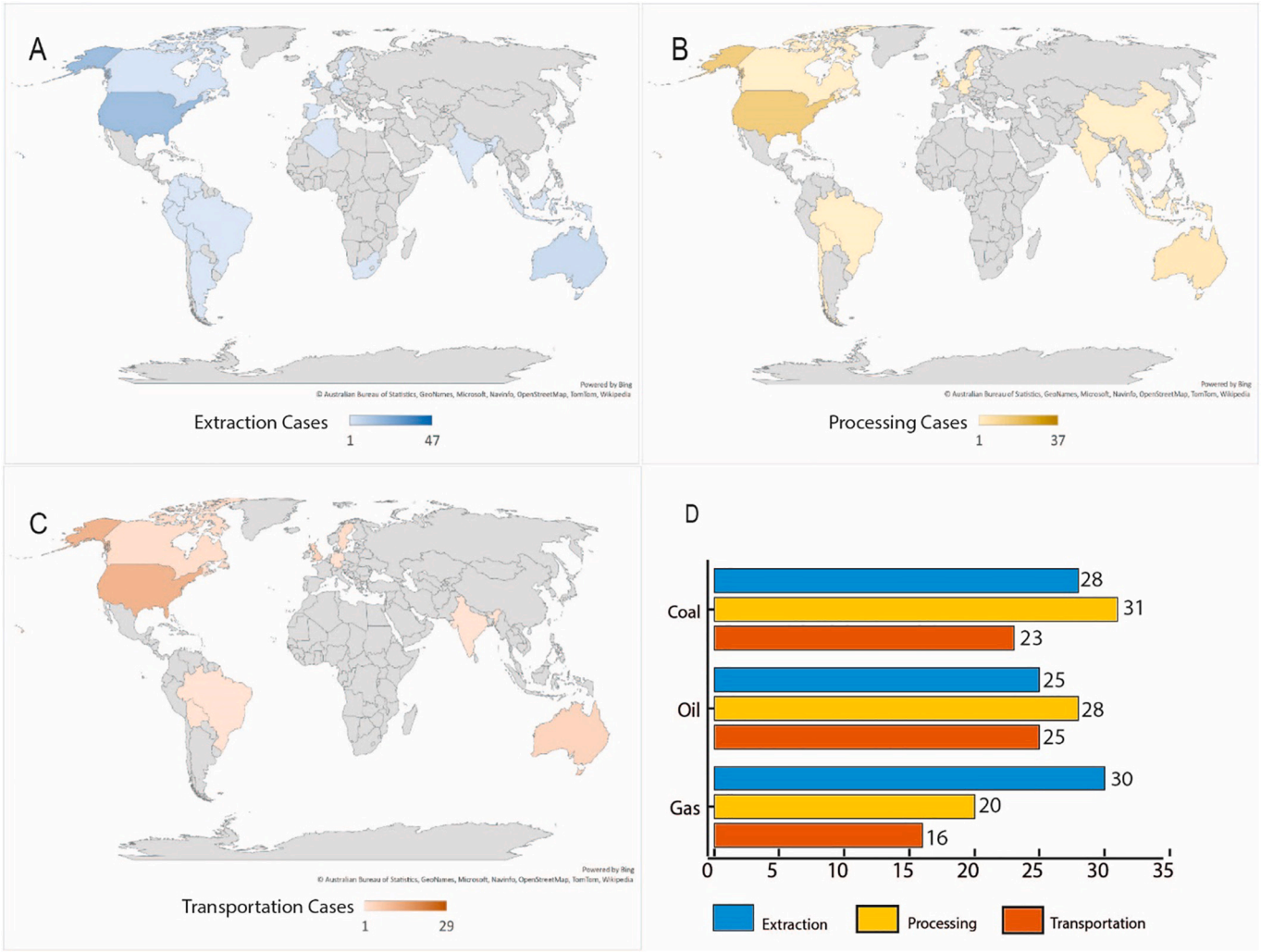

Fig. 1. Literature coverage on protests against fossil fuels across extraction, processing and transportation stages.
Notes: Indicated numbers refer to the number of cases documented in the literature sample. In some cases, the movement against one commodity would target multiple chain stages. For instance, some movement against the oil commodity would involve extracting tar sands, the refinery facilities and the transportation through pipelines or shipping. That is why numbers in the graph add up to more than 57 (see, for example, that the total number of cases for the coal commodity equals 82). The different combinations of commodities and chain stages simultaneously contested in the case studies are presented in the appendix. *Source: Authors.*

stage, no studies are available for Africa and very few for Asia (Map C). These results highlight the considerable research gap of social movement studies concerning fossil fuels in East Asia, Eastern Europe, and Africa. However, countries in East Asia, such as China, Japan and South Korea, are high-emitting countries, and mobilisations against fossil fuel use could be expected to occur, despite the lack of coverage in the literature.

Fig. 1 D reveals how the 57 cases of social mobilisations reported in the literature did not equally target all the commodity chain stages. For instance, out of the 34 cases against coal, 28 targeted extraction activities, 31 focused on the processing, and only 23 acted on transportation. In the case of oil, out of 33 total cases, 25 were against extraction, 28 against processing and 25 against transportation activities. Again, out of the 33 cases of contestation against gas, 30 focused on extraction, 20 on processing, and 16 on transportation activities. In the case of coal and oil, the highest number of movement cases was found in the processing stage, while for gas, the highest number was against extraction. Some movements included in the study were reported to protest various types of fossil fuels or were active at different stages of the commodity chain. For instance, some movements against oil were involved in protesting the extraction of tar sands, refinery facilities and transportation through pipelines or shipping. The different combinations of commodities and chain stages simultaneously contested in the case studies are presented in Appendix A (A1 and A2).

Based on the open-ended questions of the coding book (see 'contributions', 'actors and networks' and 'strategies' in Table 1), we created a series of categories of movement strategies, actors involved and outcomes observed in the literature. Table 2 describes these categories and shows their frequency. The discussions of these results are presented in the following section. We identified six different types of strategies, three types of participation, and ten contributions among the 57 observed cases of social movements. One case commonly involves multiple strategies, contributions, and forms of participation. This is because the social mobilisations were described not as a single event at a single point in time but as a process over time that can involve various actors, places, forms of participation and outcomes. The specific combinations of strategies and outcomes found in the literature are listed in Appendix A (Table A3 and A4).

4.2. *Contributions to climate mitigation and limiting carbon emission*

This section focuses on the relationship between mobilisation strategies and contributions to limiting carbon emissions. Table 3 provides a summary of these relationships. The following subsections review the

Table 2
Movement strategies, actor networks, and contributions of movements.

Codes	Description	Frequency (n = 57)	Per cent
Strategies[a]			
Protest:	Street protests and demonstrations were used as a form of mobilisation by the movement in the case.	42	73.68%
Campaign:	Media campaigning was used as mobilisation, related events passing the same message or actions to achieve a goal.	35	61.40%
Civil disobedience:	Sit-ins, blockades and similar actions that may involve some degree of violation of the law were used as a form of mobilisation by a movement in the case.	29	49.12%
Lobby:	The movement in the case used to lobby, negotiation, and/or coalitions with governments and corporations.	21	36.84%
Lawsuit:	A civil lawsuit against fossil fuel corporations/governments was used as a form of mobilisation by the movement in the case.	12	21.05%
Violence:	Violence was used as a form of protest, including weapons and material damage.	3	5.26%
Actors and network			
Participation of indigenous/ minorities	Indigenous people organising and representing minorities were involved in the movement	21	36.84%
Participation of women:	Women organising and representing women's activism were reported within the movement.	14	24.56%
Participation in citizen science:	The case study informs about the involvement of medical professionals, scientists, citizen science, or the formation of study groups in the movement.	5	8.77%
Contributions[a]			
Raised awareness:	The movement contributed to disseminating information about the need to limit the supply and demand of fossil fuels to individuals, organisations, corporations, or governmental agencies, and/or was regarded as a symbolic victory and/or resulted in influencing or mobilising other actors to become involved in the climate/decarbonisation movement.	34	59.64%
Postponed:	The movement contributed to delaying the project from one month to several years, stopping the emission or impacting future emission between these periods.	26	45.61%
Regulation and legislation:	The movement contributed to enacting a set of rules or creating laws and regulations enforced by legal institutions.	24	42.11%
Stopped for good:	The movement stopped the project (whether ongoing or planned) completely.	16	28.07%
Divestment	The movement contributed to disinvesting from publicly traded fossil fuel companies.	16	28.07%
Just transition	The movement contributed to an alternative development path to challenge deepening poverty and inequality. The movements are either led by or involved by the local communities and indigenous people who claim their rights and justice	13	22.80%
Policy Change:	The movement contributed to creating a new policy, a change in a specific aspect of old/new policy related to reducing carbon emission. (National policy such as environmental policy and energy policy, resource management policy)	12	21.05%
Corporate Social Responsibility:	The movement contributed to achieving a change by corporations and companies to limit the over-exploitation of resources or reduce their environmental and social impact.	11	19.29%
Energy democracy:	The movement contributed to a more distributed locally-based energy system with a regionally appropriate mix of renewable sources satisfying 100% of society's energy needs through progressive social change resulting in the removal of fossil fuels used for energy at the local level.	8	14.03%
Providing a market solution:	The movement contributed to forming a new market, proposing new renewable energy sources, technology, and infrastructure to reduce fossil fuel demand.	6	10.52%
Emissions avoided:	The case study mentioned a specific estimate of emissions from executing a fossil fuel project or projects. Coder fills in the amount of carbon emission or CO_2 emission/other expressions of measurements in the database. It is also acceptable to use barrels of oil and tons of coal. 0: No information on potential emissions avoided is reported	6	10.52%
Other outcomes			
Repression/violence	Instances of criminalisation, death threats and murder of activists were reported concerning the movement activities.	14	24.56%

