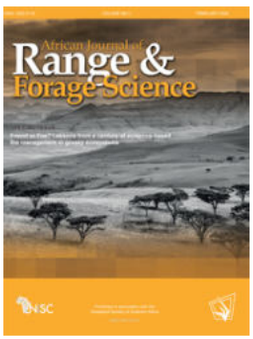

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Fire as friend or foe: the role of scientists in balancing media coverage of fires in National Parks

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Fire can destroy infrastructure and livelihoods, and claim lives. Yet, fire is inevitable and plays several vital ecological roles that have shaped ecosystems over millennia. Planned fires also serve human needs. Critical media content analysis of 390 media reports (print, online and broadcast) on fires in South African National Parks over a three-year period were used to investigate the portrayal of fire by the mass media. We found a strong emphasis on reactive fire suppression along with a predominantly negative sentiment towards fire (93.9% of total media reach) focussing primarily on losses, destruction and the threat of fires to infrastructure, human health or lives and vegetation. In the few cases where scientists were involved (2.3% of total reach), the narrative, sentiment and images provided a more nuanced perspective of fire as having both detrimental and beneficial consequences (63.6%), imparting key fire ecology concepts to understand fire behaviour better and highlighting the importance of proactive fire-risk reduction measures. Given the influence of the mass media on the views and opinions of the public and policymakers, and its socio-political and management consequences, we conclude that scientists and journalists should do more to engage with one another. We provide pathways and tips to scientists on how to increase their media footprint to promote a more balanced media portrayal of fire.

Keywords: fire perceptions and policy, impact of science on media, media framing and bias, science communication, wildfires

Supplementary material: An infographic summarising the key results from this manuscript, as well as supplementary tables and figures are available at https://doi.org/10.2989/10220119.2021.1991473.

Introduction

Fire is a foe that can destroy infrastructure and livelihoods, and even claim lives. It may also have negative environmental impacts, such as stimulating alien plant germination or escalating erosion. Yet, fire is a natural phenomenon that has shaped our ecosystems over millennia (Bond and Van Wilgen 1996; Bond and Keeley 2005). Fire is also a friend that humans and human ancestors have used for more than a million years (Brain 1993; Berna et al. 2012). Fire is necessary for the maintenance of biological diversity and critical for the dynamics and vitality of certain biomes (Bond and Keeley 2005; Kraaij and Van Wilgen 2014). Fire reduces bush encroachment in savanna systems (Joubert et al. 2012; Case and Staver 2017), can promote biodiversity (Ponisio et al. 2016; Kelly et al. 2020), stimulates nutrient cycling (Van Wyk et al. 1992; Coetsee et al. 2010) and reduces wildfire intensity and risk to human lives and infrastructure through fuel reduction (Bond and Van Wilgen 1996; Moritz et al. 2014; Furlaud et al. 2017). In healthy ecosystems, it also enhances water yield, improves forage production, kills alien plant species and manipulates habitats for desired species (Bond and Van Wilgen 1996).

With the understanding that fires in fire-prone landscapes are inevitable (Bond and Van Wilgen 1996), there has been an increasing call to recognise fires as a natural disturbance with which humans should learn to coexist in order to build fire-resilient communities (Myers 2006; Jakes and Langer 2012; Moritz et al. 2014; Smith et al. 2016), in particular along the wildland-urban interface (Forsyth and Le Maitre 2016). An environment in which valuable infrastructure is surrounded by high amounts of flammable vegetation, is bound to result in costly damages when a wildfire burns (Forsyth et al. 2019). There is growing disjunct between modern society and wildfires as people have abandoned their traditional land-use practices (Úbeda et al. 2019). This disjunct fosters uncertainty and fear around fires, consequently creating a fire-averse society distrusting of

proactive fire management in the form of prescribed burning, because it is viewed as a high-risk, destructive exercise (Winter and Fried 2000; Jacobson et al. 2001; Toledo et al. 2013). Although fire is an important ecosystem management tool, burning of vegetation is legislated by law that defines liabilities and provides for fines or imprisonment of offenders (Van Wilgen et al. 2012). Hence, this practice is often outside of the comfort zone and budget of smallholders and municipalities. Furthermore, the 'positive' side of fire is much harder to communicate to the public, particularly in instances where fire has brought about significant damage to property and loss of life (Jacobson et al. 2001). Building fire-resilient communities will require education and acceptance that wildland fires will occur despite the most rigorous fire-suppression strategies (Forsyth et al. 2019) and continued analysis and mitigation of fire risks (McAneney et al. 2009) and plans to minimise damage to properties and avoid the loss of human life (Holling and Meffe 1996; Calkin et al. 2014; Moritz et al. 2014).

Mass media (including newspapers, television, radio and social media) is the primary and dominant source of public information about wildfires. Media reporting on fires, influences the views, opinions and memories of policymakers and citizens, and therefore has political and social consequences (Soroka et al. 2013; Crow et al. 2017; Anderson et al. 2018; Kroepsch et al. 2018; Cordner and Schwartz 2019). This shapes the way people understand and respond to wildfires (Paveglio et al. 2011). As such, media content analysis is used by social scientists to analyse media portrayals of environmental issues and the associated effects on public audiences (Schäfer 2012; Metag 2016), which can provide key insights into promoting a balanced discourse. The pursuit of maximum readership and the need for fast updates in the age of digital media provide significant challenges for objective and thorough journalistic reporting on fire, and may lead to sensationalism and also premature publication of 'breaking news' (Grundlingh 2017; Usher 2018).

Wildfires are dramatic, compelling and often visually spectacular. They can also be tragic and may stir up emotions. As such, wildfires have high news value, i.e. they combine a number of factors that make them newsworthy. For example, Harcup and O'Neill (2016) suggest a list of 15 contemporary news values that largely determine whether a story will be covered by the news media. The list includes bad news, conflict, surprise, arresting visuals, ability to share via social media, drama (including accidents, searches and rescues), relevance and magnitude. Measured against these news values, it becomes clear why fire events attract considerable media attention. Furthermore, media coverage of wildfires may be characterised by a distinct type of news coverage typically associated with crisis reporting (Anderson et al. 2018; Terracina-Hartman 2020).

