



Research article

Communicating conservation: how do the Nepalese print media portray caterpillar fungus? An analysis of newspaper coverage from 2008–2021

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ABSTRACT

Caterpillar fungus (*Ophiocordyceps sinensis*) makes an economically important contribution to livelihoods of the local people in the Himalaya. Its extraordinarily high market price as an aphrodisiac, and pressure in the natural habitats due to overharvesting and climate change, have attracted local and global media attentions. Despite the wide media coverage on various social and environmental aspects of the caterpillar fungus, a consolidated analysis of the news and featured articles about the different dimensions of the caterpillar fungus is lacking. In this paper, we assess how the Nepalese print media have portrayed the social, economic, governance, and biological dimensions of caterpillar fungus conservation and management. We conducted a thematic analysis of newspaper articles published for fourteen years from 2008–2021 in seven national daily newspapers in Nepal. We used an inductive method to extract the keywords from the printed newspapers, resulting in 3,777 keywords from 681 news items belonging to eight thematic areas. Based on the similarities and differences in the keywords, the news items were categorized into eight themes: impacts of caterpillar fungus harvesting (28% news coverage), trade of caterpillar fungus (16%), general information about the fungus (15%), harvesting of the fungus (14%), governance mechanisms (14%), challenges to the harvesters (6%), policy gaps (4%), and institutional and policy responses (3%). We found that Nepalese media highlighted the socio-economic and environmental impacts of caterpillar fungus harvesting but presented less information about the government response to its conservation, gaps in knowledge and governance mechanisms necessary to conserve the fungus. The thematic analysis of media reporting can help in devising long term conservation and management policies of the caterpillar fungus, particularly focussing on the issues frequently reported by the national media.

1. Introduction

Ecosystem services, also called nature's contribution to people, are the goods and services provided by the natural world for human wellbeing. The caterpillar fungus (*Ophiocordyceps sinensis*), a medicinal fungus popularly known as *Yarsagunbu*, is one ecosystem goods in the Himalayan region. It is one of the most valuable biological resources in the world, having a multibillion-dollar global market (Shrestha, 2012; Hopping et al., 2018; Winkler, 2009; Shrestha, 2014; Wang et al., 2018). It is an ecologically unique fungal-caterpillar complex formed by an endo-parasitic relationship between a fungus and host larvae of several species of moths belonging to the genus *Thitarodes* (Winkler, 2009). The caterpillar fungus is found in the alpine pastures of the Himalayas and the

Tibetan Plateau at elevations of 3000–5000 m above sea level (masl). Local people in this region have used it for centuries as a traditional medicine to treat kidney and lung problems and to enhance vitality (Zhang et al., 2012; Li et al., 2011). Recent decades have witnessed an upsurge in the trade of the caterpillar fungus primarily for its use as an aphrodisiac, sometimes called 'Himalayan Viagra' (Winkler, 2009; Holiday and Cleaver, 2008).

Anthropogenic drivers such as climate change and overharvesting have caused pressure on the natural habitats of caterpillar fungus (Hopping et al., 2018) resulting in a population decline. It has recently been ranked as 'vulnerable' in the International Union of Nature Conservation (IUCN) red list of threatened species (Yang, 2020). Previous studies on the caterpillar fungus have investigated different aspects of the

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fungus such as contribution to the household income (Shrestha and Bawa, 2014a; Timmermann and Smith-hall, 2020), management (Shrestha et al., 2019; Childs and Choedup, 2014), trade and harvesting (Shrestha et al., 2019; Pyakurel et al., 2018), and governance and institutions (Pant et al., 2017). These studies have highlighted the significant contribution caterpillar fungus makes to household income, the increasing trade and demand in recent times, the emergence of community-based institutions for caterpillar fungus management, conflicting tenure of the caterpillar fungus habitats, and anthropogenic pressure in its natural habitats.

Interestingly, annual income from caterpillar fungus in *Darchula* district, Nepal, is higher than the district's annual budget (Pouliot et al., 2018). Winkler (2008) claimed that caterpillar fungus trade accounted for USD 225 million of the Tibetan autonomous region's GDP in 2004 (Winkler, 2008). The economic contribution that the caterpillar fungus makes to mountain household income and the national economy is

Table 1. Description of different themes.

Themes	Description
General Information	Articles having general information on caterpillar fungus such as its geographical locations and habitats, the bioclimatic condition of the mountain pastures, facilities (e.g. hotel services in the pasture), economic value of the species, poverty in the mountain regions, and scientific information about the species.
Harvesting of caterpillar fungus	Articles that discussed the duration of harvesting, harvester demography, harvesting information, quantitative information about harvests, start and end dates of the harvesting season, technology and techniques used for harvesting, and overcrowded pastures.
Trade of caterpillar fungus	Articles related to the demand for the species, illegal trade of the species, and market information of the caterpillar fungus, temporal dynamics of price, temporal dynamics of the number of traders, trade income, trade volume, trading mechanisms, value addition, tax evasion and value chain.
Impacts of caterpillar fungus harvesting	Articles related to issues of conflict, criminal and unethical activities, ecological degradation (forest destruction, soil compaction, solid waste), economics (household income, per capita income), social impacts (school closure, local developmental activities carried out due to caterpillar fungus revenue), and agriculture abandonment to collect the caterpillar fungus.
Policy gap	Articles that measured or discussed gaps at the policy level concerning caterpillar fungus management and harvesting plans and guidelines, provided recommendations for improvement concerning data gaps, knowledge gaps or ineffective monitoring, the need of research, the lack of implementation of policy at the local level, and operational and institutional shortcomings.
Governance mechanisms	Articles related to resource governance of caterpillar fungus including the amount of revenue, the revenue rate, the formation of local management committees, rules and procedures made by local governing bodies, revenue contribution to the mountain villages, revenue sharing mechanisms, temporal dynamics of the revenue amount, temporal dynamics of the revenue rate, and restriction in collection due to COVID-19.
Institutional and policy responses	Articles related to the conservation initiative, control of criminal and unethical activities, establishment of checkpoints and increasing security provisions, data collection, local management, mobilisation of security forces, provision of health facilities, policy guidelines and research initiatives.
Harvesters challenges	Articles related to the environmental, climatic and topographic challenges faced by the harvesters including death of harvesters, disaster events in the caterpillar fungus habitats, insecurity in the pastures, food and water shortages faced by harvesters, bad weather conditions, poor health facilities in the pastures, weak telecommunication in the pastures, incidences of insecurity and vulnerability of harvesters, and species collection affected due to COVID-19 pandemic.

