A Distant Threat? The Framing of Climate Futures across Four Countries

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Abstract

Future scenarios of a changing climate are not only an integral part of climate research, but they are also part of media coverage on climate change. Such reporting affects how people imagine the future to be, as well as their current and intended behaviors. Hence, this article made use of a quantitative, manual content analysis with qualitative and automated approaches for sample construction, to analyze the framing of climate futures in journalistic media across four countries (Germany, India, South Africa, and the United States; $n = 1\,010$). Four frames were identified: "Solutions to climatic and social consequences", "Distant threats to humanity", "Economic opportunities", and "Distant threats to ecosystems"—these frames describe different climate futures, with only a few differences between Global North and Global South countries. Implications for climate change communication will be discussed.

Keywords: climate change, frames of climate futures, journalistic reporting, media, country comparison

A Distant Threat? The Framing of Climate Futures across Four Countries

For decades, research has been working with models projecting future pathways of a changing climate; such projections help with understanding the long-term effects of decisions we make today. For instance, the Intergovernmental Panel on Climate Change (IPCC, 2022) has been working with Representative Concentration Pathways (RCPs) but recently introduced Shared Socioeconomic Pathways (SSPs) to model *climate futures*. While RCPs describe levels of greenhouse gas emissions and other radiative forcing, SSPs focus on mitigation and adaptation challenges and include socioeconomic factors such as population growth and technological change (see also Riahi et al., 2017). Nevertheless, imaginations of our future with climate change are not only based on scientific reports, but also on political and economic assessments or even science fiction; the specific models and imaginations vary, for instance, regarding their evaluation (e.g., doomsday vs. desirable scenarios) or their plausibility (see Guenther et al., 2022a; Iossifidis & Garforth, 2021).

At the same time, the way individuals imagine their future with climate change has important repercussions on how they act in the present (c.f. *sociology of the future*; Adam, 2011; Selin, 2008) and thereby ultimately shape actual future pathways (e.g., Bell, 1996; Kumpu, 2013). Imaginations of climate futures held by individuals are not created randomly, but they most likely originate in—or are at least affected by—(journalistic) media representations. The reasons for that are that climate futures are frequently reported by scientific bodies such as the IPCC and also frequently covered in journalistic media (e.g., Hellsten et al., 2014; Kumpu, 2013); these media are (still) seen as the most important sources of information about climate change for many members of the public (e.g., Guenther el al., 2022b; Newman et al., 2021). That is why the way climate futures are represented, or *framed* (e.g., Entman, 1993; Nisbet, 2009), in a variety of journalistic media can affect how members of the audience make sense of them (Ruiu, 2021; Schäfer & Painter, 2020). For instance, researchers often refer to the fact that (visually) framing climate change as a distant threat and

not one affecting people's individual lives can lead to feelings of powerlessness, which accordingly does not motivate them to act on climate change (e.g., O'Neill & Nicholson-Cole, 2009). In contrast, representations of local, and thus geographically near, future scenarios seem to be more effective for problem awareness and support for actions (e.g., Happer & Philo, 2016). Such findings emphasize the importance of studying how media frame climate futures. Furthermore, most journalists do not just mirror their sources' information but they actively select information (e.g., the IPCC displays several pathways) and create their own frames of climate futures (e.g., Foust & O'Shannon Murphy, 2009; Guenther et al., 2022a). Although there is an abundance of research studies on the framing of climate change in communication (e.g., Guenther et al., 2023; Schäfer & O'Neill, 2017), researchers are only starting to focus on specific aspects of the larger topic of climate change, such as extreme weather events or, as in this paper, climate futures. Thus, this article will analyze the framing of climate futures in reporting on climate change, to assess the larger patterns/constructions of how climate futures are represented journalistically, which affects how audiences understand and act on them.

Although this region "bear[s] the brunt of effects from climate change due to geographic happenstance" (Comfort et al., 2020, 327; see also Ngyuen & Tran, 2019), there is a lack of research in climate change communication in the Global South (Metag, 2016; Schäfer & Painter, 2020). This is problematic for a transnational problem such as climate change that needs to be addressed globally (e.g., Hase et al., 2021). Fighting climate change requires international action; relying solely on analyses from the Global North would thus not paint the whole picture (e.g., Guenther et al., 2023). To counter tendencies of research to predominantly look at Western countries, researchers have started to take on comparative assessments of countries from both the Global North and the Global South (e.g., Hase et al., 2021; Liang et al., 2014). Following their lead, this article takes countries of both areas into account: Germany, India, South Africa, and the United States (US).