In some cases, media coverage may exaggerate or sensationalise fires, but the mass media also provides a way to deliver crucial updates during a fire event, as well as information about fire prevention, safety and recovery to affected or risk-prone communities (Anderson et al. 2018; Cordner and Schwartz 2019). In particular during a time of crisis, citizens rely on the mass media for information and updates (Terracina-Hartman 2020); and, furthermore, it is also in the mass media where the public finds out about ongoing environmental issues, trends and concerns (Boykoff 2009). The inclusion of scientific expertise can help to make media content more credible, reliable and nuanced, and can help people make sense of complex environmental issues (Boykoff 2009). However, earlier studies show that the news media do not necessarily tap into scientists' knowledge and that scientists receive minimal exposure in media reports on fires, thereby limiting their ability to influence policy discourses via the mass media (Ekayani et al. 2016). Ekayani et al. (2016) call for an increase in the participation of scientists as 'speaking actors' and 'issue advocates'. It is therefore important to determine whether, and to what extent, scientists are involved in media coverage on fire, as opposed to politicians, firefighters and other role players.

In this study, we sought to understand the type of media reports about fires in or surrounding South Africa's 19 national parks, the specific topics reported on and the visuals that accompanied these media reports, to understand how this coverage may affect public opinion. To do this, we analysed media portrayals of wildfire and fire-related topics within South African National Parks (SANParks) over a three-year period from 1 April 2018 to 31 March 2021. We were interested to determine:

- Q1: What type of fire-related stories do the media report on, what topics are covered and what visuals are used to illustrate these media reports?
- Q2: Who informs the narrative (i.e. who has a voice) in the mass media discourse on fires in or near national parks?
- Q3: What sentiment is expressed towards fire, as well as towards SANParks, in the context of fire in or near national parks?
- Q4: How much media attention is directed towards the positive and important roles of fires as an ecological process and as a tool to safeguard infrastructure and people from the effects of uncontrolled fires?

Because fire is an opinion-related and emotive topic (Forsyth et al. 2019) bound to draw public and media attention (Harcup and O'Neill 2016), we hypothesised that the media predominantly covered current fire events that posed a direct risk to people, livelihoods or infrastructure, and as such, that the media portrays fire mostly as a foe. We also hypothesised that scientists are mostly absent from the mainstream media discourse and we expected that the sentiment towards fire would be predominantly negative, and by association, sentiment towards SANParks in relation to fire, would also be negative.

Materials and methods

We used media content analysis (as described by Macnamara 2005) to analyse journalistic media coverage of wildfires directly or indirectly linked to SANParks in the South African mainstream media. Media reports were obtained for analysis from PEAR Africa, a South African media monitoring company that monitors a wide range of public and subscription-based mainstream media outlets, consisting of 1 188 print and online publications, 129 television and 124 radio stations. Although social media undoubtedly play an important role in the modern media

landscape, analysing such data sources require different tools than what we employed here and were beyond the scope of the present study. Search terms included 'SANParks', individual park names, as well as the names of spokespersons of SANParks, and included media coverage from the period beginning 1 April 2018 up to 31 March 2021. This initial dataset was refined using the keywords 'burn' and 'fire'. Many supplied media reports were duplicated. True duplicates were considered as media reports by the same media outlet, using the same content, and which were often included in the original database, because of different keywords identifying the same clippings. All such duplicates were deleted. Most media reports were in English, but a few Afrikaans reports were also included.

In the next step, we used the following 'inclusion statement' as a criterion to determine whether a particular media report was relevant to our study or not: 'Fires in national parks (wildland fires and infrastructure fires), or that originated or burned in parts of the park and/or are relevant to fire management in the park (e.g. land-use adjacent to parks that facilitates or retards fires). In addition, media reports related to fires (even if not an actual fire) that reflect on fire and fire management within SANParks'.

After removing media reports deemed to be irrelevant (referring to fire in a different context, for example a 'campfire' or 'shots fired'), and those where links to online articles or broadcasts were no longer available, the number of unique clippings for our analysis was reduced to 390. Some of the media reports referred to the same event, but were retained as separate media reports if they were at least >10% different (subjective assessment). Media reports that made use of the same content, but were presented in different outlets were given the same media report number, but were retained in the database to enable accurate calculations of reach. Therefore, the number of media reports analysed differs from the final number of clippings in the database, which was used to calculate the total reach of each media report.

Codebook, coders and inter-coder reliability

We developed, tested and refined a codebook to guide our analysis of the media articles. The codebook measured the relevance of the article, and identified the key actors in the discourse, the type of media report, ecological concepts mentioned, the portrayal of fire (negative, neutral or positive), the sentiment towards SANParks, the key topics that emerged in each media report, as well as an analysis of the associated visuals. In total, 58 variables were coded for in each media report, as can be seen in the detailed codebook (see the Supplementary Material). For the analysis of visuals in the case of print and online media coverage, we coded all photos that were used to illustrate each media report, but excluded photos linked to social media (mostly via Twitter). In cases where a video was embedded as part of the article, we categorised the still photo from the displayed video. For videos used in broadcast coverage, we analysed the entire visual sequence (all images) in the video clip.