Notes: The categories are ordered by frequency. One case can qualify for multiple strategies and contribution pathways; therefore, the sum of observations across categories can be higher than the total sample size (n=57). See frequency of cases for strategies and outcomes in Table A3 and A4 in Appendix A. All categories were coded as binary variables, whereby '1' represents the presence of the characteristics described. Source: Authors.

[a] One case can qualify for multiple strategies and contribution pathways; therefore, the sum of observations across categories can be higher than the total sample size (n = 57). All categories were coded as binary variables, whereby '1' represents the presence of the characteristics described. Note: the categories are ordered by frequency.

results for each of the contribution categories. Among the six different mobilisation strategies, up to five different strategies were employed in one protest case. Furthermore, the contributions observed within one case can involve immediate changes at the project level, such as postponing or stopping a project, as well as institutional changes, new regulations, the promotion of energy democracy and just transitions. Therefore, the contributions of social movements are not limited to contesting hydrocarbon activities at the local level, but achieved outcomes can be relevant to broader social transformation processes occurring at different levels.

4.2.1. Raised awareness

Out of the 34 cases that raised awareness, more than three-quarters involved protests, and the large majority used multiple strategies. Only half implicated civil disobedience or campaigns, while very few used lawsuits, lobbying, or violence. The coding criteria for *raised awareness* include when the movement contributed to disseminating the message, information, or knowledge about limiting fossil fuels and emissions to individuals, organisations, corporations, and governmental agencies. It is also categorised as such when the movement was presented successfully as a symbolic victory, which means it does not produce the desired result, but the effort made was acknowledged or legitimised. Furthermore, a case was considered to raise awareness when it influenced or mobilised other actors in the climate justice and decarbonisation movement. An example of raised awareness includes two civil society campaigns in the Hunter region of Australia (Pearse, 2016): 'Stop T4' and 'Groundswell' mobilised in Newcastle and Gloucester. The Stop T4 coal terminal campaign focused on air quality, health impact and preserving the landscape from coal mines and port facilities.

4.2.2. Postponed

The literature includes 26 movements that delayed the targeted

Table 3
Intersections between contributions and strategies.

Contributions										
Strategies	Raised awareness (n = 34)	Postponed (n = 26)	Regulation and legislation (n = 24)	Stopped for good (n = 16)	Divestment (n = 16)	Just transition (n = 13)	Policy change (n = 12)	CSR (n = 11)	Energy democracy (n = 8)	Market solution (n = 6)
Multiple	29(85%)	24(92%)	19(79%)	16(100%)	11(69%)	11(85%)	9(75%)	10(91%)	6(75%)	5(83%)
Protest	27(79%)	22(85%)	17(71%)	14(88%)	11(69%)	11(85%)	8(67%)	9(82%)	8(100%)	6(100%)
Campaign	22(65%)	15(38%)	13(54%)	10(63%)	11(69%)	8(62%)	6(50%)	7(64%)	3(50%)	3(50%)
Civil disobedience	18(53%)	16(62%)	12(50%)	10(63%)	7(44%)	10(77%)	6(50%)	7(64%)	5(63%)	4(67%)
Lobby/coalition	9(26%)	5(19%)	13(54%)	6(38%)	7(44%)	4(31%)	8(67%)	6(55%)	2(25%)	3(50%)
Lawsuit/ litigation	8(24%)	9(35%)	5(21%)	6(38%)	3(19%)	3(23%)	1(8%)	2(18%)	0(0%)	1(17%)
Violence	3(9%)	2(8%)	2(8%)	1(6%)	1(6%)	1(8%)	0(0%)	0(0%)	0(0%)	0 (0%)

Notes: The categories of outcomes and strategies are ordered by frequency as presented in Table 3. The cells indicate the frequency of movement strategies observed across the contribution categories. Proportions are calculated from the 'contribution' categories (columns). Please note that one case can qualify for multiple strategies and contribution pathways; therefore, the column percentages add more than 100%. Source: Authors.

activity for at least one month to several years, stopping the emission or impacting future emissions between these periods. These movements overwhelmingly engaged in multiple strategies (92%). Eighty-five per cent had protested, while 62% and 58% used civil disobedience and campaigns, respectively. A good example at hand is the Keystone XL pipeline case in the US. President Biden revoked the construction permit of this long-disputed project on his first day in office on 20th January 2021. This outcome was not yet reported in the observed samples. The XL pipeline in this study was considered as a postponement outcome due to the grassroots actions. In the project proposal, the pipeline would have delivered 830,000 barrels per day to refineries on the Gulf Coast of the US. The processing of this amount of oil is equivalent to 147 to 168 million metric tons ($MMTCO_2$) of emissions per year (Bradshaw, 2015).

4.2.3. Regulation

Twenty-four cases contributed to the creation of new regulations. The regulation category is selected when the movement contributed to enacting a set of rules or creating laws and regulations enforced by legal institutions. Compared to policy change, these cases involved a higher share of confrontations. One of the cases is *Limity jsme my* ("Limits are us!"), a grassroots social movement in the northern Czech Republic (Černoch et al., 2019) that emerged in response to the government's initiatives which aimed to nullify coal mining limits by 2015. As a result of the resistance, the ČSA mine in Northern Bohemia had to keep the limits. The mining activities at the ČSA have gradually declined since then (Bradshaw, 2015; Černoch et al., 2019). Another example is the resistance to a set of legislative decrees known as "The Law of the Jungle", which would allow 60% of the Peruvian Amazon forest to be granted to multinational corporations. After more than two weeks of protests by 1250 indigenous communities, Congress was forced to repeal the legislative decrees.

4.2.4. Project cancellation

The study found sixteen cases of movements that stopped fossil fuel activities completely, either for an ongoing project or a project planned to operate in the future. They all used multiple strategies, the majority of which were protests, civil disobedience and campaigns. Interestingly, 38%of the cases involved lawsuits, the highest share of lawsuits among the different outcomes. Between 2012 and 2017, several coal-fired power plants (CFPPs) were shut down in the US, including the Salem Harbor, the Valmont, the Fisk, and the AES Redondo Beach power plants, built between the 1900s and 1960s (Grant and Vasi, 2016). These outcomes are related to activists' efforts using direct action, legal confrontations and entering into coalitions with the local governments. Cancelled fossil fuel projects in one place do not necessarily translate into overall emission reductions because of leakage problems; for example, the cancellation of planned CFPP in one place leads to the opening of new ones in other places. However, social mobilizations, particularly those achieving cancellation of hydrocarbon projects, make their operation significantly more costly (Franks et al., 2014), arguably incentivizing alternative energy sources. Moreover, in some cases, old power plants were closed, and new CFPPs were being prevented. For example, in Germany by networks of environmental organisations, such as Climate Alliance Germany (CAG) and Fossil Free Germany (FFG). Since 2008, CAG managed to successfully prevent 18 out of 30 planned German coal facilities, preventing 94.7 million tons of CO_2 emissions (David, 2018).

4.2.5. Divestment

There were sixteen cases in which movements contributed to fossil fuel divestment. Contrary to other outcomes, these cases showed the lowest share of multiple strategies (69%) and civil disobedience (44%). On the other hand, it had the highest share of campaigns (69%). Fossil fuel divestment generally refers to "the act of disinvesting from publicly traded fossil fuel companies", the largest fossil fuel companies with proven reserves (Stephens et al., 2018, p.1). In the case of coal

mining in Kalimantan, Indonesia, local Indonesian activists and environmental organisations formed an alliance with UK based activists, performed theatrical protest events at the London headquarters to make the GHP Billiton executives, shareholders, and UK media aware of the social and environmental impact of coal mining in Kalimantan. As a result, these awareness displays have pressured the investing company to exit from the extraction projects (Brown and Spiegel, 2017).

