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Politics triumphs: A topic modeling approach for analyzing news media coverage of climate change in Pakistan

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Abstract

News media is one of the main sources of information for many people around the world on climate change. It not only increases awareness among the public but also has the potential to sensitize people toward climate change impacts. To date, few studies focus on media coverage of climate change in low-income countries such as Pakistan which is among the top ten countries impacted by global warming. This study used Latent Dirichlet Allocation (LDA) topic modeling and analyzed 7,655 climate change-related news articles published between 2010 and 2021 in three Pakistani English newspapers. Our results suggest that climate change coverage in Pakistan has substantially increased over the years, however, the focus has generally been on "climate politics," "climate governance and policy," and "climate change and society." Evolution of the different themes and their potential impacts on people are discussed.

Keywords Environmental communication

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Introduction

Among many challenges faced by humanity today, climate change is one that has been termed as an existential threat to human civilization [IPCC, 2022]. Unequivocal scientific consensus has warned of unprecedented consequences to our modern way of life if we do not change and adapt to the climate crisis [van der Linden, Leiserowitz, Feinberg & Maibach, 2015], which sets to impact the least developed countries far more than the developed ones [IPCC, 2022]. For example, the recent 'super-flood' in Pakistan is one such example of the unprecedented impact of climate change that has killed over 1400 people while submerging a third of the country and displacing 32 million citizens [Bokhari & Reed, 2022]. In other parts of the world, during the first half of 2022, we have already seen record-breaking heatwaves followed by drought in Europe, hurricanes in Japan, and a historic 500-year flood in Montana [Marwan, 2022], all of which show the enormity of the challenge and efforts required in preparing people to adapt for the climate crises.

However, in the wake of the looming crisis and the challenge of making people aware of it, news media plays a vital role because the adaptation at the global scale is always contingent upon mass cognition and respective information [Moser, 2010]. Past research informs us that increasing levels of news media attention to climate change increases public concern about the issue [Sampei & Aoyagi-Usui, 2009]. Additionally, the news media coverage of climate change also influences public discourses [Carvalho, 2007] and also people's behavioral intentions on the issue [Arlt, Hoppe & Wolling, 2011]. However, this public concern and awareness are not equal across different regions because we do not have enough empirical evidence and information on news media coverage in low-income countries and its impact on consumers. The meta-analysis by Schäfer and Schlichting [2014] confirms a lack of scholarly attention on climate change communication from low-income countries. A recent study conducted by Mattar, Jafry, Schröder and Ahmad [2021] further recognized that "the poorest and most vulnerable, particularly from the Global South, have been historically under-represented within debates on mitigation, adaptation and resilience-building to climate change" [p. 2], thus impeding our understanding toward how media shapes the climate change-related narrative in such countries.

Notwithstanding the general paucity of climate change communication research originating from the Global South, some specific progress has been made [e.g., Hase, Mahl, Schäfer & Keller, 2021; Keller, Hase, Thaker, Mahl & Schäfer, 2020; Newman, Fletcher, Robertson, Eddy & Nielsen, 2022]. However, Pakistan, a fifth most populous country that is ranked among top ten most vulnerable to climate change [Eckstein, Künzel, Schäfer & Winges, 2019; Ejaz, Ittefaq & Arif, 2022; Kamboh, Ittefaq & Yousaf, 2022] has seldom been part of such empirical studies that examine news media coverage of climate change [Schäfer & Schlichting, 2014], thus highlighting a research gap. To fill this void, specifically concerning Pakistan, two recent studies understanding climate journalism found that journalists in the country face numerous challenges [Sharif & Medvecky, 2018], including missing relevant educational background, lack of support from the newsroom, and pushback from corporations which in turn significantly influence their coverage of the issue [Ejaz et al., 2022].

The above-mentioned studies, however important, emphasized just the role journalists play in climate change-related discourse but not the coverage itself. Hence, responding to the call for more research from low-income countries and underscoring the importance of media content, this study aims to focus on climate change-related news coverage in Pakistan's three largest English newspapers, *The News*, *Express Tribune*, and *Dawn*. By using an automated content analysis method, we analyzed climate change-related stories published between 2010 and 2021. In terms of scholarly contribution, this exploratory study is aimed to add to our understanding regarding (a) the frequency of climate change news stories, (b) the prevalence of overarching themes in the reporting, and (c) the evolution of coverage of main themes over the years.

Literature review

Media coverage of climate change

Many climate scientists agree that climate change is a global problem that has a substantial chance of having catastrophic environmental, social, emotional, and

economic effects during this century [Reid, 2019]. Consequently, the problem of climate change and its potential risks to humankind have evidently gained media's attention in many parts of the world, particularly over the last two decades [Schmidt, Ivanova & Schäfer, 2013]. The vital role performed by the media is not surprising, as it is still the major source of information for the public on a range of different issues, including climate change [Newman, Fletcher, Schulz, Andı & Nielsen, 2020].

Hence, this importance of media naturally garnered ample scholarly attention giving rise to diverse empirical studies examining news coverage in various contexts. Several studies — predominantly based on countries in the Global North and some from the South — have tried to scrutinize media coverage by focusing on a single or comparing a few countries, and in this paper, we particularly want to include more work from countries that are usually less represented in the literature.

For example, looking at media framing in newspapers from Turkey and Nigeria, Günay, İşeri, Ersoy and Elega [2021] found significant variations in the media coverage of two countries, i.e., Nigerian papers tend to focus more on adaptation, whereas Turkish news stories are evenly distributed between adaptation and mitigation. Similarly, Naguimbing-Manlulu [2021] studied climate change narratives in the Philippines' print media. The findings suggest that newspapers framed the climate change narrative around the themes such as international cooperation, the government's opposition to climate change effects, and demanding climate justice. Furthermore, Lück, Wessler, Wozniak and Lycarião [2018, p. 1645], in their comparative study, found that media in Brazil frames climate change as a "hopeful struggle", signifying the urgency of the situation while instilling hope, however in the U.S., India, Germany, and South Africa, media predominantly covers climate change in an "ongoing conflict" frame.

A recent study conducted by Hase and colleagues [2021] analyzing 71,674 news articles related to climate change published in 10 Global South and North countries found that the Global North countries publish more climate-related stories with a focus on the societal dimension of the crisis. However, the media in Global South countries is more prone to highlighting climate change impacts on humans. Following a similar approach, Keller et al. [2020] used topic modeling to examine 18,224 articles published from 1997 to 2016 in leading Indian newspapers and found significant increase of climate coverage with extensive focus on the impacts of climate change. Moreover, many other studies, based on the Global North countries, suggest that media reporting has shifted toward covering more scientific consensus [Gibson, Craig, Harper & Alpert, 2016; Grundmann & Scott, 2014; Matthews, 2017] and decrease in adopting alarming descriptions [Ruiu, 2021] which was found to prove counterproductive for individual engagement [O'Neill & Nicholson-Cole, 2009].