All authors contributed to developing, testing, and refining the codebook. Inter-coder reliability was tested by asking all seven authors to code a subset of 44 media reports (>10% of the total data sample) independently. A reliability test was conducted using two measures: (a) percentage agreement (Bayerl and Paul 2011; Cho 2011) and (b) Fleiss' kappa, using the 'irr' package (Gamer et al. 2019) in R (R Core Team 2020). Percentage agreement remains the most frequent inter-annotator agreement index, because of its simplicity, but with the drawback that it does not account for agreement that could occur by chance. Across all codes, we obtained an average agreement percentage of 92.7% (range 65.6% to 98.6%), with only three of the codes having an agreement percentage of less than 85%. Because two coders did not complete the coding frame fully (i.e. they left blank cells), Fleiss' kappa calculations were based on the remaining five coders. Across all the variables, the average Inter-Rater Reliability (IRR) was 0.553 (n = 48; SD = 0.27), suggesting moderate agreement (Landis and Koch 1977). Some authors argue that the cut-off values are arbitrary (Sim and Wright 2005), because Fleiss' kappa is influenced by other factors, for example, the number of possible codes and how clearly differentiated the codes are from one another (McHugh 2012). Closer inspection of the kappa values for individual variables showed that some scoring was inconsistent. For example, for some media reports there were very little intra- and inter-coder response variability, resulting in anomalies in calculating Fleiss' kappa. When these variables were removed and kappa was recalculated, the average IRR was 0.59 (n = 43; SD = 0.23), suggesting moderate to good IRR (Landis and Koch 1977). These results were used to guide updates and refinement of the codebook to remove ambiguities, in a session attended by all coders. After that, the full dataset was divided equally among the seven coders for the final coding.

Metrics analysed – number of media reports versus reach of media reports

Reach statistics for each individual media outlet were provided by PEAR Africa. Reach statistics are reflective of the maximum potential audience reached by a specific outlet, based on circulation numbers (print), online readership (online media) and viewership or listenership (broadcast). Reach statistics can be used as a weighting metric for assessing the potential impact or penetration of a media report into society. Therefore, in the results below we report both on the percentage of media reports with a particular characteristic, as well as the percentage reach of those media reports. Graphs were drawn in R (R Core Team 2020) using the 'tidyverse' package (Wickham et al. 2019).

Results

Media interest in fires in SANParks (1 April 2018 to 31 March 2021)

The media reports appeared continuously throughout the three-year monitoring period, but with a distinctive peak around October and November 2018 when large wildfires swept through the Garden Route National Park and surrounding areas (Supplementary Material Figure S1). Most media reports appeared in print (51.3%), and the least in broadcast (10%), yet the potential reach of broadcast media (81.9%) overshadowed the reach for the

Table 1: Media sources analysed and reach statistics

	Number (% in brackets) of media reports*	Percentage of total reach	Minimum reach per media report	Maximum reach per media report	Median reach per media report
Online	214 (54.8%)	14.6%	134	1 837 604	28 167
Print	200 (51.3%)	3.5%	1 953	1 210 235	19 041
Broadcast (radio TV)	39 (10.0%)	81.9%	21 000	29 908 215	425 500

* The percentages do not add up to 100%, as some media reports appeared in multiple media types, e.g. in print and online

online (14.6%) and print (3.5%) media reports, respectively (Table 1).

Media reports included in the analysis mostly had fires as a central focus (74.8% of media reports; 95.9% of reach), but a quarter contained just a brief mention to fire (e.g. how a past fire delayed the development of new tourism infrastructure, or hiking trails being reopened after fires) (25.2% of media reports; 4.1% of reach). Only a few media reports (5.6% of media reports; 2.5% of reach) were scored as containing a fair amount of science (i.e. in-depth and scientifically founded media reports).

Although media monitoring was designed to pick up media reports mentioning any of the 19 national parks in South Africa, two parks dominated the media coverage. During our study period, these were the Garden Route National Park (41.3% of media reports; 53.7% of reach) and Table Mountain National Park (33.8% of media reports; 23.1% of reach). Several media reports did not mention a specific park and only mentioned SANParks in general (76 media reports; 22.6% of reach). Only two other parks were mentioned, namely Kruger National Park (23 media reports; 0.7% of reach) and Mokala National Park (three media reports; 0.01% of reach).

Actors informing the narrative

SANParks, the management authority on whose land many of these fires occurred, was the most prominent voice consulted or quoted (38.2% of media reports; 53.6% of reach) (Figure 1). SANParks was represented by organisational spokespersons, park managers, scientists, rangers, and firefighting teams or through official media releases. The second most common voice heard was from those that coordinate or conduct fire suppression (i.e. firefighters, firefighting groups and disaster or joint management teams or centres) (34.1% of media reports; 26.1% of reach). Although fire victims were a relatively minor actor in terms of the number of media reports in which they were consulted, interviewed or quoted (6.9% of media reports), they were the second most prominent group, based on reach statistics (44% of reach). This large discrepancy between the percentage of media reports and percentage reach is as a result of the broad reach of broadcast media outlets who interviewed victims of fires. A diversity of other groups (e.g. 'Friends of ….' groups, volunteers, municipalities, special interest groups, members of the public) (31% of media reports; 26% of reach) also informed the fire narrative.

A central result from our study is that scientists (i.e. actively working as scientists and/or identified by the media as scientists) made contributions to only 34 (8.7%) of the 390 media reports, with a reach of 2.3%. The media reports

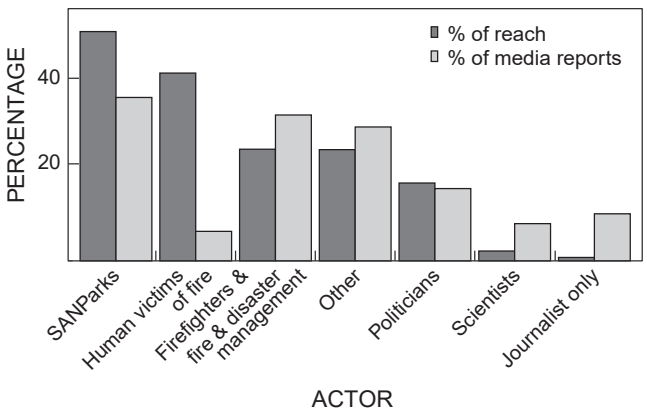

Figure 1: Actors informing the media narrative regarding fire in SANParks. Scientists had a limited footprint in reaching society through the mass media.

with input from scientists with the highest reach (>100 000) are reported in the Supplementary Material (Table S1).