4.2.6. Just transition

Thirteen cases contributed to just transitions. Most used multiple strategies, mainly protest and civil disobedience, which was reported most frequently in relation to this outcome (77%). The term 'justice and energy transition' in the literature has several connotations. These movements aim to achieve justice by confronting hydrocarbon regimes from different perspectives: intergenerational justice, justice for indigenous and tribal peoples, and justice for ethnic minorities. Just transition thus requires the involvement of the local communities, local workers and indigenous people directly affected by the projects. Moreover, justice is pursuable when the activist's values and responses towards the hydrocarbon regime are supported by the resistance culture of a particular group of people who were oppressed or negatively affected by the hydrocarbon economy. One of the cases included in this category is the case of Climate Camp Scottland action against the Mainshill open-cast coal mine, where climate activists were able to address the negative impacts on the surrounding community and were supported by the community (Scandrett, 2016). Two cases against hydrocarbon policies in Ecuador and Bolivia also fell into this category because these movements were heavily supported by the Amazonian Indigenous people and the employees of the hydrocarbon industry who were directly affected by the oil and mining development (Perreault and Valdivia, 2010). Moreover, studies based on the global Environmental Justice Atlas (EJAtlas) (Pérez-Rincón et al., 2019; Scheidel et al., 2020; Temper et al., 2020) have explored how mobilisations around fossil fuel conflicts can positively contribute to more just and sustainable transitions.

4.2.7. Policy change

Twelve cases resulted in creating a new policy or a change in a specific aspect of an existing policy related to reducing carbon emission. In these cases, more institutional means were used than confrontation. These cases include the movement that resulted in creating a new policy or a change in a specific aspect of the old or new policy related to reducing carbon emission. The policy here means the national policies such as environmental, energy, and resource management policies that influence at a national or transnational level. Policy change sometimes, but not necessarily always, comes with concrete legislation or regulations that influence limiting emissions. For example, one of the cases explored is the case of California's climate policy shift in reducing hydrocarbon industries, particularly in limiting permits for new oil wells. In this case, the shift towards supply-side policy was steered by the public interests in fossil fuel extraction and social movements towards a low-carbon society (Erickson et al., 2018). The sample also includes the well-known cases in Colombia and Ecuador, "leave the oil in the soil" or leave the "unburnable fuels" underground initiated by local indigenous communities, which became public policy for six years in Ecuador with the Yasuni ITT proposal, 2007–2013 (Vallejo et al., 2015).

4.2.8. Corporate social responsibility (CSR)

Although only eleven cases led to CSR, it appears that most involved multiple strategies, including protest, civil disobedience, campaign and lobby/coalitions. Conversely, only two used lawsuits and none engaged in violence. In recent years, the strategies pressuring corporations to stop exploiting human and natural resources have changed from lobbying and coalitions to targeting firms directly through the term 'private politics' coined by Baron (2003, 74). This form of strategy is a more coordinated and organised form of social punishment. It includes 'name and shame' campaigns, cooperative labelling schemes, social media shaming and certification systems (Thörn and Svenberg, 2016). For example, the case of the anti-fracking movement in Ireland resulted in allowing fracking activities to proceed under self-regulation to eliminate the potential effects on groundwater resource pollution and community safety. Later, local authorities banned these activities (Hooper et al., 2016; Steger and Drehobl, 2018). Examples of CSR used by movements include a Swedish case of shaming multinational corporations to change their exploitive behaviours. The idea is to dismantle socially constructed barriers that support incumbent fossil fuel providers, which are more deeply rooted than other market forces.

4.2.9. Energy democracy

Energy democracy means achieving a more distributed, locally-based energy system with a regionally appropriate mix of different renewable sources satisfying 100% of society's energy needs through progressive social change (Stephens, 2019). Interestingly, the eight cases that led to energy democracy showed protests without violence. Out of eight cases, five engaged in civil disobedience. Additionally, they did not involve lawsuits. The outcome is classified as energy democracy when smaller administrations units such as states, villages, and cities achieve autonomy and control over energy production. One of the cases is the United States' community choice aggregation (CCA) industrial transition movement in California, which has contributed to local, democratic control over electricity (Hess, 2019). Such outcomes and movements can also be found in cases from Thailand's countryside (Pa Deng network) and the Philippines' Palawan Province movements (Marquardt and Delina, 2019). These local communities envisioned the future of energy supply, moving away from the dominant hydrocarbon regime to more sustainable renewable energy systems.

4.2.10. Providing market solutions

Only six cases led to market solution outcomes. They contributed to forming a new market, proposing new renewable energy sources, technology, and infrastructure to reduce fossil fuel demand. All involved protests and none used violence. Interestingly, four of the six resulted in a market solution that involved civil disobedience as a strategy. Authors categorised it as an outcome when the movement contributed to forming a new market, proposing new renewable energy sources, technology, and infrastructure to reduce fossil fuel demand. Some movements may bring solutions in the renewable market in drafting policies, but it is not always the case. An example is the climate change solution think-tank, "Beyond Zero Emissions (BZE)'s movement" in Australia, which established a bottom-up, deliberative process with local communities to envision ways to deploy renewable energy technologies locally (Pearse, 2016). Another example illustrates how the mobilisation of Chilean environmental organisations led to opportunities for renewables to enter the electricity market in collaboration with experts from local universities and renewable energy companies (Madariaga and Allain, 2018).

4.3. Strategies and contribution

After exploring the different outcomes delivered by social movements, we ran a Chi-squared test of independence to determine whether the sample's outcomes and strategies variables are independent of or associated with each other (Franke et al., 2012).[3]

Table 4 shows the results of the Chi-squared tests with a *P*-value less

[3] The formula for the Chi-squared test is $x^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$, where O is the observed (the actual count of cases in each cell of the table), E is the expected value, and n refers to the number of cells in the table (Mchugh, 2013).

than $P < 0.05$, which allows rejecting the null hypothesis of independence.[4] The entire list of cross-tabs and test results is reported in Table B1 (Appendix B). Moreover, we included the Fisher's exact test's P-value for the categories with the expected value less than 5. The cases are ordered by strategies (presence or absence) in rows and outcomes (presence or absence) in columns. The cells report the observed frequency and expected values (in parentheses) for each category. To understand the differences between groups, we compared the observed and expected values (Mchugh, 2013). Firstly, we observe a difference in the occurrence of postponement and cancellation outcomes when comparing the movements that use multiple strategies and those that do not. As shown in the table, when movements rely on multiple strategies, postponement outcomes tend to be more frequent (24) than expected (20.5), and cancellations too (16 as compared to 12.6[5]). By the same token, in the absence of multiple strategies, the postponement and cancellation outcomes tend to be less frequent than expected. These findings align with previous studies suggesting that tactical diversity is an effective strategy of environmental movements to block specific development projects (Scheidel et al., 2020).

Civil disobedience also makes a difference. The results show a significant association between the civil disobedience strategy and the postponement outcome. The postponement outcome is more frequent (17) than the expected value of (13.2) when the civil disobedience strategy is used. The same is true in the case of just transition and repression outcomes. Achieving a just transition outcome is more frequent than expected when civil disobedience is employed as a strategy. Also importantly, civil disobedience tends to be associated with violent repressions of activists compared to other strategies (Burkett, 2018; Grant and Vasi, 2016).

The lobby/coalition strategy is significantly associated with raised awareness, postponement, policy change and regulations outcomes. The outcomes of policy change and regulations occur more frequently than expected when lobbying is used and vice-versa (Fisher's exact $P = 0.022$). The opposite occurs with the awareness raising and the postponement outcomes. These outcomes relatively less frequently occur when lobbying is present. Also, the movements that use lawsuits/litigation have a statistically significant higher frequency of postponement outcomes than expected. These associations can be explained by the nature of the lobby/coalition strategy, which relies on institutional "venue shopping" to the detriment of, e.g., the joint use of public spaces and public voicing strategies along with other non-governmental actors.

Also, we looked specifically at the participation of three different civil society groups in the sample: women's organisations, professionals in medical science, lawyers and scientists, and indigenous people and minority groups (Table 5). We did not find statistically significant associations between the participation of women and professionals in movements and any of the outcomes; however, the results indicate that movements that are participated by indigenous people are more frequently associated with awareness-raising and just transition outcomes than otherwise.[6] Last but not least, indigenous group-participated movements were also more frequently associated with repression and violence outcomes than otherwise.

