UNIVERSIDADE FEDERAL DE LAVRAS

THIAGO JOEL ANGRIZANES ROSSI

USING SOCIAL LISTENING TOOLS FOR UNDERSTANDING ECOSYSTEM SERVICES AWARENESS AND CONSERVATION.

LAVRAS – MG

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Monograph presented to the Federal University of Lavras, as part of the requirements for obtaining the title of Bachelor of Agronomy.

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To all beings that have lived, are living or are going to live this shared journey over the Earth and inside the Universe. I feel you.

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First, I would like to thank all the obstacles that had come to my way here. The Obstacle is the Way!

To those who, direct or indirectly contributed for the little successes I achieved so far.

To my family, who have dedicated their love, their lives and resources for me to be here.

To my son, Lucas, who inspires me now and always.

To Nicoli, my partner and best friend.

To my friends, close or distant.

To all the animals that suffer daily for science to be where it stands today. Hope you can forgive us.

Also, to AnswerThePublic Team, who allowed me to conducted the searches for free.

Lastly but not least, I would like to thank all scientists and thinkers who have built the knowledge we can easily access today. Without you society would still be a very dark place.

"If a man does not keep pace with his companions, perhaps it is because he hears a different drummer. Let him step to the music which he hears, however measured or far away.'
(Henry David Thoreau)

RESUMO

A sustentabilidade como a entendemos hoje, está caracterizada pela nossa capacidade de lidar e usar os recursos naturais e serviços ecossistêmicos. Porém, ainda há uma grande lacuna em nosso entendimento sobre os impactos que nossas ações têm sobre esses recursos e serviços. Para entender e mensurar nossa relação com a natureza, seja ela positiva ou negativa, temos hoje uma diversidade de ferramentas analógicas e digitais. Essas ferramentas podem ser utilizadas como uma forma de observar o comportamento humano frente à sua consciência ambiental e ecológica, como o uso de ferramentas de escuta social. Essas ferramentas tem se difundido por diversos setores do mercado. No entanto, ainda há poucos estudos de caso do uso dessas ferramentas para dar suporte e apoiar comunidades científicas como um todo e, mais especificamente, a conservação ambiental e ecológica. Neste estudo, buscamos entender se há correlação entre o volume de buscas de termos relacionados aos recursos naturais e serviços ecossistêmicos com a porcentagem de áreas terrestres protegidas. A pesquisa demonstrou que há uma correlação positiva entre o volume de buscas e a área terrestre protegida de um país. Além disso, pode-se observar que as palavras-chave tem relevâncias diferentes de acordo com o país. As correlações mais fortes encontradas foram para as palavras-chave "ecosystem", "ecosystem services"e "erosion". Os resultados evidenciam que as áreas protegidas podem influenciar a consciência pública a respeito da temática ambiental e sua capacidade de agir em prol da conservação.

Palavras-chave: Biodiversidade. Serviços Ambientais. Escuta Social. Consciência Pública.

ABSTRACT

Sustainability as we understand it today is characterized by our ability to deal with and use natural resources and ecosystem services. However, there is still a large gap in our understanding of the impacts our actions have on these resources and services. To understand and measure our relationship with nature, whether positive or negative, today we have a variety of analog and digital tools. These tools are used as a way of observing human behavior in light of their environmental and ecological awareness, as the use of social listening tools. These tools have spread across different market sectors. However, there are still few case studies of the use of these tools to support scientific communities as a whole and, more specifically, environmental and ecological conservationists. In this study, we sought to understand whether there is a correlation between the volume of searches for terms related to natural resources and ecosystem services and the percentage of protected terrestrial areas. The research has shown that there is a positive correlation between search volume and a country's protected terrestrial area. In addition, it can be observed that the keywords have different relevance according to the country. The strongest correlations were found for the keywords "ecosystem", "ecosystem services"and "erosion". The results show that protected areas can influence public awareness regarding environmental issues and their ability to act in favor of conservation.