Type and relevance of media reports

As expected, current fire events ('news events') received the most media attention (48% of media reports; 74.5% of reach). Media reports reflecting on previous high-profile fire events also received a significant amount of media attention (21.5% of media reports; 19.2% of reach). For example, various of the 2018 media reports reflected on the Knysna fires that burnt more than 15 000 ha in four days in June 2017 along the southern Cape coast of South Africa, resulting in the deaths of seven people and the destruction of more than 800 buildings and >5 000 ha of commercial forestry plantations (Kraaij et al. 2018). Although a fair number of media reports were dedicated to medialised reporting (e.g. reporting on events, but not relating to a specific fire event, such as deploying fire teams in parks, burning firebreaks, profiling a firefighter) (24.6% of media reports), these media reports did not often make it into the high-reach media outlets (only 6.0% of total reach). Most media reports could be adequately captured by the three aforementioned media report types (i.e. current fire events; past fire events and medialised reporting), with only 9.4% of media reports (1.4% of reach) falling outside of these categories (e.g. popularisation of science).

Scientists were rarely involved in media reports about current fire events (only two media reports; 5.9% of all the media reports involving scientists), as opposed to 16 media reports (47% of all media reports involving scientists)

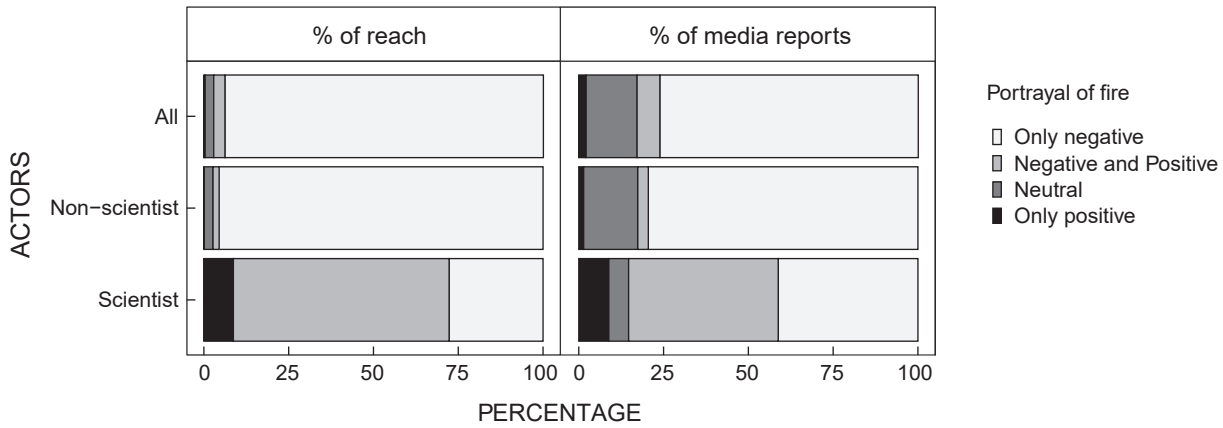

Figure 2: Portrayal of fire (positive or negative) in media reports that include scientists as actors and those that do not. Media reports without scientists' involvement focussed almost exclusively on the negative effects of fires, whereas reports that contained inputs from scientists were more nuanced, mostly reflecting on both the positive and negative effects of fire within the same report

reflecting on past fire events. The remainder of scientist media reports were either medialised reporting or other types of stories (e.g. the popularisation of fire science).

Sentiment towards fire and land management authority (SANParks)

When considering all 390 media reports, the vast majority of reports only mentioned the negative effects of fire, such as damage or risk to human infrastructure or health (76.2% of media reports; 93.9% of total reach). In contrast, very few media reports mentioned any positive effects of fires (8.7% of media reports; 3.5% of total reach) (Figure 2). However, the subset of 34 media reports involving scientists, reflected a more nuanced view of fire, with 63.6% of these reports detailing both positive and negative effects of fire (Figure 2).

Most media reports did not express a specific sentiment towards SANParks (51.8% of media reports; 59.9% of reach) or expressed a neutral sentiment towards SANParks by describing the SANParks response or actions without expressing a positive or negative judgement (32.1% of media reports; 12.6% of reach) (Figure 3). The media reports reflecting a negative sentiment towards SANParks (5.6% of media reports; 14.5% of reach) focussed mostly on two events that occurred over the three-year study period (Figure 3). In a certain event, eight people died in a large wildfire in October and November 2018 in the Garden Route National Park, with some victims blaming SANParks for allegedly not warning them in time, not fighting fires early enough and for not maintaining firebreaks and fire equipment at the staff housing where the tragedy occurred. Three fires that destroyed infrastructure in SANParks (a restaurant and a shop in Kruger National Park and another restaurant and shop in the Garden Route National Park) in three separate events within two weeks of each other also attracted negative sentiment towards SANParks, including speculation about arson with staff unhappiness posed as a potential cause, and even resulted in attracting political attention. Other

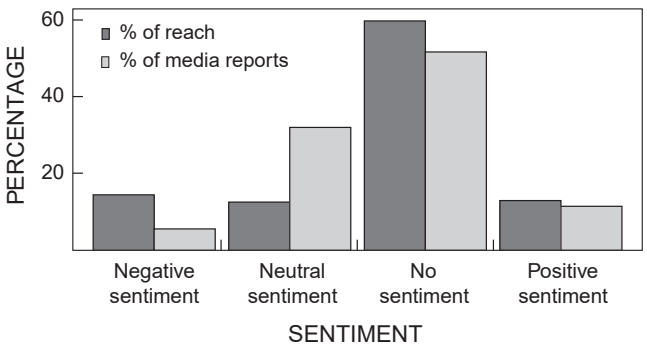

Figure 3: Sentiment expressed towards SANParks in media reports about fires within national parks. In most cases no sentiment was expressed, and where negative sentiment was expressed, it was mostly focused on a couple of isolated events (see text for details).

media reports with negative sentiment revolved around allegations that SANParks does not manage its land well and are negligent, accordingly increasing fire risk in certain areas.

