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Social Constructions of Climate Futures: Reframing Science's Harmful Impact Frame Across News Media, Social Movements, and Local Communities

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ABSTRACT

Climate research has established a cultural authority in modelling our future with climate change, and often uses a harmful impacts frame to communicate about climate change and climate futures. This paper investigates the social constructions of climate futures by analyzing how the harmful impacts frame resonates and is reframed in three social arenas – news media, climate movements, and local communities. Data for this study stems from a larger interdisciplinary project, drawing from content analyses, participant observations, interviews, and a survey. The findings highlight that news media and climate movements reframed the harmful impacts frame only slightly, mostly to generate attention. Members of local communities reframed to a greater extent, making stronger applications to their lifeworlds. The study also points to a lack of connections across the social arenas. Implications for climate change communication will be discussed.

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The practice of *futurework* (Fine, 2007) can be applied in climate research more seamlessly than in hardly any other research area. At its core are scenarios based on complex climate models; e.g. the Intergovernmental Panel on Climate Change (IPCC) projects future climate change based on different emission scenarios for the year 2100 (IPCC, 2022). Linked to the overall cultural authority of science (e.g. Bauer et al., 2019; Jasanoff, 2004), climate research has established a *cultural authority of science's futurework* (Rödder et al., 2020). It is institutionalized, legitimized, and mandated (e.g. through an intergovernmental status) to explore society's future in times of climate change. Drawing on this authority, climate research has triggered public attention to the "climate catastrophe" (Weingart et al., 2000, p. 268), mainly by using a *harmful impacts frame* when communicating about climate change, climate futures, and their social implications (see also Bolsen & Shapiro, 2018; Eriksson & Reischl, 2019; Nisbet, 2009; Pan et al., 2019). The harmful impacts frame can be summarized as follows: a projected global temperature increase causes, among others, more frequent weather extremes, ocean acidification,

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glacier retreat, sea level rise, mass species extinction, health problems, migration, and food and water shortages. Broadly, causes lie in anthropogenic sources such as emissions, and the urgency to act against climate change is stressed through proposed mitigation and adaptation measures.

In the context of *framing* (e.g. Entman, 1993; Nisbet, 2009), the harmful impacts frame introduces the problem, assigns responsibility for its cause, and advocates specific solutions. According to a recent systematic review, it is the frame most frequently used in climate change communication (e.g. Guenther, Susan, Daniela, & Michael, 2023a): although names of this frame vary (e.g. risk or disaster frame), it was identified in more than half of the 275 papers included in the review. While the origin of this frame lies in climate research (e.g. Eriksson & Reischl, 2019), which triggers the *social construction of climate futures*, there is no direct flow from climate research to other social arenas. Rather, the harmful impacts frame may resonate with actors from other social arenas and in this process gets contextualized (e.g. Grundmann & Rödder, 2019; O'Neill et al., 2015; Weingart et al., 2000) and thus *reframed*. However, the specific mechanisms of such a reframing across different social arenas are not fully understood and will be explored in this study. Because of its dominance for the discourse, the harmful impacts frame serves as a test case to study reframing practices. Furthermore, the frame has been found to be successful in raising public attention but may not motivate people to act on climate change (e.g. O'Neill & Nicholson-Cole, 2009). Understanding its resonance and reframing may help elucidate further explanations of why that is.

Three social arenas that are particularly relevant for the social construction of climate futures will be considered: (1) *news media,* because for most people they are the preferred source of information about climate change (e.g. Guenther, Reif, Silva-Schmidt, & Brüggemann, 2022a; Newman et al., 2020); (2) *climate movements* such as Fridays For Future (FFF) and Extinction Rebellion (XR) because they became a key voice in climate debates from 2019 (e.g. de Moor et al., 2021) and movements have for long acted as alternative science communicators (Maeseele, 2009) and as carriers of beliefs and ideologies (Benford & Snow, 2000); (3) and *people in local communities*, who make sense of climate change information in light of their lived experiences and knowledge, which results from embedded and embodied practices (e.g. Schnegg et al., 2021; Simonetti, 2019). For these social arenas, we consider the specific (reframing of) climate futures that each communicate in reference to the harmful impacts frame, including the conditions under which this happens and specific motives. We advance research by assessing each social arena inductively, to gain a deeper understanding, and then focus on the links across these arenas. The present study makes use of data collected as part of a larger interdisciplinary project on the social constructions of climate futures in different cultural contexts (e.g. Global North and Global South countries; urban and rural settings), drawing from several content analyses, participant observations, interviews, and a survey.

Conceptual framework

Framing is not only a widely-used approach in environmental and climate change communication (e.g. Guenther et al., 2023a; Nisbet, 2009), its integrational and bridging potential encompasses the entire process of the social construction of climate futures and connects individual sense-making (cognitive frames) with communication (strategies) of different actors and wider cultural contexts (e.g. Brüggemann, 2014; Entman, 1993; Gamson et al., 1992). While there are numerous definitions of what a frame is, here we follow Entman (1993) in acknowledging that frames carry a problem definition, a causal interpretation, a (moral) evaluation, and a treatment recommendation. Framing is based on two principles: selection (of certain aspects of reality) and salience (i.e. only some information is made salient). Frames are articulated by specific communicators (e.g. scientists) who interact with others (such as journalists) in the process of *frame building*, ultimately influencing the sense-making of broader publics (*frame setting*; e.g. Brüggemann, 2014). In the following, we focus on the harmful impacts frame from the location of science, news media, climate movements, and local communities.

