1 **Is there a climate change reporting bias? A case study of English language news articles,**
2 **2017-2022**

3 ~~Storming the news media: 5 years of reporting weather hazards and climate change~~

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9 **Abstract:** How weather hazards are communicated by the media is important. Which risks are
10 understood, prioritised, and acted upon, can be influenced by the level of attention they
11 receive. In this paper the ~~Global heating has increased the risk of weather hazards in recent~~
12 ~~years. Communication of weather hazard risk by the news media has importance.~~
13 ~~Newsworthiness affects weather hazards reporting. Here, the methods used to adhere to the~~
14 ~~open science principles of reproducibility and transparency.~~ mMethods used are advanced
15 Google searches of media articles and the emergency disaster database (EM-DAT) that
16 consider the weather hazards floods, heat waves, wildfires, storms and droughts from 2017 -
17 2022. Storms are more likely to be reported than any other climate risk. But wildfires generate
18 more news articles per event. Bias in reporting needs to be addressed and is important
19 because it can exacerbate un-preparedness.~~Storms have had a large number of articles in the~~
20 ~~last five years. But, wildfires have a large number of articles per individual occurrence. Science~~
21 ~~and media collaborations could address the bias and improve reporting.~~

22 **Plain Text Summary:**

23 Climate change is increasing the risk of weather hazards (i.e. Storms and Heatwaves). Using
24 open science methods it is shown that there is a bias in weather hazard reporting. Storms
25 have had a large number of articles in the last five years. But, wildfires have a large number
26 of articles per individual occurrence. Science and media collaborations could address the bias
27 and improve reporting.

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36 The Intergovernmental Panel on Climate Change's AR6 report ~~Weather hazards are having an~~

37 flooding, heat waves, wildfires and droughts have been increasing in intensity and frequency

38 with climate change (IPCC, 2021). Since 2017, there have been a number of notable weather

39 events: Pacific Typhoon season 2018, European floods in 2021, Mediterranean heatwave and

40 wildfires in 2021). ~~The last 5 years has experienced a number of notable weather hazards,~~

41 ~~from the costly 2018 Pacific Typhoon season to the Pacific North West heat wave and~~

42 ~~European flooding in June 2021 and the Mediterranean heat wave and wildfire in August 2021~~

43 (Gao et al., 2020; Kreienkamp et al., 2021; Sjoukje Philip et al., 2021; Sullivan, 2021).

44 Communication of a risk does not always lead to the risk being understood (Porter and Evans,

45 2020), however the media is a key actor in communicating climate change and has a moral

46 obligation to highlight the risk of extreme weather and what action is needed ~~to report all~~

47 ~~aspects of the climate emergency to highlight in this case the risk of extreme weather and~~

48 ~~what action is being taken~~ (Boykoff and Yulsman, 2013; Kitzinger, 1999).In addition, it has

49 ~~previously~~ been found that the media gives ~~has often given~~ more attention to

50 sensationalist ~~outlier~~ views on climate change, instead of the consensus view (Meah, 2019;

51 Petersen et al., 2019).

52 ~~Previous R~~research demonstrates that the bias in reporting hazards and climate change leads

53 to attention and material resource deficit, not fully recognising or addressing the risk

54 (Brimicombe et al., 2021a; Howarth and Brooks, 2017).In comparison, it has been found that

55 when visual hazards such as floods and storms (Wilby and Vaughan, 2011) are used to

56 demonstrate climate change risk there is an improved understanding of climate risk, ~~this is~~

57 also known as objectifying climate change (Höijer, 2010).

58 Reported here for the first time, this study uses open science principles (Armeni et al. 2021;

59 Nosek et al. 2015) alongside the advanced search ~~In this study, open science principles~~

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60 ~~(Armeni et al., 2021; Nosek et al., 2015) are adhered to whilst using simple advanced search~~

61 how weather hazards are mentioned in news articles, from 2017-22. The aim is to understand:

62 (1) has the number of articles focused on weather hazards increased since 2017; (2) which

63 weather hazards receive the most attention; and (3) how often is climate change discussed in

64 relation to those weather hazards.

65 ~~(EM-DAT) (CRED, 2020). This, allows for an examination of the English news media articles~~

66 ~~produced over the last 5 years to answer the key questions: Has there been an overall increase~~

67 ~~in articles in the last 5 years? What weather hazard had the most attention? And how many~~

68 ~~articles also discussed climate change?~~

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71 **2. Methods and Data**

72 All the methods and data chosen by this study are in keeping with open data and open

73 science. Open data ~~science~~ is where the research results are reproducible and transparent,

74 whilst open science is a term given for removing the barriers for sharing any kind of output

75 (Armeni et al., 2021).