4.4. Discussion: do social movements contribute to staying within the global carbon budget?

In January 2019, Special Report 1.5 revised the remaining GCB to 420 $GtCO_2$ to keep the global temperature within 1.5 degrees (Masson-Delmotte et al., 2018). Even with increased emission cuts, nations are likely to fail in reaching the goal of the GCB target. Therefore, it is crucial to understand and consider alternatives, including the role of social movements. The linkages between social movements and the reduction of carbon emissions can take many forms, making it difficult to establish a causal relationship. Social movements are dynamic and form a chain of processes involving different mobilisation strategies, actors and outcomes. Furthermore, the heterogeneous social, political, and cultural contexts of the different movements make drawing one-to-one comparisons challenging (Della Porta and Diani, 2006; Tilly, 2004). Nevertheless, as shown in this study, it is still possible to identify and draw preliminary patterns about said strategies, actors and outcomes across contexts.

In this systematic review, we find that social movements can contribute to staying within the global carbon budget in a variety of indirect and direct ways. These range from raising awareness of risks and strategies, promoting knowledge transfer, and pressuring corporations to engage in corporate social responsibility or divestment actions, to bringing policy changes, laws and regulations, fostering just energy transitions, energy democracy, and alternative market solutions, and forcing the postponement or cancellation of hydrocarbon activities. These findings complement previous knowledge on the watchdog role grassroots organisations and ENGOs monitor environmental conditions and ensure that polluters do not violate standards (Grant and Vasi, 2016; Madariaga and Allain, 2018; Steger and Drehobl, 2018). More broadly, the findings support and expand previous claims about the importance of 'governance from below' and the role of social movements as a recognisable challenge to transnational extractive corporations and 'business as usual' in the climate change context (Lemos and Agrawal, 2006; Villamayor-Tomas and García-López, 2018; Scheidel et al., 2020).

Our findings also illustrate that the studied movements tend to rely on multiple mobilisation strategies. As pointed out by social movement scholars, the use of multiple strategies at once or sequentially would be explained by the need to fit a changing environment, e.g., in response to counter-measures implemented by governments and multinational corporations (Della Porta, 2013). Furthermore, and also shown in our analysis of contributions, movements often pursue different goals, requiring different sets of strategies. While the institutional means of lobbying and coalition building are widely used and seem to support policy change and regulation, these strategies are not used to deliver awareness or postponement outcomes. Similarly, while movements tend to rely on civil disobedience to stop hydrocarbon projects in the short term, they rely on multiple strategies to cancel them in the longer term. Last but not least, our study shows that mobilisation also comes at the price of increased violent repression and criminalisation against activists, despite the absence of violence from the protestors, which warns us about the dramatic trade-offs that involved movements face between promoting change and maintaining well-being and safety in their communities (Del Bene et al., 2018; Scheidel et al., 2020).

Also, our findings show that outcomes of mobilisation against fossil fuels are not independent of each other. The cases in the sample (Burkett, 2018; Martinez-Alier et al., 2016; Pearse, 2016) reveal that raised awareness, CSR and divestments can be linked together. At the same time, while postponement is a contribution on its own, vis a vis limiting carbon emissions, they can also pave the way to cancellation. For example, the postponement of the XL pipeline projects contributed to years of delaying emissions from the project until its recent official cancellation. In the meantime, similar mobilisations in Chile, Australia, and the US achieved the outcome of policy-making and market solutions

[4] We decided to include only statistically significant associations in our analysis as an attempt to digest the results for the reader. Thus, we used statistical significance as a proxy, or rule of thumb, to identify the strongest associations between strategies and outcomes. Generally speaking, stronger associations are more likely to be statistically significant. To be sure, although some strategies did not have a significant association with the outcomes, they are still relevant strategies (the movements employed these strategies and authors of the reviewed studies pointed out to them for a reason); however, our sample did not contain sufficient evidence about their relative stronger associations with outcomes as compared to other strategies. See Appendix B1 for the entire list of cross-tabs and test results.

[5] Based on Fisher's exact test (Fisher's exact $P = 0.013$) (given that the expected value is lower than 5)

[6] Fisher's exact test was conducted given expected value less than 5.

Table 4
Chi-squared test for outcomes and strategies (observed value (expected value)).

Strategies	Outcomes		Chi2	Fisher's exact *P*-value
Multiple Strategies	No Postponed	Postponed	*5.13***	
No	10(6.5)	2(5.5)		
Yes	21(24.5)	24(20.5)		
Multiple Strategies	No Cancelled	Cancelled	*5.93***	*0.013*
No	12(8.6)	0(3.4)		
Yes	29(32.4)	16(12.6)		
Civil Disobedience	No Postponed	Postponed	*4.03***	
No	19(15.2)	9(12.8)		
Yes	12(15.8)	17(13.2)		
Civil Disobedience	No Just Transition	Just Transition	*4.57***	
No	25(21.6)	3(6.4)		
Yes	19(22.4)	10(6.6)		
Civil Disobedience	No Repression/Criminalisation	Repression/Criminalisation	*5.69***	
No	25(21.1)	3 (6.9)		
Yes	18(21.9)	11(7.1)		
Lobby/Coalition	No Raised Awareness	Raised Awareness	*3.90***	
No	11(14.5)	25(21.5)		
Yes	12(8.5)	9(12.5)		
Lobby/Coalition	No Policy Change	Policy Change	*5.81***	*0.022*
No	32(28.4)	4(7.6)		
Yes	13(16.6)	8(4.4)		
Lobby/Coalition	No Regulation	Regulation	*5.34***	
No	25(20.8)	11(15.2)		
Yes	8(12.2)	13(8.8)		
Lobby/Coalition	No Postponed	Postponed	*6.37***	
No	15(19.6)	21(16.4)		
Yes	16(11.4)	5(9.6)		
Lawsuit/Litigation	No Postponed	Postponed	*5.29***	
No	28(24.5)	17(20.5)		
Yes	3(6.5)	9 (5.5)		
Obs.			57	

Notes: **, and *** refer to 5% and 1% significance levels, respectively.
Here only shown the associations that turned out statistically significant. See all cross-tabs in Appendix. Source: Authors.

Table 5
Chi-squared test for outcomes and participations.

Participation	Outcomes		Chi2	Fisher's exact *P*-value
Indigenous people	No raised awareness	Raised awareness	*6.26***	
No	19(14.5)	17(21.5)		
Yes	4(8.5)	17(21.5)		
Indigenous People	No Just Transition	Just Transition	*7.59****	*0.009*
No	32(27.8)	4(8.2)		
Yes	12(16.2)	9(4.8)		
Indigenous People	No Repression and violence	Repression and violence	*9.54****	
No	32(27)	4 (8.8)		
Yes	11(15.8)	10 (5.2)		
Obs.			57	

Note: **, and *** refer to 5% and 1% significance levels respectively. Source: Authors.

(Grant and Vasi, 2016; Madariaga and Allain, 2018; Pearse, 2016). Likewise, in several cases in the United States, Argentina, Algeria, and cross-countries studies (Hess, 2019; Hess, 2018; Martinez-Alier et al., 2016; Riffo, 2017), the exhibited regulation and energy democracy were also interconnected. These findings illustrate the interest of applying a 'cycles' lens to mobilisation strategies, the co-evolution of social movements and their impact (Oliver and Myers, 2006; Snow and Benford, 1992; Tarrow, 1989; Tilly, 1978; Traugott, 1995).[7] Further research should explore our data from this perspective.

Last but not least, our findings suggest that indigenous communities, scientists and women's groups play non-deniable roles within the movements against hydrocarbon activities. A recent report by Oil Change International and Indigenous Environmental Network claimed that more than 700 million metric tons of annual Co2 emissions were prevented by indigenous resistance in the US and Canada (Oil Change International, 2021). This research also indicates the critical role of indigenous people in shaping a future with low carbon emissions. In addition to their role featuring resistance actions, our study illustrates their role as inspirational actors that raise awareness about climate change and justice.

As a limitation, it is essential to note that our search of studies resulted in limited cases from East Asia and African countries. However, the Environmental Justice Atlas (EJAtlas, n.d.) has documented globally hundreds of cases of protests against fossil fuels and for climate justice (Africa 141, Asia 142), suggesting that there is a substantial lack of peer-reviewed articles in the areas identified in this study.

5. Conclusions: social movements constrain fossil fuel supplies and potentially avoid emissions

The study aimed to understand the diverse contributions of social movements to staying within the global carbon budget by systematically reviewing academic research papers on activism against fossil fuel extraction, processing, and transportation. After conducting an intensive preliminary review, a qualitative meta-analysis of 57 selected cases of anti-fossil fuel movements was undertaken. The results showed that social movements constrain fossil fuel supplies, support social and political processes needed for climate change mitigation, and potentially avoid emissions through at least ten different contributions. The findings further identified how the specific contributions to staying within the global carbon budget were associated with the different movement

[7] 'Cycles' refers to protest cycle dynamics, which entails shifts in the types of actions/strategies and shifts in the combination of actions across time. These actions can be varied as confrontational protests, mass demonstrations, institutionalized politics and violence (Oliver and Myers, 2006; Tilly, 1978).

strategies and the participation of specific actors, such as indigenous people involved in mobilisations. In this context, scientists, science-policy interface institutions, notably the IPCC, and policymakers, should pay more attention to the contributions of social movements to staying within the global carbon budget. Additionally, the analysis indicates that indigenous participation in movements significantly contributes to limiting fossil fuels; however, the possibility of violent repression is undeniably high. Therefore, the protection of indigenous people's right to defend their traditional way of life and ancestral lands should be highlighted in climate change mitigation frameworks and pathways to achieve global carbon budget goals.