Notwithstanding the growing literature on the subject, Pakistan, a country at fore to negative climate change consequences, remains absent from such empirical investigations, rendering us unaware of how its media cover climate change. Therefore, in this study, we aim to provide, as per our knowledge, the first empirical evidence of exploring climate change coverage from 2010–2021 in three leading newspapers of Pakistan.

Pakistan, climate change, and media

Pakistan is the fifth largest country in the world in terms of population. The country's Human Development Index value for 2019 is 0.557 — which puts Pakistan in the medium HDI category — positioning it at 154 out of 189 countries and territories [United Nations Development Programme, 2020]. A recent report by the International Energy Agency (IEA) shows that Pakistan is not among the world's top ten countries in terms of greenhouse gas emissions [IEA, 2019]. However, Pakistan is among the top ten countries which are suffering from climate change [Eckstein et al., 2019]. Pakistan is burdened by climate change in two ways: first, the country has been facing acute climate change-induced extreme weather events such as heatwaves [Saifi & Yeung, 2018], glacial meltdown induced flooding, and expansive smog [Ali, 2021], all of which is projected to increase in intensity and magnitude in the future. Second, climate change is constraining Pakistan's economic growth by negatively impacting energy access and energy security and threatens to restrict Pakistan's national development goals, such as reducing poverty, improving public health, controlling air pollution, and providing clean water [Ali, 2021].

Prior research suggests that prolonged exposure to hazardous air causes varied health complications, including asthma, lung damage, bronchial infections, strokes, heart problems, and shortened life expectancy [Ali, 2021]. A recent report by the Global Alliance on Health and Pollution [2019] estimated that 128,000 Pakistanis die annually due to pollution-related illnesses. In addition to pollution, climate change-induced floods have also created havoc in Pakistan. A recent study on "super floods" in Pakistan shows that climate change likely increased extreme monsoon rainfall and submerged a third of the country while impacting more than 32 million people [Otto et al., 2022].

Hence, the extreme vulnerability and dire consequences of climate change has designated it a key issue in Pakistan after evading policymaker's attention for a long time. However, it changed when the previous Prime Minister, Imran Khan, started campaigning and advocating for actions to mitigate climate change. He started Pakistan's Ten Billion Tree Tsunami project which is supported by the United Nations Environment Program (UNEP) and aimed to plant 10 billion trees by 2023. The project was launched in 2019 and recently reached a milestone — planting of the billionth tree [United Nations Environment Programme, 2021]. Furthermore, the administration took several other policy decisions to reduce air pollution, focus on renewable energy generation, and build water reservoirs, all of which are important steps required to be adequately communicated to masses.

To consider the sufficient coverage of climate-related issues as a yardstick, Schmidt et al. [2013] analyzed media content published between 1996 and 2010 from 27 countries and found that the newspapers of selected low-income countries such as Algeria, Yemen, Jordan, Indonesia, Malaysia, Brunei, and Thailand, just gave 0.36%, 0.07%, 0.07%, 1.64%, 1.15%, 0.39%, and 1.85% coverage to climate change. In contrast, newspapers in Australia, Canada, Germany, the United Kingdom, and the United States gave 15.40%, 5.66%, 8.39%, 14.74%, and 11.02% coverage to climate change. In another study, Barkemeyer et al. [2017] examined 41 countries media coverage of climate change in 2008 and found that selected Chinese, Nepali, Filipino, Thai, and Pakistani newspapers scarcely published an average number of

1.01, 0.31, 0.20, 0.54 and 0.16 articles per newspaper issue on climate change. Similarly, Hase et al. [2021] analyzed the climate coverage from 2006–18 in ten different countries and found most of them in the Global South publish less than half a percent of news related to climate change. Consequently, the previous studies do not answer how much climate coverage is enough, but the literature shows that low-income countries like Pakistan tend to have less coverage of climate change issues.

With regards to Pakistan, numerous studies have tried to document the challenges [Sharif & Medvecky, 2018] and risks of climate journalists [Volkmer & Sharif, 2018]. However, we have not come across any study that has tried to investigate the quantity, themes, and evolution of climate change news coverage. Nonetheless, the previous studies that are concerned with Pakistan and climate change news coverage show that environmental reporters face various levels of influence, i.e., lack of incentives, resource-intensive nature of climate reporting, and pressure to self-censor from corporations while investigating their climate degradations practices, which significantly shape their climate stories [Ejaz et al., 2022]. Apart from news stories, some scholars have also examined editorial coverage of environmental issues. For instance, Kamboh and colleagues examined editorial journalism and environmental issues in the majority world (i.e., Pakistan, Bangladesh, India, and China) suggested that editorialists in these countries failed to perform their normative role when it comes to linking environmental issues with the pandemic. The study further suggested that civic advocacy groups should help in building news media capacity to cover climate change issues amid a global health crisis such as COVID-19 [Kamboh et al., 2022]. Furthermore, Hussain, Khan and Zubair Iqbal [2022] found that reporters believe that climate is not considered a newsworthy event in Pakistan compared to other issues such as politics, consequently preventing them and media organizations to invest their resources on its coverage.

Despite the importance of the said studies, we believe that the non-existence of research on the media coverage itself shows a gap in the literature which hampers our understanding concerning the frequency of climate-related news stories in Pakistani media, key topics that received more attention, and how its coverage of the issue has evolved over the years. Hence, our explorative study is an attempt to answer these important questions while adding to the existing literature on the role of media in covering climate change. Thus, the present study is guided by the following research questions:

RQ1: How frequently Pakistani newspapers covered climate change from 2010 to 2021?

RQ2: Which themes and topics are prevalent in Pakistani news media coverage of climate change?

RQ3: How did the climate news coverage classified in main themes evolve between 2010 and 2021?

Method

To answer our research questions, we first examined the frequency of climate-related news coverage in three English-language newspapers from

2010–2021. Then, we look at the climate news coverage over the years to find the main themes and topics through topic modeling with Latent Dirichlet Allocation (LDA) method [Blei, Ng & Jordan, 2003]. In the following, we describe various steps to obtain the final data which comprised 7,655 newspaper articles.

Sample

We chose three-largest circulated Pakistani English language newspapers, *The Express Tribune*, *Dawn*, and *The News*. Since English is commonly spoken and read among the elite including policy makers, therefore, the selected newspapers play a pivotal role in national politics and discourse. Further, these newspapers influence policy making processes related to climate change in the country. We used the NexisUni database to collect data by using various key terms which have been used in previous studies [see Schmidt et al., 2013], including "climate change" OR "global warming" OR "environment". The search resulted in a total 12,138 — *Dawn* $= 4,288$; *The News* $= 4,813$; and *The Express Tribune* $= 3,037$.