Science. Frame production, and thus processes, of how frames are created are an understudied research area (e.g. Guenther et al., 2023a; Borah, 2011). In theory, frames enter debates and compete

for attention – some of them will become dominant for public discourses. Communicators use frames strategically to support their own agenda (e.g. Bolsen & Shapiro, 2018). In this context, science is the social world that constructed the harmful impacts frame (e.g. Weingart et al., 2000); it is a thematic frame (for definitions, see Borah, 2011), tied closely to climate research and the IPCC. The IPCC is often credited with successful agenda-setting – only since the IPCC has started publishing reports in 1990 has the problem of climate change penetrated society more broadly (e.g. Jasanoff, 2010).

According to Eriksson and Reischl (2019, p. 70; see also Hulme & Mahony, 2010), the IPCC – established in 1988 – is the "expert authority" that provides the epistemic knowledge basis on climate change. Its authority results from a complex process of generating, assessing, and synthesizing knowledge, via different technologies of trust (e.g. Rödder et al., 2020; Rödder & Pavenstädt, 2023), including material technologies (computer models), literary technologies (Assessment Reports), and social technologies (orchestrating scientific consensus). When it comes to framing, for instance, in the IPCC's fourth Assessment Synthesis Report from 2007, the effects on ecosystems and human society are discussed (e.g. warnings of irreversible impacts), natural and anthropogenic drivers of climate change are named as causes, and responses relate to mitigation and adaptation, preferably achieved through global international cooperation (Eriksson & Reischl, 2019). Reports since then make a similar case, with the difference that there is stronger evidence on human activities causing climate change (Eriksson & Reischl, 2019). This frame has been promoted by the IPCC at least since the second Assessment Report of 1995 (e.g. Shehata & Hopmann, 2012). Many IPCC documents provide short summaries with headline-ready keywords and visuals, which helps set a dominant framing; its visuals predominantly display climate change impacts as a future threat (e.g. Wardekker & Lorenz, 2019). It is from here that the harmful impacts frame enters broader frame contests, competes for attention, and in this process gets reframed in other social arenas as part of the social construction of climate futures.

News media. The news media frames climate change in their own ways – in texts, visuals, and multimodal combinations (e.g. O'Neill, 2013; Wessler et al., 2016). News media, whose content is also widely distributed on social media, have power over the salience of certain frames. According to Weingart et al. (2000), the early years were characterized by a sensationalized climate change coverage. Content analyses often show that a negative framing dominates, accompanied by risks and doomsday scenarios (e.g. Painter, 2016). O'Neill et al. (2015), when assessing media coverage on IPCC assessments reports, found that in many cases, a disaster frame (i.e. dire impacts that threaten all aspects of life) was most frequent. This frame aligns largely with the harmful impacts frame. During climate summits, media coverage across countries uses a similar framing (e.g. Shehata & Hopmann, 2012).

Engesser and Brüggemann (2016) identified an IPCC consensus among climate journalists in five countries. This consensus relates to broad agreement among journalists that global temperatures have increased and are caused by humans, which is seen as problematic and future global warming needs to be limited. A factor connecting these journalists is their frequent use of scientific sources, including IPCC reports. Hence, the harmful impacts frame seems to resonate well with journalists (e.g. Guenther et al., 2023a). However, the specific reframing practices in journalistic coverage in connection to this frame have not explicitly been explored in the context of social climate futures construction.

Climate movements. In social movement studies, the concept of collective action frames as diagnostic, prognostic, and motivational is utilized as a framing approach (e.g. Benford & Snow, 2000). These are used by movements to develop their group identity and to promote their case in public claims-making to shift perceptions and discourses. For a long time, environmental movements have relied on scientific evidence as a source of legitimacy (e.g. Yearley, 2008) and the IPCC consensus has been widely used to legitimate activism and demands for climate action (e.g. Karnik Hinks & Rödder, 2023; Rödder & Pavenstädt, 2023). Climate movements are strongly supportive of science;

they seem to use scientific evidence as currency and activism then draws directly on the cultural legitimacy and authority of scientific knowledge (e.g. Yearley, 2014).

Climate movements such as FFF and XR oscillate between general demands of political action in line with emission pathways as described by the IPCC to fulfill the Paris Agreement goals (which connects to the harmful impacts frame) and more justice-oriented demands that reflect specific policy and ideological orientations (see also Haunss & Sommer, 2020; Marquardt, 2020; Wahlström et al., 2019). Depending on the specific movement (FFF, XR, or the Sunrise Movement (SM) in the US) and the time of observation, conclusions as to the politicizing qualities of movements' frames differ. Given the relevance for social movements to introduce new meanings and frames to broader debates, as well as their role as alternative science communicators, it is important to consider climate movements' specific reframing practices in connection to the harmful impacts frame for the social construction of climate futures, also because these movements gain news media attention (e.g. von Zabern & Tulloch, 2021), while being active on social media themselves (e.g. Hopke & Hestres, 2018).

Local communities. Local communities is used as a term here to talk about discourses in very specific delimited local settings, such as specific rural regions that heavily dependent on forestry and agriculture and are therefore directly affected by climate change. Often, members of these local communities strongly self-identity with their respective region. For community members, frames, as (activated) cognitive schemas (e.g. Scheufele & Scheufele, 2010), guide information processing. Cognitive schemas are used to make sense of issues; through communication, they are activated/established or altered (e.g. Scheufele & Tewksbury, 2007). When exposed to (applicable) frames, audiences usually compare and potentially integrate information into their existing schemas/frames (e.g. Nisbet, 2009); such an integration is dependent on pre-existing values and beliefs when making sense of the world (e.g. Brüggemann & Rödder, 2020). There are multiple ways of knowing about climate change (e.g. Schnegg et al., 2021) and in many cases, knowledge is localized to appropriate contexts. However, scientific and local knowledge should not be seen as separate but as interactive (e.g. de Wit et al., 2018). Hence, the harmful impacts frame, as a direct outcome of science or already reframed by media and climate movements, may either resonate with audiences, get reframed, or rejected – affecting the social construction of climate futures.