Framing, and the Framing of Climate Futures

Framing as a Theoretical Lens

Climate futures have been described as sets of meanings (e.g., Hellsten et al., 2014); thus, framing is an appropriate theoretical lens to study media representations of future imaginations of climate change (see also Guenther et al., 2022a). Although framing, as an interdisciplinary concept, is still facing conceptual/theoretical and methodological challenges (e.g., D'Angelo et al., 2019), it is a widely used concept in climate change communication (e.g., Guenther et al., 2023; Schäfer & O'Neill, 2017). The fact that different conceptual understandings co-exist (e.g., Borah, 2011) means that researchers are obliged to make clear, and rationalize, which theoretical tradition and definition they follow when studying frames (see recommendations in Guenther et al., 2023).

In this article, as do many empirical studies in our field, we rely on Entman (1993), whose definition emphasizes the principles of *selection* and *salience,* which we deem useful when analyzing news frames and thus the journalistic construction of climate futures through selection of topics, actors, quotes, etc. and the process in which some of them are made more salient than others. Using this definition implies drawing on the sociological rather than the psychological tradition of framing (e.g., Borah, 2011; Nisbet, 2009). Since the present article focusses on a specific topic (i.e., climate futures), for which there is a lack of research, we are in line with issue-specific rather than generic frames. Entman's (1993) definition is furthermore useful because it entails four elements that constitute a frame—problem definitions, causal attributions, treatment recommendations, and (moral) evaluations— together, they create typical *patterns* of meaning (see also Liang et al., 2014; Matthes & Kohring, 2008). The four frame elements allow for interpretation and can thus be applied to more specific research questions—as intended in the present study.

While *problem definition* typically refers to the topic (e.g., a climate future) and associated actors (see also Matthes & Kohring, 2008), this can be extended by categories that

define climate futures in more detail. For instance, dimensions of psychological distance (see also Duan et al., 2017, 2021; Guenther & Brüggemann, 2023): how temporal (near vs. distant future), spatial (geographically near vs. distant), social (elite vs. common people associated), and hypothetical (implausible vs. plausible) distant climate futures are represented. In addition, the base of knowledge (i.e., where the knowledge about climate futures stems from) can be a valuable extension (e.g., Guenther et al., 2022a). Since climate futures are likely evaluated (e.g., Fløttum et al., 2014; Kumpu, 2013), this covers the frame element of (moral) *evaluation* (Entman, 1993). Likewise, framing includes two types of responsibility attributions: *causal attributions* typically refer to responsibilities for causing the problem (e.g., the climate future or climate change in general; this can be situations or actors who are blamed); *treatment recommendations* refer to responsibilities for solving the problem (e.g., the climate future or climate change in general; these are specific solutions as well as actors responsible). Hence, by applying framing, this study aims to identify the larger patterns of how climate futures are constructed journalistically.

Regarding the frames that have been identified so far in climate change communication, a *harmful impacts frame* seems most dominant (Guenther et al., 2023). In this frame, negative future scenarios, especially concerning ecological/meteorological contexts and their effects on life (e.g., health, (national) security)) are made salient (see also, Nisbet, 2009; Pan et al., 2019). However, it is not enough to simply summarize climate futures in one frame; rather, there are variations (e.g., dependent on the assessments: scientific, political, or economical; see also Fløttum et al., 2014; Guenther et al., 2022a; Hellsten et al., 2014; Kumpu, 2013), also rooted in the complexity and different understandings of the framing approach.

Framing Climate Futures

In line with previous studies (e.g., Guenther et al., 2022a; Kosow & Gaßner 2008), a *climate future* is defined as a situation, which – from a point of reference – lies in the future

and is related to the impacts of climate change; such scenarios are often hypothetical, include

a path description, and emphasize elements of a possible future. Studies to date have found

that future expectations about climate change are often undefined in journalistic reporting

(e.g., Hellsten et al., 2014). This is supported by visual framing studies showing that climate

change is often represented as a distant threat (e.g., O'Neill, 2013; Rebich-Hespanha et al.,

2015). Furthermore, studies point to the fact that many of the climate futures represented in

(journalistic) media can be categorized into descriptions of negative, catastrophic, almost

apocalyptic global doom scenarios (e.g., Fløttum et al., 2014; Foust & O'Shannon Murphy,

2009; Weingart et al., 2000) that describe a world that is not desirable (see also Kumpu,

2013). Guenther et al. (2022a) found that such futures, as well as reporting on local events in

connection to climate change, often follow the logics and warnings of science (hence, they are

based on scientific knowledge), usually accompanied by drastic visuals. Global doom

scenarios are the extreme form of what issue-specific framing studies identify as *impacts* or

consequences frames (e.g., Pan et al., 2019; Schmid-Petri & Arlt, 2016). Such frames paint

negative scenarios and, in many cases, do not contain references to appropriate response

actions (e.g., Feldman et al., 2017; Hart & Feldman, 2014; for a multimodal assessment, see

Lück et al., 2016; Wessler et al., 2016). These frames make up a large share of journalistic

reporting on climate change and it is commonly assessed that, granting that they may raise

attention in audiences, they do not motivate people to act on climate change (e.g., O'Neill &

Nicholson-Cole, 2009). However, the evidence supporting this assumption is contested and

dependent on various audience characteristics (e.g., attitudes, political affiliations; Ettinger et

al., 2021). Furthermore, framing-effect studies in general often rely on testing single climate

change frames (Guenther et al., 2023). It is therefore all the more important to focus on

quantitative assessments of how journalists construct climate futures, as is intended in the

present study.