Pre-processing

After downloading the data, we removed duplicates from the dataset. Next, we used the LexisNexis Tools R package to calculate the similarity index [Gruber, 2021]. The package checks the similarity by calculating the index using two distinct methods, (a) text similarity, which compares the word similarity of two given texts [Benoit et al., 2018], and (b) Levenshtein distance, which measures the difference between two string sequences [Gruber, 2021]. Upon computing the similarity index, we removed all those articles above the suggested 20% cut-off value. This step helped us to remove 842 articles leaving us with 11,296 unique articles. In addition, the dataset offered by NexisUni usually contains tags categorizing each article. These tags indicate the prevalence (in terms of percentage) of certain content/theme in the article. In order to include only those articles that are related to climate coverage, we removed all those articles from the corpus which did not have "climate change", "environment", and "global warming" tags and appeared in search results merely because of the presence of any of our search terms. Then, we calculated the average relevance of each article based on the individual percentage — provided by the NexisUni — of the three tags. Lastly, after the manual scrutinizing the data, a discussion between co-authors, and the desire to only retain highly relevant articles in the final corpus, we decided to remove all those articles from the dataset with a relevance score of less than 50%, yielding a final dataset of 7,655 news articles across three newspapers.

LDA topic modeling

Topic modeling is an unsupervised machine learning method of textual analysis that allows researchers to find patterns in large datasets. It reduces the complexity of language to a simplistic assumption, namely that certain words often occur together, and these co-occurrences — word clusters — carry traces of meaning [Ylä-Anttila, Eranti & Kukkonen, 2022]. These topics are clusters of words that co-occur across documents according to certain patterns [Jacobi, van Atteveldt & Welbers, 2016] inferred by ignoring the order of words according to a

"bag-of-words" assumption [Keller et al., 2020]. By observing patterns and variations in the usage of these word clusters, we observed variations in meaning-making habits. This makes topic modeling suitable for discovering patterns in large datasets, and therefore also used in this study.

Selecting k

As an unsupervised machine learning method, LDA, in addition to the data itself, requires only the number of topics that the algorithm should churn out. The selection of topics is an important step as it determines the model fitness [Hase et al., 2021] because selecting too many topics results in topics that are too specific, whereas choosing fewer topics forces an algorithm to mix many topics into one. Therefore, to find the best *k*, we tested models of 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110 and 120 topics using the package "topicmodels" [Grün & Hornik, 2011] in R ["R Core Team", 2020] after processing our corpus using the package "stm" [Roberts, Stewart & Tingley, 2019]. After analyzing each output (top terms and correlations between different topics) and assessing different model fit indices, i.e., semantic coherence, exclusivity, and held-out likelihood, we ended up with a model of 50 topics.

Results

Frequency of climate change news (RQ1)

In the last ten years, climate change news coverage in Pakistan has substantially increased (see Figure 1). The issue of climate change has transitioned from absolutely receiving no coverage to appearing a minimum of 58 and a maximum of

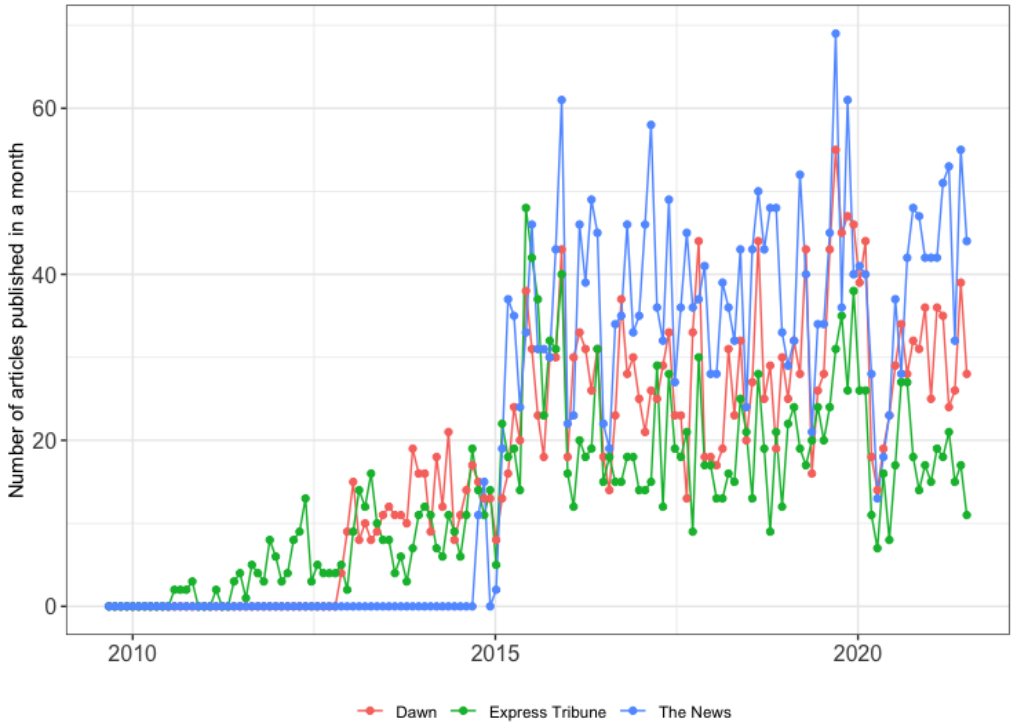

Figure 1. Monthly frequency of climate change media coverage from 2010–2021 ($N = 7,655$).

146 times per month at an aggregate-level across three newspapers. Furthermore, Figure 1 clearly shows that each newspaper has started covering climate change at different time. Among the three papers, *The News*, though began publishing on climate change as late as 2014 but still has paid substantially more attention to the issue than the other papers, consequently representing 40% of total articles published on climate change from 2010–2021.

The results also indicates that the frequency of publishing climate change-related news coverage shares a similar trend across all three newspapers. The result of the present study corroborates Schmidt et al. [2013] who reported considerable ups and downs across 27 countries (excluding Pakistan) and contrasts from Keller et al. [2020] who found Indian media increases its coverage of the issue around important Conference of Parties (COP) meetings.

Identifiable prevalent themes and topics (RQ2)

Results of topic modeling offered 50 different topics within the article corpus. Table 1 illustrates the main themes and sub-topics along with the top five key terms. It also shows the occurrence of each sub-topic and its prevalence across the complete corpus. According to the results, the terms in each topic show a significant range of themes within the corpus, consequently highlighting the diversity in climate change reporting in Pakistani newspapers. Among the sub-topics, the analysis shows that coverage of the *Paris Agreement* (10.97%), *Adaptation Policy* (4.66%) measures, and education on the *Reality of Climate Change* (3.94%) remained dominant.