Keywords: Biodiversity. Ecosystem Services. Social Listening. Public Awareness.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

1 INTRODUCTION

Sustainability and conservation are central concerns of modern days as climate changes continue to impact our lives, warning about our choices. Sustainability can be understood as the human capacity of interacting with nature and people without depleting the natural resources for future generations (KEEBLE, 1988). However, the concept of sustainability is subject to the complexity of its intertwined variables.

To reduce the subjectivity regarding the understanding of sustainability, it is necessary to obtain quantifiable data and metrics about the variables. Some of the quantifiable data available today are the ecosystem services data. These services can be understood as the benefits received by humankind from nature.

Understanding the role of ecosystem services in society is deeply connected with the culture of a nation's peoples. Nowadays, behavioural patterns can be analyzed through social listening tools like *Google Trends* and *Answer the Public*. These tools monitor the interest and search behaviour on the internet, examining the searches relative frequency and volume during a specific period of time.

The role of the culture in sustainability and natural resources conservancy is, consequently, of great importance. As suggested by Ladle et al. 2016, popular interest is strongly correlated to the number of media articles regarding the subject.

In this study, we aimed to analyze patterns of cultural awareness about ecosystem services expecting to find a positive correlation between the search relative volume and the percentage of terrestrial protected area of a country as Do et al. 2015 suggested that public participation depends upon public awareness.

2 THEORETICAL FRAME OF REFERENCE

2.1 ECOSYSTEM SERVICES AND BIODIVERSITY

Sustainability and ecosystem conservation are central subjects of current political and scientific discussions. The IPBES 2016 links the importance of peoples' connections with nature and well-being in policy decision-making and people's well-being. Recent scientific arguments underpin that ecosystem properties depend greatly on biodiversity in terms of the functional characteristics of the organisms present in the ecosystem (SCHNEIDERS et al., 2012).

Nonetheless, in order to understand the relationship between ecosystem services and the biodiversity they rely on, it is important to comprehend their interdependencies. In some cases a single ecosystem service is the product of two or more ecosystem functions whereas in other cases a single ecosystem function contributes to two or more ecosystem services (COSTANZA et al., 1997).

Moreover, to evaluate ecosystem services, it is necessary to go beyond the benefits and look for a perspective that includes the human capabilities (knowledge and abilities) that enable the population to obtain those benefits (SANGHA et al., 2018).

2.2 INTERNET SEARCH AND PUBLIC AWARENESS

Information, on the internet era, gained some momentum impacting positively the scientific community (CUENCA; TANAKA, 2005). This knowledge sharing environment made it possible the creation of novel tools also for gathering information in an accessible way.

According to Correia 2017, public awareness of biodiversity is increasingly being recognized at all scales of conservation action, from local community projects to the development of international policy.

Internet search behavior (ISB), characterized by the frequency of a query submitted to internet search engines, is a tool for quantifying public interest about specific social and environmental issues. ISB can be used to examine how people use the Internet over time. The technique assumes ISB mirrors a society's activities and public concerns (DO et al., 2015).

Do et al 2015 used ISB to identify wetlands of public interest and determine which wetland components (i.e., flowers, animals, trees, birds, news releases) increase public awareness.

People value nature's benefits for their relationships with, knowledge and understanding of nature. These values are expressed through peoples' customs, and rituals involving a considerable element of reciprocity, some of which are explained through the concept of socio-ecological resilience proposed by Folke 2016.

Highlighting the role of culture in sustainability and natural resources conservation, Do et al 2015 also suggested that popular interest is strongly correlated to the number of news articles in the media, showing a reinforcing causal loop between public awareness regarding sustainability and people's engagement.

2.3   SOCIAL LISTENING AND CULTUROMICS

The internet provides novel opportunities to develop large-scale quantitative metrics of public interest in and visibility of biodiversity (LADLE et al., 2016). However, the continuous stream of freely available data remains underexploited by conservation biologists (PROULX; MASSICOTTE; PÉPINO, 2014).