In contrast, some researchers also point to media depictions of a desirable and bright future (e.g., Fløttum et al., 2014; Kumpu, 2013). In a multimodal analysis, Guenther et al. (2022a) found a *sustainable future* frame in media reporting after 2015 (Paris Agreement), including a set of solutions to climate change as well as responsibilities attributed to politicians and economic actors, but also individuals. This can be linked to common frames such as *opportunity* or *sustainability* (e.g., Pan et al., 2019). Such frames may be more effective in motivating audiences to act on climate change.

Recently, some evidence was collected that the representations of climate change may be changing. For instance, for a long time it was reported that science dominated the coverage of climate change, but Hase et al. (2021) found in their study that the social dimension (i.e., social implications of climate change) was most frequent (see also Painter & Schäfer, 2018). More specifically, focusing on climate futures, Guenther et al. (2022a), identified a shift from negative (even apocalyptic) future scenarios to more empowering ones in international news magazines, analyzed from the 1980s to 2019; the authors emphasized that this may indicate a trend towards more *constructive* or *solution-oriented journalism,* but they explored this only qualitatively.

Most of the relatively few studies that concentrate on climate future framing (Fløttum et al., 2014; Guenther et al., 2022a; Hellsten et al., 2014; Kumpu, 2013) only take ecosystem changes into account (e.g., rising temperatures, extreme weather), neglecting that climate futures need to be thought of more broadly, including economic (e.g., strategies of companies/industry, or a nation's economy), socio-political (e.g., social (in)equality, migration, or a nation's political system), and individual scenarios (e.g., individual habits or lifestyles), especially since these scenarios may be more likely to motivate people to act. Furthermore, greater inclusiveness regarding the variety of scenarios mirrors, to some degree, the expansion of RCPs by SSPs in climate research (e.g., IPCC, 2022) and acknowledges that there are multiple bases of knowledge. In addressing this research gap, this article thus applies

a holistic understanding of climate futures. Its first research question (RQ) reads: *How do journalistic media across four countries (i.e., Germany, India, South Africa, and the US) frame climate futures?*

Taking on a Comparative Perspective

Taking on a comparative perspective of media in both the Global North and the Global South is an important and timely endeavor. Although media coverage around the globe shares some characteristics when it comes to attention to climate change, the events that trigger reporting (e.g., Conferences of the Parties (COPs), IPCC reports), and specific frames (e.g., Painter & Schäfer, 2018), there are country-specific factors. For instance, Billett (2010) found that newspapers in India often link climate change to national contexts and events, something to be expected for other countries. Frames can also differ; for instance, Western countries show a stronger focus on national/energy security, while Global South countries focus on food and water security (e.g., Painter & Schäfer, 2018). Hase et al. (2021) support this and show that, comparatively, countries of the Global South report less often on climate change; simultaneously, those countries have a larger share of *social reporting*, i.e., they more often focus on issues such as societal challenges and implications. Content analyses to date also indicate that responsibilities attributed vary between countries, which may be an outcome of a nation's relative responsibility for climate change and approaches to act against it (see also Comfort et al., 2020). There is a tendency for developed countries to attribute responsibilities to themselves, while emerging economies attribute them to developed countries (e.g., Post et al., 2019; see also for India: Billett, 2010; and for China: Liang et al., 2014).

What needs to be considered when comparing across countries are societal contexts (e.g., the vulnerability to climate change (e.g., Germanwatch, 2021), political and economic systems, climate change denial) and media contexts, such as media systems, the (national) journalistic cultures, and funds and resources available to dedicate coverage to scientific and climate change-related issues (e.g., Comfort et al., 2020; Ngyuen & Tran, 2019; Painter &

Schäfer, 2018; Schäfer & Painter, 2021). What this implies is that countries could vary when it comes to journalistic framing of climate futures. Simultaneously, the transnational nature of climate change, and its research and policy, may lead to strong similarities in reporting on climate futures across countries (e.g., Guenther et al., 2022a; Wessler et al., 2016). Such shared imaginations of our future with climate change could be the basis of a common ground to fight climate change. To explore this further, the second RQ of this article reads: *How do journalistic media across four countries (i.e., Germany, India, South Africa, and the US) differ in their framing of climate futures?*