Table 1. Main themes and topics of climate change media coverage in Pakistan ($N = 7,655$).

k	*Label*	*Occurrence (% of articles in corpus)*	*Top five terms*
	Theme: Climate governance and policy		
1	*Adaptation policy*	357 (4.66%)	Adaptation, impacts, vulnerable, vulnerability, extreme
3	*Plastic ban*	109 (1.42%)	Bags, plastic, polythene, ban, plastics
5	*Water scarcity*	278 (3.63%)	Dams, water, groundwater, dam, scarcity
6	*Conservation*	116 (1.51%)	Leopard, snow, biodiversity, habitat, habitats
12	*Local administration*	144 (1.88%)	CDA, Pak-EPA, capital, hills, margalla
15	*Energy generation*	108 (1.41%)	Coal, power, electricity, hydropower, generation
17	*Deforestation*	169 (2.20%)	Forest, forests, deforestation, forestry, timber
18	*Legal issues*	125 (1.63%)	Court, petition, justice, hearing, supreme
19	*Illegal hunting*	48 (0.62%)	Saudi, hunting, birds, permits, houbara
25	*Animals*	76 (0.99%)	Zoo, art, sanctuary, elephant, iwmb
30	*Disaster management*	148 (1.93%)	Disaster, ndma, dengue, relief, tribune
37	*Administrative appointments*	77 (1.00%)	Karachi, SEPA, Sindh, CM, Wahab
46	*Provincial climate policy*	127 (1.65%)	Provinces, policy, implementation, ministries, draft
49	*Waste management*	65 (0.84%)	Waste, solid, garbage, disposal, treatment

Continued on the next page.

Table 1. *Continued from the previous page.*

k	*Label*	*Occurrence (% of articles in corpus)*	*Top five terms*
	Theme: Climate change impacts		
2	*Agriculture*	139 (1.81%)	Cotton, wheat, seed, rice, bales
8	*Drought*	101 (1.31%)	Desert, Thar, villages, rainwater, village
11	*Marine life*	92 (1.20%)	Marine, turtles, ocean, island, fish
14	*Agri-business*	66 (0.86%)	Mango, fruit, fruits, exporters, mangoes
26	*Monsoon rainfall*	187 (2.44%)	Rain, rainfall, meteorological, pmd, weather
35	*Melting glaciers*	117 (1.52%)	Glacial, mountain, glaciers, chitral, outburst
39	*Coastal*	102 (1.33%)	Mangroves, delta, coastal, wetlands, mangrove
42	*Rising temperature*	181 (2.36%)	Temperature, Celsius, degrees, ice, century
44	*Pandemic*	94 (1.22%)	Deaths, disease, pandemic, health, COVID-19
	Theme: Climate change and society		
4	*Policy seminar*	122 (1.59%)	Evidence, political, governance, approach, elite
7	*Green initiatives*	98 (1.28%)	Trees, olive, planting, flowers, cutting
13	*Environmental workshops*	119 (1.55%)	Mercury, workshop, participants, collaborations, programme
20	*Climate conference*	170 (2.22%)	Seminar, dr, speakers, organized, speaking
21	*Air quality*	164 (2.14%)	Smog, air, brick, kilns, smoke
23	*Transport financing*	146 (1.90%)	Adb, urban, financing, infrastructure, banking
24	*Tree plantation*	230 (3.00%)	Plantation, campaign, saplings, drive, planted
32	*Earth hour*	162 (2.11%)	Hour, festival, theme, earth, celebrated
41	*University event*	166 (2.16%)	University, sciences, universities, faculty, prof
47	*Public awareness*	184 (2.40%)	Must, generations, steps, environment, responsibilities
48	*Climate and gender*	99 (1.29%)	Women, gender, rights, violence, migration
	Theme: Climate politics		
9	*Foreign actors*	128 (1.67%)	Ambassador, conference, delegation, Australian, U.K.
10	*Domestic politicians*	155 (2.02%)	Minister, imran, pti, prime, premier
16	*Climate financing*	90 (1.17%)	Committee, senator, senate, budget, standing
27	*U.S. politics*	166 (2.16%)	Trump, American, weapons, Obama, nuclear
29	*Regional summit*	120 (1.56%)	SDGS, goals, sustainable, agenda, development
33	*Regional politics*	139 (1.81%)	Peace, Afghanistan, Indian, India, terrorism
34	*Climate project funding*	205 (2.67%)	Aslam, amin, green, adviser, tsunami
40	*Economic development*	83 (1.08%)	CEPC, investment, economy, economic, jobs
43	*Paris agreement*	840 (10.97%)	Paris, agreement, negotiations, commitment, developing
50	*Climate protests*	97 (1.26%)	Crisis, corporations, activists, strike, greta
	Theme: Climate science		
22	*Greenhouse gases*	103 (1.34%)	Dioxide, carbon, gases, greenhouse, ozone
36	*Scientific evidence on the economic impacts*	142 (1.85%)	Report, population, cent, gdp, per
38	*Reality of climate change*	302 (3.94%)	Know, things, something, really, going
	Theme: Climate solution		
28	*Renewable*	127 (1.65%)	Renewable, energy, solar, wind, technologies
31	*Quality fuel*	103 (1.34%)	Oil, electric, vehicles, diesel, vehicle
45	*Sustainable farming*	169 (2.20%)	Food, agriculture, productivity, farming, fao

Upon calculating the model for the complete corpus, we relied on human validation to classify 50 different sub-topics into six overarching themes without removing any topics designating them as background topics [Maier et al., 2018]. These six predominant themes include: "Climate Politics", "Climate Governance and Policy", "Climate Change and Society", "Climate Change Impacts", "Climate Science", and "Climate Solution". Some of these themes appear similar to Keller et al. [2020] who investigated coverage of Indian newspapers on climate change.

Figure 2 illustrates that among these overarching themes, "Climate Politics" was the most prevalent topic (26.4%) which is comprised of ten different sub-topics. Within this theme, the issue of *Paris Agreement* with a prevalence of 10.97% and *Climate Project Funding* (2.67%) were extensively discussed. Besides these two sub-topics, most other coverage deals with various *Domestic Politicians* (2.02%), *Regional Summits* (1.56%) and *Politics* (1.81%), and *Foreign Actors* (1.67%). For example, the articles that are classified as *Foreign Actors* runs with the headlines such as, "Climate change in focus as royal couple visits Chitral".