To analyze behavioral trends, there is a variety of digital technologies to discover patterns, correlations and also predict human behavior. Among these technologies are social listening tools, like *Google Trends* and *Answer the Public*. Both monitor popular interest and internet search behavior (ISB), examining the searches frequency and using Search Relative Volume (SRV) during a specific period of time (DO et al., 2015).

Culturomics can be understood as the formal study of human culture through the analysis of changes in word frequencies in large bodies of texts (corpora) (MICHEL et al., 2011). The quantitative analysis of changes allow conservationists to react to cultural trends, where the main application areas are the public demonstration of interest about nature, new metrics and tools for near real-time environmental monitoring, support decision making, evaluate the intervention's cultural impact and promote public understanding about the subject (LADLE et al., 2016).

2.3.1 SOCIAL LISTENING TOOLS

2.3.1.1 GOOGLE TRENDS

Google Trends is a freely accessible web-crawling engine that returns the usage volume of a particular search term for a specific region of the world over a defined period. Search-term hits are recorded at the spatial resolution of individual cities within a region (e.g., Brazil > Minas Gerais > Lavras) and at the temporal resolution (PROULX; MASSICOTTE; PÉPINO, 2014).

According to Proulx, Massicote and Pépino 2014, Google Trends can be used to monitor changes in biological processes, spacial distribution of invasive species and the popular awareness level over conservation matters.

2.3.1.2 ANSWER THE PUBLIC

AnswerThePublic is a paid tool for Search Listening. This means that the tool listens into autocomplete or autosuggest data from search engines like Google then quickly engineer every useful phrase and question people are asking around the keyword. Autosuggest data offers insight into the volume of questions millions of users search for in online search engines (ALAGHA; HELBING, 2019).

To this date, only two references (CANO-ORÓN, 2019) (ALAGHA; HELBING, 2019) mention AnswerThePublic as a tool for social and search listening. That is probably because the tool is used mostly for companies insights over consumer behavior and brand awareness.

As it is a paid tool, the company allowed premium access for this research during two weeks in the third quarter of 2021.

3 MATERIAL AND METHODS

We randomly selected twenty countries (Table 3.1) using Python in Google Colaboratory. They were clustered in High-Income Countries, Upper Middle-Income Countries, Lower Middle-Income Countries and Low-Income Countries, to reduce any economical bias that would appear in a disproportionate sample. Together these countries are responsible for a population of 2,122,689,000.

Table 3.1 – Summary of the Twenty randomly selected countries

	Country	Code	Pop. (in millions)	GDP (per capita) (USD$)	% of Protected Area
1	Bangladesh	bd	164.700000	1968.79	4.61
2	Bulgaria	bg	6.927000	9975.78	41.40
3	Burundi	bi	11.890000	274.01	7.59
4	Chile	cl	19.120000	13231.70	20.90
5	Cape Verde	cv	0.555988	2.90	NaN
6	Czechia	cz	10.700000	22762.20	22.17
7	Ghana	gh	31.070000	2328.53	14.84
8	India	in	1380.000000	1900.71	7.52
8	Kuwait	kw	4.271000	32373.25	17.10
10	Lithuania	lt	2.795000	19997.59	17.08
11	Latvia	lv	1.902000	17619.95	18.18
12	Mauritius	mu	1.266000	8622.68	4.73
13	Mozambique	mz	31.260000	448.61	29.48
14	Namibia	na	2.541000	4211.05	37.89
15	Nigeria	ng	206.100000	2097.09	19.93
16	Nauru	nr	0.010834	10983.22	0.00
17	Oman	om	5.107000	15343.04	3.58
18	Russia	ru	144.100000	10126.62	11.45
19	Thailand	th	69.800000	7189.04	18.55
20	Zambia	zm	18.380000	1050.92	41.26

For each country, we collected data searching the keywords: 'air quality', 'biodiversity', 'biological control', 'biomass', 'climate', 'ecosystem services', 'ecosystem', 'erosion', 'nutrient cycling', 'water cycling', 'pollination', and 'soil fertility' on both social listening tools.