Method

Sample Selection

For sample selection, we aimed for an equal spread between Global North and Global South countries. For the Global North, we chose Germany and the US; for the Global South, we chose India and South Africa. These four countries (from four continents), despite their differences (e.g., developed vs. developing countries), seem at least partially comparable due to their social contexts (e.g., democratic and media systems), although differences remain (e.g., climate change vulnerability, Germanwatch, 2021; national journalistic cultures; Ngyuen & Tran, 2019; Painter & Schäfer, 2018; Schäfer & Painter, 2021). For each country, we included a variety of journalistic media: print quality newspapers, print regional newspapers, tabloid newspapers, weekly newspapers/magazines, and online newspapers. Preference was given to print and online media due to their availability in databases and the fact that they—combined—reach substantial audience numbers (e.g., Newman et al., 2021). Table S1 in the supplemental material lists all media included; they range from eleven to fifteen outlets per country (dependent on their availability). An effort was made to select each country's leading outlets (see also Hase et al., 2021), including different ideological leanings (see also Duan et al., 2017), where applicable; nevertheless, our sample selection is a compromise between importance of media outlets (e.g., in reader/subscription numbers) and

their availability. We discussed our selection with colleagues in the respective countries. For regional newspapers, geographical spread (i.e., east, north, west, and south regions) was considered. The German media comprise German-language outlets, the other countries comprise English-language outlets.

Search String Validation and Data Retrieval

To download relevant content, i.e., coverage on climate change, search strings were used. The process is described in detail in the supplemental material (see also Mahl et al., 2023). For the actual download of articles, more than one database had to be used, due to the large number of outlets and their availability: Factiva, LexisNexis, FAZ Bibliotheksportal, Sabinet SA Media, and the Online Media Monitor. The smallest common dominator of available dates between the databases was January 2017–December 2020 (i.e., four total years), which we deemed a good fit because in many countries, as compared to before, there was a larger volume of climate change reporting (see also Brüggemann & Sadikni, 2022). Thus, all relevant articles were downloaded for this period. The sample that was collected contained 56,394 articles[1], which were not spread equally across countries and media outlets (see Table 1)—something that was expected based on the state of research (e.g., given that tabloid newspapers or newspapers in South Africa report less often on climate change).

(Insert Table 1 about here)

Sample Construction

Since assessing variables relevant for the framing of climate futures would be difficult to perform automatically (see also Nicholls & Culpepper, 2021), we decided to use manual coding. Hence, only a subset of the corpus could be analyzed further. To identify articles that likely contain a future scenario, we used a *dictionary-derivation approach*. Two student assistants were trained to qualitatively code a random sample of articles from the collected

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[1] We removed duplicates by applying database-specific tools and matching the tokenized and cleaned data for similarity to detect and remove equivalent or very similar articles.

corpus (250 English (from all three countries) and 450 German articles[2]) and highlight all passages (i.e., words, sentences, or whole paragraphs) that were related to a climate future.

The English articles contained 231 such passages; the German ones 151. Due to the difference in numbers, we decided to extract the most frequent 1 000 words for the English and the most frequent 2 000 words for the German passages, and all words were individually assessed and discussed by two individuals involved in this research. To create a dictionary, work done by others (e.g., on journalists' use of temporal references or reporting on climate change; Baden & Stalpouskaya, 2015; Wozniak et al., 2021) was considered and selected terms were included in the dictionary. We also cross-compared the German and English translations of the selected terms, resulting in two dictionaries: 191 English and 210 German (combinations of) words (see Table S2 in the supplemental material). We then applied a relevance-score to each article, based on the matches regarding each dictionary term; the terms were not weighted, and each occurrence was counted once per article, regardless of its frequency within the article.

Working with such a dictionary approach to identify articles that likely contain a climate future gives preference to longer texts, which is why we had to establish a normalization criterion: the total number of matches per dictionary term was divided by the number of unique words per article, which resulted in a *climate future score* per article. After applying the score to the articles and checking for its validity, another adjustment was made: we set a minimum of 170 words per article to more thoroughly exclude short texts that could not meaningfully discuss climate futures due to their brevity but still sometimes gained a relatively high score due to the match/word count ratio.

For the actual manual coding, this score determined the ranking of articles. Following, the top ranked 3% of articles, equally split across countries, were considered to reach a

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[2] Initially, we considered 250 German articles but this resulted in a low number of identified passages; thus, we increased the number of German articles.

sample size of approximately 1 000 articles. In total, 1 489 articles were considered by coders, 40 articles (3%) were formally irrelevant (i.e., captions of images, compilations of headings). Without those, 318 (22%) articles were deemed not relevant, which indicates good fit of the dictionaries. However, another 121 (8%) articles did not contain all elements of what was deemed a detailed climate future (see below) but only parts of it. Thus 1 010 (70%) articles were judged to be relevant and coded in depth.

