

Bibliometric Analysis of Publications Related to Bhutan, 1894-2022

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Abstract

This study provides an overall growth of Bhutan-related literature to understand scientific productivity of the nation. This paper aims to assess scientific productivity of Bhutan in terms of the country's literature growth in the international arena and to establish baseline information on research trends and hotspots, benefiting both scholars and policymakers. The bibliometric technique was employed to analyze the evolutionary trend, identify key institutions, prolific authors, leading countries, and prominent themes, while also highlighting emerging areas of research in Bhutan. A total of 4145 Bhutan-related publications were identified and retrieved from the Scopus database (1894-2022). The result showed that the growth of Bhutan-related literature increased significantly over the last decade with a maximum publication in 2021 (n=461). Of the total, about 72% consists of articles, whereas conference reviews and data papers were minimum. Journal of Threatened Taxa published the highest number of literature. Among the Bhutanese institutions, the Jigme Dorji Wangchuck National Referral Hospital (JDWRH) published the highest (n=398) total number of publications, while the Ministry of Agriculture and Forests (MoAF) received the highest network of publication connections. Keyword analysis revealed that the field of taxonomy, new species and climate change were dominant in Bhutan's research landscape and are expected to remain prominent in the future. The findings revealed that

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Bhutan published the highest number of literature among the top ten countries, and ranked the highest number of corresponding authors from multiple countries (n=159). However, the international collaboration rate in literature publication was low compared to Australia, Thailand and Nepal.

Keywords: Bhutan, bibliometric, literature, scholarly, publications, documents

Introduction

Published literature of various disciplines such as journal articles, books, reports, conference proceedings, and monographs reflects the history, trends, research practices and social structures of communication among scholars, policymakers, educationists and citizens (Walia & Kaur, 2012). Advance in scientific knowledge serves as the foundation for the development of a country. The scientific productivity of scholars from diverse educational institutions, research centres, and government organizations often determine the country's current position and potential prospects for development (Allik, 2008). Assessing a nation's overall state of scientific literature publication serves as indicator for understanding development progress of a country.

In the past, Bhutanese authors published numerous literature, particularly in the field of Buddhist religion, history, philosophy and social sciences in the form of scholarly commentaries, biographies, poetry, short stories, dances and traditional songs. Increasingly, Bhutanese scholars are also publishing scientific literature in various international journals of diverse disciplines including humanities, social science, medicine and natural science of high impact factors. As a result, its not only intriguing but also significant to evaluate how science has progressed in Bhutan through the lens of scientific literature productivity over the years.

Considering the importance of understanding Bhutan's scientific knowledge, which can support informed decision-

making and showcase Bhutan's contributions to the international arena, it is essential to undertake an assessment of its scientific landscape. More importantly, in recent years, Bhutan has been recognized for offering an alternative paradigm, the Gross National Happiness (GNH) to measure the development of a country and remaining carbon-negative country, thus, the number of literatures may continue to grow. Similarly, Bhutan has been a pioneer in the field of environmental conservation. This significant contribution from Bhutan have garnered international attention, potentially triggering numerous scientific publications in these fields by both national and international researchers. Moreover, studying the overall scholarly literature production plays a key role in understanding past research, and current knowledge (López-Muñoz et al., 2021), while also portending the future trajectory of scientific literature growth in Bhutan.

From this perspective, bibliometric analysis of scientific publications related to Bhutan not only offers insights of Bhutan's scientific productivity and its contribution to global scientific knowledge but also identifies the future research directions for the nation. Bibliometric refers to the quantitative analysis of bibliometric data such as publications, citations, authors, journals, and institutions to understand patterns and trends within specific field of study or across disciplines (Anglada-Tort & Skov, 2022). It provides insights into the dissemination of knowledge, the influence of research, and the productivity of researchers, institutions, and academic fields over time (Huang, et al., 2022). This approach offers invaluable insights into the dynamics of scholarly communication, assisting researchers, institutions and policymakers make informed decisions based on the empirical scientific knowledge. It plays an essential role in evaluation of productivity, impact and development of scholarly work within diverse disciplines.

With the exponential growth of scholarly literature, the application of bibliometric analysis has been amplified in various fields such as management, decision-making, and

documenting the development of new research fields (Glänzel, 2003). Additionally, bibliometric analysis provides scientific knowledge discovery in various fields and disciplines (Su et al., 2022). However, unlike other countries, Bhutan has limited bibliometric analysis of its scientific publications, with only two studies so far on specific journals, the *Journal of Bhutan Studies* (JBS) and the *Bhutan Journal of Research and Development* (BJRD) by Dorji (2020 & 2017).

Assessing the accounts of scientific publications through a bibliometric analysis not only helps to identify the national pressing issues and themes discussed by researchers (Windsor & Windsor, 1973) but also helps to understand Bhutan's literature growth in the international arena. This study explores the global scientific literature related to Bhutan published by Bhutanese and foreign authors to establish the first baseline data and its development trends and research hotspots. The study evaluates the scientific papers published over the years including the number and year-wise distribution of articles, authorship patterns, rank of authors and most productive institutions. This study also analysed the citation distribution, frequency of citation, most cited authors and articles and prolific institutions. The paper is expected not only be useful to scholars and academicians but also to the policymakers. The specific research objectives of this study are:

- Examine changes in the patterns and trends of literature from 1894-2022
- To evaluate the overall growth of literature and analyze the key contributors to scientific research productivity in Bhutan
- Categorize influential contributions through bibliographic citations, most cited authors, most cited articles, and keyword analysis

Literature Review

Global Scientific Publication Culture

The publication of international academic journals dates back to 1665 aimed towards sharing research findings with the domain of academicians and scholars (Allahar, 2021). A shift in the system of sharing research findings beyond the premises of scholars occurred by the 1960s, with the emergence of commercial publishers, who procured the journals earlier published by non-profit academic societies (Peters et al., 2016). Since then, access to scholarly literature was commercialised through publishing houses. With the introduction of the internet and digital platform, scholarly articles are published online offering instant access to readers.