Topics expressed and visuals used in media reports with and without scientists' involvement

The top five topics (each with >30% of total reach) included in the media reports were updates on current fires, fire suppression (i.e. reactive firefighting) and the losses and/or damage and/or threats fires cause to infrastructure, health and vegetation (Figure 4). This focus on fire suppression and the negative impact of fire was also reflected in the categories that were often used to illustrate the fire reports, with photos or videos of firefighting equipment, burnt or damaged infrastructure, victims and firefighters all having reach of more than 30% (Figure 5). When considering the subset of media reports that included inputs from scientists, the prominent topics change to a focus on fire ecology, proactive fire risk reduction, and fire education and awareness tips. The media reports involving scientists

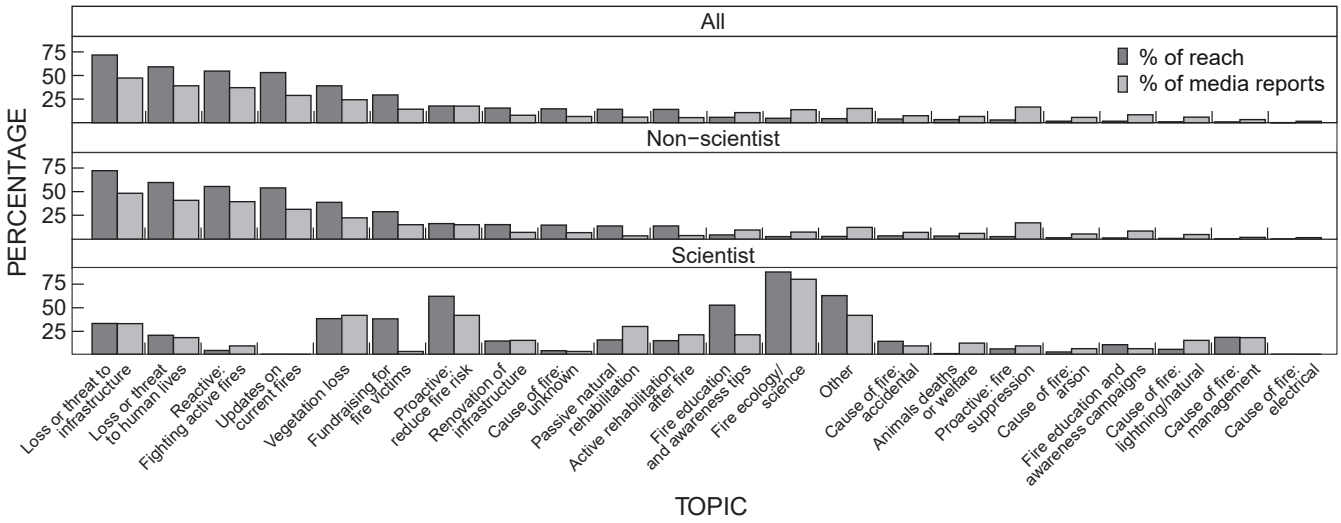

Figure 4: Topics addressed in media coverage involving scientists and not involving scientists, expressed as a percentage of reach. Non-scientists focussed mostly on damage, losses, or threats of fire to infrastructure, human lives and vegetation, as well as updates on current fires and efforts in suppressing them. Scientists focussed mostly on fire ecology, proactive fire risk reduction, and fire education and awareness tips, as well as a range of other topics (e.g. climate change)

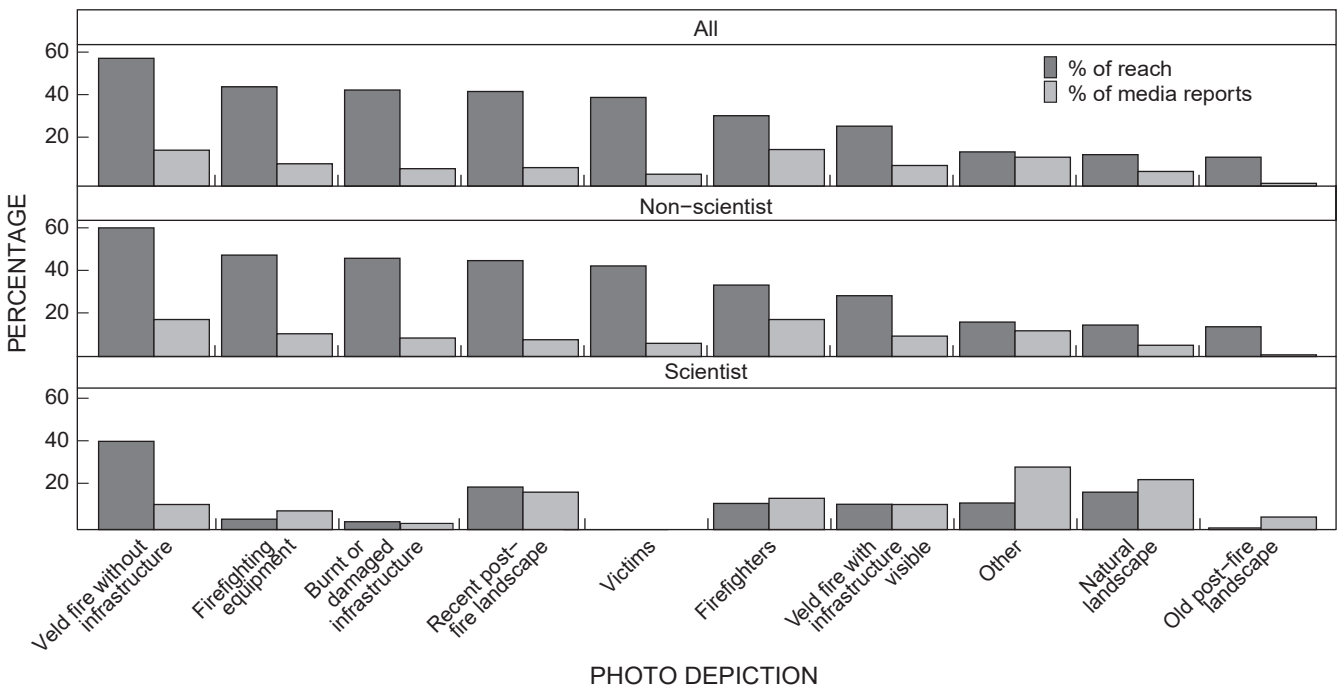

Figure 5: Visuals accompanying media reports. Media reports incorporating scientists' input used fewer visuals, and these visuals focussed less on fire suppression efforts (e.g. firefighting equipment) and damage (human victims and infrastructure) than the reports that did not include scientists