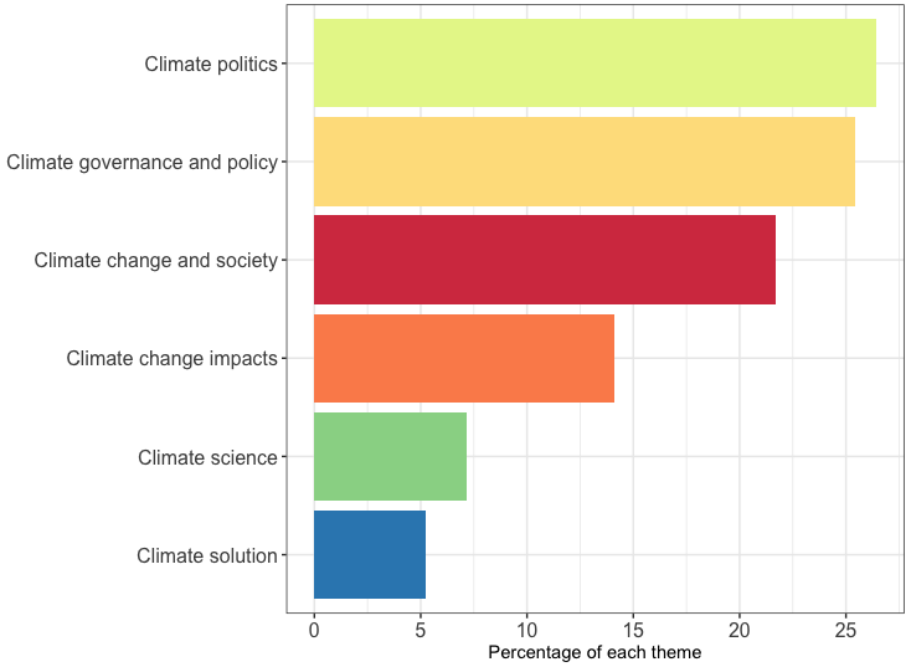

Figure 2. Percentage of coverage by main themes.

The second most dominant theme in the Pakistani news coverage is labelled as "Climate Governance and Policy". It includes fourteen different sub-themes that collectively constitute a quarter (25.4%) of print media coverage in Pakistan. Within this theme, *Adaptation Policy* (4.6%) and *Water Scarcity* (3.3%) are two most prevalent sub-themes. The coverage related to *Adaptation Policy* deals with the media reporting on policies related to sustainable development and growth to mitigate the adverse effects of climate change. Additionally, the previous government in the last three years has paid significantly more attention to address issues related to climate change and accordingly took several administrative steps and policy initiatives. Thus, continuously providing media a lot to report on that contribute as sub-topics within this theme, related to implementing *Plastic Ban* (1.42%) on single-use shopping bags, designating numerous areas as *Conservation* (1.51%) habitat, and empowering *Local Administration* (1.88%) to enforce climate

change-related policies. As for the coverage classified as *Water Scarcity*, the dominance of the topic makes sense because Pakistan is constantly ranked among those countries where ground water-level is continuously decreasing making it transition from water "stressed" to "scarce" country [Parry, Terton, Osman, Ledwell & Asad, 2016].

In terms of prevalence, "Climate Change and Society" is the third (21.7%) overarching theme which is comprised of eleven sub-topics, including, *Tree Plantation* (3.00%), *Public Awareness* (2.40%), *Climate Conference* (1.62%), *Air Quality* (2.14%), *Climate and Gender* (1.29%). Newspaper articles related to this theme has a wide scope and includes news stories with a human angle along with covering various societal actions to mitigate climate change as well as highlighting pervasive environmental degradation in different contexts. For example, the most prominent sub-topic corresponding to this theme and across all other topics *Tree Plantation* (3.00%) discuss various nation-wide campaigns initiated by different stakeholders including the government, NGOs, and private sector. The coverage in the topic also pertains a very important issue of unequal impact of climate change across gender while highlighting how women are at the forefront of facing the direct consequences of the crisis [Halton, 2018] especially, in the rural areas where their rights are seldom guaranteed. Besides, some articles corresponding to this theme also cover the awareness and informational efforts on different interest groups by organizing events and publishing media stories on the subject. In contrast, to show humans as victims of climate change, a small portion of media coverage in this theme includes stories presenting how they are also causing harm to their ecology by using hazardous chemicals and not adopting effective sanitation techniques, thus endangering the public health, and spread of different diseases.

The fourth overarching theme "Climate Change Impacts" that constitutes (14.05%) of the total climate coverage comprised of nine sub-topics (see, Table 1). The three most dominant sub-topics within this theme are *Monsoon rainfall* (2.44%), *Rising temperature* (2.36%), and *Agriculture* (1.81%). Pakistan is a semi-industrialized country and almost quarter of its economy is linked with agriculture [FAO, 2022], therefore, it makes sense for the media to focus on the impacts of climate change specifically on agricultural output of the country. However, the impacts of climate change are diverse and not limited to just one sector, and this is reflected by the media coverage who reports on issues like *Drought* (1.31%), *Marine life* (1.20%), *Melting glaciers* (1.52%), and degradation of *Coastal* (1.33%) communities.

The fifth theme, "Climate Science" represents 7.13% of the total coverage of climate change and consists of three topics. The most prominent among them concerns with educating the readers about the *Reality of climate change* (3.94%) while also reporting on what are different scientific solutions available for humans to adapt and prepare for any eventuality. For example, stories classified under this sub-theme contain headlines like "Climate change a future development and economic challenge" or "Roadmap for decarbonization". Lastly, three sub-topics constitute the overarching theme *Climate Solution* (5.21%). Among them, *Sustainable farming* (2.20%) is the most prevalent and consists of news articles that discuss the need to transform farming from traditional to sustainable. Furthermore, the coverage informs the public of new policy initiatives taken by the government to promote the use of *Renewable* (1.65%) energy sources and use of *Quality fuel* (1.34%).

Occurrence of overarching themes in news media coverage between 2010–21 (RQ3)

To examine the development and variations in the news media coverage related to climate change, we calculated the sum of the total occurrences of each theme in a single year. Figure 3 illustrates the prevalence of each topic in a single year as well as between 2010 and 2021. Like the answer of RQ1, we can see that the news coverage of climate change in Pakistan has increased over time. Figure 3 shows that between 2010–15, the coverage was mostly dominated by the theme "Climate Politics", however, the prevalence of this theme has gradually decreased. In contrast, "Climate Governance and Policy" has gained dominance, indicating growing shift on the administrative and policy measures to mitigate climate change.