substantial. Harvesting caterpillar fungus contributes to over 53% of the total household income in *Dolpa*, Nepal (Shrestha and Bawa, 2014a). In other region, 80–100% in five villages in Bhutan (Wangchuk et al., 2012), 70–72% in 58 villages across Tibet; 50 households in Western Sichuan, China (Wang et al., 2018; Woodhouse et al., 2014; Winkler, 2008) and 74% in 32 villages of Nanda Devi Biosphere Reserve in Western Himalaya, India (Yadav et al., 2019). Similarly, a recent field study in *Maikot*, eastern *Rukum*, Nepal found an average of 75%–80% of total household income came from the harvesting and sale of the caterpillar fungus (Poudel, 2020).

The caterpillar fungus is harvested every year between late spring and early summer by hundreds of thousands of people living in the mountains of Bhutan, China, India, and Nepal (Shrestha et al., 2019). In Nepal, most harvesters belong to marginalized and poor mountain communities living in 27 northern districts (Thapa et al., 2014). However, the high economic significance and increased trade of caterpillar fungus have recently added pressure in the natural habitats (Shrestha and Bawa, 2013; Cannon et al., 2009; Hopping et al., 2018). The overexploitation of the resource due to its high economic and medicinal value, locally, nationally and globally has led to resource decline and considerable media attention in the regions where it grows (Watts, 2010; Schultz, 2016; Jane, 2013; Greenwood, 2016; Hopping et al., 2018).

New policies, guidelines, and management plans have been developed in Nepal at the federal level to prevent and reduce overharvesting. Evolving community-based institutions at the local level have also emerged to manage the harvest of caterpillar fungus (Pant et al., 2017; Poudel, 2020). As part of policy development, Nepal drafted its Caterpillar Fungus Management Directives in 2017 (DNPWC, 2017), which is considered a major milestone for conservation and management of the fungus. There are other policies in Nepal regulating caterpillar fungus management, harvest and trade to prevent resource-based conflict and promote community based management practices (see Table 2 in Supplementary Material A).

Newspapers and other media sources are considered powerful and influential actors in shaping the public understanding of environmental issues including water sustainability (Thompson-saud et al., 2018; Johns

Table 2. Key legislative policies on caterpillar fungus.

S. No.	Act/Rule/Directives	Legal Status
1	Forest act 1993 (Forest Act, 1993)	Totally banned for the caterpillar fungus harvesting.
2	Nepal Gazette 2001 (GON/MoFSC/DoF, 2001)	Banned for export in crude form and royalty rate NRs 20000/kg fixed.
3	Nepal Gazette 2004 (GON/MoFSC/DoF, 2004)	No requirement of processing and royalty rate NRs 20000/Kg of the species.
4	Nepal Gazette 2006 (GON/MoFSC/DoF, 2006)	Royalty rate reduced to 10000/kg
5	Himalayan National Park Rule 1979 (first amendment 2014) (Himalayan National Park Rule, 1979)	Defined Rara, Shey-Phokshundo and Malaku-Barun National Parks under this rule and regulate harvesting permits, harvesting time periods and trade on Yarsagumba and other Non-timber forest products (NTFPs) inside Himalayan protected areas.
6	Nepal Gazette 2016 (GON/MoFSC/DoF, 2016)	Royalty rate increased to 25000/kg
7	Yarsagumba Management (harvest and trade) Directives 2017 (DNPWC, 2017)	Ensure the caterpillar fungus harvesters age, harvesting time duration prohibited actions under range lands. trader should take last 60 days of the caterpillar fungus transfer permit for more 30 days of maximum time periods.
8	Nepal Gazette 2018 (GON/MoFSC/DoF, 2018)	Royalty rate increased to 30000/kg

and Jacquet, 2018), marine conservation (Thompson-saud et al., 2018), climate change (Schmidt et al., 2013), forest conservation (Park and Kleinschmit, 2016), and wildlife trade (GAO et al., 2016; Brackzowski et al., 2018). News media are also a platform for analysis of critical environmental issues such as lack of regulation and legislation, and strategies for environmental protection (Kushwaha, 2015). The issues raised by media help to inform decision and policymakers on challenges and controversies concerning the environment (Thompson-saud et al., 2018). However, failure of the media to accurately frame information and content may be problematic when covering environmental and scientific topics (Boykoff and Boykoff, 2007). Media coverage that is either too alarmist or optimistic may enhance ignorance, build despair, monger fear, and create negative attitudes among the public towards environmental concerns (Johns and Jacquet, 2018; Bombieri et al., 2018).

In recent years, there has been increased analysis of media content and how the media frames news on environmental issues. By analysing US newspapers and television coverage of climate change, Boykoff and boykoff (2007) showed that journalistic activities shaped the interface of climate science, policy, and the public (Boykoff and Boykoff, 2007). On ocean-related issues, Johns and Jacquet (2018) found that optimistic language outnumbered doom and gloom language in articles published in mainstream US newspapers (Johns and Jacquet, 2018). The way in which environmental issues are framed can be critical for their interpretation. For example, news coverage on the largest ivory destruction in history at Kenya in 2016 was portrayed by some media as a positive conservation action, while others reported it as harming elephant conservation (Brackzowski et al., 2018). News media can also be biased. For example, when covering predator attacks on humans, the media can provoke fear rather than provide insights into the cause of the attacks and possible remedies (Bombieri et al., 2018). Therefore, thematic analysis of the media content can help inform how the media plays a role in prioritizing issues which, in turn, shapes public perceptions.