Manual Content Analysis

The codebook used for the analysis contained formal and content-related categories. Based on a qualitative, exploratory analysis (see Guenther et al. 2022a), a quantitative codebook was developed. The categories were further refined in several rounds of test-coding. The formal categories assessed the *type of article* (e.g., journalistic article, news agency report, guest contribution) and the broad *topic*. Content-related categories, first, were assessed for the single climate future scenario(s) of the article, combining the first frame element, problem definition (see Entman, 1993), with dimensions of psychological distance (see also Duan et al., 2017; Guenther & Brüggemann, 2023). Hence, included were categories assessing the *type of scenario* (i.e., climate/ecosystem, economic, socio-political, individual) and the *actors* associated with this scenario (e.g., scientists, political actors, civil society). For each scenario, categories assessed the *time frame* (e.g., near (this or next year)–distant (50+ years)), *scope* (e.g., near (regional/local)–distant (global)), and *plausibility* (e.g., very unlikely–very likely). We also assessed the *knowledge basis* of the scenario(s) (e.g., scientific, political, individual) and their *evaluation* (e.g., negative, ambivalent, positive), mirroring the fourth frame element, (moral) evaluation (Entman, 1993).[3] We allowed for more than one scenario to be present in an article and defined scenarios as the base for coding. To code a

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[3] Guenther et al. (2022) proposed to treat (moral) evaluations as cross-cutting to the other frame elements but tests and their findings showed that there is little variation when it comes to frames of climate future; e.g., causes were almost always evaluated negatively. Thus, we only included an evaluation category for problem definition. For solutions, we assessed whether they were advocated for or rejected.

new scenario, three out of the following four categories needed to be fulfilled: time frame, scope, plausibility, and/or knowledge basis. That is also the reason why, as mentioned before, coders had to assess if an article contained sufficient elements of a future scenario.

Second, in line with the frame element causal attribution (Entman, 1993), the content-related categories also considered the *causes* mentioned for climate change (e.g., emissions, individual behavior, political aspects) on the article level, as well as the *actors blamed* (e.g., political, economic actors, consumers)—both indicate causal responsibilities. Similarly, in line with the frame element treatment recommendation (Entman, 1993), for a set of *measures* (e.g., mitigation, political measures, corporate measures), we assessed if they were mentioned, advocated for, or rejected. Furthermore, the *actors responsible* for acting (e.g., political actors, citizens) were coded. Both measures and actors indicate treatment responsibilities and link to framing; categories were informed by literature (e.g., Engesser & Brüggemann, 2016; Guenther et al., 2022a; Post et al., 2018; Wessler et al., 2016) and each of them encompassed a single category, allowing coding of several causes, actors blamed, measures, and actors responsible. The codebook used in this study can be found in the supplemental material.

Testing Intercoder Reliability

In ten training sessions over four months, three coders were thoroughly trained by the principal investigator to use the codebook. During that time, the codebook was adjusted to increase understanding and assure that all coders used it the same way. A number of articles were coded in these sessions, first together, then independently, with exhaustive comparisons and discussions. Intercoder reliability was assessed with two random samples of 15 and 30 articles, respectively. Using Krippendorff's Alpha (and Holsti, as a check), the coders reached satisfactory results, with the average scores for the formal categories ($\alpha = .93$; CR = .97), broad topic ($\alpha = .89$; CR = .93), and the content-related categories (scenarios: $\alpha = .85$; CR = .90; actors: $\alpha = .83$; CR = .93; causes: $\alpha = .81$; CR = .92; actors blamed: $\alpha = .85$; CR = .96; measures: $\alpha = .83$; CR = .94; and actors responsible: $\alpha = .92$; CR = .97) in an acceptable

range. Due to the larger sample size for manual coding, we detached from the 10% criterion,

while maintaining an exhaustive number of texts for testing intercoder reliability. Therefore,

the training was complex, thorough, and successful. After intercoder reliability was

established, there were regular check-ins between the principal investigator and the coders, to

discuss progress and problems.

Data Analysis

To answer RQ1, cluster analyses were performed to identify frames of climate futures.

We relied on the level of identified scenarios ($n = 1\ 240$)—and not articles—and included

variables related to the frame elements. We checked for appropriate frequencies of variables

(i.e., more than 5%) and, in some cases, recoded them. In total, 44 variables were included

(see Tables 2–4). Then, we applied single-linkage clustering to identify outliers, and removed

five cases. To estimate the numbers of clusters (i.e., frames), we applied Ward's method

(Euclidean distance) for binary variables, similar to the method Matthes and Kohring (2008)

proposed to identify frames in their seminal study. The elbow criterion recommended a four-

cluster solution, which we deemed a good fit for the data.

Due to the high number of cases, we applied k-means cluster analysis, specifying the

number of clusters as four. Means and t-values as well as prototypical examples were

exported and considered when describing the frames (see Tables 2–4); F-values were used to

check cluster homogeneity (which was the case). A discriminant analysis was applied for

validation, showing a good fit (94% of the cases were classified the same way).