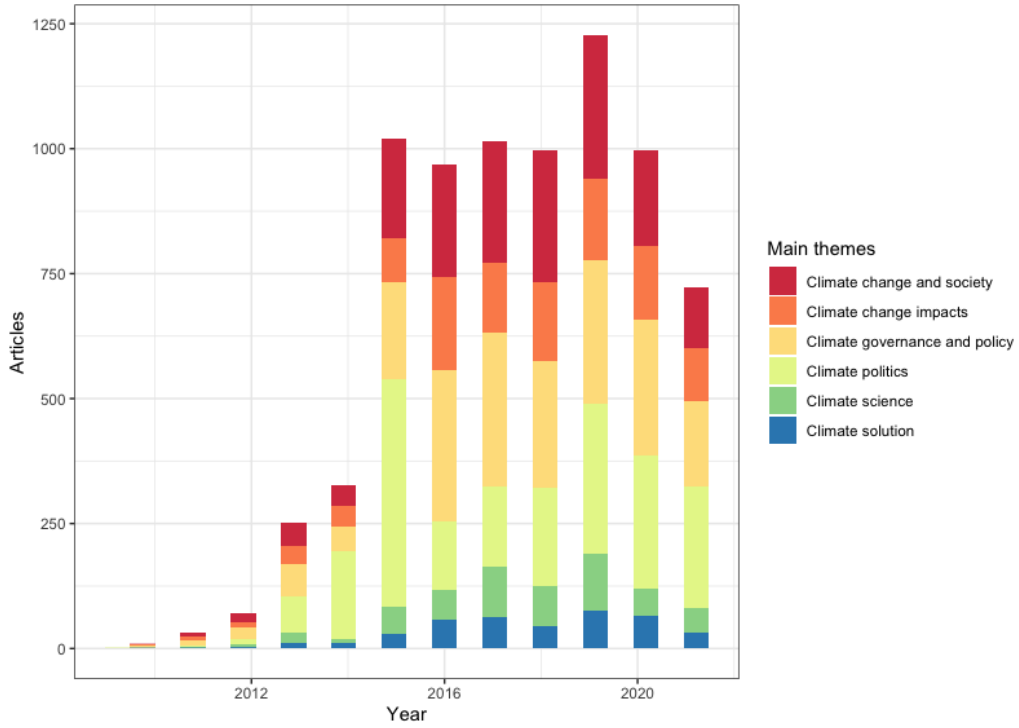

Figure 3. Prevalence and variations of main themes across time.

Additionally, Figure 3 shows that over time the theme "Climate Change and Society" has also increasingly become part of the news coverage. However, it is worth noticing that Pakistan's news media has not included stories that pertain to "Climate Change Impacts" despite the country being one of the most vulnerable to adverse impacts of climate change. Moreover, the consistently low dominance of news stories related to "Climate Science" and "Climate Solution" has not changed throughout the observed timeframe, which indicates the focus of media coverage.

Discussion

The current study exploratively examine the climate change-related news media coverage in the three leading English newspapers of Pakistan. To the best of our knowledge, the present study is the first of its kind originating from Pakistan that examines a large corpus of climate change-related media coverage published between 2010–2021. The results indicate that Pakistani print media has gone from not covering climate change-related stories to including at least two of such stories

per day, which show substantial uptake of climate journalism. However, considering the scale of the issue, its impact on Pakistan, and compared to other countries, the media still pays less attention to the topic. An estimate — shared by the editors of each newspaper in this sample — informs us that three newspapers publish approx. 900–1020 news stories daily. Hence, the average coverage related to climate change news is 0.2%, which is below compared to other countries of the world [Schmidt et al., 2013; Hase et al., 2021], including the region, for example, India, whose climate coverage is 0.33% [Keller et al., 2020]. Therefore, based on our findings, we recommend the media to consider the importance of climate change and focus more on the impending crisis to inform the public and policymakers with continuous calls for action.

With regards to content published in different Pakistani newspapers, the study found 50 topics that were further classified into (1) Climate Politics, (2) Climate Governance and Policy, (3) Climate Change and Society, (4) Climate Change Impacts, (5) Climate Science, and (6) Climate Solution. The findings presented in this study indicate the diversity of topics with which Pakistan print media covers the issue of climate change. However, the coverage itself is more focused on covering issues pertaining to politics, including highlighting project fundings, statements by domestic and international politicians on the issue, and international agreements. These findings contradict other studies [Hase et al., 2021; Olausson, 2014] that have reported the increasing tendency of media to domesticate the issue of climate change by highlighting its impact on different communities. One reason for this variation, as per the country's commitment to Paris Agreement, could be its insistence on implementing climate-related policies only if it can secure international grants, which amount to approximately $40 billion [Chaudhry, 2017]. Accordingly, the news media also covers such political statements regarding funds, initiating new projects, and seeking more grants from foreign actors.

Besides covering politics, Pakistani media also report on how different governance and policy-related matters either exacerbate or mitigate the adverse effects of climate change. Such coverage is often linked to the government's adaptation policies and promotes the need to focus on conservation, sustainability, and pro-environmental infrastructure development.

The past research informs that the inclusion of human element is critical in effective climate change communication [Maibach, Nisbet & Weathers, 2011]. Accordingly, Pakistani media substantially include this angle in its coverage labelled as "Climate Change and Society", where people get to tell their first-hand accounts of dealing with the harmful effects of environmental degradation, various awareness campaigns, and different private public partnerships on pro-environment initiatives. The study shows that Pakistani print media also covers "Climate Science". However, the percentage of this theme are relatively low, which corresponds to the previous work of Nguyen and Tran [Nguyen & Tran, 2019] that finds a lack of interest among the Global South journalists in covering scientific topics. The results of this study highlight a similar trend for the coverage related to "Climate Solution". The dismally low and less diverse media coverage on science and solution aspects of climate change needs more attention from the media in Pakistan, both of which have been found to be critical for effective climate change communication [Howarth, Parsons & Thew, 2020; McAllister et al., 2021].

Despite the importance of this explorative study, it still has several limitations. First, the newspapers selected for this study, despite having a significant readership, were in the English language, whereas the native language of Pakistan is Urdu. Thus, not considering the widely spoken language limits the generalizability of the findings of this study. Secondly, the machine learning based technique of topic assignment to individual newspaper article needs to be considered with caution. Although, we have been rigorous in choosing the highly relevant articles, but it is almost unlikely a newspaper article is solely based on one single topic. Third, the classification of topics to broad themes was done manually by the authors based on lengthy deliberations and their knowledge of local dynamics, however, this subjective categorization may not garner broad consensus.

Notwithstanding the limitations, our first of its kind study originating from Pakistan offers some pertinent insights into how the country's print media has covered climate change between 2010–21. The growth in covering the issue across different newspapers is a healthy sign, nevertheless, the low average of daily coverage points toward that media in Pakistan is a long way from making climate change reporting mainstream. Furthermore, it is valuable that the climate change news coverage in Pakistan consists of diverse topics, however excessive emphasis on politics and governance aspects of climate change does little to make people aware of adaptation and mitigation actions that become useful, especially with the increased frequency of climate change-induced extreme weather events. Therefore, the news coverage should include more stories related to climate solutions.