also make less use of photos of fire suppression and fire damage to infrastructure or victims when illustrating the reports. Photos of areas that recovered from earlier fires were rare both for scientists' and non-scientists' media reports, and present an opportunity for providing important perspectives on post-fire recovery and resilience in future media reports on fire. The 'other' category included a range of visuals (e.g. satellite image of fire scar, funeral of victims), but often included photos of people involved or asked for opinions (e.g. politicians, experts, municipal office-bearers).

Key fire ecology concepts, including the benefits of fire, fuel load (among others the role of alien plants in increasing fuel loads), and fire regime (including fire return

period or fire season) were frequently mentioned in media reports that involved scientists (close to 80% of reach of all scientists' media reports), yet these concepts received limited attention in reports that did not involve scientists (typically <10%; Figure 6). Scientists also mentioned other ecological concepts (noticeably climate change) that did not feature in non-scientists' media reports.

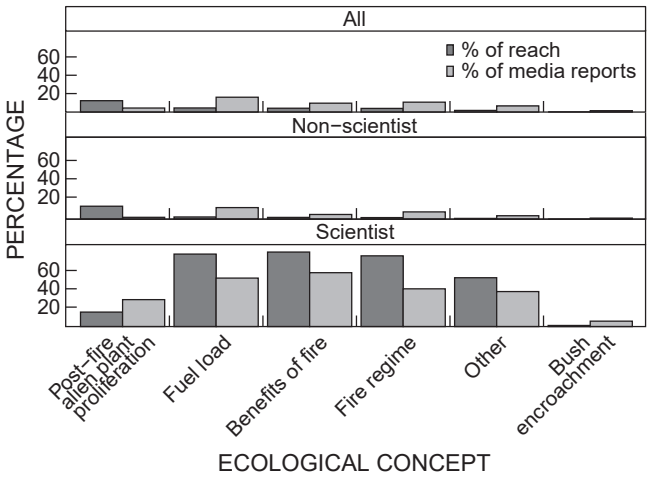

Figure 6: Key ecological concepts addressed by media reports involving scientists, compared with reports not involving any scientists. In media reports including inputs from scientists, fire ecological concepts important for contextualising and understanding fire risk and management responses were prevalent, whereas these concepts were virtually absent from those reports that did not include input by scientists

Discussion

Journalists tend to pick up a wildfire news lead based on the perceived danger or threat level (Terracina-Hartman 2020) and as such, media coverage of fire is dominated by reports from fire-prone regions exhibiting high population densities and where lives are lost or at risk (Doerr and Santin 2016). This was also observed in our study, with most of the media reports originating from fires occurring at the wildland-urban interfaces (i.e. the Table Mountain and Garden Route National Parks), with less than 1% of the total reach of media reports from fires in rural parks, even though some of these parks, such as the Kruger, Marakele and Golden Gate Highlands National Parks, are highly fire-prone and burn frequently. For example, close to 280 000 ha (average of 4.8% of total park area per year) burnt in the Kruger National Park during the study period (<1% of reach), as opposed to 44 036 ha (average of 11.1% of total park area per year) in the Garden Route National Park (53.7% of reach) and ~650 ha (average of 0.9% of total park area per year) in the Table Mountain National Park (23.1% of reach), respectively.

Both the themes and the visuals from the media reports focussed mostly on updates on current fires, suppression of these fires and the loss, damage or threat of these fires to infrastructure and human health or lives. Earlier studies (e.g. Martin et al. 2007; Paveglio et al. 2011) highlight the importance of private property to society and hence the threat to private property as a significant and dominant frame for wildfire, which creates a narrow capitalistic focus (Terracina-Hartman 2020) on physical and economic affects (Walker et al. 2020). Strong beliefs in fire risk vulnerability and severity arouses the motivation to protect oneself and one's property (Martin et al. 2007). This type of discourse that continually emphasises the costs or personal financial loss can lead to resentment and decreased social cohesion (Terracina-Hartman 2020).

Although Parks (2018) has warned against journalism education encouraging an emphasis on disasters, our results, showing that fires are overwhelmingly portrayed as negative (i.e. fire as foe) in the media, is in line with media portrayal of fire in other parts of the world (e.g. Walker et al. 2020). Such a focus on conflict and bad news fosters a distorted sense of social relations, increases fear, and depresses civic participation (Parks 2018). As such, one can speculate on how the current fire framing, with a dearth of information about wildland fire as an inevitable, natural and beneficial process, would influence society's perspective of the role of fires in national parks.

Similarly to earlier studies (Paveglio et al. 2011; Ekayani et al. 2016), we found that scientists did not have a strong voice in fire narratives portrayed in the media. Doerr and Santin (2016) recommend that the scientific community should be involved in the narrative and provide an objective basis for society to understand and judge the consequences of the choices made in managing, modifying and coexisting with fire. These studies emphasise that scientists can and should become actors in the media discourse around fire, thereby improving the reliability of media information and helping to inform fire policy debates. This was noticeable in our study where we found that the addition of scientists as actors or writers in media reports, provided a more balanced portrayal of wildland fire (i.e. fire as friend and foe), utilised different visuals and introduced key ecological concepts. Without scientists' involvement, these concepts were largely missing and the media portrayal of fire was overwhelmingly negative, which is unlikely to foster policy that enables or promotes ecological burns or acceptance of fire as part of the landscape with potential benefits as well as the accompanying reduction in risks. Likewise, a lack of information, communication or coverage of ecological burns and their benefits, but coverage of uncontrolled wildfires promotes scepticism from landowners as to the benefits and applicability of ecological or controlled burns (Winter and Fried 2000; Loomis et al. 2001).