Yet, it is rather rare that studies focus on the cognitive frames of audiences or specific communities (exceptions include studies on farmers; e.g. Asplund, 2016; see also Guenther et al., 2023a). However, framing effects studies found that (visually) framing climate change as a distant threat – just as in the harmful impacts frame – can lead to feelings of powerlessness, which does not motivate people to act on climate change (e.g. O'Neill & Nicholson-Cole, 2009). In contrast, representations of local/near future scenarios seem to be more effective for problem awareness and support for actions (e.g. Happer & Philo, 2016). That is why local interpretations of climate change gain relevance (e.g. Brüggemann & Rödder, 2020); they will be considered here in connection to the harmful impacts frame for the social construction of climate futures.

In this study, we consider how news media, climate movements, and members of local communities reframe the harmful impacts frame set by science. The social arenas will be analyzed both inductively and comparatively, also because combinations of different frame locations have been called for in a recent systematic review (Guenther et al., 2023a).

Methods

We synthesize individual studies of an interdisciplinary research project, and thus use data collected in different contexts, which will be described next. Detailed information about each individual study can be found in methodological fact sheets in the Supplementary Material.

News media: For news media, we combined insights from a qualitative multimodal (i.e. text and visuals) analysis of news magazine cover stories of climate change in four countries with findings

from a quantitative textual analysis of online and print newspapers' and magazines' reporting on climate futures, again in four countries. The quantitative analysis was also used to identify journalists in the respective countries and invite them to a semi-structured, reconstruction interview (i.e. organized around one of their articles).

The qualitative analysis of content and interviews was performed with a deductive-inductive approach and the quantitative analysis with a deductive approach only, with the larger goal to identify frames of climate futures. Here, we predominantly focus on the parts of the research that link to the harmful impacts frame; for the interviews, we will use statements to support the findings of the content analyses.

Movements: To investigate movement discourses, a comparative case study was carried out in Germany and in the US, focusing on three climate movements: FFF and XR for Germany; FFF, XR, and SM for the US. FFF and XR are highly relevant in Germany; SM is the most central movement within the US youth strike coalition (Fisher & Nasrin, 2021). The qualitative document analysis included movement documents and German and US media reporting. The field study consisted of problem-centered interviews and observations of key events (i.e. protests, marches) in both countries.

Data analysis of the documents was conducted in a deductive-inductive manner. Starting from key categories based on framing (e.g. Entman, 1993; Benford & Snow, 2000) and narratives (e.g. Davis, 2002; Leipold & Winkel, 2017), further elements were inductively identified. Frame identification was achieved through iterative steps.

Members of local communities: To investigate localized discourses, three ethnographic case studies were carried out in rural (mainly) German-speaking areas (Harz Mountains, Germany; Vinschgau, South-Tirol, Italy) and the US (Flagstaff, Arizona). Unlike other ethnographic studies (e.g. Brüggemann & Rödder, 2020; Crate & Nuttall, 2016; Hastrup & Skrydstrup, 2013) which focus on visibly vulnerable communities (e.g. in the Arctic, small islands in the Pacific Ocean), our research adds depth to the perspectives of people living with climate shifts in Europe and North America. People in these regions emit high levels of carbon dioxide (Friedrich et al., 2020). Additionally, our ethnographic work uncovered less visible vulnerabilities in these communities, such as land dispossession, political marginalization, and systematic economic precarity.

We worked primarily with local foresters and farmers to gain access to the field. These particular livelihoods highlighted presently occurring changes due to shifting weather patterns as well as effects of climate change. Our ethnographies are mainly based on participant observations, interviews, and in the context of the Harz Mountains an additional quantitative survey, to verify findings from the interviews. The analysis followed an inductive, grounded theory approach (Glaser, 1998). For this paper, we searched our material for references to "science" and related scenarios.

Data analysis. Although data were collected individually, a guiding analytical framework allowed for comparisons. This framework was developed collectively before the individual studies were conducted; it directs attention towards four elements: (1) an actor (individual, organizational), (2) imagines the future, (3) attributes responsibility to something or someone (for causing and solving), and (4) advocates to take some action (to arrive at the desired future/avert a future that is feared). A set of questions was derived from these four elements that the individual studies sought to answer through methods adapted to the respective research context. In regular meetings, the members of the interdisciplinary project presented and discussed their individual approaches and findings. For the present study, we have either reanalyzed existing data (e.g. codings, transcripts) or looked for yet unconsidered parts in the data (e.g. specific interview questions). In many instances, this study developed a meta-view across the findings of several studies.

For the news media studies, this meant assessing to what degree and under what conditions the identified frames of climate futures in journalistic content linked to the harmful impacts frame, as well as the motives journalists mention. For climate movements, we looked at the degree to which the identified frames linked to the harmful impacts frame, and if and how the use of this frame differs between movement groups. For the local communities, this meant reanalyzing references

to science and scientists, in order to detect how the harmful impacts frame was reframed locally, and when and under which conditions people talk about these climate futures. Lastly, any links across the actors with respect to the harmful impacts frame were noted, in light of answering the larger question of if and how a frame set by climate research resonates across social arenas.

Results

The results will be organized, first, per social arena when focusing on connections to the harmful impacts frame and conditions under which/or the motives of when this happens; secondly, insights are brought together when looking at the links across arenas. Table 1 provides a summary of all frames found.