(Insert Tables 2–4 about here)

Results

Sample Overview

Most of the articles in the sample were published in 2019 ($n = 329$; 33%). As Table 1

indicates, the largest share of articles was from online newspapers ($n = 544$; 54%), with print

quality newspapers ($n = 261$; 26%) and print regional newspapers ($n = 171$; 17%) following.

Furthermore, most articles had consequences of climate change ($n = 687$; 68%) as a broad topic.

Table 2 reveals that ecosystem scenarios were most common; time frames of climate futures were often unknown or far in the future; scopes were often distant/global. The scenarios were most frequently based on scientific assessments and were highly probable, with negative evaluations dominating. Scientific actors were most commonly associated with the scenarios, followed by political actors and citizens/individuals. Climate change was mentioned as a cause in almost all articles, emissions were a distant second, while other causes were not frequently mentioned (see Table 3). The same was true for actors blamed. Measures were also not mentioned or advocated frequently (and almost none of them were opposed/rejected); if they were mentioned, then they were mostly mitigation measures and political ones (see Table 4). There were also hardly any actors made responsible to act: if there were, then they were most often political actors.

Frames of Climate Futures (RQ1)

The first frame, "Solutions to climatic and social consequences" ($n = 235$; 19%), equally concerns scenarios related to the ecosystem and the socio-political system. What they share is an unclear time frame and a focus on local, national, or continental contexts. Furthermore, the basis of knowledge is often political or individual, assessed as (very) likely and negatively evaluated. A variety of actors are involved (i.e., political actors, civil society, citizens) but, comparatively, scientists are not so much. Causal attributions are seen in climate change in general; if actors are blamed, then they are political actors. In this frame, a variety of solutions is mentioned or advocated, such as mitigation, adaptation, renewables, political measures, research/technology, and individual behavior. Responsible to act are predominantly political actors, but also citizens. Among the examples of this frame are reporting on local/state or national climate change mitigation and adaptation strategies/plans, to stay in line with the goals of the Paris Agreement, to reduce emissions, and to stop negative projections

of increasing temperatures, extreme weather events, but also public health, as well as water, food, and energy shortages.

The second frame was labeled "Distant threats to humanity" ($n = 345$; 28%), with a strong focus on the ecosystem but also including the socio-political system. The time frame is either unclear or far in the future; the scope often global. Scenarios are predominantly based on science, and thus they are rather likely (i.e., common use of conjunctive). At the same time, these are the most negatively evaluated scenarios. Involved actors are mostly scientists, and less often citizens and political actors. A variety of causes are given (mostly emissions, but also political aspects); actors blamed are political actors and citizens. Again, a variety of solutions are brought forward, but in this frame, this concerns predominantly mitigation and political measures, for which, again, political actors and citizens are made responsible to act. Journalistic articles in this frame often deal with scientific assessments, reports, and warnings, for instance, from the IPCC, United Nations, or from COPs, about what would happen to the world if nations did not adhere to the Paris Agreement. That is also why this frame has a strong political focus. Some of the scenarios paint global doom pictures; the urgency to act is thus often stressed.

The third frame is "Economic opportunities" ($n = 176$; 14%), in which economic scenarios dominate. Their time frame is shorter (current–50 years); they have an equally national and global perspective. These scenarios are based on political assessments and are very certain. They also show more mixed and positive evaluations. Involved are political, economic, and civil society actors. Causes are seen in emissions, and financial/economic/political aspects; blamed are politicians. This frame advocates mitigation, adaptation, renewables, and most strongly, political actions. That is also why political and economic actors are seen as responsible to act. Among the examples of this frame is reporting on sustainable, carbon-neutral, or emission reduction economic ideas, such as in green energy,

renewables, use of plastic, water conservation, or agriculture – with solutions put forward for the years to come (common references are 2030 and 2050).

The most frequent frame, however, is "Distant threats to ecosystems" ($n = 479$; 39%). In this frame, the focus is almost entirely on the ecosystem, with an either unclear time frame or one far in the future (50+ years). These scenarios often concern other parts of the world or are seen globally. They are almost solely based on science, and are rather likely. The evaluation is negative. Scientists are the actors associated with the scenarios. Climate change in general, and less frequently human-nature interactions are seen as causes; there are no actors blamed frequently. There is also an absence of solutions put forward, as well as actors who are responsible to act. This frame is typical of science journalistic reporting, often dealing with single aspects of climate change (e.g., extreme weather events like hurricanes, heat waves, or monsoons, glacier/ice melting, oceans/coral reefs, mass extinction of species), based on the most recent scientific studies and reports. They focus on scientific explanations, often citing the researchers, rather than mentioning potential solutions. Since this is the largest frame, coverage of climate futures usually follows this pattern.