76 **2.1 Advanced Google Search**

77 An advanced Google search of the news category was carried out for the period 1st January

78 2017 to the 1st January 2022. The search involved two stages: first, a search for all news

79 articles in the period containing keywords – flood, heat wave, wildfire, storm and drought,

80 was conducted, and second, this search criterion was repeated with the keywords – climate

81 change~~The individual search selection was for all news articles in the period containing the~~

82 ~~keyword flood, heat wave, wildfire, storm and drought and then the search was carried out~~

83 ~~again this time including climate change as a keyword~~ (cf. Brimicombe et al., 2021). Each

84 hazard was evaluated separately and their results compared, with duplicated results not

85 included. Articles that mention more than one weather hazard are counted twice.

86 ~~Further, T~~to counter any overestimates that ~~might~~ occur where articles are not discussing a

87 weather hazard but are using the term to describe something else, the approach taken is to

88 look at the first 100 articles headlines and remove articles not discussing a weather hazard,

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89 to give a better estimate of the true number of news articles. Examples included articles
90 discussing 'Goal droughts', 'NFL Storm' and 'Glass Animals single Heatwave'. Then, this
91 proportion of articles was removed from the overall total, giving a new overall count of
92 articles. For example, for Storms in 2017, the initial search returned 6.31 million articles, but
93 21 out of the first 100 were not about the weather hazard so 4.98 million articles were
94 counted for Storms. Therefore, 21% of the total articles were removed leaving 4.98 million
95 articles.

96 Limitations of this method do remain it can still capture articles not explicitly about the
97 weather hazard, however, this is limited by the proportional approach taken. In addition, it is
98 only likely to capture the English news media and will give a slightly different number of
99 articles between users. As such it is recommended that further in-depth research should be
100 carried out looking at news media sentiment.

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104 **2.2 EM-DAT Hazard Reporting**

105 To supplement the findings of the advanced google search, we use another source of data is
106 used that is in keeping with open science, the emergency events database (EM-DAT). EM-DAT
107 is the leading international disaster database, it contains details of over 22,000 mass disasters
108 worldwide since 1900 and is compiled from a range of sources including UN agencies and
109 Non-Governmental Organisations (NGOs) (CRED, 2020). This provides us with an overview of
110 the number of weather hazards that have occurred every year for the last 5 years. This then
111 allows for an us to assessment on average how many articles have been written about each
112 weather hazard. Table 1 shows a count of the weather hazards every year from 2017 to 2021
113 considered by this study included in EM-DAT (CRED, 2020).

114 *Table 1: Displaying the total number of disaster reported per weather hazard for the last 5*
115 *years as reported by EM-DAT* (CRED, 2020).

Hazard/Year	2017	2018	2019	2020	2021	Total
Drought	12	17	15	10	15	69

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Heat wave	1	14	17	4	2	38
Flood	127	128	195	202	222	874
Storm	130	96	91	128	119	564
Wildfire	15	10	14	8	19	66
Total	285	265	332	352	377	1611

Limitations of this method are that there are biases in how hazards in this database are reported and there is under-reporting of hazards by this database (Brimicombe et al., 2021a; Gall et al., 2009). In addition, this database only includes hazards that are considered a disaster, where an agency declares a state of emergency, or where it is reported that over 100 people have been affected(CRED, 2020). However, it remains the most comprehensive source of reported weather hazards (Brimicombe et al., 2021a; Gall et al., 2009).

3. Results

3.1 have the number of weather hazards news article increased since 2017?Overall number of articles has increased

In total since 2017, over 142 million articles have been written by the English language news media about weather hazards. There has also been an increase in the number of English language news media articles for all weather hazards from 2017 to 2022. In 2021, . Per year storms have the most articles, whilst heat waves have the least number of articles (Figure 1). The ranking of the total number of articles for each weather hazard type is storms, floods, wildfire, drought and heat wave. 28.1 million articles are about storms, whereas 169,000k articles are about heat waves in 2021 (Figure 1). Of interest, only 0.7% of all news articles mentioned climate change and the weather hazard together. The results for number of articles mirror those for overall news articles written.

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3.2 Which weather hazards receive the most attention in news articles?