The investigation of media coverage of caterpillar fungus harvesting provides an opportunity to better understand public perceptions of the socio-economic and biophysical implications of caterpillar fungus harvesting and trade. This may influence policymakers when designing and implementing conservation policies and management options. Despite extensive media coverage of the caterpillar fungus, a thorough analysis of how caterpillar fungus-related issues are portrayed in the media is lacking.

In this paper we present the first assessment of media reporting on caterpillar fungus in Nepal. We analyse how social, economic, governance, and biological dimensions of caterpillar fungus have been covered, framed, and communicated in the news from 2008 to 2021. We specifically focus on two aspects: first, how the media portrays issues surrounding caterpillar fungus conservation and management (i.e., sustainable harvesting); and second, whether issues raised through the media concerning caterpillar fungus conservation and harvesting practices are addressed through institutions and policies. It helps the understanding of how the media shapes public perceptions of the caterpillar fungus conservation and management. This analysis will translate messages drawn from news published by the media into relevant information for policy, scientific inquiry, and local level conservation planning. Additionally, this analysis of media reporting on caterpillar fungus provides insights to guide journalists to frame news related to the caterpillar fungus more accurately.

2. Materials and methods

We examined 681 news reports on caterpillar fungus published in seven major daily newspapers from 2008 to 2021 in Nepal.

2.1. Data

Newspaper reports published from April 2008 to June 2021 (total 681 news clips) in seven major daily Nepalese newspapers (*Annapurna Post,*

Gorkhapatra, Karobar, Kantipur, Nagarik, Nayapatrika, and Rajdhani) were selected for the study. Except for *Gorkhapatra*, a government-owned newspaper, all newspapers are privately-owned. These seven newspapers are considered the most widely distributed newspapers in the Nepali language and have national and international reach through their online platforms. We examined the news published by these newspapers from 2008 to 2021 by accessing newspaper archives in the libraries of three research institutions: Tribhuvan University, Kathmandu Forestry College, and Martin *Chautari*—a non-governmental research organisation based in Kathmandu, Nepal.

We recorded five different types of news reports (editorials, news, opinion pieces, photo stories and features) to use as data (which we call “newspaper article”) for further analysis. We recorded descriptive attributes from each news reports including date of publication, newspaper’s name, title, report type, and geographic origin of the news respective to districts (see Supplementary Material B, and map in Figure 1) along with keywords and key phrases (see Supplementary Material C).

2.2. Thematic analysis

2.2.1. Keywords/key phrases extraction

Following the standard protocol developed by Braun and Clarke (2006) on thematic analysis, we applied a six phase procedure for extracting keywords and key phrases (referred to as keywords hereafter) (Maguire and Delahun, 2017; Braun and Clarke, 2006). The guiding six phases for thematic analysis are:

2.2.1.1. Phase 1 familiarisation of the data. The newspaper articles were in Nepali language. The keywords from the newspaper articles were extracted after the scientific literature review on the caterpillar fungus. The keywords were determined on the broader frame of social, economic, political, and environmental dimensions. An average of five to nine keywords were extracted from each news article.

2.2.1.2. Phase 2 generating the initial codes. We extracted keywords/key phrases from each newspaper article according to themes developed from reading the articles and the scientific literature. The coding of keywords for reliability and consistency was checked by tallying the keywords with the evolving themes. Altogether, 3,777 keywords were extracted from the 681 news articles.

2.2.1.3. Phase 3 identification of themes. We first read the entire news article related to caterpillar fungus and developed a set of categorical themes from what was discussed in the articles. We also derived various themes related to caterpillar fungus and natural resource management from scientific literature (Shrestha and Bawa, 2013; Hopping et al., 2018; Winkler, 2009; Negi et al., 2015; Yadav et al., 2019; Woodhouse et al., 2014; Stewart, 2014; Shrestha, 2014).

2.2.1.4. Phase 4 review of themes. The keywords were pooled together to generate a master list of keywords (see Supplementary Material C). A word cloud (see Figure 5) was generated to explore the number of keywords that appeared more than 50 times in the keyword master list. We counted frequencies of the keywords associated with different thematic categories.

2.2.1.5. Phase 5 defining and naming themes. By using expert opinion and repeatedly comparing the similarities and differences between the keywords, eight clusters or different thematic categories were derived: a) general information, b) harvesting of caterpillar fungus, c) trade of caterpillar fungus, d) impacts of caterpillar fungus harvesting, d) policy gaps, e) governance mechanisms, f) institutional and policy responses, and g) harvester challenges (see Section 1.4). We counted the frequencies of keywords in the newspaper articles based on the published sources and year. Based on the frequency of keywords we also examined newspaper

articles on temporal trends (increases or decreases) of key variables related to the fungus trade: caterpillar fungus price (i.e., news on an increase or decrease of the caterpillar fungus price), harvester numbers, revenue amounts and revenue rates.

2.2.1.6. Phase 6: final analysis. Quotations or examples relevant to theme were extracted from the newspaper article.

2.3. News themes

The description of each theme is provided in Table 1. Snippet examples of quotations from news reports matched with a theme are provided (see Supplementary Material D).

3. Results

3.1. Number, origin, and frequency of news with keywords/key phrases

Altogether 681 data items (newspaper article) that include content concerning the caterpillar fungus were identified from the search process. The number of news reports reported by individual newspaper ranges from 59 (by *Karobar* daily) to 212 (by *Kantipur* daily). Out of the 681 news reports, most news clips were news followed by opinion pieces, articles, features, editorials and photo stories.