SANParks, the manager of the fire-affected land in our study, was often quoted in or provided information for the media reports. This provided an important opportunity for the organisation to influence the narrative around fires. Because SANParks is a conservation organisation that employs various scientists and fire ecologists, it is an organisation that appreciates the inevitability of fires, the importance of pro-active fire management and the ecological benefits of fire, while at the same time also being acutely aware of the risks and damages of uncontrolled wildfires, with infrastructure damage and lost lives also part of the organisational experience and memory. It was therefore surprising at first that even the media reports incorporating inputs from SANParks were overwhelmingly negative

towards fire and focussed on fire suppression and the risks and damage of fire to humans and their infrastructure. There can be various reasons for this. Firstly, media attention is often drawn to fire disasters (e.g. where people lose their lives or where infrastructure is damaged), and in such cases it would be inappropriate for SANParks to include the ecological role and benefits of fire or focus on pro-active fire management. As such, the fire events that are naturally well covered by the media are negative by their very nature. A proactive recourse could be to stimulate media coverage containing key messages and a more balanced view of fire at the start of a fire season and in anticipation of ensuing fires. Secondly, the timing of requested media input within the timeframe of a fire event, and the type of questions being asked do not always necessitate or allow for the involvement of scientists. Because SANParks was most often contacted for inputs during unplanned fire events, the media focus would naturally be on damage, potential risks and on fire suppression. In such instances changing the narrative would require not simply answering the typical questions (e.g. related to area affected, fire suppression efforts and risks), but also pro-actively providing content (e.g. the inevitability of fire, importance of pro-active fire management, and, when appropriate, the ecological importance of fires).

Terracina-Hartman (2020) shows that scientists only became prominent in the discourse later on, which was mostly the case in our study as well. However, that may often be too late, as the 'frame adopted in initial news reports persists, with potential to serve as a primary source of public knowledge'. As such, if possible, it is important to get a more nuanced view of fire early on during an event (or even before one takes place), which means that scientists and spokespersons need to be ready to join the conversation early and pro-actively. This will of course be context specific, as it would be insensitive and inappropriate to engage early on regarding benefits and the ecological role of fires when wildfires are threatening or destroying human livelihoods. Terracina-Hartman (2020) concludes that the fire discourse must include bigger-picture factors, such as climate change, and here we propose that it also should include key ecological concepts that will allow the public to understand the inevitability of fires in fire-prone landscapes (Moritz et al. 2014), the importance of proactive fuel-reducing measures (including management burns), additional precautions to adhere to on high fire danger days and the ecological importance of appropriate fire regimes.

We identified four main pathways in which scientists can inform the fire narrative in the media, which is further complemented by ten practical tips for scientists to work effectively and pro-actively with the mass media (see Box 1). The first and most obvious one is to provide research updates and popular summaries of research articles in a media-friendly format, focussed on the information needs of journalists and direct relevance to their audiences. One example in our study is a range of online and print media outlets that published a popularisation of a scientific publication that appeared in the journal 'Fire Ecology' (Kraaij et al. 2018). These media reports highlight the role that alien invasive vegetation played in the spread and intensity of the 2017 Garden Route wildfires, which is an important message to share with society. Likely as a result of the fact that the science was linked to an earlier high-profile fire, the Kraaij et al. (2018) publication drew considerable media interest. Similar scientific studies that are not linked to a high-profile fire event, are likely to attract less media attention.

A second way for scientists to inform the fire narrative is to write opinion or perspective pieces in anticipation of fires (e.g. 'How Kruger National Park is preparing for its winter fire season', published online in May 2021 on IOL) or after high-profile fires (e.g. Van Wilgen and Van Wilgen-Bredenkamp 2021). Similarly, media reports about planned fires, and providing reasons for burning can be used to keep the public interested and informed and provide more nuanced perspectives of fire, but without the emotive, uncertain and fearful context that often prevails during dramatic unplanned wildfires (e.g. 'Residents warned about TMNP's controlled fires across the metro in July', published online in July 2019 on IOL). We agree with Loomis et al. (2001) that benefits of prescribed burning should receive greater media attention, because the lack of coverage of successful prescribed burns can potentially contribute towards a distrust towards these fires displayed by homeowners (Winter and Fried 2000), especially if wildfire dominates the media discourse, as shown in this study.

Thirdly, nuanced media reports reflecting on past high-profile fire events can be effective to provide a more balanced perspective regarding fires. For example, we found various media reports reflected on the 2017 Knysna wildfires around its anniversary date. Once the emotions and newsworthiness have subsided, society may be receptive to reflect more deeply and rationally on past fire events and also be more convinced of the ecological restorative and beneficial roles that those fires may have brought about. For example, Kroepsch et al. (2017) found that the anniversaries of notable wildfires present ideal opportunities for critical reflection and future mitigation planning in the mass media. However, Nilsson and Enander (2020) found that the media's initial focus on the causes of fire and its escalation later shifts to focussing on poor management or response, and hence negative sentiments can increase over time. Clearly context is critical, and appropriate pre-emptive communication is needed about fire events, during events and after events, to provide balanced perspectives.

Because of the timeframes associated with research projects, scientists may also feel more empowered to engage meaningfully with the media with scientific findings resulting from studies into the fires, sometime after these events. This has also been observed in our study, where most of the reports involving scientists were reflective of historic fire events, as opposed to current fire events. These reflective media reports should of course never minimise or be insensitive to the real human trauma and economic suffering brought about by these fires, but could, where appropriate, provide the nuance of the inevitability of fires, the ecological benefits and the lessons learned to reduce loss of lives and damage to infrastructure in future.