The results in section 3.1 change when the number of articles is considered as a proportion of the number of weather hazards reported in EM-DAT in table 1. The approach taken here is to aggregate the totals for the 5 years per hazard to reduce the influence of the under-reporting bias in EM-DAT. Table 2 is another representation of the reporting bias introduced by EM-DAT where total costs for each hazard each year are show, no losses are attributed to heat waves, the results for total damages mirror those for total number of article written. It can therefore be suggested that articles are more likely to be written for hazards that have the biggest financial loss reported for them.
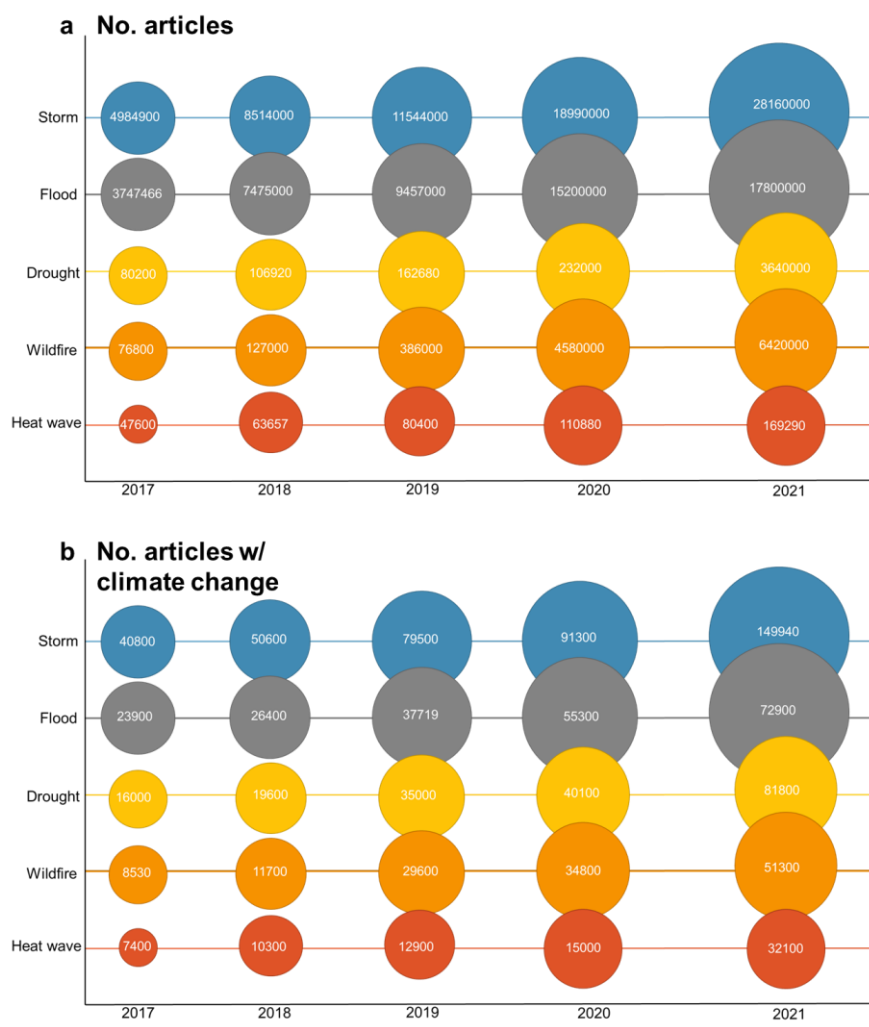
a No. articles

	2017	2018	2019	2020	2021
Storm	4984900	8514000	11544000	18990000	28160000
Flood	3747466	7475000	9457000	15200000	17800000
Drought	80200	106920	162680	232000	3640000
Wildfire	76800	127000	386000	4580000	6420000
Heat wave	47600	63657	80400	110880	169290

b No. articles w/ climate change

	2017	2018	2019	2020	2021
Storm	40800	50600	79500	91300	149940
Flood	23900	26400	37719	55300	72900
Drought	16000	19600	35000	40100	81800
Wildfire	8530	11700	29600	34800	51300
Heat wave	7400	10300	12900	15000	32100

Figure 1:: Displays number of articles (on a logarithmic scale) per hazard per year for 2017 to 2022₁ .a)The darker colour indicates overall article numbers whilst b) the lighter colour indicates only articles that contain the weather hazard and climate change as its subject.