Evolution of Bhutanese Literature and Education

After the introduction of Bhutanese script Jog yig (fast-script) or lho yig (southern script) by Denmgang Tsemang, steadily the literature of language, arts, and philosophies related to Buddhist religion were published (Dukpa, 2016). Gradually new dzongs (fortress) were built by Zhabdrung Ngawang Namgyel (1616) and also witnessed a growth of private and community temples in villages as learning centres. Bhutanese scholars also pursued higher studies in Tibet and India. As a result, more Bhutanese scholars emerged leading to numerous literary publications.

In 1914, the first King, Ugyen Wangchuck opened the first school (Ura, 2010; Dorji, 2002). Since then, a few more schools were established and after the launch of the first Five-Year Plan in 1961, several western-style modern schools were instituted including Sherubtse college. Education became a priority for the government and the state provides free education to all children and also offers various scholarships for higher education. Today, there are more than 960 schools including monastic, technical and tertiary institutions in the country (Policy and Planning Division, 2021). As a result, valuable research related to Bhutan has been published by numerous scholars, government agencies and academic institutions in

different international journals (Wangdi et al., 2020). Furthermore, many international scholars studied related to Bhutan due to popularity in Gross National Happiness (GNH) and environmental conservation efforts.

Publication and Print Culture of Bhutan

Bhutan has had a book culture from the 8th century, although book production, such as history and biographies became prevalent across the country only by the 12th century (Gyaltzen, 2016). By 17th century, books were printed using carved woodblocks in Deshog (paper processed out of Daphne plant) until the end of the 20th century. Gradually, the Bhutan's printing culture was revolutionized with the use of typewriter, computer and printer using xerox paper. In recent decades, the invent of internet and World Wide Web (WWW) revolutionized the conventional literature publication approach. The literature suggests that "Bhutan Journal of Animal Husbandry" was the first Bhutanese journal published in 1978, followed by "TSENDEN: A General Publication on Forestry in Bhutan" published in March 1989. However, Penjore, (2002) asserts that "Sherab Doenme: Academic Journal of Sherubtse College" in 1995, and the Journal of Bhutan Studies in 1999 were the first Bhutanese academic journals. Since then, several academic journals have emerged. The first and second journals have ceased to publish while the third and fourth actively sustained to publish many scientific articles till today. Currently, Bhutan holds about twenty one active (Annexure I) journals managed by different government-based institutes and non-governmental organization. All of these journals publish under open access domain to ensure wider access and dissemination of scholarly information to the public.

According to Tshering (2020), "Folktales of Bhutan" was the first Anglophone literature in English published by a Bhutanese author, Kunzang Choden in 1993, followed by "A Hero with Thousand Eyes" by Karma Ura and "Rainbows and Clouds" by Ashi Dorji Wangmo Wangchuck in 1995 and 1999 respectively. However, with the establishment of Bhutanese

journals, a few Bhutanese authored scientific articles in English before 1993, even though foreign authors particularly Indian, who has been deployed to work for the Royal Government of Bhutan dominated the content of the journal. For instance, “Medicinal Plants and their Present Status in Bhutan” by Raling Ngawang and “Stem Analysis” by Lungten Norbu were both published in 1989. In 1992, the following research articles were published: “Inoculum Production Trial with Locally Devised Fermenters”, “Review of Causes of Mortality of Government Breeding Male Stock”, and “Incidence of Pork Measles in Pema Gatshe” by Tshewang Dorji, J.B. Gurung, and Kinzang Wangchuk respectively.

Methodology

Glänzel (2003) asserts that even though statistical analysis of published scholarly literature was conducted before the term “bibliometric” and “scientometrics” was coined by Pritchard and Nalimov and Mulchenko respectively in 1969. The author explains that the bibliometric method was used for analyzing “books and other media of communication”, whereas, scientometric was used as a quantitative approach that “deals with science and viewed as an information process” (p. 6). Since then, several terms such as Webometrics/Cybermetrics (studies quantitative aspects of the World Wide Web), Infometrics (deals with electronic resources), and Altmetrics (measures resources through social networking sites) emerged (Chellappandi & Vijayakumar, 2018). Despite the advent of various methods purported to study specific categories of information resources, bibliometric methods were most frequently used in analyzing the overall scientific productivity across multidisciplinary fields. The most common tools for bibliometric analysis include R programming and VOSviewer.

Study Design

This study employed bibliometric analysis, a technique that has been increasingly used as a tool and foundation for measuring the productivity of research across a wide range of scientific areas and driving policy choices (Kawuki et al., 2020). Despite bibliometric analysis focus on specific subject

disciplines or particular journals, this study considers any literature related to Bhutan by both Bhutanese and international researchers. This approach allows a thorough understanding of the scholarly information landscape surrounding the country and also offers deeper insights of Bhutan's position within the global academic community.