The findings from our study confirm several arguments in the existing literature and add systematic evidence to the body of research. Firstly, our findings support existing arguments claiming that fossil fuel resistance movements create viable pathways and important political spaces to achieve climate mitigation targets. Moreover, the results yield new evidence that nuances popular assumptions regarding how social movements contribute to decarbonisation. According to our findings and qualifying previous studies (Biglan et al., 2020; Büchs et al., 2015; Landholm et al., 2019), there is a different approach to mobilisation between the lifestyle changes movements and movements that target hydrocarbon supplies. While both types of movements share the objective of limiting emissions, the former tend to use a non-confrontational approach directed to a broader audience (i.e., consumers) (Büchs et al., 2015), while the latter frequently employs more confrontational and direct actions.

Also, our analysis extends the argument on movements as forces of sustainability (Temper et al., 2020) by providing evidence on the diversity of mobilisation strategies and contributions and identifying associations between both. We found the use of multiple strategies to be particularly effective for achieving the postponement of projects, in addition to lawsuits and civil disobedience. While the sample considered reveals more confrontational, direct action than the institutional lobby/coalition approach in the movements, the results firmly suggest that direct action and confrontation can effectively delay emissions.

Secondly, the study provides further evidence for the existing claims that marginalised people, in alliance with other segments of society, contribute to global environmental and climate justice through collective resistance against unsustainable resource use, such as hydrocarbon activities. These alliances are identified in various grassroots movements that include women, indigenous people and minorities, and professional communities to form partnerships across the social spectrum. From a climate justice perspective, participation from vulnerable groups, indigenous people, and movements from the Global South is vital in shaping more just energy transition pathways and climate change mitigation (Campion, 2021).

Finally, the analysis reveals research gaps that can inform a future research agenda at the intersection of ecological economics, political ecology and social movement studies. For instance, women's participation in these movements is under-researched in the academic literature. Similarly, Africa and Asia are severely under-represented in social movement studies looking at protests against fossil fuels. Therefore, we expect future studies on movements against fossil fuels to address these gaps by including the types of under-represented populations and geographical areas identified in this paper. Furthermore, this study revealed that postponement and cancellation of hydrocarbon activities are crucial outcomes of social mobilisations, suggesting that social movements may have a tangible impact on limiting the global carbon budget. However, based on the information available in the surveyed literature, it has not been possible to estimate the actual amount of carbon emissions reduced by these actions. This remains to be further explored in future research.

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. Combination of categories identified in the study

The study identified cases of social movements targeted at multiple fossil fuel commodities simutainaously. Furthermore, a single type of fossil fuels can have overlapping commodity chain stages. These overlapping combinations are shown in Tables A1 and A2.

Furthermore, we also identified multiple strategies and multiple contributions in a single case study. Few cases were identified using single strategies, while protest is most likely to be an overlapping strategy among the combinations. These combination of strategies identified in the sample of the study are listed in A3, and the contributions in A4.

Table A1
Different combinations of commodities.

Type of FF	Frequency
Coal	12
Oil	8
Gas	13
Coal, Oil	3
Coal, Gas	0
Oil, Gas	2
Coal, Oil, Gas	19
	57

Table A2
Combintions of commodity and chain stages.

Fossil fuel and commodity chain	Frequency
Coal, Extraction	3
Coal, Processing	3
Coal, E,P	3
Coal, P, T	1
Coal, E,P,T	3
Coal, Oil, E,P,T	3
Oil, Extraction	1
Oil, Transportation	1
Oil, processing	2
Oil, E,P,T	4
Gas, Extraction	13
Oil, Gas, P	1
Coal, Oil, Gas, P	3
Coal,Oil, Gas E,P,T	16
Total	57

Table A3
Frequency of cases informing about single (level = 1) and multiple (level≥1) strategies.

Levels	Strategy	Frequencies
1	Protest	3
1	Campaign	3
1	Lobby	5
2	Protest, CD	6
2	Protest, Campaign	4
2	Protest, Lobby	1
2	Protest, Lawsuit	2
2	CD,Campaign	1
2	Campaign,Lawsuit	1
2	Campaign, lobby	3
3	Protest, Campaign, Lobby	5
3	Protest,CD, Lawsuit	2
3	Protest,Campaign,Lawsuit	1
3	Protest,CD, Campaign	8
3	Protest, CD, Lobby	1
3	Campaign,Lawsuit,lobby	1
4	Protest, CD, Campaign, Lobby	4
4	Protest,CD, Campaign,Lawsuit	2
4	Protest,CD,Violence,lawsuit	1
4	Protest,CD,Violence,lobby	1
5	Protest,CD,Campaign,lawsuit,lobby	1
5	Protest,CD,Violence,Campaign,lawsuit	1
	Total	57

Source: Authors.

Table A4
Frequency of cases informing about single (level = 1) and multiple (level ≥ 1) outcomes.

Levels	Outcome	Frequencies
1	Raised Awareness	5
1	CSR	1
1	Regulation	2
1	Postponed	4
2	Raised Awareness,CSR	1
2	Raised Awareness, Policy Change	1
2	Raised Awareness, Postponed	3
2	Raised Awareness, Divestment	2
2	CSR,Divestment	1
2	Regulation, Just Transition	1
2	Postponed, Stopped	1
2	Stopped, Just Transition	1
3	Raised Awareness, CSR, Policy Change	1
3	Raised Awareness, Policy Change, Divestment	1
3	Raised Awareness, Regulation, Just transition	2
3	Raised Awareness, Energy Democracy, Postponed	1
3	Raised Awareness, Postponed, Just transition	2

(*continued on next page*)

Table A4 (*continued*)

Levels	Outcome	Frequencies
3	Raised Awareness, Postponed, Stopped	1
3	Raised Awareness, Postponed, Divestment	2
3	Policy Change, Regulation, Divestment	2
3	Policy Change, Regulation, Market solution	1
3	Regulation, Market Policy, Energy Democracy	1
3	Regulation, Postponed, Stopped	2
3	Regulation, Just Transition, Divestment	1
3	Postponed, Stopped, Just Transition	1
4	Raised Awareness, Regulation, Postponed	3
4	Raised Awareness, Policy Change, Postpone, Stopped	1
4	Raised Awareness, Regulation, Energy Democracy, Stopped	1
4	Raised Awareness, CSR, Postponed, Stopped	1
4	Raised Awareness, Energy Democracy, Just Transition, Divestment	1
4	Regulation, Energy Democracy, Postponed, Stopped	1
5	Raised Awareness, CSR, Policy Change, Regulation, Divestment	1
5	Raised Awareness, Market Solution, stopped, Just Transition, Divestment	1
5	CSR, Policy Change, Regulation, Market Solution, stopped	1
5	CSR, Policy Change, Regulation, Just Transition, Divestment	1
5	CSR, Regulation, Market Solution, Energy Democracy, Postponed	1
5	Regulation, Energy Democracy, postponed, Stopped, Divestment	1
7	Raised Awareness, CSR, Regulation, Energy Democracy, Postponed, Just Transition, Divestment	1
8	Raised Awareness, CSR, Regulation, Market Solution, Postponed, Just Transition, Divestment	1
	Total	57

Source: Authors.

Appendix B. Examining the association between strategies and contribution

Table B1
Chi-squared test of independence between outcomes and strategies (observed value (expected value)).