Figure 1 shows the district-wise distribution of news clips among the 77 districts of Nepal. This shows that the districts with the highest number of news concerning the caterpillar fungus are also the districts where the caterpillar fungus are found or traded, except in the case of Kathmandu, the capital of Nepal. The highest number of news originated from *Bajhang* (n = 104), followed by *Dolpa* (n = 101), *Rukum* (n = 92), and *Mugu* (n = 79) districts, while the lowest number originated from *Mustang* (n = 2).

Annual frequencies of the total number of news reports published by individual newspapers is given in Figure 2. It is evident that the total

number of news clips fluctuates across years. After the peak in 2019 the number of reports declined in 2020, likely due to the restriction of collection in effect due to the COVID-19 pandemic. *Kantipur*, a privately run newspaper, mostly reports the highest number of news clips related to caterpillar fungus each year. There is no consistency in the number of news reporting (frequency) among other newspapers over the years, including the Government-owned newspaper, *Gorkhapatra*.

3.2. Number of keywords and key phrases by newspaper and year

The number of keywords extracted from all the news reports by newspaper and by year are given in Figure 3. The total number of keywords were highest in *Kantipur* (n = 1,101), followed by *Nagarik* (n = 635); while the *Karobar* has the least (n = 293) of keywords related to caterpillar fungus. The temporal trend in the number of keywords followed the trends in the total number of news clips published (Figure 3). The year 2014 witnessed the highest number of keywords (n = 564) appearing in the newspapers. Comparatively, the year 2010 was limited in its news reports on caterpillar fungus with only 148 keywords recorded for that year, approximately seven times less than for 2014.

3.3. Clusters of keywords and key phrases

The cumulative number of keywords belonging to eight major clusters is given in Figure 4 (see Supplementary Material C). Based on the clustering of keywords extracted from the news reports, the socio-economic impact of caterpillar fungus harvesting (n = 1 052) was the top reported theme. On the other hand, government response (n = 120) was the least reported theme. Among the newspapers, *Kantipur* had the highest number of keywords for all themes except for policy gaps. *Karobar* had the least number of keywords related to the themes of impact, general information and trade. *Nayapatrika* had the least number of keywords for challenges to harvester and government responses themes, while *Gorkhapatra* had the least number of such words

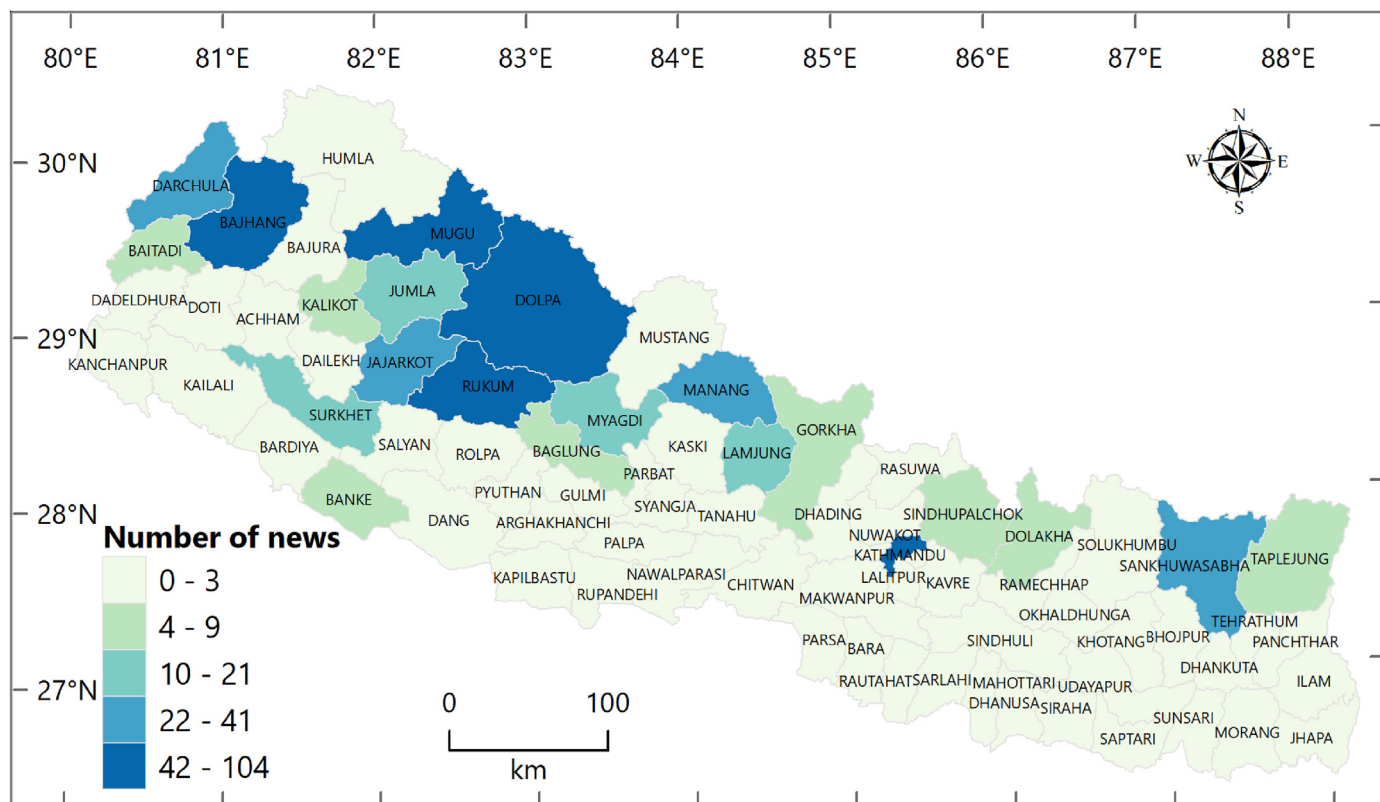


Figure 1. Map showing the geographic origin (district) of news stories.