Data Source

In the past, the Web of Science (WoS) was the main database for citation analysis until the creation of Scopus and Google Scholar in 2004. In recent years, a few new databases such as Microsoft Academic Research and Dimension have emerged giving more options to the bibliometric research community. Several studies have extensively compared these databases (Martín-Martín et al., 2020; Mongeon & Paul-Hus, 2016; Singh et al., 2021) for article coverage. Dimension and Google Scholar tend to have high coverage of publications than WoS and Scopus. However, Dimension includes preprints that are not yet peer-reviewed articles offering an opportunity for manipulative citation (Singh et al., 2021) and Google Scholar provides relatively low-quality metadata and is also difficult to extract the data (Delgado López-Cózar et al., 2019) making challenging to use in the bibliometric analysis. Thus, WoS and Scopus databases became more relevant for research productivity assessment. However, for this study, we used data from Scopus, since the database covers higher publications than WoS.

Search Strategy

The study used the keywords: “Bhutan”, “Bhutanese”, “Bhutan AND Bhutanese”, and “Bhutan OR Bhutanese” to retrieve articles about Bhutan from the Scopus database. This study applied these keywords to the title, abstract and keyword field of the articles keeping other search filters open to maximize the accuracy of the retrieved search output in June 2022. The search query retrieved a total of 4248 documents related to Bhutan. Documents without publication year, non-English literature and article which mentioned the word Bhutan with minimum detail about Bhutan were excluded. Items coded as

errata were also excluded from the analysis. A total of 4145 publications were used for analysis.

Data Analysis

Using a descriptive statistics, the study systematically presents publication trends and patterns, including the distribution of the most productive countries, institutions, authors, research areas, journals, document types, keywords and total citations. I used bibliometrix package within R programming, VOSviewer software and Microsoft Excel to process, analyse and map the retrieved data (Donthu et al., 2010). Table 1 summarizes the main technical terms used for analysis. These terms are the key components and metrics of bibliometric analysis, which examines scientific literature and research output. They are used for interpreting the results of bibliometric analysis in understanding productivity, collaboration patterns, and thematic developments.

The study focused particularly to provide insights into the past, present and future research areas of Bhutan through the use of co-citation analysis (past), bibliographic coupling (present) and co-occurrence analysis (future).

Table 1. *Description of terms used in the analysis*

Term	Description
Link	Connection or relation between two items (e.g., co-occurrence of keywords)
Items	Objects of interest (e.g., publications, researchers, keywords, authors).
Link Strength	Each link's attribute is represented by a positive numerical number. When it comes to co-authorship ties, the greater the value, the more papers the two scholars have co-authored.
Total link strength	The cumulative strength of the links of an item with other items.
Co-authorship	Researchers, research institutions, and nations are connected in co-authorship networks based on the number of papers they have co-authored.
Citation	In citation networks, two items are linked if at least one cites the other.
Co-occurrence	The number of publications in which both keywords appear together in the title, abstract, or keyword list is the number of co-occurrences of two keywords.
(Quartile) Q1	Top 25% of journals in the list (99th – 75th CiteScore Percentile) of impact index
(Quartile) Q2	25 to 50% of journals in the list (74th – 50th CiteScore Percentile) of impact index
(Quartile) Q3	50 to 75% of journals in the list (49th – 25th CiteScore Percentile) of impact index
(Quartile) Q4	75 to 100% of journals in the list (24th – 0 CiteScore Percentile) of impact index

Source: Su et al., 2022; Van Eck & Waltman, 2010; Vijayan & Renjith, 2021

Results and Discussions

Publications Growth Trend

The total number of publications remained almost static below 10 until 1983 and gradually increased from 1984 to 2003 with a maximum of 31 publications in a year (Figure 1). After 2004, the total number of publications increased exponentially even though the total number of publications in 2011 and 2014 declined slightly compared to the previous year. From 2012 onwards, total growth exceeds 100 publications annually and the number of publications increased sharply every year. The maximum publication per year was recorded in 2021 (n=461) and the minimum was observed in a few initial years (n=1). Among different document types, articles (n=3005; 72%), book

chapters (n=328; 7%) and reviews (n=258; 6%) were revealed to be the maximum number of publications, in contrast, the data paper publication was the minimum (n=4; .1%) (Table 2). A total number of article publications per year followed the similar trend of overall document types with maximum publications of 331 in 2021, while book chapters and reviews remained slow growth with maximum publications of 52 in 2016 and 33 in 2021 respectively. The article titled “Bhutan and the Himalayas east of Darjeeling” (unknown author) published in 1894 by Scottish Geographical Magazine was the first paper recorded in the Scopus. However, the first Bhutanese-authored article recorded in the Scopus database was “Water resources development in Bhutan” by Dorgi & Pradhan in 1985. This establishes a plausible connection for academic literature publications by Bhutanese authors following the inception of the “Bhutan Journal of Animal Husbandry” (1978) and “TSENDEN: A General Publication on Forestry in Bhutan” (1989).