Outcomes	Strategies		Chi2
Raised Awareness	No Protest	Protest	*1.43*
No	8 (6.1)	15(7)	
Yes	7 (16.9)	27(25.1)	
CSR	No Protest	Protest	*0.47*
No	13 (12.1)	33(33.9)	
Yes	2 (2.9)	9(8.1)	
Policy Change	No Protest	Protest	*0.39*
No	11(11.8)	34(33.2)	
Yes	4(3.2)	8(8.8)	
Regulation	No Protest	Protest	*0.04*
No	9(8.7)	24(24.3)	
Yes	6(6.3)	18(17.7)	
Market Solution	No Protest	Protest	*2.40*
No	15(13.4)	36(37)	
Yes	0(1.6)	6(4.4)	
Energy Democracy	No Protest	Protest	*3.32*
No	15(12.9)	34(36.1)	
Yes	0(2.1)	8(5.9)	
Postpone	No Protest	Protest	*2.95*
No	11(8.2)	20(22.8)	
Yes	4(6.8)	22(19.2)	
Cancellation	No Protest	Protest	*2.19*
No	13(10.8)	28(30.2)	
Yes	2(4.2)	14(11.8)	
Just Transition	No Protest	Protest	*1.04*
No	13(11.6)	31(32.4)	
Yes	2(3.4)	11(9.6)	
Divestment	No Protest	Protest	*0.28*
No	10(10.8)	31(30.2)	
Yes	5(4.2)	11(11.8)	
Repression	No Protest	Protest	*3.51*
No	14(11.3)	29(31.7)	

(*continued on next page*)

Table B1 (*continued*)

Outcomes	Strategies		Chi2
Yes	1(3.7)	13(10.3)	
Raised Awareness	No Civil Disobedience	Civil Disobedience	*0.84*
No	13 (11.3)	10 (11.7)	
Yes	15(16.7)	19 (17.3)	
CSR	No Civil Disobedience	Civil Disobedience	*089*
No	24(22.6)	22(23.4)	
Yes	4(5.4)	7(5.6)	
Policy Change	No Civil Disobedience	Civil Disobedience	*0.00*
No	22(22.1)	23(22.9)	
Yes	6(5.9)	6(6.1)	
Regulation	No Civil Disobedience	Civil Disobedience	*0.18*
No	17(16.2)	16(16.8)	
Yes	11(11.8)	13(12.2)	
Market Solution	No Civil Disobedience	Civil Disobedience	*0.67*
No	26(25.1)	25(25.9)	
Yes	2(2.9)	4(3.1)	
Energy Democracy	No Civil Disobedience	Civil Disobedience	*0.50*
No	25(24.1)	24(24.9)	
Yes	3(3.9)	5(4.1)	
Postpone	No Civil Disobedience	Civil Disobedience	*4.03***
No	19(15.2)	12(15.8)	
Yes	9(12.8)	17(13.2)	
Cancellation	No Civil Disobedience	Civil Disobedience	*1.20*
No	22(20.1)	19(20.9)	
Yes	6(7.9)	10(8.1)	
Just Transition	No Civil Disobedience	Civil Disobedience	*4.57***
No	25(21.6)	19(22.4)	
Yes	3(6.4)	10(6.6)	
Divestment	No Civil Disobedience	Civil Disobedience	*0.00*
No	20(20.1)	8(7.8)	
Yes	8(7.9)	8(8.1)	
Repression	No Civil Disobedience	Civil Disobedience	*5.69***
No	25(21.1)	18(21.9)	
Yes	3(6.9)	11(7.1)	
Raised Awareness	No violence	Violence	*2.14*
No	23(21.8)	0(1.2)	
Yes	31(32.2)	3(1.8)	
CSR	No violence	Violence	*0.76*
No	43(43.6)	3(2.4)	
Yes	11 (10.4)	0(0.6)	
Policy Change	No violence	Violence	*0.84*
No	42(42.6)	3(2.4)	
Yes	12(11.4)	0(0.6)	
Regulation	No violence	Violence	*0.78*
No	32(31.3)	1(1.7)	
Yes	22(22.7)	2(1.3)	
Market Solution	No violence	Violence	*0.37*
No	48(48.3)	3(2.7)	
Yes	6(5.7)	0(0.3)	
Energy Democracy	No violence	Violence	*0.51*
No	46(46.4)	3(2.6)	
Yes	8(7.6)	0(0.4)	
Postpone	No violence	Violence	*0.57*
No	30(29.4)	1(1.6)	
Yes	24(24.6)	2(1.4)	
Cancellation	No violence	Violence	*0.04*
No	39(38.8)	2(2.2)	
Yes	15(15.2)	1(0.8)	
Just Transition	No violence	Violence	*0.20*
No	42(41.7)	2(2.3)	
Yes	12(12.3)	1(0.7)	
Divestment	No violence	Violence	*0.04*
No	39(38.8)	2(2.2)	
Yes	15(15.2)	1(0.8)	
Repression	No violence	Violence	*0.04*
No	41(40.7)	2(2.3)	
Yes	13(13.3)	1(0.7)	
Raised Awareness	No Campaign	Campaign	*1.38*
No	10(8.1)	13(14.9)	
Yes	10(11.9)	24(22.1)	
CSR	No Campaign	Campaign	*0.01*
No	16(16.1)	30(29.9)	
Yes	4(3.9)	7(7.1)	
Policy Change	No Campaign	Campaign	*0.06*
No	15(15.8)	30(29.2)	
Yes	5(4.2)	7(7.8)	

(*continued on next page*)

Table B1 (*continued*)

Outcomes	Strategies		Chi2
Regulation	No Campaign	Campaign	*0.91*
No	9(11.6)	24(21.4)	
Yes	11(8.4)	13(15.6)	
Market Solution	No Campaign	Campaign	*0.37*
No	17(17.9)	34(33.1)	
Yes	3(2.1)	3(3.9)	
Energy Democracy	No Campaign	Campaign	*3.07*
No	15(17.2)	34(31.8)	
Yes	5(2.8)	3(5.2)	
Postpone	No Campaign	Campaign	*0.39*
No	12(10.9)	19(20.1)	
Yes	8(9.1)	18(16.9)	
Cancellation	No Campaign	Campaign	*0.50*
No	15(14.4)	26(26.6)	
Yes	5(5.6)	11(10.4)	
Just Transition	No Campaign	Campaign	*0.90*
No	14(15.4)	30(28.6)	
Yes	6(4.6)	7(8.4)	
Divestment	No Campaign	Campaign	*0.05*
No	14(14.4)	27(26.6)	
Yes	6(5.6)	10(10.4)	
Repression	No Campaign	Campaign	*0.34*
No	16(15.1)	27(27.9)	
Yes	4(4.9)	10(9.1)	
Raised Awareness	No Lawsuit/Litigation	Lawsuit/Litigation	*0.31*
No	19 (18.2)	4 (4.8)	
Yes	26 (26.8)	8 (7.2)	
CSR	No Lawsuit/Litigation	Lawsuit/Litigation	*0.07*
No	36 (36.3)	10 (9.7)	
Yes	9(8.7)	2 (2.3)	
Policy Change	No Lawsuit/Litigation	Lawsuit/Litigation	*1.48*
No	34 (35.5)	11 (9.5)	
Yes	11 (9.5)	1 (2.5)	
Regulation	No Lawsuit/Litigation	Lawsuit/Litigation	*0.00*
No	26 (26.1)	7 (6.9)	
Yes	19 (18.9)	5 (5.1)	
Market Solution	No Lawsuit/Litigation	Lawsuit/Litigation	*0.08*
No	40 (40.3)	11(10.7)	
Yes	5 (4.7)	1(1.3)	
Energy Democracy	No Lawsuit/Litigation	Lawsuit/Litigation	*2.48*
No	37(38.7)	12(10.3)	
Yes	8(6.3)	0(1.7)	
Postpone	No Lawsuit/Litigation	Lawsuit/Litigation	*5.29***
No	28 (24.5)	3 (6.5)	
Yes	17 (20.5)	9 (5.5)	
Cancellation	No Lawsuit/Litigation	Lawsuit/Litigation	*3.62*
No	35(32.4)	6(8.6)	
Yes	10(12.6)	6(3.4)	
Just Transition	No Lawsuit/Litigation	Lawsuit/Litigation	*0.04*
No	35(34.7)	9(9.3)	
Yes	10(10.3)	3()2.7	
Divestment	No Lawsuit/Litigation	Lawsuit/Litigation	*0.07*
No	32(32.4)	9(8.6)	
Yes	13(12.6)	3(3.4)	
Repression	No lawsuit/Litigation	Lawsuit/Litigation	*0.00*
No	34(33)	9(9.1)	
Yes	11(11.1)	3(2.9)	
Raised Awareness	No Lobby/Coalition	Lobby/Coalition	*3.90***
No	11(14.5)	12(8.5)	
Yes	25(21.5)	9(12.5)	
CSR	No Lobby/Coalition	Lobby/Coalition	*1.84*
No	31(29.1)	15(16.9)	
Yes	5(6.9)	6(4.1)	
Policy Change	No Lobby/Coalition	Lobby/Coalition	*5.81***
No	32(28.4)	13(16.6)	
Yes	4(7.6)	8(4.4)	
Regulation	No Lobby/Coalition	Lobby/Coalition	*5.35***
No	25(20.8)	8(12.2)	
Yes	11(15.2)	13(8.8)	
Market Solution	No Lobby/Coalition	Lobby/Coalition	*0.50*
No	33(32.2)	18(18.8)	
Yes	3(3.8)	3(2.2)	
Energy Democracy	No Lobby/Coalition	Lobby/Coalition	*0.56*
No	30(30.9)	19(18.1)	
Yes	6(5.1)	2(2.9)	
Postpone	No Lobby/Coalition	Lobby/Coalition	*6.37***