News media: In both the qualitative multimodal and the quantitative textual content analyses of newspapers and news magazines, two frames of climate futures were identified as close to the harmful impacts frame (e.g. Guenther, Reif, Silva-Schmidt, & Brüggemann, 2022b; Guenther et al., 2023b). In the multimodal analysis, this predominantly concerned the frame "Global doom"; in the quantitative analysis the frame "Distant threats to humanity." These frames were among the most frequent frames found. In both cases, there were distant, global, and negative scenarios about harmful impacts of climate change, stressing the urgency to act. The "Global doom" frame furthermore used almost apocalyptic language and visuals. In both frames, scenarios were largely based on climate research and scientific assessments and warnings (e.g. IPCC, scientific reports, conferences, studies) and used scientific explanations – with few differences across the countries. The anthropogenic causes of climate change were often mentioned; solutions usually concerned urgent mitigation and adaptation measures mostly directed at (international) politicians (e.g. the idea of treaties). The frames are thus a close representation of the harmful impacts frame but they also show tendencies of simplification and dramatization, especially in the "Global doom" frame. In interviews, journalists using this frame expressed their trust in scientists/experts, scientific predictions, and especially the IPCC. Journalists using this frame have long-term time frames and global effects in mind (e.g. on the most vulnerable and/or developing countries). A German journalist stressed that her reporting is not "a horror scenario because it is simply the reality." A US-based colleague stated: "I hate to say this. … I'm fighting against human extinction. I think we're headed for extinction. That's how I feel. It's terrible to say. But I feel like we're just not doing enough, you know, it's like we're spitting into the wind and there's so much fighting against us."

Furthermore, there were frames that only shared some characteristics with the harmful impacts frame, and they were also quite common in news media reporting. "Local tragedies", as a frame in the multimodal analysis, as well as "Distant threats to ecosystems" in the quantitative analysis. These frames were more regionally bound (e.g. the Amazonas, the Arctic), yet still often based on climate research but usually on single aspects of climate research (e.g. regional or case studies on, among others, extreme weather). At the same time, events and local circumstances (such as wildfires) also triggered this frame. While global and local causes were often given, especially in the quantitative analysis, this frame frequently failed to discuss solutions. Despite its negative evaluation, this frame is already more detached from the harmful impacts frame. Journalists using this frame emphasized that local aspects are important for their reporting on climate futures, as well as nearer time horizons (i.e. up to 2050), and that due to (local) events, the first effects of a changing climate are already observable. This is reinterpreted as the experts (i.e. the scientists) were right in the past. Naturally, most scenarios are based on science; local circumstances are used as a "microcosmos of the global picture", as a South African journalist explained.

Lastly, the "Sustainable future" frame identified in the qualitative multimodal analysis as well as the frames "Solutions to climatic and social consequences" and "Economic opportunities" identified in the quantitative analysis were the most detached from the harmful impacts frame. In these frames, connections made to the frame were only indirectly present, mostly as reference to the Paris Agreement of 2015. Hence, in these cases, climate research is not setting the scene for

Table 1. Summary of the identified frames across arenas.

	Problem definition	Causal interpretation	(Moral) Evaluation	Treatment recommendation
Arena: **science**				
Harmful impacts frame	Global temperature increases cause, e.g. weather extremes, ocean acidification, glacier retreat, sea level rise	Anthropogenic sources such as emissions	Negative, urgency to act	Mitigation and adaptation measures, through global international cooperation
Arena: **news media**				
Global doom	Distant, global temperature increases, extreme consequences; often triggered by science	Anthropogenic causes explained in detail (fossil fuels, greenhouse effect)	Negative, alarming, often apocalyptic	Mitigation and adaptation measures, (international) treaties
Distant threats to humanity (39%)[a]	Distant, global temperature increases and severe consequences; often triggered by science	Variety of causes given (mostly emissions, but also political aspects)	Negative, urgency to act	Variety of solutions, mostly mitigation and political measures
Local tragedies	Regionally bound aspects of climate change; often triggered by events (e.g. fires, storms) or research	Global (in connection to climate change) and local (e.g. land use) causes mentioned	Negative, urgency to act (locally)	Some global (e.g. technologies) or local (conservation) solutions
Distant threats to ecosystems (28%)[a]	Distant, global and mostly single effects of climate change on ecosystems; often triggered by events or research	Climate change in general or human-nature interactions	Negative	Often fails to mention solutions
Sustainable future	Limiting the temperature increase to 1.5/2 degrees Celsius; many triggers for reporting; references to the Paris Agreement	Often fails to mention causes; if mentioned, then anthropogenic causes	Negative if limit is exceeded, hopeful if kept	Variety of different solutions, including individual behavior
Solutions to climatic and social consequences (19%)[a]	Effects of climate change on ecosystems and socio-political systems; many triggers for reporting; references to the Paris Agreement	Climate change in general	Negative	Large variety of solutions mentioned and advocated
Economic opportunities (14%)[a]	Effects of climate change on economic systems; often triggered by political assessments and economic ideas	Largely emissions, often financial, economic, or political aspects	Negative, mixed, and positive evaluations	Advocated are mitigation, adaptation, renewables, and most strongly, political actions
Arena: **climate movements**				
Evidence first	Distant: climate change as global crisis situation; notion of future harmful impacts and that knowledge about threats has been available for long	Anthropogenic sources (following scientific reports); limited public awareness and political inaction	Mixed; negative: evaluation of a lack of action (thus, negative projected futures); positive: can-do mentality, "solutions are ready to go"; urgency	Political action and commitment (scientific targets); techno-based mitigation options; stronger integration of science in policy-making
Inter-generational injustice	Climate change (consequences) as a threat for the freedom	Former generations due to their way of life; these are the people	Mixed: anger and despair, but also	No specific policies but targets and planning; limiting freedom (in

(*Continued*)

Table 1. Continued.