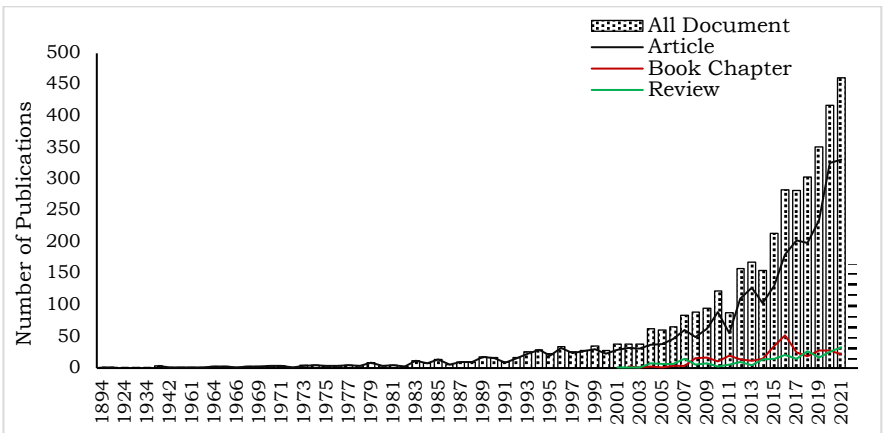


Figure 1. Annual growth trend of all documents and top three document types between 1894 and 2022

Table 2. *Types of documents related to Bhutan (1894-2022)*

Document types	No. of document	% (N=4135)
Article	3005	72.7
Book Chapter	328	7.9
Review	258	6.2
Conference Paper	224	5.4
Book	86	2.1
Undefined	70	1.7
Note	68	1.6
Letter	41	1.0
Editorial	23	0.6
Short Survey	18	0.4
Conference Review	10	0.2
Data Paper	4	0.1

Journal Network Analysis

Based on the number of publications, the top ten most productive journals were analysed (Table 3). A total of 308 publications were produced by the top ten journals comprising 7.5% of overall contributions. Journal of Threatened Taxa published the highest number of literature (54), followed by Edinburgh Journal of Botany and Plos One with 46 and 42 publications respectively. The total number of citations for all the documents was 56,106, with an average of 13.5 citations per publication. A total of 7150 citations were received for the top ten publications with an average of 715 citations per publication. Plos One journal received the highest citations (3741), followed by Tectonics (1045) and Vaccine (636). The listed top ten journals were ranked between Q1-Q3 and the majority of journals ranked in Q1 and Q2 indicating that the most of journals hold the top 25% to 50% journal groups.

Of the total of 2214 generated results, 127 of them met the threshold of at least 5 articles per journal. Among the top 10 journals, Tectonics (12079) ranked the highest in total link strength, followed by Scientific Reports (1413) and Plos One (1128) (Figure 2).

Bibliometric Analysis of Publications Related to Bhutan

Table 3. Top 10 active journals in publishing Bhutan-related literature (1894-2022)

Journal	Documents	Links	Total link strength	Citations	Journal Rank	Country
Journal of Threatened Taxa	54	188	827	94	Q3	India
Edinburgh Journal of Botany	46	47	145	373	Q3	United Kingdom
Plos One	42	293	1128	3741	Q1	United States of America
Zootaxa	35	101	232	226	Q2	New Zealand
Asian Survey	32	85	209	105	Q2	United States of America
Mountain Research and Development	24	246	1030	427	Q2	Switzerland
Scientific Reports	20	261	1413	265	Q1	United Kingdom
Tectonics	19	143	12079	1045	Q1	United States of America
Journal of Immigrant Minority Health	18	128	757	238	Q2	United States of America
Vaccine	18	51	282	636	Q1	United Kingdom

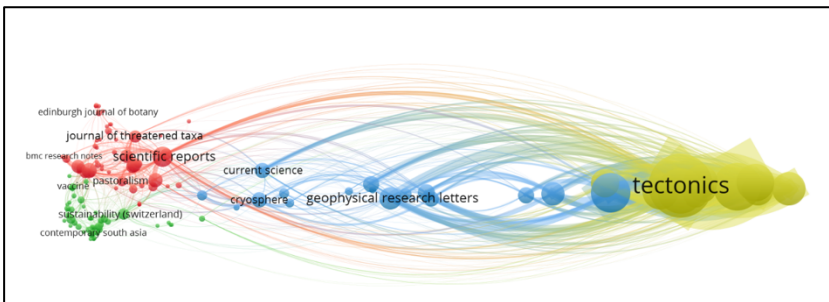


Figure 2. Citation map of 127 journals

Bhutanese Institution Network Analysis

Ministry of Agriculture and Forest (MoAF) ranked the highest in both total link strength (5552), and links (4217) followed by Jigme Dorji Wangchuk National Referral Hospital (JDWNRH) and the Ministry of Economic Affairs (MoEA) with 5459 and 1599 total link strength and 3460 and 1136 respectively (Table 4). However, in terms of the number of publications and citations JDWNRH ranked the highest with 398 and 4838, respectively, followed by MoAF and the Ministry of Health (MoH). Royal Society for Protection of Nature (RSPN) and the National Land Commission ranked lowest in both total link strength and links, while Menjong Sorig Pharmaceuticals and RSPN ranked lowest for the number of publications and citations. MoAF and JDWNRH tend to be the most prolific institutions which produce scientific publications in the country and potentially the most authoritative institution on Bhutanese scientific literature particularly related to natural environment and health.