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Table B1 (*continued*)

Outcomes	Strategies		Chi2
No	15()19.6	16(11.4)	
Yes	21(16.4)	5(9.6)	
Cancellation	No Lobby/Coalition	Lobby/Coalition	*1.34*
No	24(25.9)	17(15.1)	
Yes	12(10.1)	4(5.9)	
Just Transition	No Lobby/Coalition	Lobby/Coalition	*0.27*
No	27(27.8)	17(16.2)	
Yes	9(8.2)	4(4.8)	
Divestment	No Lobby/Coalition	Lobby/Coalition	*0.46*
No	27(25.9)	14(15.1)	
Yes	9(10.1)	7(5.9)	
Repression	No Lobby/Coalition	Lobby/Coalition	*1.90*
No	25(27.2)	18(15.8)	
Yes	11(8.8)	3(5.2)	
Raised Awareness	Single	Multiple	*2.04*
No	5(4.8)	18(18.2)	
Yes	7(7.2)	27(26.8)	
CSR	Single	Multiple	*1.17*
No	11(9.7)	35(36.3)	
Yes	1(2.3)	10(8.7)	
Policy Change	Single	Multiple	*0.14*
No	8(9.5)	37(35.5)	
Yes	4(2.5)	8(9.5)	
Regulation	Single	Multiple	*0.48*
No	9(6.9)	25(26.1)	
Yes	3(5.1)	21(18.9)	
Market Solution	Single	Multiple	*0.08*
No	12(10.7)	39(40.3)	
Yes	0(1.3)	6(4.7)	
Energy Democracy	Single	Multiple	*0.09*
No	10(10.3)	39(38.7)	
Yes	2(1.7)	6(6.3)	
Postpone	Single	Multiple	*5.13***
No	10(6.5)	21(24.5)	
Yes	2(5.5)	24(20.5)	
Cancellation	Single	Multiple	*5.93***
No	12(8.6)	29(32.4)	
Yes	0(3.4)	16(12.6)	
Just Transition	Single	Multiple	*0.95*
No	8(9.3)	36(34.7)	
Yes	4(2.7)	9(10.3)	
Divestment	Single	Multiple	*1.39*
No	6(8.6)	35(32.4)	
Yes	6(3.4)	10(12.6)	
Repression	Single	Multiple	*0.0016*
No	9(9.1)	34(33.9)	
Yes	3(2.9)	11(11.1)	
Raised Awareness	No Participation IP/RM	Participation IP/RM	*6.27***
No	19(14.5)	4(8.5)	
Yes	17(21.5)	17(12.5)	
CSR	No Participation IP/RM	Participation IP/RM	*0.54*
No	28(29.1)	18(16.9)	
Yes	8(6.9)	3(4.1)	
Policy Change	No Participation IP/RM	Participation IP/RM	*091*
No	27(28.4)	18(16.6)	
Yes	9(7.6)	3(4.4)	
Regulation	No Participation IP/RM	Participation IP/RM	*2.50*
No	18(20.8)	15(12.2)	
Yes	18(15.2)	6(8.8)	
Market Solution	No Participation IP/RM	Participation IP/RM	*3.91***
No	30(32.2)	21(18.8)	
Yes	6(3.8)	0(2.2)	
Energy Democracy	No Participation IP/RM	Participation IP/RM	*0.00*
No	31(30.9)	18(18.1)	
Yes	5(5.1)	3(2.9)	
Postpone	No Participation IP/RM	Participation IP/RM	*1.78*
No	22(19.6)	9(11.4)	
Yes	14(16.4)	12(9.6)	
Cancellation	No Participation IP/RM	Postponed	*0.30*
No	25(25.9)	16(15.1)	
Yes	11(10.1)	5(5.9)	
Just Transition	No Participation IP/RM	Participation IP/RM	*7.59****
No	32(27.8)	12(16.2)	
Yes	4(8.2)	9(4.8)	
Divestment	No Participation IP/RM	Participation IP/RM	*0.30*
No	25(25.9)	16(15.1)	

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Table B1 (*continued*)

Outcomes	Strategies		Chi2
Yes	11(10.1)	5(5.9)	
Repression	No Participation IP/RM	Participation IP/RM	*9.54***
No	32(27.2)	11(15.8)	
Yes	4(8.8)	10(5.2)	
Raised Awareness	No Citizen Science	Citizen Science	*0.94*
No	22(21)	1(2)	
Yes	30(31)	4(3)	
CSR	No Citizen Science	Citizen Science	*0.00*
No	42(42)	4(4)	
Yes	10(10)	1(1)	
Policy Change	No Citizen Science	Citizen Science	*1.46*
No	40(41.1)	5(3.9)	
Yes	12(10.9)	0(1.1)	
Regulation	No Citizen Science	Citizen Science	*3.99***
No	28(30.1)	5(2.9)	
Yes	24(21.9)	0(2.1)	
Market Solution	No Citizen Science	Citizen Science	*0.52*
No	47(46.5)	4(4.5)	
Yes	5(5.5)	1(0.5)	
Energy Democracy	No Citizen Science	Citizen Science	*0.89*
No	44(44.7)	5(4.3)	
Yes	8(7.3)	0(0.7)	
Postpone	No Citizen Science	Citizen Science	*0.46*
No	29(28.3)	2(2.7)	
Yes	23(23.7)	3(2.3)	
Cancellation	No Citizen Science	Citizen Science	*5.29***
No	39(37.4)	13(14.6)	
Yes	2(3.6)	3(1.4)	
Just Transition	No Citizen Science	Citizen Science	*0.92*
No	41(40.1)	3(3.9)	
Yes	11(11.9)	2(1.1)	
Divestment	No Citizen Science	Citizen Science	*2.76*
No	39(37.4)	2(3.6)	0.06
Yes	13(14.6)	3(1.4)	
Repression	No Citizen Science	Citizen Science	
No	39(39.2)	4(3.8)	
Yes	13(12.8)	1(1.2)	
Raised Awareness	No Women	Women	*0.04*
No	17(17.4)	6(5.6)	
Yes	26(25.6)	8(8.4)	
CSR	No Women	Women	*0.05*
No	35(34.7)	11(11.3)	
Yes	8(8.3)	3(2.7)	
Policy Change	No Women	Women	*0.51*
No	33(33.9)	12(11.1)	
Yes	10(9.1)	2(2.9)	
Regulation	No Women	Women	*0.00*
No	25(24.9)	8(8.1)	
Yes	18(18.1)	6(5.6)	
Market Solution	No Women	Women	*2.18*
No	37(38.5)	14(12.5)	
Yes	6(4.5)	0(1.5)	
Energy Democracy	No Women	Women	*0.84*
No	38(37)	11(12)	
Yes	5(6)	3(2)	
Postpone	No Women	Women	*0.14*
No	24(23.4)	7(7.6)	
Yes	19(19.6)	7(6.4)	
Cancellation	No Women	Women	*2.00*
No	33(30.9)	8(10.1)	
Yes	10(12.1)	6(3.9)	
Just Transition	No Women	Women	*0.35*
No	34(33.2)	9(9.8)	
Yes	10(10.8)	4(3.2)	
Divestment	No Women	Women	*5.40*
No	30(30.9)	11(10.1)	
Yes	13(12.1)	3(3.9)	
Obs.			57

Note: **, and *** refer to 5% and 1% significance, respectively. Source: Authors.

Appendix C. Publications

Table C1
List of publications used in this study.