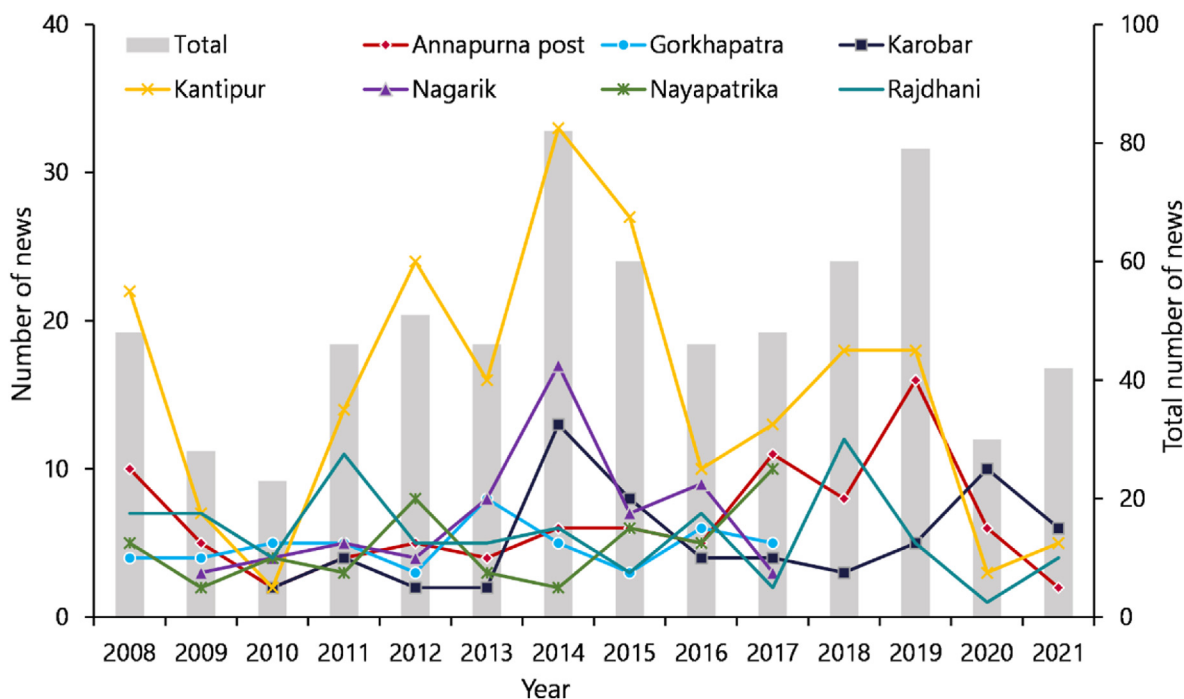


Figure 2. Total number of news clips on caterpillar fungus by year and by newspaper.

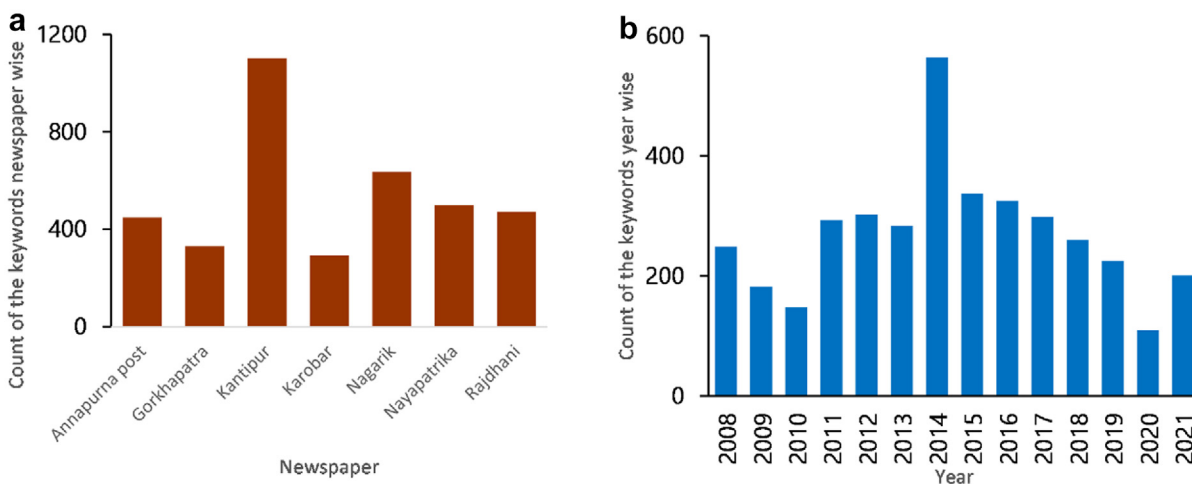


Figure 3. Total number of keywords and key phrases by: a) newspaper; b) year.

for policy gaps and governance mechanism, and Annapurna Post the least number for harvesting methods. These general patterns were evident even when we looked at the reported proportion of thematic keywords over time (Figure 4). For example, socio-economic impact of fungus harvesting had the highest percentage and government response had the lowest percentage of keywords and key phrases each year with a slight increase in percentage coverage of trade related news in 2012 and 2013.

The eight themes with highest total number of keywords were impacts (n = 1 052) and trade (n = 586), followed by information (n = 580), governance (n = 537), harvesting (n = 531), challenges (n = 221), gaps (n = 150) and response (n = 120). Keywords appearing more than 50 times within the; major eight themes were extracted to create a word cloud (Figure 5). The themes of trade, gaps and response did not have more than keywords.