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158 ~~3.2 Per hazard occurrence wildfire has the greatest number of articles~~

Hazard/Year	2017	2018	2019	2020	2021	Total
Drought	$ 6,767,619	$ 10,093,560	$ 143,086	$ 7,852,337	$ 12,500,000	$ 37,356,602
Heat wave						$ -
Flood	$ 22,484,1	$ 21,273,576	39,033,864	53,874,005	75,957,000	$212,622,545
Storm	$301,722,795	$ 78,567,020	61,089,189	92,336,036	$137,675,753	$671,390,793
Wildfire	$ 18,706,572	$ 24,605,677	3,954,463	11,696,841	9,253,912	$ 68,217,465
Total	$349,681,086	$134,539,833	$104,220,602	$165,759,219	$235,386,665	$989,587,405

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160 Overall, on average for each individual weather hazard, 89,000 articles were written,

161 however, the picture for each hazard varies widely, for example one storm can have 10 times

162 more articles written about it than another, and a future study on this would be beneficial.

163 On average per wildfire, there have been in total 175,000 articles written in the last 5 years

164 (Figure 2). The weather hazard with on average the least number of articles per weather

165 hazard occurrence over the last 5 years are heat waves with 12,000 articles (Figure 2). ~~The~~

166 ~~ranking of the number of articles on average per weather hazard occurrence is wildfire, storm,~~

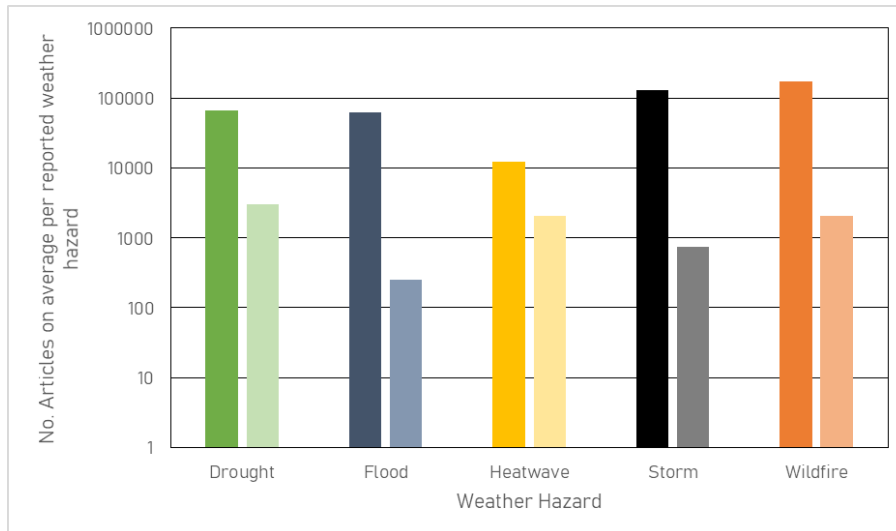167 ~~drought, flood and then heat wave.~~

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Figure 2: <u>The average number of articles per individual hazard category for the last 5 years. Dark colour is total number of articles and light colour is articles including climate change.</u> ~~displaying on average the total number of articles per reported weather hazard in EM-DAT for the last 5 years (Logarithmic scale). Dark colours are all weather hazard articles, whilst lighter colours are articles also including climate change.~~

3.3 <u>how often is climate change discussed in these news articles in relation to weather hazards?</u>~~Individual droughts have the most articles discussing climate change~~

Overall, on average for each individual weather hazard, 650 articles were written that also consider climate change<u>. The hazard with the most articles written is drought, </u>~~, however as with all weather hazard articles the picture for each hazard varies widely. o~~<u>O</u>n average per drought, there have been 3k articles in the last 5 years (Figure 2). The weather hazard with on average the least number of articles per weather hazard occurrence over the last 5 years are floods with 200 articles (Figure 2). ~~The ranking of the number of articles that also consider climate change on average per weather hazard occurrence is drought, wildfire, heat wave, storm, floods.~~

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4. Discussion

4.1 Why are some hazards discussed by the English Language News media more?

Heat waves have the least amount of news media articles. This should not be of surprise given other research demonstrating the consistent underreporting of this weather hazard (Harrington and Otto, 2020; Vogel et al., 2019). It however, may be of surprise given the number of record-breaking heat waves during recent years such as the June 2021 Pacific North-West heat wave which was attributed to climate change was found likely to of been impossible without Climate Change (Sjoukje Philip et al., 2021).