	Problem definition	Causal interpretation	(Moral) Evaluation	Treatment recommendation
	and justice of future generations	in (economic, political) power and are therefore called into action	hope; notion of moral (in)justice	terms of emissions) of current generation
Global climate justice and intersectionality	Climate change intersects with injustice; oppression and power imbalances; future harmful impacts and unjust distribution in certain regions (i.e. Global South)	Historical responsibility of the Global North, often specific actors are blamed (e.g. fossil fuel companies, conservative politicians, media)	Negative: historical and moral injustice	Climate policies; social justice; technological innovation; changes in ownership structures, consumption, power, and commitment to justice for historical debt (international cooperation)
System change – disruptive change	Global and abstract; system inhibits a life in harmony with nature; existential crisis	Anthropogenic causes; toxic systems; the last 30 years have shown that the political system is incapable of real action	Negative: "courage, not hope" – sacrificial, spiritual, anger, negative future scenarios seen as likely	No specific recommendation; deliberation and system change; construct a society that can live in harmony with nature
System change – localization and value change (from 2021)	Economic systems and culture based on extractivism, profit, and growth; reasons for societal ills, including climate change; general overuse of resources	Over-consumption, profit orientation, and societal values that build on nature-human duality; lack of democracy	Negative: questioning the probability and timelines in comparison to urgency; positive: providing a (local) positive vision and hope	Reorientation of fundamental societal values towards sufficiency, community, and post-productivism; degrowth; democratization of social spheres; localization
Political fight	Global problem definition, yet regionalizing: economic injustice and climate change as "twin crises" that can only be solved together	Fossil fuel industry and lobby interests are blocking progress on action; hence, economic and political reasons	Mixed; negative: militaristic tone, "fight and defeat" logic; positive: hopefulness, visionary, "as the sun rises each morning"	Opportunity for progressive policies; renewables; changes in ownership structures, community development, redistribution, and adaptation
Arena: **local communities**				
Pessimistic	Climate change triggers a range of negative thoughts and emotions: nuances of doom, helplessness, grief, and distant threats	Anthropogenic climate change (especially thoughts of extreme weather events frighten people)	Negative (e.g. grief, helplessness)	Policy changes, international cooperation; changes in consumption; land back to Indigenous groups (US)
Tentative	Climate change is real and it is happening; the effects might be bad but not a complete "doom"	Both anthropogenic and natural causes (long term climate cycles)	Mixed and not hopeless; nuances of agency (e.g. planting trees)	Adaptation; local solutions
Optimistic	People feel capable to face climate change; it also entails (economic) possibilities	Both anthropogenic and natural causes (long term climate cycles)	Positive: resilience (of forest/"nature"/ people); new opportunities for tourism/ agriculture	Not applicable
Scientific solutions	Science holds the solution for climate change	Stronger emphasis on anthropogenic climate change, although natural causes were also mentioned	Climate change is seen as something negative yet solvable (by others)	Research; techno-based solutions; no individual changes (e.g. consumption) needed

(*Continued*)

Table 1. Continued.

	Problem definition	Causal interpretation	(Moral) Evaluation	Treatment recommendation
Distrust in science	Questioning scientific authority and the existence of climate change in general	Conspiracy; linked to COVID-19 and other socio-political issues	Negative	No climate action needed

Notes. [a]Indicates frequency across the quantitative content analysis (Guenther et al., 2023b).

reporting on climate futures. Furthermore, especially in the "Sustainable future" frame, causes of climate change are often not mentioned, but instead a variety of solutions, including connections to individuals and their lives. Furthermore, there are more mixed and positive evaluations. A journalist from the US explained why she often uses this framing: "I feel like readers … if they're just presented with doom and gloom, they just assume that they cannot do anything about it. I try to be very real about the fact that we cause this and this is going to get worse. … If there is any kernel of something that can be done, I just feel responsible to mention that and help people understand."

In total, news media commonly used the harmful impacts frame – and there were diverse conditions under which this happened. Common triggers of news media reporting in line with the harmful impacts frame were IPCC reports and COP conferences, scientific studies and conferences, but also extreme weather events and even political/economic ideas if a reference was made to what will happen in case of non-action.

Climate movements: The qualitative analysis of movement documents and media reporting in 2019 showed that all movements used frames close to the harmful impacts frame. In the beginning, this frame's elements were strongly represented in an "Evidence first" frame, central to all movements and FFF in particular. For instance, similar to the "Global doom" and "Distant threats to humanity" frames in news media, FFF and XR in Germany predominantly relied on global scientific scenarios and reports, mostly those from the IPCC, for informing their (negative) future visions (Rödder & Pavenstädt, 2023). They appeared simplified compared to science, and future imaginations were largely polarized between negative future scenarios that would unravel after a certain deadline (i.e. temporal markers, such as 2030, 12 years; described as "collapse", "extinction", or "no future") and apocalyptic vocabulary (social upheaval, natural disasters, poverty, migration and hunger), with a distinct theme of "losing agency" in accelerating climate change after crossing tipping points in the climate system, which points to the necessity of urgent action. This frame defined emissions and political action that do not adhere to scientific advice as key problems, with common references to the time that has passed since knowledge of climate change has been available. Responsibility is put on politicians and national governments to enact climate policies following the Paris Agreement. Unlike news media, movements often discussed a lack of acknowledgement of "the" (climate) science, and identified it as a major reason for perceived lack of action. A stronger connection to scientific knowledge in policy-making and broader awareness-making of the science is thus portrayed as potential solutions.

Furthermore, for FFF (and partly SM), an "Intergenerational injustice" frame was central, whose future imaginations were inspired by the harmful impacts frame: the "non-existence" of a future is communicated as a (negative) future scenario. Hence, there was a reframing to possible harsher living conditions for future generations. This combination of a moral and emotional discourse and scientific authority provides a narrative quality to the global, data-driven, and distant assessment of climate change. The consequences of climate change become concrete and affect the audience directly: e.g. "our children".