Table 4. *Top 10 Bhutanese institutions ranked by total link strength*

Institutions	Total link strength	Links	Documents	Citations
Ministry of Agriculture and Forest (MOAF)	5552	4217	254	4224
Jigme Dorji Wangchuk National Referral Hospital (JDWNRH)	5459	3460	398	4838
Ministry of Economic Affairs (MoEA)	1599	1136	27	1035
Ministry of Health (MoH)	1393	831	165	1356
Royal University of Bhutan (RUB)	633	470	198	429
Ministry of Education (MoE)	455	300	13	82
Tobgay & Tobgay Consultancy	95	72	1	12
Menjong Sorig Pharmaceuticals	57	49	1	6
National Land Commission	35	34	1	30
Royal Society for Protection of Nature (RSPN)	35	35	1	1

Analysis of Keywords

Keyword occurrence analysis is a rational and multidimensional indicator, which is one of the most effective approaches for identifying trends and upcoming study areas (Leydesdorff & Hellsten, 2006). Author keywords provide a snapshot of the document on the research topic. Of the total 8974 generated results, only 271 met a minimum threshold of 5 occurrences. The keyword, taxonomy ranked the most frequent occurrence, followed by new species, climate change, and Himalayas (Table 5 and Figure 3). Furthermore, the taxonomy received the highest citation link strength followed by new species, whereas, the keyword Himalayas and conservations recorded the highest link. Figure 3 showed the total link strength (1922), links (1281) with 14 clusters and 269 items. Results indicate that scientific literature on Bhutan is mostly on classifications of new species related to flora and fauna and also climate change, conservation, Gross National Happiness, mental health, and epidemiology occurred in the top ten keyword lists.

Table 5. *Co-occurrence of author keyword ranked by occurrences*

Keywords	Occurrences	Links	Total link strength
Taxonomy	63	30	106
New Species	62	31	95
Climate Change	60	36	75
Himalayas	60	41	54
Conservation	43	41	59
Distribution	42	37	76
Gross National Happiness	40	22	40
Mental Health	35	32	79
Epidemiology	33	31	41
Covid-19	29	21	34

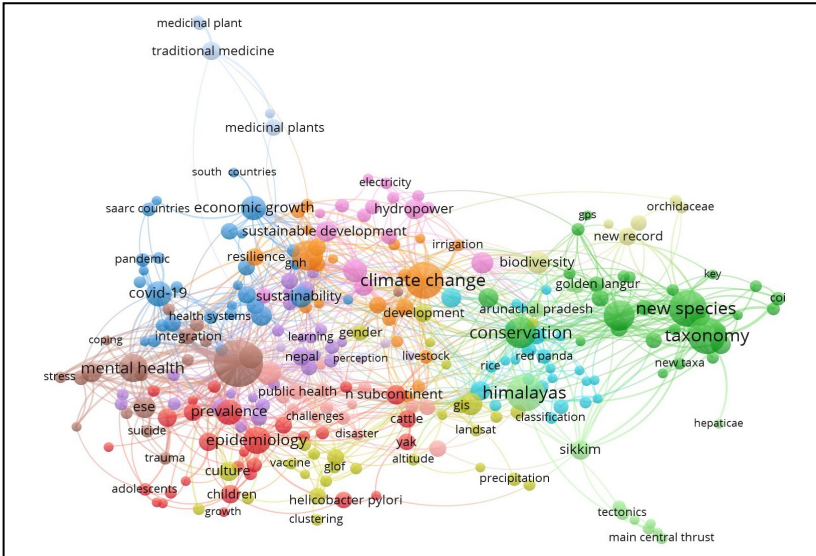


Figure 3. Network visualization map of author keywords

Note: The minimum occurrences of included terms were 5. The size of nodes indicates the frequency of occurrence. The curves between the nodes represent their co-occurrence in the same publication. Shorter the distance between two nodes, the larger the number of co-occurrences of the two keywords.

Country Network Analysis

The country network analysis was conducted using co-authorship relations to provide a snapshot of which countries have contributed the highest to the development of Bhutan-related literature. This analysis not only identifies the countries with the highest contribution but also reflects the region and level of influence on Bhutan-related scientific literature development. Of the 155 countries, 57 meet the threshold with a maximum number of countries per document (25) and a minimum number of documents of a country (5). For obvious reasons, Bhutan contributed the highest for all variables (Total link strength, Documents, & Citations) except for links (Table 6). India ranked second followed by the United States for total citation strength, while for documents and citation remained vice-versa.

Figure 3 shows the collaboration network among countries in publishing the Bhutan-related scientific literature with a minimum of five publications from different countries. The network visualization map reveals a total of 74 countries. The map consists of 6 major clusters, 57 items, 711 links, and 4417 total link strengths. The size of the nodes represents the weight of an item based on the total link strength. Apart from Bhutan, India, the United States, Australia and the United Kingdom has the strongest collaboration network. Previous studies claim that neighboring countries generally develop strong collaboration networks (Su et al., 2022), which was in contrast to our findings except India.