	Author	Title	Case 1	Case 2	Case 3	Case 4	Year	Journal name	Document type
1	Thörn, Håkan; Svenberg, Sebastian	'We feel the responsibility that you shirk': movement institutionalisation, the politics of responsibility and the case of the Swedish environmental movement	Swedish Environmental Movement				2016	Social Movement Studies	Journal Article
2	Widener, Patricia	A protracted age of oil: pipelines, refineries and quiet conflict	the Keystone XL Pipeline a	Oil sands refinery, the Hyperion Energy Center			2013	Local Environment	Journal Article
3	Černoch, Filip; Lehotský, Lukáš; Ocelík, Petr; Osička, Jan; Vencourová, Žaneta	Anti-fossil frames: Examining narratives of the opposition to brown coal mining in the Czech Republic	Brown Coal Mining in the Czech Republic				2019	Energy Research and Social Science	Journal Article
4	Bradshaw, Elizabeth A.	Blockadia Rising: Rowdy Greens, Direct Action and the Keystone XL Pipeline	the Keystone XL Pipeline b				2015	Critical Criminology	Journal Article
5	Nulman, Eugene	Climate Change Social Movements	Climate change Act	the Green Investment Bank			2015	PALGRAVE MACMILLAN	Book
6	Grant, Don; Vasi, Ion Bogdan	Civil Society in an Age of Environmental Accountability: How Local Environmental Nongovernmental Organisations Reduce U. S. Power Plants' Carbon Dioxide Emissions	ENGOs on U.S. power plants' CO2 emissions				2016	Sociological Forum	Journal Article
7	Marquardt, Jens; Delina, Laurence L	Reimagining energy futures: Contributions from community sustainable energy transitions in Thailand and the Philippines	Palawan resistance against coal power	Thailand community-driven sustainable energy access			2019	Energy Research & Social Science	Journal Article
8	Burkett, Maxine	Climate Disobedience	Civil Disobedience in the US				2018	Duke Environmental Law and Policy Forum	Journal Article
9	Almeida, Paul	Climate justice and sustained transnational mobilisation	Climate justice mobilisation				2019	Journal of World-Systems Research	Journal Article
10	Brown, Benjamin; Spiegel, Samuel J	Coal, climate justice, and the cultural politics of energy transition	Coal, Climate Justice				2019	Global Environmental Politics	Journal Article
11	Hess, David J	Coalitions, framing, and the politics of energy transitions: Local democracy and community choice in California	CCA in California				2019	Energy Research & Social Science	Journal Article
12	Madariaga, Aldo; Allain, Mathilde	Contingent Coalitions in Environmental Policymaking: How Civil Society Organisations Influenced the Chilean Renewable Energy Boom	Chilean Renewable Energy				2018	Policy Studies Journal	Journal Article
13	Hall, Nina L.; Taplin, Ros; Goldstein, Wendy	Empowerment of individuals and realisation of community agency: Applying action research to climate change responses in Australia	Australia Climate Action Coogee				2010	Action Research	Journal Article
14	Hess, David J	Energy democracy and social movements: A multi-coalition	Green jobs and on-bill financing	Moratoria on natural gas infrastructure	The regional greenhouse gas initiative	The REV implementation coalition	2018	Energy Research & Social Science	Journal Article

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Table C1 (*continued*)

	Author	Title	Case 1	Case 2	Case 3	Case 4	Year	Journal name	Document type
		perspective on the politics of sustainability transitions		and development					
15	Macpherson-Rice, Breana; Munro, Paul G.; de Rijke, Kim	Energy solution or future pollution? Applying an energy justice perspective to coal seam gas in New South Wales	Coal seam gas in New South Wales				2020	Australian Geographer	Journal Article
16	Ladd, Anthony E.	Environmental disputes and opportunity-threat impacts surrounding natural gas fracking in Louisiana	Haynesville Shale region				2014	Social Currents	Journal Article
17	Veltmeyer, Henry; Bowles, Paul	Extractivist resistance: The case of the Enbridge oil pipeline project in Northern British Columbia	the Enbridge oil pipeline project				2014	Extractive Industries and Society	Journal Article
18	Riffo, Lorena	Fracking and Resistance in the Land of Fire	Northern Patagonia, Argentina				2017	NACLA Report on the Americas	Journal Article
19	Nyberg, Daniel	Fracking the future: temporality, framing and the politics of unconventional fossil fuels	Fracking in the UK				2017	Unassigned	Journal Article
20	Lawlor, Andrea; Gravelle, Timothy B.	Framing trans-border energy-transportation: the case of Keystone XL	the Keystone XL Pipeline c				2018	Environmental Politics	Journal Article
21	Turner, Terisa E.	From Cochabamba, a new international and manifesto for Mother Earth	Cochabamba, Bolivia				2010	Capitalism, Nature, Socialism	Journal Article
22	Boudet, Hilary Schaffer	From NIMBY to NIABY: Regional mobilisation against liquefied natural gas in the United States	Northeast	The Gulf Coast	West Coast		2011	Environmental Politics	Journal Article
23	Smith, Jackie	Counter-hegemonic networks and the transformation of global climate politics: rethinking movement-state relations	activist 'spillover'				2014	Global Discourse: An Interdisciplinary Journal of Current Affairs and Applied Contemporary Thought	Journal Article
24	Simonelli, Jeanne	Home rule and natural gas development in New York: Civil fracking rights	Hydraulic fracturing in New York State				2014	Journal of Political Ecology	Journal Article
25	Schlembach, Raphael	How do radical climate movements negotiate their environmental and their social agendas? A study of debates within the camp for climate action (UK)	Camp for Climate Action				2011	Critical Social Policy	Journal Article
26	Scandrett, Eurig	Climate justice: contested discourse and social transformation	Climate justice movement				2016	International Journal of Climate Change Strategies and Management	Journal Article
27	Kinniburgh, Colin	From Zuccotti Park to z•urawlów: The global revolt against fracking	New York, anti-fracking	Algeria shale gas	global revolt		2015	Dissent	Journal Article
28	Perreault, Tom; Valdivia, Gabriela	Hydrocarbons, popular protest and national imaginaries: Ecuador and Bolivia in comparative context	Hydrocarbon in Ecuador	Hydrocarbon in Bolivia			2010	Geoforum	Journal Article
29	Martinez-alier, Joan; Temper, Leah; Bene, Daniela Del; Scheidel, Arnim	Is there a global environmental justice movement?	Ejatlas				2016	Journal of Peasant Studies	Journal Article
30	Erickson, Peter; Lazarus, Michael; Piggot, Georgia	Limiting fossil fuel production as the next big step in climate policy	Us State of California				2018	Nature Climate Change	Journal Article

(*continued on next page*)

Table C1 (*continued*)

	Author	Title	Case 1	Case 2	Case 3	Case 4	Year	Journal name	Document type
31	Pérez-Rincón, Mario; Vargas-Morales, Julieth; Martinez-Alier, Joan	Mapping and Analysing Ecological Distribution Conflicts in Andean Countries	Andean countries				2019	Ecological Economics	Journal Article
32	Pearse, Rebecca	Moving targets: Carbon pricing, energy markets, and social movements in Australia	social movements in Australia				2016	Environmental Politics	Journal Article
33	Feng, Jeff	Power beyond powerlessness: Miners, activists, and bridging difference in the Appalachian coalfields	Central Appalachia and the Coal River Valley				2020	Energy Research and Social Science	Journal Article
34	Cock, Jacklyn	Resistance to coal inequalities and the possibilities of a just transition in South Africa*	just transition in South Africa				2017	Development Southern Africa	Journal Article
35	Brown, Benjamin; Spiegel, Samuel J.	Resisting coal: Hydrocarbon politics and assemblages of protest in the UK and Indonesia	end coal now south wales, UK	Kalimantan, Indonesia			2020	Geoforum	Journal Article
36	Colvin, R. M.	Social identity in the energy transition: an analysis of the "Stop Adani Convoy" to explore social-political conflict in Australia	Stop Adani Convoy				2017	Energy Research and Social Science	Journal Article
37	Ethan, B	Social Movements and Market Transformations: Lessons From HIV/AIDS and Climate Change	CSRmovement				2019	International Studies Quarterly	Journal Article
38	Black, Sara Thomas; Milligan, Richard Anthony; Heynen, Nik	SOLIDARITY IN CLIMATE/IMMIGRANT JUSTICE DIRECT ACTION: Lessons from Movements in the US South	climate immigrant justice, USA				2014	International Journal Of Urban And Regional Research	Journal Article
39	Allen, Maggie; Bird, Stoney; Breslow, Sara; Dol, Nives	Stronger together: Strategies to protect local sovereignty, ecosystems, and place-based communities from the global fossil fuel trade	Pacific Northwest, USA				2014	Marine Policy	Journal Article
40	Steger, Tamara; Drehobl, Ariel	The Anti-Fracking Movement in Ireland: Perspectives from the Media and Activists	Anti-Fracking Movement in Ireland				2018	Environmental Communication	Journal Article
41	Faruque, M. Omar	The politics of extractive industry corporate practices: An anatomy of a company-community conflict in Bangladesh	company-community conflict in Bangladesh				2018	Extractive Industries and Society	Journal Article
42	Stephens, Jennie C; Frumhoff, Peter C; Yona, Leehi	The role of college and university faculty in the fossil fuel divestment movement	fossil fuel divestment movement				2018	Elementa	Journal Article
43	David, Martin	The role of organised publics in articulating the exnovation of fossil-fuel technologies for intra- and intergenerational energy justice in energy transitions	CAGandFFG, Germany				2013	Applied Energy	Journal Article
44	Evans, Geoff; Phelan, Liam	Transition to a post-carbon society: Linking environmental justice and just transition discourses	Coal mining in Hunter Valley				2016	Energy Policy	Journal Article
45	Hopke, Jill E.	Translocal anti-fracking activism: An exploration of network structure and tie content	anti-fracking movement translocal				2013	Environmental Communication	Journal Article

Source: Authors.

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