The interviews showed that the harmful impact frames continues to be highly relevant for movement communication, joined by a shared commitment to socially just solutions. Yet, activists disagreed about effectiveness of using scientific frames to communicate climate change, and there were different viewpoints regarding epistemology, the role of science, and the need for the articulation of

moral and political frames vs. taking political arguments out of the discussion around climate change. A German interviewee put it this way: "Science has to tell us which way to go, to ensure that we take the right path … It may sound banal, but science doesn't lie." There were ambivalences, for instance between the centrality of climate research as orientation for solutions and a rejection of specific technologies like negative carbon emissions or, more generally, a critique of techno-optimist frames and advocacy for post-capitalist normative orientations. An interviewee from the US explained: "I think the danger is in letting feeling like science is something that only the experts can do … If I'm just like, oh, I don't understand all these things anyway. And this expert over here is saying, you know, we can suck the carbon out of the air … But I think there needs to be a broader understanding. Democratization of science, basically." However, movements did not pose an oppositional view to science; rather, critical remarks to the implementation of technologies like geo-engineering were associated with economic greed or climate delay strategies by incumbent political and economic actors.

Furthermore, we see reframing that occurs in regard to the harmful impacts frame. More often than in 2019, climate movements contextualized scientific frames with moral and justice-based arguments. In terms of future visions, more "intermediate" future scenarios were imagined by individual activists, including scenarios in which climate action occurs in a technocratic, but socially unjust manner. The greatest plausibility was given to those intermediate scenarios in which there is some political and civil societal reaction to climate change, yet, severe consequences of climate change cannot be avoided: "So, I think that there is a way that we could avoid the worst of the climate crisis without doing much of those fundamental … restructuring[s]. I think it would still be pretty bleak. I think that a lot of humanity would still suffer", is what an interviewee from the US said. The imagined victims are mainly in the Global South; hence, activists would draw on different future visions for the Global North and the so-called MAPA (i.e. most affected peoples and areas) in a "Global climate justice and intersectionality" frame, which is closer to the "Local tragedies"/"Distant threats to ecosystems" frames identified in news media. This gained particular relevance in the German movements from 2020. A German interviewee: "I've definitely noticed lately that I rarely think about my own future in terms of the climate crisis … One future scenario where I think a lot right now is the issue of climate-induced migration."

In XRs communication, a "System change" frame enacts a reframing of the scientific concept of "tipping points" to a societal perspective, invoking the need for disruptive (societal system) change. This frame draws upon the most negative scientific scenarios, to deduce the need for system change. However, XR denies proposing specific solutions, seeing democratic decision-making (e.g. citizens assemblies) as a vehicle for radical transformation and argues it to be beyond politics. This positioning, combined with the centrality of apocalyptic imagery, hampered the articulation of alternative futures in 2019. Interviews showed that many activists held implicit ideas about the desired societal value change towards degrowth and sufficiency as well as deep democratization of social spheres – summarized under a "Localization and value change" frame. Specific meanings of system change remain contested within and between the climate movements: "For me personally it would not be about somehow building up and breaking the existing political system … So, system change means above all societal economic change" (German interviewee).

In addition, with SM (and to a lesser degree FFF and XR in the US), we find both negative visions informed by IPCC science and positive visions informed by political and normative ideas about social justice. For instance, the *Green New Deal* offers a cultural narrative of prosperity through economic policies and state intervention. Hence, the negative framing of the harmful impacts frame is softened, leading to a "Political fight" frame, which is more closely aligned with a specific policy future vision and the prospect of gaining political power and enacting solutions. Thus, SM's framing action, to a degree, can be contrasted to FFF and XR, in that the harmful impacts frame was less emphasized for the formulation of future visions.

Overall, the harmful impacts frame provided a basis for framing strategies and can be described as key to climate movements' framing, inspiring imaginations of mainly negative futures, and

therefore raising urgency to act on climate change. However, over time, by framing through justice-lens and moral arguments, scientific perspectives on climate change became increasingly contextualized and also partially localized, as activists' noted the need for "storying" climate change and science to make it relate to people's lives.

Members of local communities: In contrast to news media and climate movements, in local communities, references to the harmful impacts frame were not always or consistently encountered, and a variety of other frames and links to science emerged. A "Pessimistic frame" was rather close to the harmful impacts frame (e.g. causes, solutions); however, it carried differences. By labeling the frame as pessimistic, we encompass the many forms it can take, e.g. the nuances of doom, helplessness, grief, and distant threats. When discussing climate futures with an interlocutor in Flagstaff, one responded by stating: "If I start thinking about it, it will keep me up at night. Yeah, you know, I instantly find myself in a state of despair and hopelessness." Another stressed the feeling of grief with respect to climate change, saying: "I feel like I feign optimism a lot. That's like, fake it till you make it. I stopped reading the news as much just because I can't, it's too much, too much all the time. It's definitely a really heavy sense of grief." Moreover, what was often found is that interviewees had a pessimistic vision, yet it was located in other places, such as in the melting of the poles. An interviewee from the Harz: "I would say, low-lying cities or countries have a huge problem. Definitely." Hence, this pessimistic framing could easily be set by the harmful impacts frame or the frames (rather) close to this frame found in news media reporting or in movements. Notably, however, this frame did not rely on the same scientific terminology and was not the most salient in the field sites.

At least for the two German speaking regions, a "Tentative frame" seemed to occur more often. Since the ethnographies worked with a lot of foresters and forest workers who manage trees with lifespans of hundreds of years, many of them acknowledge climate change as something negative; yet, their way of framing was frequently more tentative, and they would also acknowledge natural causes of climate change. This result is unsurprising as their future-oriented work would be meaningless in a negative or even apocalyptic scenario. "Well, that's true, we have climate change and it's going to change. But whether it will really be as terrible as it is announced to be – I don't know. No idea." This tentativeness is in contrast to the news media and movement frames.