3.4. Thematic categories of the news

From the eight thematic categories (Figure 6), each of these themes have multiple sub-themes. A series of examples linking the news clip texts to keywords and to sub-themes and theme are given in Supplementary Material D. The newspapers mostly covered issues related to impacts of caterpillar fungus, general information on caterpillar fungus, trade of caterpillar fungus, and harvesting of caterpillar fungus in order of most to least within the common themes. Keywords related to institutional and policy responses (3%), policy gaps (4%) and challenges (6%) faced by harvesters were covered less frequently compared to the other five themes of governance (14%), harvesting of caterpillar fungus (14%), impacts (28%), information (15%), trade (16%) (see Supplementary Material C on keywords). Most of the media portrayed the impact of the harvesting caterpillar fungus activity heavily. It is in the conservation

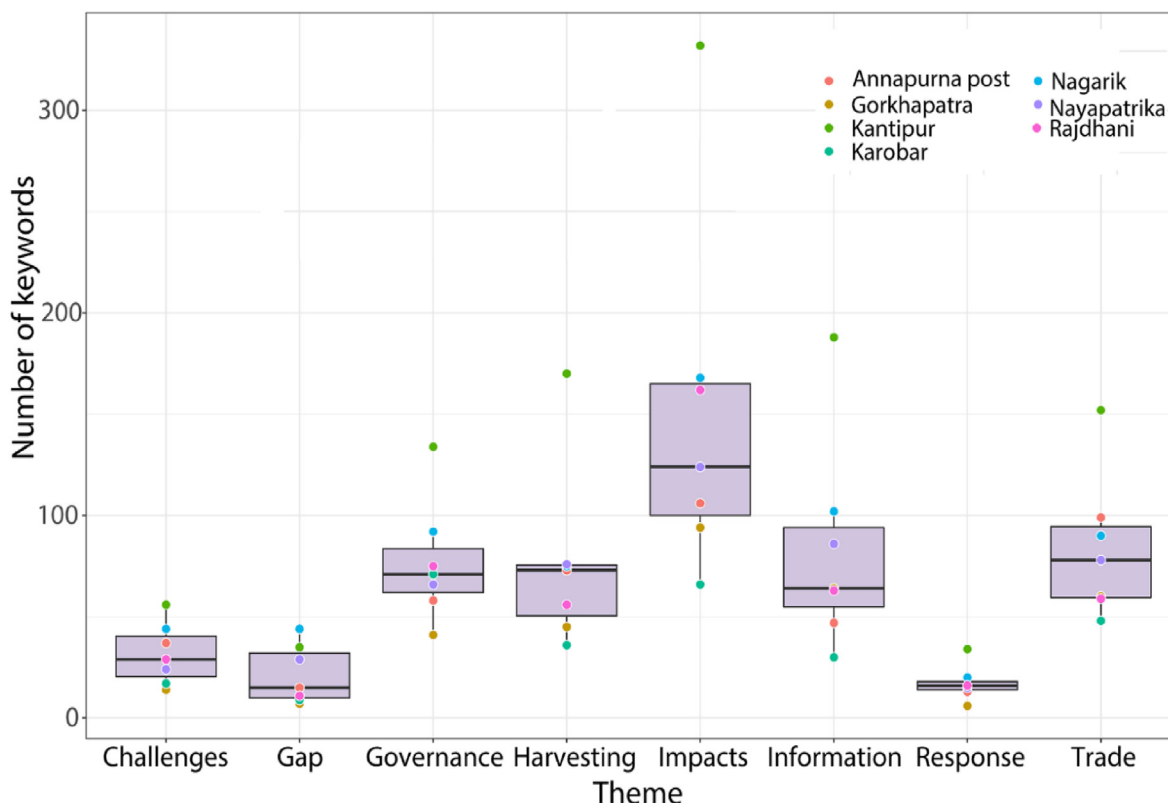


Figure 4. Cumulative number of keywords and key phrases per theme over the decade (2008–2021) by newspaper.



Figure 5. Word cloud of keywords and key phrases.

interest to report the policy responses to these impacts, which is less covered by the newspapers.

3.5. News reporting on temporal trends of key issues related to fungus trade

We undertook an analysis of newspaper articles that reported a temporal change in key economic variables: caterpillar fungus prices, number of harvesters, revenue amount and revenue rate (Figure 7). The frequency of newspaper article concerning an increase in the number of harvesters was greater than the frequency of newspaper article on a decrease in the number of harvesters. Similarly, there was a greater frequency of newspaper article on an increase in caterpillar fungus price than on a price decrease. News reports on a decrease in the amount of

revenue were six times higher than the number of news reports on an increase in the revenue amount.

4. Discussion

This study is the first to critically examine the newspaper coverage of caterpillar fungus in Nepal. We analysed 3 777 keywords based on 681 news clips from Nepali language national newspapers from 2008 to 2021. Those keywords were broadly categorized into eight themes that describe the media portrayal of conservation, harvesting, and the gap in caterpillar fungus policy and research in Nepal. The thematic analysis provides further insight into the issues that were highlighted by the media, potentially influencing what actions are perceived as necessary to support sustainable harvesting and the management of caterpillar fungus. The thematic analysis also enables policymakers to consider the issues highlighted by the media in relation to policy making and implementation.

Unsurprisingly, the news reports show a higher news coverage on caterpillar fungus in hilly or mountainous districts where the fungus is found and being harvested; specifically, the western and far western hill districts. There was also a high number of newspaper article on caterpillar fungus originating from the Kathmandu, the capital of Nepal, as the newspaper is read nationally and reports on national news. Also, Kathmandu is the ultimate destination for exports and the international trade of caterpillar fungus in Nepal.