References

Ali, S. M. (2021). How Lahore became the world's most polluted place. *Foreign Policy*. Retrieved October 6, 2022, from https://foreignpolicy.com/2021/11/29/pakistan-lahore-pollution-fossil-fuels-climate/#:~:text=This%20past%20month%2C%20Lahore%2C%20Pakistan,the%20health%20of%20its%20citizenry

Arlt, D., Hoppe, I. & Wolling, J. (2011). Climate change and media usage: effects on problem awareness and behavioural intentions. *International Communication Gazette 73* (1–2), 45–63. doi:10.1177/1748048510386741

Barkemeyer, R., Figge, F., Hoepner, A., Holt, D., Kraak, J. M. & Yu, P.-S. (2017). Media coverage of climate change: an international comparison. *Environment and Planning C: Politics and Space 35* (6), 1029–1054. doi:10.1177/0263774x16680818

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S. & Matsuo, A. (2018). quanteda: an R package for the quantitative analysis of textual data. *Journal of Open Source Software 3* (30), 774. doi:10.21105/joss.00774

Blei, D. M., Ng, A. Y. & Jordan, M. I. (2003). Latent Dirichlet Allocation. *Journal of Machine Learning Research 3*, 993–1022. Retrieved from http://www.jmlr.org/papers/volume3/blei03a/blei03a.pdf

Bokhari, F. & Reed, J. (2022). 'A super-flood to beat all': monsoon disaster piles misery on Pakistan. *Financial Times*. Retrieved September 7, 2022, from https://www.ft.com/content/375f9673-bcb6-4ca8-abcc-19e13888fe63

Carvalho, A. (2007). Ideological cultures and media discourses on scientific knowledge: re-reading news on climate change. *Public Understanding of Science 16* (2), 223–243. doi:10.1177/0963662506066775

Chaudhry, Q. U. Z. (2017). *Climate change profile of Pakistan*. Asian Development Bank. doi:10.22617/TCS178761

Eckstein, D., Künzel, V., Schäfer, L. & Winges, M. (2019). *Global climate risk index 2020. Who suffers most from extreme weather events? Wether-related loss events in 2018 and 1999 to 2018*. Germanwatch. Bonn, Berlin, Germany. Retrieved October 6, 2022, from https://www.germanwatch.org/en/17307

Ejaz, W., Ittefaq, M. & Arif, M. (2022). Understanding influences, misinformation, and fact-checking concerning climate-change journalism in Pakistan. *Journalism Practice 16* (2–3), 404–424. doi:10.1080/17512786.2021.1972029

FAO (2022). FAO in Pakistan: Pakistan at a glance. Retrieved September 20, 2022, from https://www.fao.org/pakistan/our-office/pakistan-at-a-glance/en/

Fuller, R., Sandilya, K. & Hanrahan, D. (2019). *Pollution and health metrics: global, regional and country analysis*. Global Alliance on Health and Pollution. Genève, Switzerland. Retrieved September 15, 2022, from https://gahp.net/solutions-2/pollution-and-health-metrics-2/

Gibson, T. A., Craig, R. T., Harper, A. C. & Alpert, J. M. (2016). Covering global warming in dubious times: environmental reporters in the new media ecosystem. *Journalism 17* (4), 417–434. doi:10.1177/1464884914564845

Gruber, J. (2021). LexisNexisTools. An R package for working with newspaper data from 'LexisNexis'. Retrieved September 20, 2022, from https://github.com/JBGruber/LexisNexisTools

Grün, B. & Hornik, K. (2011). topicmodels: an R Package for fitting topic models. *Journal of Statistical Software 40* (13), 1–30. doi:10.18637/jss.v040.i13

Grundmann, R. & Scott, M. (2014). Disputed climate science in the media: do countries matter? *Public Understanding of Science 23* (2), 220–235. doi:10.1177/0963662512467732

Günay, D., İşeri, E., Ersoy, M. & Elega, A. A. (2021). Media framing of climate change action in carbon locked-in developing countries: adaptation or mitigation? *Environmental Communication 15* (5), 663–677. doi:10.1080/17524032.2021.1885462

Halton, M. (2018). Climate change 'impacts women more than men'. *BBC News*. Retrieved September 20, 2022, from https://www.bbc.com/news/science-environment-43294221

Hase, V., Mahl, D., Schäfer, M. S. & Keller, T. R. (2021). Climate change in news media across the globe: an automated analysis of issue attention and themes in climate change coverage in 10 countries (2006–2018). *Global Environmental Change 70*, 102353. doi:10.1016/j.gloenvcha.2021.102353

Howarth, C., Parsons, L. & Thew, H. (2020). Effectively communicating climate science beyond academia: harnessing the heterogeneity of climate knowledge. *One Earth 2* (4), 320–324. doi:10.1016/j.oneear.2020.04.001

Hussain, S., Khan, A. & Zubair Iqbal, M. (2022). Media reporting of climate change crisis in Pakistan: identifying corrective strategies. *Information Development*. doi:10.1177/02666669221104612

IEA (2019). *World energy outlook 2019*. Retrieved October 5, 2022, from https://www.iea.org/reports/world-energy-outlook-2019

IPCC (2022). *Climate change 2022: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. Cambridge, U.K. Retrieved from https://www.ipcc.ch/report/ar6/wg2/

Jacobi, C., van Atteveldt, W. & Welbers, K. (2016). Quantitative analysis of large amounts of journalistic texts using topic modelling. *Digital Journalism 4* (1), 89–106. doi:10.1080/21670811.2015.1093271

Kamboh, S. A., Ittefaq, M. & Yousaf, M. (2022). Editorial journalism and environmental issues in the majority world. *International Journal of Communication 16* (2022), 2646–2668. Retrieved from https://ijoc.org/index.php/ijoc/article/view/18128/3783

Keller, T. R., Hase, V., Thaker, J., Mahl, D. & Schäfer, M. S. (2020). News media coverage of climate change in India 1997–2016: using automated content analysis to assess themes and topics. *Environmental Communication 14* (2), 219–235. doi:10.1080/17524032.2019.1643383

Lück, J., Wessler, H., Wozniak, A. & Lycarião, D. (2018). Counterbalancing global media frames with nationally colored narratives: a comparative study of news narratives and news framing in the climate change coverage of five countries. *Journalism 19* (12), 1635–1656. doi:10.1177/1464884916680372

Maibach, E., Nisbet, M. & Weathers, M. (2011). *Conveying the human implications of climate change: a climate change communication primer for public health professionals*. George Mason University Center for Climate Change Communication. Fairfax, VA, U.S.A. Retrieved October 6, 2022, from https://www.climatechangecommunication.org/wp-content/uploads/2016/04/Climate-Communication-Primer-for-Public-Health-Professionals-1.pdf