How notable events or weather hazards get attention and are reported is subject to 'newsworthiness', which can also be known as the political economy between society and the media (Boykoff and Yulsman, 2013; Kitzinger, 1999). This is made up of 4 main factors: *the availability effect/heuristic which is if a hazard is presented as risk before it is more likely to be remembered in this manner, stories from impacted groups, geographically bound and are visually impactful* (Kitzinger, 1999; Tomlinson et al., 2011). The results of this study show that the hazards that fit the criteria the most were storms which have the most articles by quantity and wildfires that have the most articles per individual occurrence.

In addition, this study's results highlight a huge reporting bias in favour of storms and wildfire in the news media. This attention bias in the overall number of reports has a material cost where storms receive more research, funding and policy than other hazards (Brimicombe et al., 2021b; Harrington and Otto, 2020; Howarth and Brooks, 2017; Vogel et al., 2019). However, despite ranking second in terms of the overall number of articles, per individual occurrence floods have the least number of articles. This is something that should be explored further in a news media sentiment study.**4.2 How does the English Language News Media discuss climate change and hazards?**

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change is not following the 'newsworthiness' criteria and therefore drought, wildfire and heat waves have the most articles. Instead, the media can be suggested to follow the science where it is seen these hazards are easier to attribute to climate change than floods or storms (Ciavarella et al., 2020; Kreienkamp et al., 2021). Whilst the media does have a moral obligation and plays a key role in communicating climate risk, how science, the public and those in position of power communicates climate change has influence on what is portrayed by the media (Boykoff and Yulsman, 2013; van der Hel et al., 2018; Howarth and Anderson, 2019).

Therefore, it could be suggested that this reporting of climate change has come about by the increasing collaboration between science (across career stages) and the media examples include Science Media Centre, The Conversation and Voice of Young Science. This comes in spite of the discourse around the role of science in both communication and policy spaces (Boykoff and Yulsman, 2013; Pielke, 2007).

4.3 Why is consistent reporting important?

Attention deficit in the English Language News Media leads to a lack of investment in adaptation for some hazards, making us unprepared. In addition, this pushes us towards more precarious tipping points where adaptation becomes more a challenge for society (Howarth and Brooks, 2017). This study's results highlight a huge reporting bias in favour of storms and wildfire in the news media. This has a material cost where storms receive more research, funding and policy than other hazards (Brimicombe et al., 2021b; Harrington and Otto, 2020; Howarth and Brooks, 2017; Vogel et al., 2019).

However, despite ranking second in terms of the overall number of articles, per individual occurrence floods have the least number of articles. This could be an indication that there are a bigger range of number of articles written per flood (i.e. one flood has 1 million articles but another only has 1,000 articles) and this is something that should be explored further in a news media sentiment study, with particular focus given to geographical bias.

4.4 What does using an open science approach demonstrate?

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243   This study uses advance google search trends to show the bias that is apparent in the English
244   Language News Media surrounding weather hazards and climate change. This is not the most
245   robust method to carry out a study of this kind, however it is the most accessible. For example,
246   long-scale newspaper databases are not free to access.

247   Using an open science approach highlights the transparency surrounding the reporting bias
248   (Armeni et al., 2021). This is a positive because it means that it is easy to track improvements
249   and changes in reporting. Bias reduces the ability of reporting as a tool to reduce hazard risk
250   and highlighting it is the first step in changing the narrative (Brimicombe, et al., 2021a,b).

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255   **5. Conclusion**

256   There is a bias in terms of which weather hazards English language news media report on,
257   and a bias in terms of which weather hazards are linked to climate change. This is important
258   because in terms of material cost some hazards have more investment than others. This leads
259   to hazards being subject to under preparedness as a result of underreporting of their impacts.
260   Reporting is a key way that we can improve communication and plays a part in avoiding
261   societal tipping points. This study suggests greater collaboration between scientists (across
262   career stages) with the English news media is key to improve reporting overall and continue
263   to grow the reporting of the risk of weather hazards and their intrinsic links with climate
264   change.

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266   ~~The English News Media has a bias for weather hazards and climate change. Storm articles~~
267   ~~have the largest total for the last five years, whilst wildfires have the most article per~~
268   ~~individual hazard occurrence.~~

269   *The authors~~s~~ report~~s~~ there are no competing interests to declare.*

270   **Data availability:**

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271   All data is available via advance Google searches and the EM-DAT database.

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