Some notable events took place in Nepal during the study period that may have influenced the number of news clips during that time. Some of the notable events featured in the news related to caterpillar harvesting include: a) development of the *Yarsagumba* Management (Collection and Trade) directives in 2017; b) *Yarsa Pupal* festival at 4500 m above sea level in *Rukum* with attendance of key political leaders in 2016; c) the mega earthquake in 2015 during harvesting season; d) killing of a harvester by police in *Dolpa* in 2014; e) harvesters murdered in *Manang* in 2009; and, f) the COVID-19 pandemic in 2020 (Prasain, 2020)

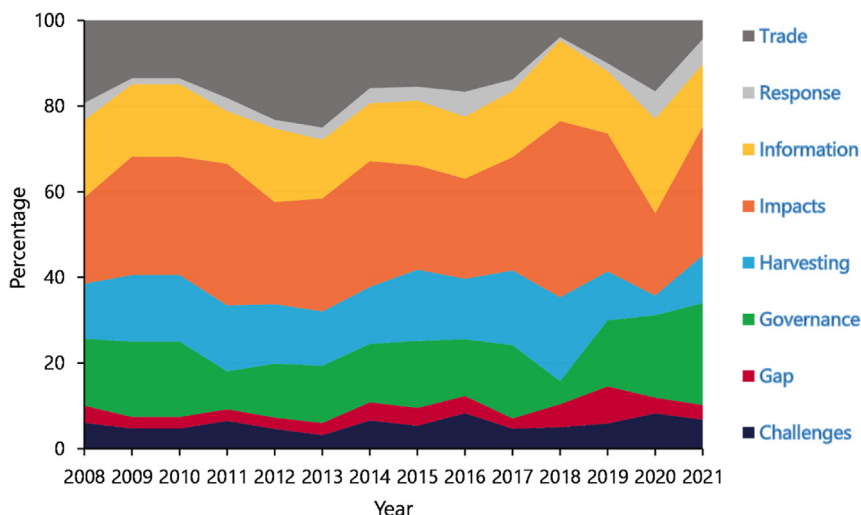


Figure 6. Percentage of keywords and phrases per theme by year.

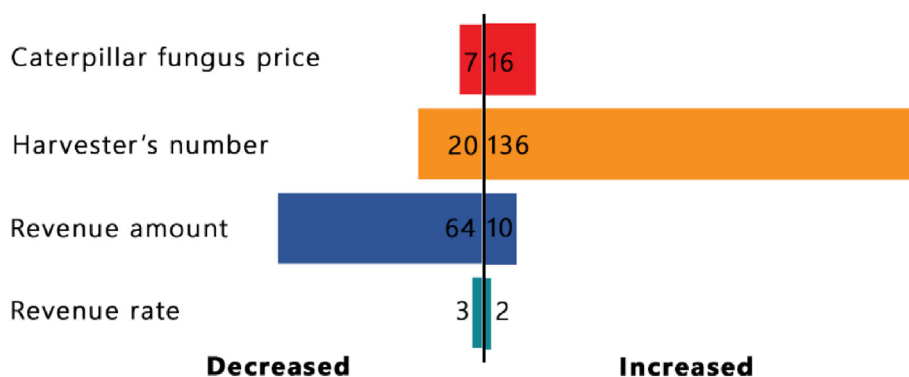


Figure 7. Frequency of news reporting of temporal trends of fungus price, harvester numbers and revenue.

A peak in news reports about caterpillar fungus was observed in our study for 2014, coinciding with the year police killed a harvester in *Dolpa* during a public demonstration for local rights to manage the revenue of the caterpillar fungus (Kantipur, 2014). The peak in news reports on caterpillar fungus in 2014 may also be related to the publication of field-based scientific studies on Nepal's caterpillar fungus. These studies documented the changes in community development due to a decreased volume of caterpillar fungus and therefore a decrease in community revenue generated from the caterpillar fungus harvest (Thapa et al., 2014). The news connected with the scientific studies reported that harvesters' perceived a decline in the number of caterpillar fungus (Shrestha and Bawa, 2015); that climate change impacts caterpillar fungus populations (Shrestha and Bawa, 2014b) there was an increase in the number of harvesters in the pastures (Shrestha and Bawa, 2014a), and, there was a change in the economic contribution of caterpillar fungus to mountain households (Shrestha and Bawa, 2014a). Newspapers act as a bridge between science and society, informing societies about scientific research findings. Similarly, news related to over-harvesting, unsustainable harvests, and resource depletion were frequently reported in the news.

In 2009, another instance of news report on caterpillar fungus was when harvesters from Gorkha were murdered in *Manang* (BBC, 2011). Locals of the Nar village, *Manang* district, murdered seven harvesters from Gorkha districts who allegedly entered their *Manang* community pastures to collect the caterpillar fungus (Gyawali, 2009). Therefore, news reports likely increased because they were discussing notable

events of conflict between state authority and locals and among local harvesters. Similar resource-based conflict of, *Shauka* (indigenous people) and non-*Shauka* conflict around resource sharing of the caterpillar fungus is evident in the *Api Nampa* conservation area (Pant et al., 2017; see resource based conflicts in Supplementary material A). Newspaper articles can provide information and evidence about conflicts on resource ownership, and because reporting conflict tends to garner more viewers or readers of news, these events explain the temporal increase in the number of news clips on the caterpillar fungus.

Events that may have decreased or limited the news coverage include the COVID-19 pandemic collection restriction of the caterpillar fungus in 2020. Similarly, the year 2015 saw drop in news reports on caterpillar fungus. This is likely due in part to the timing of the harvesting season which coincided with the disastrous earthquake in Nepal; as a result, the harvesters stopped heading towards pastures due to the trauma incurred by the disaster (Sejuwal, 2015).

Global warming is a stressor partly responsible for lessening the availability of caterpillar fungus (Hopping et al., 2018), with scientific studies showing the impact of climate change on caterpillar fungus distribution and production (Hopping et al., 2018; Shrestha and Bawa, 2014b; Yan et al., 2017). The decreasing availability of caterpillar fungus at low elevation and the shifting availability to higher elevations is reported both in scientific studies (Yan et al., 2017) and science-based reporting in the Nepalese media. The news media also reported the views of the local harvesters that climate change impacts caterpillar fungus (Sejuwal, 2014). As reported by newspapers, a common belief in

the harvesting districts is that the caterpillar fungus production is linked with the rate of snowfall and rainfall before the harvesting season. Newspapers therefore act as bridge of scientific communication between scientists and the public, making the public aware of scientific findings and showing how scientific findings can match public perceptions of change.