Table 6. *Top ten countries ranked by total link strength*

Country	Links	Total link strength	Documents	Citations
Bhutan	6	52	1343	1089
India	3	51	705	935
United States	4	49	864	812
Australia	7	47	622	513
United Kingdom	5	46	487	385
China	2	44	276	203
Nepal	3	44	407	192
Switzerland	4	44	235	125
Bangladesh	3	41	285	121
Germany	2	41	239	135

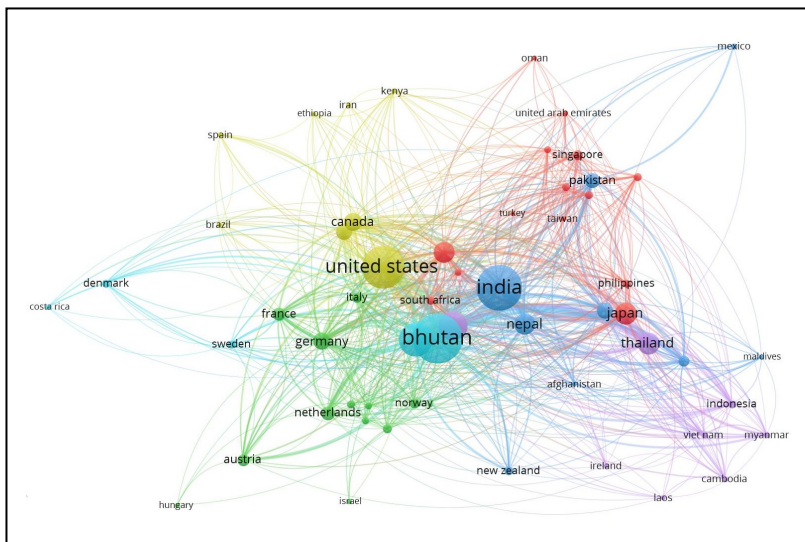


Figure 4. Network visualization map of international research collaboration among top 74 countries

Note: The strength link is proportional to the amount of research collaboration between the countries involved. The size of each country's node indicates the percentage of documents with international researchers. Larger node size is indicative of greater international research collaboration for that country. A similar color indicates close research interest.

Author Analysis

Table 7 shows the top ten active Bhutanese authors who published scientific literature related to Bhutan. Wang & Macdonald (2006)'s, paper titled "Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan", published in Biological Conservation ranked the highest total citations (171). Dorji and Ghomashchi (2014) and Sangay and Vernes (2008) followed the second and third highest with total citations of 118 and 109 respectively. On the contrary, the article authored by Dorji and Ghomashchi (2014) received the highest total citation per year (13.11), followed by Tashi (2016) and Wang & Macdonald (2006) with 12 and 10 total citations per year respectively.

In the international arena, Alver et al., (2012), followed by Kääb et al., (2012) and Wang, et al., (2012) received the highest total citations of 171, 118 and 109 respectively (Table 8). Similarly, the team received the highest total citation per year (303) and Deplazes et al., (2017) ranked second (76) followed by Kääb et al., (2012) (68). The highest total citations received by international authors was almost twenty folds higher compared to Bhutanese authors. Similarly, total citation per year was observed to be significantly higher for international authors than for Bhutanese authors. However, both the Bhutanese and international authors published the top ten articles in Q1 journals.

Table 7. *Prolific top ten Bhutanese authors ranked by total citations*

Author and Year	Title of the Article	Name of the journal	Total Citations (TC)	TC per Year
Wang SW & Macdonald D.W (2006)	Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan	Biological Conservation	171	10.06
Dorji U & Ghomashchi, R (2014)	Hydro turbine failure mechanisms: An overview	Engineering Failure Analysis	118	13.11
Sangay T & Vernes, K (2008)	Human-wildlife conflict in the Kingdom of Bhutan: Patterns of livestock predation by large mammalian carnivores	Biological Conservation	109	7.27
Gurung TR et al., (2006)	Companion Modeling, Conflict Resolution, and Institution Building: Sharing Irrigation Water in the Lingmuteychu Watershed, Bhutan	Ecology and Society	97	5.71
Wangdi K et al., (2010)	Development of temporal modelling for forecasting and prediction of malaria infections using time-series and ARIMAX	Malaria Journal	88	6.77

Author and Year	Title of the Article	Name of the journal	Total Citations (TC)	TC per Year
	analyses: A case study in endemic districts of Bhutan			
Wang SW & Macdonald D.W (2009)	The use of camera traps for estimating tiger and leopard populations in the high-altitude mountains of Bhutan	Biological Conservation	85	6.07
Tashi S et al., (2016)	Soil carbon and nitrogen stocks in forests along an altitudinal gradient in the eastern Himalayas and a meta-analysis of global data	Global Change Biology	84	12.00
Tobgay T et al., (2012)	The age and rate of displacement along the Main Central Thrust in the western Bhutan Himalaya	Earth and Planetary Science Letters	84	7.64
Wang SW et al., (2006)	Farmer attitudes towards conservation in Jigme Singye Wangchuck National Park, Bhutan	Environmental Conservation	78	4.59
Dorji T et al., (2014)	Digital soil mapping of soil organic carbon stocks under different land use and land cover types in montane ecosystems, Eastern Himalayas	Forest Ecology and Management	77	8.56