Finally, a fourth and indirect way for scientists to influence the fire narrative is by actively engaging with high-profile actors or spokespersons that are often contacted for information during fire events. If specific journalists that often write stories on fires in a specific region, or SANParks spokespersons and firefighting chiefs, are continuously

Box 1: Ten tips for scientists to work effectively and pro-actively with the mass media

1 To work effectively with journalists, **you have to be a media consumer yourself, and you must vary your media diet**. In other words, get to know the printed, online and broadcast news sources that report on fire in the region where you live and work, the different types of stories they carry and the style of their reporting. Make time to get to know the community radio stations in your area – these radio stations provide an opportunity to engage local audiences with phone-in programmes.

2 The next step in becoming a trusted media source, is to **build relationships with key journalists.** Make a note of the names of journalists who report on fire in your region, so that you can reach out to them during a fire event, or when you have new fire research findings. Looking at the names of journalists included in the media database we analysed for this study, there were 229 journalists who produced fire-related media reports during our study period, with 30 of them involved in five or more reports. You can contact these journalists via their news organisations, but it is also easy to connect with them via social media.

3 It is part of the job of organisational spokespeople to interact with journalists. **Invest time and effort in getting to know the spokespeople in your organisation,** and make sure they know that you are available and willing to be interviewed. Also make sure they understand the key messages around fire and fire ecology concepts, so that they can also assist in spreading a more nuanced perspective on fires and the ecological benefits of fire.

4 **Well-written and well-timed press releases trigger media interest**, especially if they are written clearly and supported by engaging visuals. A press release can attract attention to new research, but it is important to start preparing it as soon as a new research paper is accepted, so that it can be issued on the day that the research is published.

5 '*The Conversation*' is a so-called **science amplifier**, because all the content is free-to-reuse by other media. Writing for this platform means that your research can be picked up and used by print media around the world, and you may also be contacted for radio and television interviews. Get to know what other scientists have written for this platform, for example by searching for 'fire' on the Africa edition '*The Conversation Africa*'.

6 **Be available** in the days after issuing a press release or publishing an article on a platform such as *The Conversation*. Make sure your contact details are provided in press materials.

7 **Do not go into a media interview unprepared.** Thinking about a few basic questions in advance will increase your confidence and will make the interview more relevant and engaging. Once you know who will interview you, find out as much as you can about the audience of this media outlet. Then, ask yourself (and write down the answers): (1) What are the three most important things I would like to communicate with this specific audience about this topic? (2) If I put myself in the shoes of the audience, what are the three things they are mostly likely to want to know? (3) Is there anything they could misunderstand (or object to) unless I emphasise the correct information? Prepare for your interview with all three these questions in mind. Keep it simple, and practice easy-to-understand messages that are free of scientific jargon. Come back to these prepared messages during the interview.

8 **Make it personal** (say how you feel, why you care about this issue, what you are worried about, what you are optimistic about, etc.). Telling a quick, personal story is one of the most memorable and engaging interview approaches.

9 Preparing for a media interview by thinking about the audience will also help you to **anticipate their responses and prepare how you will respond.** Especially when you work on a contested topic (such as fire), it is likely that there will be some negative and critical responses. Be prepared to listen to people's concerns respectfully, and respond calmly.

10 Finally, keep in mind that scientific jargon is a barrier to understanding, signalling to people that the content is not aimed at them and switching off their interest (Shulman et al. 2020). Therefore, when writing for a public audience or during a media interview, it is essential to conquer the skill of **getting rid of jargon**. To do this, think of the terms that you commonly use that people outside your field are not likely to know. Then, practice everyday terms and explanations to replace them, or use metaphors where appropriate. For example, instead of calling yourself a 'fire ecologist', rather say 'I study the good and bad effects of fire'. Instead of 'fuel load', discuss 'the amount of plant material that is dry enough to burn'. Instead of 'fire season', mention the exact month(s) of the year when you expect fire in the area of interest.

engaged by scientists regarding the biases on fire in the media and the importance of a more nuanced perspective and a better understanding of fire, these non-scientist actors can also reinforce some of the key messages. Scientists can also sensitise journalists and spokespersons towards changing emotive terminology that reflects particular biases towards more neutral terminology (e.g. 'hectares burned' instead of 'hectares destroyed'). These roles of scientists are very important to make journalists and spokespersons knowledgeable about fire ecology and a few engagements may potentially have a large impact in future media reports.

Despite some scientists' concerns about working with the mass media, evidence is emerging that media exposure may have positive effects on their careers and scientific reputations, resulting in the recommendation that scientists seek out engagement opportunities pro-actively and strategically, instead of waiting for journalists to approach them (Peters 2013). In the South African context, scientists

may also be motivated towards media engagement by the desire to share their passion for the natural environment, as well as a moral duty to give something back to society and combat misinformation (Joubert 2018).

There is a need to recognise fire-prone landscapes as social-ecological systems, because of the complex relationship between fire-dependent landscapes and communities (Spies et al. 2014). Such recognition may facilitate the development of more effective policy and management approaches (i.e. adaptation and mitigation frameworks) to deal with fires, and encourage the development of fire-resilient communities (Moritz et al. 2014; Smith et al. 2016; Schoennagel et al. 2017). A well-informed society, or a 'more knowledgeable citizenry', as suggested by Holling and Meffe (1996), which views fire as both a friend and foe will be able to understand the ecological need for fires, as well as the need to minimise fire risk to properties and lives. These fire-resilient communities will be more likely to support appropriate proactive fire management in order to safeguard themselves against large, uncontrollable wildfires (Forsyth et al. 2019). This social acceptance can only be achieved through appropriate and accurate information sharing (Steelman and McCaffrey 2011; Toledo et al. 2013), in which the media may have the greatest influence. Failure by the media to contextualise or discuss relevant issues adequately may create gaps between the perspectives of the public and of fire managers (Cordner and Schwartz 2019) and policymakers (Ekayani et al. 2016). Therefore, responsible journalism, as well as accessible science, is key in promoting a collaborative effort between scientists and journalists to encourage communities to coexist with fires.

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