The searches were conducted in English for both tools. For AnswerThePublic, after adding the keyword to the search, language and countries/regions were selected accordingly. For Google Trends, beyond language and country, we included the time period from January, 2004 to April, 2022.

The time period may affect future results, as new searches are made everyday and they may impact the volume of searches.

Table 3.2 – Average number of suggestions for keywords per country.

H

	Keyword	Number_of_Suggestions
1	air quality	382
2	biodiversity	390
3	biological control	301
4	biomass	377
5	climate	394
6	ecosystem services	325
7	ecosystem	394
8	erosion	393
9	pollination	377
10	soil fertility	320

Source: From the Author, 2022

On AnswerThePublic, data is made available for the autocomplete suggestions (Figure 3.1) regarding questions, prepositions, comparisons, alphabeticals, and related queries. Due to the restriction of time for the trial period on AnswerThePublic, only one day was considered for the search's suggestions.

Figure 3.1 – Display image of the suggestions made when a person types ecosystem and question words.
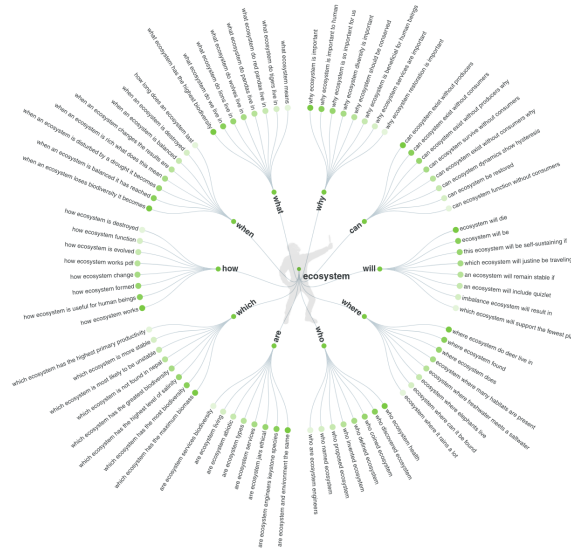
Source: From the Author, 2022

On Google Trends, the numbers represent the search interest related to the highest point in the graph in a given region and period (Figure 3.2). A value of 100 represents, therefore, a keyword's peak in popularity, and a value of 50 represents half the popularity. The number 0 means that there was not enough data about the keyword.

To verify the constancy of interest for the terms, the mean, standard deviation, and standard error were calculated for searches by term.

The relationship between the search volume and the terrestrial protected area were analyzed using Spearman correlation analysis. All statistical analyses were conducted with Statistica (TIBCO,).

Figure 3.2 – Example of a query's return for the term "Ecosystem" in Brazil for the last 12 months.
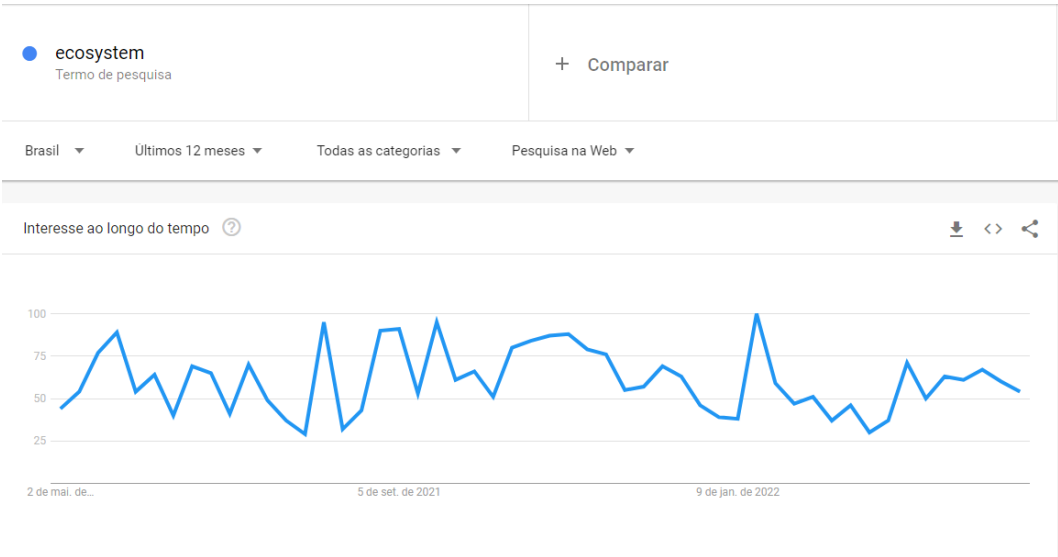
Source: From the Author, 2022