Frames of Climate Futures Across Countries (RQ2)

Regarding RQ2 (see Figure 1), comparing countries ($\chi^2 = 44.711$; $df = 9$; $p < .001$; $V = .110$), the "Distant threats to ecosystems" frame was the most common frame included in German, US (in both countries above 40%), and Indian media; it ranked second for South African media, for which the "Distant threats to humanity" (and thus the IPCC or COP-event based) frame was most frequent. Hence, the rather psychologically distant reporting was most prevalent, across all countries (together 55–74%). Nevertheless, both Indian and South African media showed a tendency to use the "Solutions to climatic and social consequences" and "Economic opportunities" frames more frequently than the other countries. These frames are seen as less psychologically distant. In total, however, the range of percentages for each frame was very similar across countries.

(Insert Figure 1 about here)

The countries varied slightly more regarding single (sub)categories (see Table S4 in the supplemental material). Indian and South African media in the sample showed more variety when it comes to scenarios. They were often represented as less psychologically distant (i.e., shorter time frames, local/national/continental scopes, more bases of knowledge, evaluations, and actors), and exhibited a tendency of higher frequencies and diversity when it comes to measures (in some cases, also causes). Sampled German media predominantly represented ecosystem scenarios, which were far in the future and often continental/global. US media, despite both politicians and citizens being blamed for climate change, often put the burden of responsibility for solving the problems on individuals.

Discussion

The present study identified frames of climate futures in a variety of journalistic media across four countries. The frames paint different scenarios of our future with climate change, which makes it likely that they affect individuals in different ways. Among the descriptive findings, an overwhelming number of articles drew on climate/ecosystem scenarios, with economic and socio-political scenarios less common, and individual scenarios almost absent. Although ecosystem scenarios, which are predominantly negative, are important to raise attention, it is the individual scenarios that could potentially be motivating people to act (e.g., O'Neill & Nicholson-Cole, 2009), although the evidence regarding this is contested (e.g., Ettinger et al., 2021). Nevertheless, a greater variety of types of scenarios in journalistic reporting may be beneficial for climate change communication. The fact that climate/ecosystem scenarios dominate could be linked to the fact that science is often setting the agenda for reporting on climate futures. The findings of this study also emphasized that this reporting is often rather psychologically distant (see also Fløttum et al., 2014; Guenther & Brüggemann, 2023; Guenther et al., 2022a; Hellsten et al., 2014, in contrast: Duan et al., 2017), although more so from a temporal, spatial, and social perspective, and less from a

hypothetical one. While causes of climate change are often mentioned, most of the time this happens in a very general sense. Furthermore, actors are hardly blamed, and if they are, the actors are politicians or citizens, but even this only happens in a minority of cases. Measures were mentioned even less frequently than causes. There was no active discussion of them, for instance, in a way that some measures were recommended while others were opposed or rejected. Thus, the present study does not support assumptions about a trend towards a more solution-oriented reporting from a recent qualitative long-term study (Guenther et al., 2022a) but this could be due to the limited time frame of the quantitative study presented here. Furthermore, hardly any actors were made responsible to act. Since responsibilities attributed can affect social problem definitions and responses to them (e.g., Post et al., 2019), it is rather surprising to see how little both causal and treatment responsibilities take politicians, economic actors, and individuals into account when negotiating climate futures. Furthermore, it has been proposed that representations of impacts should ideally be accompanied by actions (e.g., Hart & Feldman, 2014). Journalists have the power to criticize those in control as well as engage citizens to act, but according to the findings of this study, this happens only in a minority of cases. A recommendation for climate change communication could thus be to point journalists towards the fact that they could not only draw doomsday future scenarios but also stress solutions and responsibilities of actors—such as industries and governments—that could change, mitigate, or avert these scenarios.

Framing was used in the present study as a lens to examine the larger coherent patterns of how climate futures are represented. The study showed that there is a variety of ways in which climate futures are framed. Not all frames are equally psychologically distant, and a central outcome of this study is the fact that they also vary with regard to how problem-centered or solution-oriented they are; Figure 2 summarizes this. The "Distant threats to ecosystems" frame was the most frequent as well as the most psychologically distant; at the same time, this frame mentioned no solutions. Such a distant and problem-centered reporting

is probably not beneficial for topic engagement (e.g., Ruiu, 2021), as it may lead to abstract and general mental representations in individuals (e.g., Duan et al., 2017) and does not motivate them to act (e.g., O'Neill & Nicholson-Cole, 2009). The distant threats frame is reminiscent of negative, catastrophic, and undesirable climate futures described elsewhere (e.g., Fløttum et al., 2014; Foust & O'Shannon Murphy, 2009; Weingart et al., 2000). It mirrors, to some degree, the "Global doom" and "Local tragedies" frames identified in Guenther et al. (2022a): distant, global, and negative scenarios about harmful (single) impacts of climate change, largely based on climate research. This is also true for the "Distant threats to humanity" frame, which shares the science-based focus and characteristics of global doom, and at the same time is slightly less psychologically distant, introducing some solutions. This could be due to stronger ties with the political system, for instance, as part of the IPCC and the COP conferences' work.