Table 8. *Top ten international authors ranked by total citations*

Author and Year	Title of the Paper	Name of Journal	Total Citation	TC Per Year
Alvar, J et al.,(2012)	Leishmaniasis Worldwide and Global Estimates of Its Incidence	Plos One	3342	303.82
Kääb, A. et al., (2012)	Contrasting patterns of early twenty-first-century glacier mass change in the Himalayas	Nature	750	68.18
Wang, H et al., (2012)	Age-specific and sex-specific mortality in 187 countries, 1970–2010: a systematic analysis for the Global Burden of Disease Study 2010	Lancet	602	54.73
Richardson, SD & Reynolds JM (2000)	An overview of glacial hazards in the Himalayas	Quaternary International	592	25.74
Deplazes, P et al., (2017)	Global Distribution of Alveolar and Cystic Echinococcosis	Advances in Parasitology	460	76.67
Yao, T et al., (2012)	Third Pole Environment (TPE)	Environmental Development	434	39.45
Grujic, D et al.,(1996)	Ductile extrusion of the Higher Himalayan Crystalline in Bhutan: evidence from quartz microfabrics	Tectonophysics	408	15.11
Gupta, N et al.,(2012)	Childhood Obesity in Developing Countries: Epidemiology, Determinants, and Prevention	Endocrine Reviews	404	36.73
Bilham, R & England, P (2001)	Plateau 'pop-up' in the great 1897 Assam earthquake	Nature	378	17.18
Nakata, T (1989)	Active faults of the Himalaya of India and Nepal	Geological Society of America	357	10.5

Corresponding Author and Collaborations

India was observed to have the highest total number of articles for corresponding authors and single country publications, followed by the USA and Bhutan (Figure 5). Even though Bhutan and Australia recorded the highest number of corresponding authors from multiple countries with 159 each, Australia, Thailand and Nepal showed the highest international collaboration rate in publishing scientific literature related to Bhutan with MCP rates above 50%. In contrast, India, USA and United Kingdom revealed the lowest international corporation with 18%, 35% and 37% respectively.

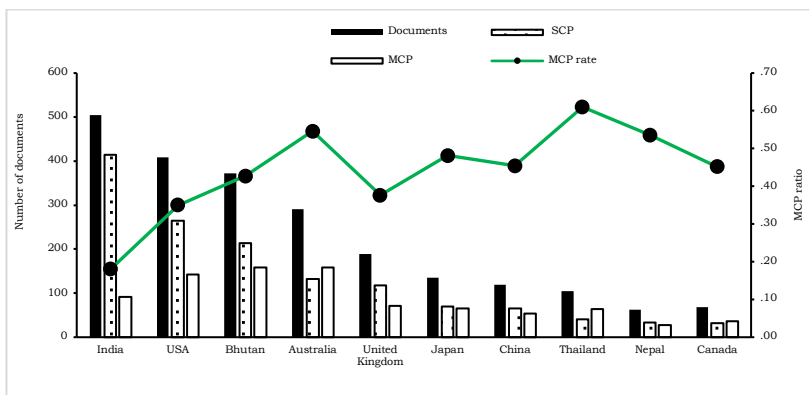


Figure 5. Corresponding author's country and collaborations

SCP: Single Country Publications
 MCP: Multiple Country Publications

Discussion

In this study, we used bibliometric analysis to provide an overview of scientific literature growth related to Bhutan. The study observed the first scientific literature on Bhutan was published in 1894 even though the first Bhutanese-authored article was published in 1985, ninety one years later. Overall, even though there was a steady increase of publications, significant growth of literature was observed during the last decade with the maximum publication in 2021 particularly in the form of articles. Accelerated growth of overall literature

across the globe contributed due to the surge in the number and size of online-only mega-journals such as Plos One, Scientific Reports and Sustainability (Thelwall & Sud, 2022). This effect may have been attributed to the exponential increase of literature on Bhutan coupled with the emergence of many Bhutanese scholars and the growing recognition of Bhutan's efforts in environmental conservation and GNH in the international arena.

Most of the scholarly literature was published in the Journal of Threatened Taxa and Edinburgh Journal of Botany even though Plos One received the highest total citations. Bhutan host a total 11,248 species across all taxa with 136 species considered globally threatened (Manita & Nepal, 2021). As a result, scientists of all nations work towards a better understanding to conserve these threatened species, thus making the Journal of Threatened Taxa extremely relevant and serving as the main source of publishing avenue for scholars.

Furthermore, the subject "taxonomy" followed by "new species" and "climate change" was the most frequent occurrence in the author's keyword analysis. These keywords reveal Bhutan's past and current development of research areas, specifically on discovering and classification of new species of plants, animals and micro-organisms. As of now, Bhutan recorded 566 new species of flora and fauna with at-least 31 new species to science discovered (Gyeltshen et al., 2018) including birds, snails, dragonflies, fishes, plants, bees, amphibians and bryophytes (Manita & Nepal, 2021). The authors further claimed that new species discoveries have occurred at a rate of 3 species per year. Bhutan's rich unexplored biodiversity blended with efficient environmental conservation is yet to offer many new species discoveries. Recently, *Erhaia norbui* sp. nov. was a new contribution to science (Gittenberger et al., 2022), while *Pteris griffithii* (fern) (Dorji et al., 2022) and woolly flying squirrel (Jamtsho et al., 2022) was a new record for the country. This field has the potential to remain an important domain of scientific study for Bhutan.

Climate change seems to be an evolving subject that attracts both national and international researchers. The topic of climate change caught the attention of scientists all over the world due to various climate-related challenges, and climate change is a multidisciplinary subject that offers multiple areas to investigate (Sweileh, 2020). More importantly, Bhutan is highly vulnerable to the impacts of climate change due to fragile mountain ecosystems (Wangchen & Dorji, 2022). Empirical evidence such as increased temperature, erratic rainfall trends and frequent occurrence of extreme weather events indicates that Bhutan is already facing the challenge of climate change. Intensive study on climate change was felt important not only for Bhutan but also for the entire Himalayan region (Lhendup, et al., 2011; Salerno et al., 2008; Sharma et al., 2009). To mitigate climate change, Bhutan became carbon-negative (Das et al., 2022) and may continue to alleviate climate change through various scientific studies and provide adaptation measures. As a result, the topic “climate change” will be a growing subject for Bhutan and is expected to increase scholarly literature related to climate change in Bhutan in the future.