Furthermore, contrary to the harmful impacts frame, some interviewees expressed an "Optimistic frame." They stressed notions of resilience and saw themselves, the forest, or nature more broadly in an encouraging position to confront climate change. An interviewee from Flagstaff stated that "we're fortunate our completely natural, ponderosa pine forest is pretty much exactly what we want for carbon, for fire risk reduction, for climate change, adaptation, and resilience." Other interlocutors stressed economic opportunities related to climate change. One interviewee in Vinschgau stated: "Climate-wise, I think we're in a situation where no matter how things go, you can often still be a climate winner". This can be interpreted as selective view on climate change impacts, e.g. a rise in mean temperature associated with more favorable agricultural conditions. It also shows that climate change vulnerability is sometimes assessed in comparison with economic competitors. Overall, we could only find very few references to this frame – although the news media also expressed economic opportunities, as did some movements, yet more from a political view.

Rather than dealing with future visions, two frames instead depicted references and attitudes specifically towards "the" science and scientists. These two frames illustrate a wide spectrum ranging from being saved by science, as in the "Scientific solutions frame", to an acute distrust of the agenda of science and those who advocate for its authority. Hence, in line with the "Scientific solutions frame", one interlocutor in the Harz said: "We can only intensively, I say, use science to try everything possible, that we arm ourselves accordingly." This acknowledgement of science's authority is reminiscent of the scientific authority established in news media and movements frames (rather) close to the harmful impacts frame.

However, other interlocutors thought that science has the solution to climate change "in its drawers" but is not allowed to use it, as one interviewee from the Harz said. The "Distrust in science frame" ranges from distrust in science (e.g. because of their presumed political agenda) to informants believing in "other scientists" as they say, or an active demarcation from science. For instance, during one conversation with an interlocutor about science in Flagstaff, he expressed his distrust this way: "But that's, you know, there's a lot of scientists that have political agendas, and as a quote scientist they can say this is what I believe and we're headed in the wrong direction. And then we're all supposed to believe it." Such a questioning of science's authority does not link with the news media or climate movements.

However, we generally found a tendency towards agreement and trust in science. In the survey in the Harz, when asked if they trust in science and scientific findings on climate change, 60% of the respondents answered with yes, 32% with partly, and only 7% with no. When looking at what triggers these frames and under which conditions, one was the close proximity with land through personal experiences, livelihood, or practices. Some examples include foresters and apple farmers, who partially expressed positive attitudes about climate change, if it could bring money and opportunities. Another condition is extreme weather events, such as floods or wildfires, which triggered fears and thoughts about negative scenarios.

Assessment across social arenas: The analysis showed that the harmful impacts frame, to a large degree, diffused from climate research to news media and climate movements, but was also contextually reframed. With local communities, however, the harmful impacts frame did not so easily resonate. When news media reported on climate futures, journalists did not link to climate movements or (local) individuals often – climate change and climate futures, in most cases, remained an abstract, scientific, far in the distance, and global topic. News media only connected to movements and local communities in frames that are infrequently used, for instance, as part of the "Sustainable future" frame, when emphasizing movement demands or how individual behavior can be adjusted. When journalists were asked about the triggers for their reporting on climate futures, demonstrations and protests (and thus, movements) were barely mentioned.

Climate movements often reproduced the global assessments of the harmful impacts frame; however, through moral discourses, they reframed the scientific concept of climate change, and, to some degree, retemporalized and relocalized its consequences. Following their nascent phase (2019), movements forged stronger connections to people's lives through regional campaigning and they shifted moral discourses towards framing climate change as an issue of global justice and intersectionality, with a stronger focus on the perspectives of MAPA. However, scientific justification remains a key element of the movement discourse. Some movements, and especially XR, reflected critically on the media's reporting on climate change, for failing to "tell the truth" about the climate crisis.

In local communities, when asked directly, some interlocutors stated that news outlets paint a relatively realistic picture regarding climate change, while others believed the media generally exaggerates. They then think that articles are one-sided, unbalanced, or have a political agenda. The survey in the Harz also captured trust in the media, showing that only 16% answered that they trusted journalistic reporting on climate change, 57% only partly trusted, and 26% did not trust. Furthermore, since the ethnographic studies were carried out in rural areas and climate activism seems to be more visible in urban areas, no climate strikes worth mentioning were carried out in the communities studied. However, some people referred to climate movements like FFF in the Harz and Vinschgau, and the SM in Flagstaff. Yet, the opinions towards the activists were mixed. "I think it's great, this Fridays For Future thing, I would say, that's such an in-between thing of commitment and pure desperation and absolutely justified slaps in the face to the older generation," is what a Nationalpark employee in the Harz told us. Hence, there is some reference to climate movements' "Intergenerational injustice" framing. Others in the Harz, however, identified it as an urban phenomenon detached from their own experiences: "And many

people, who I think are also at Fridays For Future, don't even know what it's like in agriculture/rural life at all." Flagstaff was the only field site where Indigenous peoples were relevant actors and the Land Back Movement, which advocates for climate justice, was referred to frequently in a positive way.

Discussion

The present study assumes a cultural authority of science (e.g. Bauer et al., 2019; Jasanoff, 2004), which for the case of climate change can be observed, among others, in reports produced by the IPCC and in its harmful impacts framing of climate change and climate futures. We took this scientific construction of climate change as having harmful impacts as the starting point for social constructions of climate futures in news media, climate movements, and local communities. However, a frame set by science is unlikely to flow to other social arenas without processes of reframing (e.g. Grundmann & Rödder, 2019; O'Neill et al., 2015; Weingart et al., 2000). Consequently, the reframing practices in connection to the harmful impacts frame were investigated to understand the (professional, strategic) use of this frame and how people try to make sense of it.