The "Solutions to climatic and social consequences" frame seemed less psychologically distant and had the strongest focus on solutions. The "Economic opportunities" frame seemed the least psychologically distant and did also put solutions forward. Therefore, a less psychologically distant and solution-focused reporting could probably motivate more people to act on climate change (see also Jones et al., 2017; Scannell & Gifford, 2013). In line with earlier research (e.g., the "Sustainable solutions" frame in Guenther et al., 2022a), these frames provide less scientific information, use the Paris Agreement of 2015 as a reference to demand action, and show more variety in evaluations. However, in this context, it should be mentioned that this form of constructive journalism has also been criticized, for instance, regarding the risk of ascribing journalism a specific interest, the potential violation of journalistic norms (e.g., objectivity, autonomy), or its role as a critical watchdog (see also Hermans & Drok, 2018).

Although the dominance of one frame can create a shared imagination of our future with climate change, the fact that the "Distant threats to ecosystems" frame is the most

psychologically distant and problem-oriented should motivate journalists to provide more variety when reporting on climate futures.

(Insert Figure 2 about here)

The findings of this study are to some degree in line with some earlier studies on (visual) representations of climate change and climate futures (e.g., Fløttum et al., 2014; Guenther et al., 2022a; Hellsten et al., 2014; Kumpu, 2013). What they share is that most reporting on climate futures uses negative scenarios (see also Foust & O'Shannon Murphy, 2009; Weingart et al., 2000). However, the findings of the present study can only partially be linked to what has been described as bright or desirable climate futures (e.g., Fløttum et al., 2014; Kumpu, 2013) or opportunity and sustainability frames (e.g., Pan et al., 2019); positive scenarios were not common and were mostly part of economic scenarios. The findings also reveal that the limited attention paid by previous research to the types of climate futures beyond the ecosystem is a mirror of the journalistic framing, and may in itself be part of the problem it is trying to address.

Among the aims of this study was also the comparison of countries from both the Global North and the Global South. Past research has already established that there are country-specific factors to be considered (e.g., Comfort et al., 2020; Post et al., 2019). As this study showed, there were only a few differences across countries when considering frames (but there was more variety when looking at single (sub)categories). The psychologically distant and problem-centered "Distant threats to ecosystems" frame was the frame most common in German, US, and Indian media; South African media reported most often using the "Distant threats to humanity" frame. The fact that in South Africa reporting on climate change is often event-focused was stated in previous research (e.g., Guenther et al., 2019). Drivers of media reporting such as IPCC reports and COP conferences have been identified as globally relevant (e.g., Painter & Schäfer, 2018). The two frames mentioned are both rooted in science; hence, the transnational nature of climate change and its research and policy

(e.g., Wessler et al., 2016), which seems to drive the reporting on climate futures and leads to only a few differences between countries. Nevertheless, the less psychologically distant and more solution-oriented frames were slightly more common in Indian and South African media, which could mean that in these two countries, there is potentially more social reporting (see Hase et al., 2021). There could be many reasons for this, among them that countries in the Global South are more vulnerable to climate change (e.g., Billett, 2010; Comfort et al., 2020). However, the present study cannot account for the whole variety of social and media factors that affect reporting on climate change (e.g., Ngyuen & Tran, 2019; Schäfer & Painter, 2021).

When evaluating these findings, the present study has some notable limitations. An effort was made to include several media in countries of both the Global North and the Global South; however, the fact that only four countries were considered and that we only focused on print and online journalism, is a limitation. Furthermore, due to the choice of countries, we had to work with two languages, which also meant performing several methodological steps twice, making comparisons more difficult. In all three countries for which we chose English-language outlets, there are also journalistic products in other languages. Especially the fact that for India no Hindi-language newspapers were included is a major limitation. In this regard, including more local media and languages (see also Thaker, 2022) would probably enrich the analysis (e.g., extending the knowledge base by indigenous knowledge). In addition, our sample period ended in 2020 and many major events (e.g., IPCC reports, COP26) happened afterwards – that is why studying the framing of climate futures remains an important research topic. Regarding this, it may also benefit the analysis to be more detailed when it comes to some categories: since climate futures especially affect young people, they could be treated as a separate actor type. Focusing on climate futures and using a dictionary also meant that not all media sources are represented equally (cf. Table 1), one reason we refrain from comparing media types. Additionally, using qualitative and automated

approaches for sample construction was beneficial for this specific research project; at the same time, each of these approaches has its own limitations.

Future research would benefit from linking the findings of this study back to audiences and testing for the effects the four frames identified have on motivating people to act on climate change, as this is still a contested field of research (e.g., Ettinger et al., 2021).

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