The findings showed that JDWNRH was most productive scientific publication institutions in terms of total number of publications and citations, while MoAF had the active collaborations with other institutions and co-authorship relationships. These findings corresponded with the evolving subject of taxonomy, new species, and climate change, as these themes are within the premises of MoAF. Moreover, the majority of publications in the top ten prolific Bhutanese authors revolved around the areas of MoAF. For instance, the most prolific Bhutanese author investigated livestock depredation by carnivores in Jigme Singye Wangchuck National Park. Livestock depredation has been one of the long-standing challenges for rural farmers (NPPC & WWF-Bhutan, 2016; Sangay & Vernes, 2008), while the Royal Government of Bhutan imposes stringent regulations to conserve the environment and wildlife (Seeland, 2000) leading to highly discussed and studied topic. All these factors may have

contributed to making the MoAF the most productive scientific publication institution in Bhutan.

Subjects related to health are constantly changing due to emerging of new diseases, new treatment discoveries and advanced technologies (Nilsen et al., 2020), while topics such as Covid-19 and epidemiology have surged in recent years. The most prolific international author has studied the incidence of parasitic diseases (Leishmaniasis) across the globe including Bhutan. Consequently, the scholarly literature related to health is expected to continue and may increase in the future making the JDWNRH one of the most productive scientific publication institutions in the country.

Even though Bhutan ranked the highest in total link strength, number of documents, and citations, the analysis reveals that most international collaborations in scientific literature related to Bhutan are led by corresponding authors from Australia, Thailand, and Nepal. This may suggest that Bhutanese scholars have limited international collaborations, highlighting a significant gap in global research engagement. Future studies could focus on examining the significance of these collaborations, as the growth of scholarly publications and citation frequency reflect both the current state and potential development of a nation's scientific productivity (Crespi & Geuna, 2008). Therefore, Bhutan would benefit from promoting more national and international research collaborations between various institutions and countries.

Limitations

The current study has a few caveats. Bibliometric datasets from the Scopus were not published exclusively for bibliometric analysis, thus containing errors that are bound to affect results. The inclusion of bibliometric datasets from both Web of Science and Dimension may produce more comprehensive findings. The exclusion of grey literature and publications in non-indexed journals may have increased the number of publications and citations for some countries. This may have further consequences on the top ten journals, institutions, and

authors. The search query keyword in the Scopus database was formulated with a particular focus on the keyword “Bhutan” captured in the title, keyword, and abstract of a document. A document without the mention of the term “Bhutan” but written related to Bhutan may not have been retrieved.

Conclusion

The study was the first bibliometric analysis of Bhutan-related scholarly literature. Based on 4145 documents retrieved from the Scopus database, the bibliometric analysis offered insights into the scientific literature related to Bhutan from 1894 to 2022. The volume of published literature related to Bhutan has increased substantially over the last decade, particularly research articles. Our analysis revealed that most of the studies were conducted in the field of taxonomy, new species and climate change domain. Key institutions, authors, research themes, degree of collaborations within countries, main journals, and research gaps were identified. The study also showed low international collaborations for Bhutan compared to other countries. The current study provided the overall growth of scholarly literature related to Bhutan, providing a snapshot of the scientific productivity related to Bhutan.

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Annexure I. List of journals and its institutions in Bhutan

Sl. No	Journal	Institution
1	Bhutan Health Journal	Khesar Gyalpo University of Medical Sciences of Bhutan
2	Bhutan Journal of Management	Royal Institute of Management
3	Bhutan Journal of Research and Development	Royal University of Bhutan
4	Journal of Bhutan Studies	Centre for Bhutan & GNH Studies
5	Journal of the Bhutan Ecological Society	Bhutan Ecological Society
6	Bhutan Law Review	Bhutan National Legal Institute
7	Bhutanese Journal of Agriculture	Ministry of Agriculture and Forests
8	Bhutan Journal of Animal Science	Department of Livestock, Ministry of Agriculture and Forests
9	The Journal of Gross National Happiness and Law	Jigme Singye Wangchuck School of Law
10	Bhutan Journal of Natural Resources and Development	College of Natural Resources
11	Bhutan Journal of Socio-Economic Studies	National Statistics Bureau
12	Bhutan Journal of Business and Management	Gedu College of Business Studies
13	RABSEL The CERD Educational Journal	Paro College of Education
14	Educational Innovation and Practice	Samtse College of Education

Bibliometric Analysis of Publications Related to Bhutan

Sl. No	Journal	Institution
15	Journal of Educational Action Research	Paro College of Education
16	High School Journal Happiness	Ministry of Education
17	The Druk Journal	Bhutan Centre for Media and Democracy
18	Rigzoed Journal	College of Language and Culture Studies
19	International Journal for Bhutan and Himalayan Research	College of Language and Culture Studies
20	Journal of Applied Engineering, Technology and Management (JAETM)	Jigme Namgyel Engineering College
21	Rig Tshoel	Royal Thimphu College