Maier, D., Waldherr, A., Miltner, P., Wiedemann, G., Niekler, A., Keinert, A., … Adam, S. (2018). Applying LDA topic modeling in communication research: toward a valid and reliable methodology. *Communication Methods and Measures 12* (2–3), 93–118. doi:10.1080/19312458.2018.1430754

Marwan, S. (2022). Floods, heat waves, drought, wildfires, tornadoes: summer 2022 will be one for the record books. *Fast Company*. Retrieved September 10, 2022, from https://www.fastcompany.com/90785152/natural-disasters-of-summer-2022

Mattar, S. D., Jafry, T., Schröder, P. & Ahmad, Z. (2021). Climate justice: priorities for equitable recovery from the pandemic. *Climate Policy 21* (10), 1307–1317. doi:10.1080/14693062.2021.1976095

Matthews, J. (2017). Maintaining a politicised climate of opinion? Examining how political framing and journalistic logic combine to shape speaking opportunities in UK elite newspaper reporting of climate change. *Public Understanding of Science 26* (4), 467–480. doi:10.1177/0963662515599909

McAllister, L., Daly, M., Chandler, P., McNatt, M., Benham, A. & Boykoff, M. (2021). Balance as bias, resolute on the retreat? Updates & analyses of newspaper coverage in the United States, United Kingdom, New Zealand, Australia and Canada over the past 15 years. *Environmental Research Letters 16* (9), 094008. doi:10.1088/1748-9326/ac14eb

Moser, S. C. (2010). Communicating climate change: history, challenges, process and future directions. *WIREs Climate Change 1* (1), 31–53. doi:10.1002/wcc.11

Naguimbing-Manlulu, M. F. (2021). Climate change narratives in Philippine print news media. *Media Asia 48* (3), 190–206. doi:10.1080/01296612.2021.1944541

Newman, N., Fletcher, R., Robertson, C. T., Eddy, K. & Nielsen, R. K. (2022). *Reuters Institute digital news report 2022*. Reuters Institute for the Study of Journalism. Oxford, U.K. Retrieved October 5, 2022, from https://reutersinstitute.politics.ox.ac.uk/sites/default/files/2022-06/Digital_News-Report_2022.pdf

Newman, N., Fletcher, R., Schulz, A., Andı, S. & Nielsen, R. K. (2020). *Reuters Institute digital news report 2020*. Reuters Institute for the Study of Journalism. Oxford, U.K. Retrieved October 5, 2022, from https://reutersinstitute.politics.ox.ac.uk/sites/default/files/2020-06/DNR_2020_FINAL.pdf

Nguyen, A. & Tran, M. (2019). Science journalism for development in the Global South: a systematic literature review of issues and challenges. *Public Understanding of Science 28* (8), 973–990. doi:10.1177/0963662519875447

O'Neill, S. & Nicholson-Cole, S. (2009). "Fear won't do it": promoting positive engagement with climate change through visual and iconic representations. *Science Communication 30* (3), 355–379. doi:10.1177/1075547008329201

Olausson, U. (2014). The diversified nature of "domesticated" news discourse: the case of climate change in national news media. *Journalism Studies 15* (6), 711–725. doi:10.1080/1461670x.2013.837253

Otto, F. E. L., Zachariah, M., Saeed, F., Siddiqi, A., Shahzad, K., Mushtaq, H., … Clarke, B. (2022). Climate change likely increased extreme monsoon rainfall, flooding highly vulnerable communities in Pakistan. *World Weather Attribution*. Retrieved September 20, 2022, from https://www.worldweatherattribution.org/climate-change-likely-increased-extreme-monsoon-rainfall-flooding-highly-vulnerable-communities-in-pakistan/

Parry, J.-E., Terton, A., Osman, H., Ledwell, C. & Asad, S. (2016). Making every drop count: Pakistan's growing water scarcity challenge. *International Institute for Sustainable Development*. Retrieved September 10, 2022, from https://www.iisd.org/articles/insight/making-every-drop-count-pakistans-growing-water-scarcity-challenge

R Core Team (2020). Retrieved October 5, 2022, from https://www.eea.europa.eu/data-and-maps/indicators/oxygen-consuming-substances-in-rivers/r-development-core-team-2006

Reid, A. (2019). Climate change education and research: possibilities and potentials versus problems and perils? *Environmental Education Research 25* (6), 767–790. doi:10.1080/13504622.2019.1664075

Roberts, M. E., Stewart, B. M. & Tingley, D. (2019). stm: an R package for structural topic models. *Journal of Statistical Software 91* (2), 1–40. doi:10.18637/jss.v091.i02

Ruiu, M. L. (2021). Representation of climate change consequences in British newspapers. *European Journal of Communication 36* (5), 478–493. doi:10.1177/0267323120978727

Saifi, S. & Yeung, J. (2018). Heatwave kills at least 65 in Pakistan. *CNN*. Retrieved September 20, 2022, from https://www.cnn.com/2018/05/22/asia/pakistan-heat-wave-wxc-intl/index.html

Sampei, Y. & Aoyagi-Usui, M. (2009). Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change 19* (2), 203–212. doi:10.1016/j.gloenvcha.2008.10.005

Schäfer, M. S. & Schlichting, I. (2014). Media representations of climate change: a meta-analysis of the research field. *Environmental Communication 8* (2), 142–160. doi:10.1080/17524032.2014.914050

Schmidt, A., Ivanova, A. & Schäfer, M. S. (2013). Media attention for climate change around the world: a comparative analysis of newspaper coverage in 27 countries. *Global Environmental Change 23* (5), 1233–1248. doi:10.1016/j.gloenvcha.2013.07.020

Sharif, A. & Medvecky, F. (2018). Climate change news reporting in Pakistan: a qualitative analysis of environmental journalists and the barriers they face. *JCOM 17* (01), A03. doi:10.22323/2.17010203

United Nations Development Programme (2020). *Human development insights 2020*. Retrieved May 10, 2022, from http://hdr.undp.org/sites/default/files/Country-Profiles/PAK.pdf
United Nations Environment Programme (2021). Pakistan's ten billion tree tsunami. Retrieved May 15, 2022, from https://www.unep.org/news-and-stories/story/pakistans-ten-billion-tree-tsunami
van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D. & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: experimental evidence. *PLoS ONE 10* (2), e0118489. doi:10.1371/journal.pone.0118489
Volkmer, I. & Sharif, K. (2018). *Risk journalism between transnational politics and climate change*. doi:10.1007/978-3-319-73308-1
Ylä-Anttila, T., Eranti, V. & Kukkonen, A. (2022). Topic modeling for frame analysis: a study of media debates on climate change in India and USA. *Global Media and Communication 18* (1), 91–112. doi:10.1177/17427665211023984

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