Our analysis confirms that newspapers also act as a watchdog, highlighting the challenges faced by harvesters with a focus on the cold climatic conditions and harsh environments where caterpillar fungus grow, which can cause illness in harvesters and sometimes death. These issues concerning the physiographic and climatic challenges of caterpillar fungus harvesting have been raised by newspapers frequently in the news reporting and sometimes in the editorial section (Kantipur, 2019), showing the importance of the fungus nationally. Although responses to address such challenges have been reported to be few, media outlets are continuously following issues of low responses from government, such as the state unable to provide basic facilities for harvesters. Basic facilities include sewage plans and providing medical camps to support the health of harvesters and to prevent death.

News related to trade covered the issues of illegal trade, prices of caterpillar fungus, the volume of trade and the need for adding value to caterpillar fungus by processing at the local level to maximize benefit. The reported decline of the volume of caterpillar fungus based on interviews of collectors published by newspapers also corroborated with the scientific studies (e.g., Shrestha and Bawa, 2013; Shrestha et al., 2019), showing that newspaper reports can also contribute to and confirm the findings of scientific studies.

Socio-economic impacts highlighted by the media were the phenomenon of agriculture abandonment due to easy cash income from the caterpillar fungus harvesting and school closures. Since the economic return of caterpillar fungus harvesting is lucrative, many children have been involved in the harvesting resulting in school closure during the harvesting season. This practice of school closure during caterpillar fungus harvest season occurred mainly in the mountain districts where caterpillar fungus is found. Media outlets give attention to this issue every year, yet there has been no policy or program to halt child involvement in harvesting except some local restriction by the management committees. Such unintended consequences of caterpillar fungus harvesting have also been reported elsewhere. For example, caterpillar fungus has become a 'resource curse', even for Tibetan pastoralists, as harvesting has become a disincentive for students to attending school and has increased non-farm participation (Wang et al., 2018).

The caterpillar fungus is economically significant for the household income as harvesters are dependent on the income generated from the harvest. This implies that the number of harvesters has increased in the pasture, adding anthropogenic pressure in the habitat. Since the species is a high value commodity, the increased price each year attracts more harvesters in the pastures. However, the informal transactions often in cash make it challenging to trace trade transactions which directly has an impact on revenue reporting. Our findings suggest that the media has not covered the agenda of harvesters' camp management, availability of clean drinking water and toilets for harvesters, issues of solid waste (both garbage and human waste) management, and wood fuel shortage during the harvesting season - issues identified by the caterpillar fungus harvesting directives (DNPWC, 2017). The national harvesting directives has indicators that need to be adhered to by the caterpillar fungus harvesters. For the sustainable conservation and management of caterpillar fungus, camp management is crucial as the harvesters set their camps where caterpillar fungus is found. This results in enhancing negative impacts on the pastures such as the destruction of native grasslands and soil compaction. Similarly, management of solid waste amassed by harvesters using processed foods and drinks has become a cumbersome task in the high-altitude pastures. The local management committee often dumps and burns the waste that may negatively impact wildlife in the mountain regions as observed at Maikot and Rukum in 2019 (Poudel, 2020) and in Dolpa in 2012 (Shrestha and Bawa, 2013). Therefore, the analysis of news

reports could also help to examine the execution of policy guidelines at the local level.

Our study highlights multiple roles of newspapers in informing the public on the science-policy interface. Newspapers can be a bridge between scientists and society to communicate and confirm scientific findings, a watchdog highlighting the issues faced by local people, an informer to inform locals about policy change at the central level, and as a general source of information. Media reports are equally as important as scientific field studies in conveying information. Anecdotal information provided in news reports can provide a clue for further scientific research or can be used to validate scientific findings and vice versa. However, newspapers sometimes ignore or miss important issues. Unlike other studies, we did not find controversy around how the media reports on the caterpillar fungus. This might be because the issues around caterpillar fungus harvests are not as contested as topics such as climate change or ivory burning.

4.1. Limitations of the study

Our study is based on the analysis of news published in national Nepali newspapers, which covers local and national issues. However, this study did not include news published at the local level or internationally. News published in local newspapers can be very important for understanding local issues. However, this is a challenging task and an important research question yet to answer on how caterpillar fungus conservation is communicated in local media and how that might build public perception. In addition, we did not include English newspapers published in Nepal. The Nepali and English versions of the national newspapers belong to the same media organization in Nepal, and the English version of the news is mostly translated from the Nepali version.

5. Conclusion

Nepali media has covered issues of the caterpillar fungus widely. The news covered by this analysis incorporated major aspects of the caterpillar fungus harvesting, while missing some of the elements of harvesting guidelines drafted by the Department of National Park and Nature Conservation, Ministry of Forest and Environment, and Government of Nepal. The findings of the thematic analysis indicate that coverage of the caterpillar fungus by print media over a decade appeared to focus on resource conflict related issues and published editorials on this species to show the importance of the species during the harvesting season. Once the harvesting season is over, the issues remains silent. Furthermore, there was also very limited coverage of policy gaps, responses and challenges with coverage focusing mainly on the negative impacts of caterpillar fungus harvesting. While devising species management policies, a thematic analysis study like this would help policymakers address the agenda unfolded by the media. This will help to communicate the directives to local management committees and harvesters for sustainable management of the caterpillar fungus. Increasing the coverage on policy gaps, the state's response and challenges can be a positive step towards sustainable management of the fungus.

Declarations

Author contribution statement

Sanjeev Poudel: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Uttam Babu Shrestha: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Ram Pandit: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Krishna Ram Dhital: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data included in article/supp. material/referenced in article.

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The authors declare no conflict of interest.

Additional information

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