The findings emphasize that scientific constructions of climate futures (i.e. the harmful impacts frame) were, partly, reframed in news media and activists' discourses in line with specific mechanisms such as simplification, emotional appeal, or apocalyptic vocabulary, mostly to attract attention (see also Weingart et al., 2000). Some journalists and activists were convinced by these frames and feared gloomy climate futures. Hence, the harmful impacts frame triggers frame building practices in these arenas. The frame is thus highly relevant for climate science's cultural authority and the social construction of climate futures, as it flows across social arenas. Its success may be linked to climate research's and the IPCC's authority and agenda-setting (see also Eriksson & Reischl, 2019; Hulme & Mahony, 2010). Furthermore, both journalists and activists stressed their trust in (climate) science as an institution. As was supported by the findings of the present study, news media rely heavily on climate research and the IPCC as a trigger for media reporting on climate change and climate futures (e.g. Guenther et al., 2022b). In the past, climate journalists were identified to be united behind an IPCC consensus (e.g. Engesser & Brüggemann, 2016). Similarly, climate movements were found to use science as a justification for activism and for demanding climate action, now themselves demanding for everyone to "unite behind the science" (Rödder & Pavenstädt, 2023). Even the frames we identified in news media and climate movements as further detached from the harmful impacts frame still made (indirect) references to it. A crucial difference between news media and climate movements is that for news media, frames seemed to be more dependent on what triggered reporting in the first place. Some movements discussed the lack of awareness for climate action and have slowly started to make broader connections to moral and political discourses when discussing climate futures, and also started to localize their activism, e.g. through local Green New Deal campaigns in the US. It is very likely that movements, after 2019, recognized that the harmful impacts frame was useful for initial mobilization but that they had to establish a bigger framing variety.

Through localizing knowledge or making stronger connections to everyday life, as this study found, the highest level of reframing and thus detachment from the harmful impacts frame was reached in local communities. This finding shows that frame setting always has to be seen in specific contexts, in which people apply various (local) interpretations when trying to make sense of the world. Frames such as the harmful impacts frame only resonate when they are applicable, fit with existing schemas (e.g. Nisbet, 2009) or pre-existing values and beliefs (e.g. Brüggemann & Rödder, 2020). The findings point to the fact that scientific and local knowledge are probably not standing in much interaction (e.g. de Wit et al., 2018). In local communities, the harmful impacts frame was only present to some degree, through pessimistic feelings and tentative assessments, and there were even optimistic assessments. Furthermore, (dis)trust in (climate) science seemed to play a relevant role. Many members of local communities

nevertheless referred to science's authority and made connections to negative climate predictions when exposed to extreme weather; in other conditions, they rather looked at their livelihood and (economic) opportunities. Hence, ideas about temperature increases and expectations of more extreme weather events may be points where science (via intermediaries) resonated in local communities; however, specific sources (such as the IPCC) or scientific concepts such as scenarios did not.

Despite these individual analyses of three social groups and actors, findings on the links across them seem to bear implications for climate change communication. News media and movements investigated here probably are positioned in a stronger relationship to (climate) science, which makes it more likely for them to reframe the harmful impacts frame to a degree that is still very much in line with the frame set by science. Hence, (climate) science and its authority play a powerful role for the social construction of climate futures. However, the same does not apply to the local communities sampled in this study, and a potential reason for that could lie in the lack of connections across the social arenas.

News media often fail to establish links between climate futures and the individual lives of people. Some people in local communities we talked to also stressed their distrust in media reporting. Movements, while trying to make stronger connections to people, were not of high relevance to the people in rural areas considered in this study. Furthermore, although the harmful impacts frame is often assessed to raise public attention to climate change, at the same time, the frame is not motivating much climate action (e.g. O'Neill & Nicholson-Cole, 2009). As our interviews show, some activists' noted this as a shortcoming of the communicative focus on climate science, and reported that there are discussions or ongoing efforts within the movements to relate more strongly to emotions and connect climate change (and science) to local concerns. The findings of the present study support that local factors, connections to everyday life, and also trust in information/sources seem important when people assess climate futures. We would also like to emphasize that the fact that not every aspect of science resonated in local contexts and communities does not mean that the people analyzed here are illiterate, ignorant towards scientific authority, or did not understand these frames. They simply applied what fit to their lifeworld – because it was more detached, perhaps their reframing was even more critical than what was observed for news media and climate movements. And since people applied knowledge to their lifeworlds, there may be more space for reframing practices. As an implication for climate change communication, this finding should be resonated back to (climate) research, news media, and climate movements, and their ongoing (re)framing of climate futures: localizing climate futures and making connections to everyday life may help raising awareness for climate change and may even help closing the gap between awareness and action.

While this paper studied how a frame resonates and gets reframed, a further contribution would be not to stop there but take the idea of *circulation* of a frame into account; however, the analysis performed here is not yet able to fully answer how a frame flows from one arena to another, including feedback and potential further reframing in the process. For instance, when the harmful impacts frame reaches local communities, it already underwent reframing through intermediaries. Communicators also design their frames with certain intents (e.g. the IPCC with regard to reaching news media). A more fine-grained analysis, at multiple points in time would probably shed more light on these processes.

The present study also has some notable limitations. Methodologically, they concern all individual studies (e.g. small sample sizes in some places; selection of news media, movements, and/or local communities; time frames considered), or the fact that in this paper, only a meta-view was used across the findings of individual studies. Furthermore, reframing practices were investigated for one frame (although frames stand in a competition) and across three social arenas only. However, the study is among the few combining different frame locations – it did so in an inductive but also integrative manner. Future research should take the findings of this study a step further and include links between climate future imaginations and climate action.

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Data availability statement

The data that support the findings of this study are available from the corresponding author [LG], upon reasonable request.

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