4   RESULTS

The autocomplete suggestions information gathered by AnswerThePublic showed no difference among countries and, therefore, no analysis were conducted.

One country (Montenegro) was retrieved from the analysis due to the lack of information on social listening tools. As the access to the data on AnswerThePublic was limited, we opted to not to include another country as we understood that this would not impact this research at this moment.

On Google Trends (Table 4.1), the Search Volumes mean for the 20 countries was correlated (r = 0,308271 & P < 0.05) regarding the country's terrestrial protected area. The strongest correlations between search terms and the protected area percentage were "ecosystem services" (r = 0,971145), "ecosystem" (r = 0,930618), and "erosion" (r = 0,879336).

Table 4.1 – Spearman Rank Order Correlations between keywords and % of Terrestrial Protected Area.

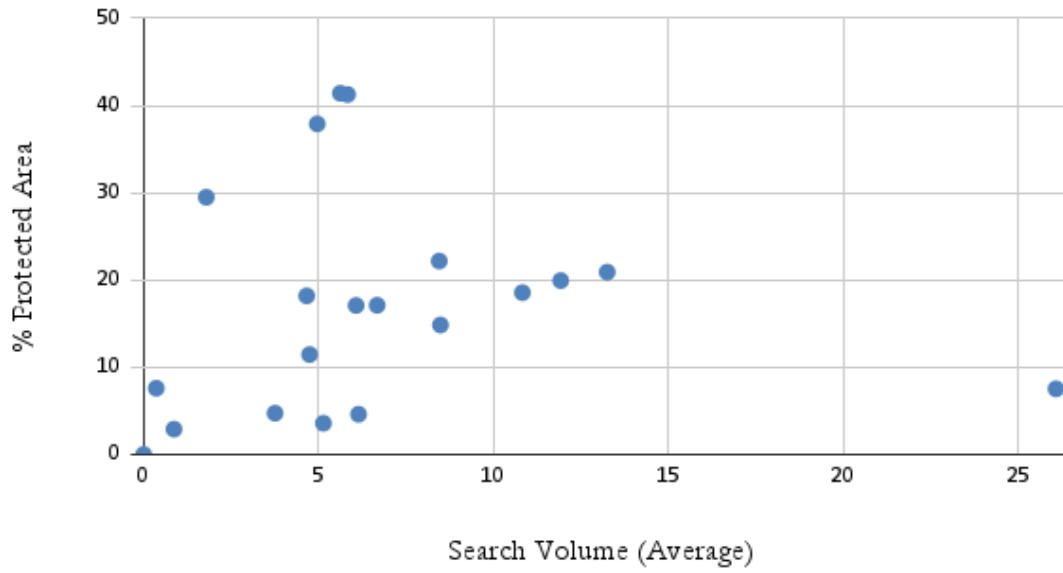| Keyword	Correlation
air quality	0.205647
biodiversity	0.165663
biological control	-0.02838
biomass	0.837879*
climate	0.419549*
ecosystem services	0.971145*
ecosystem	0.930618*
erosion	0.879336*
pollination	0.132058
soil fertility	0.100575

* Significant Correlation for p < 0.05 Source: From the Author, 2022

To produce all analyses and graphs, the Google Colaboratory Software was used with Python, and Microsoft Excel.

The search volume of some terms was non-existent, therefore, reducing the data available for the experiment.
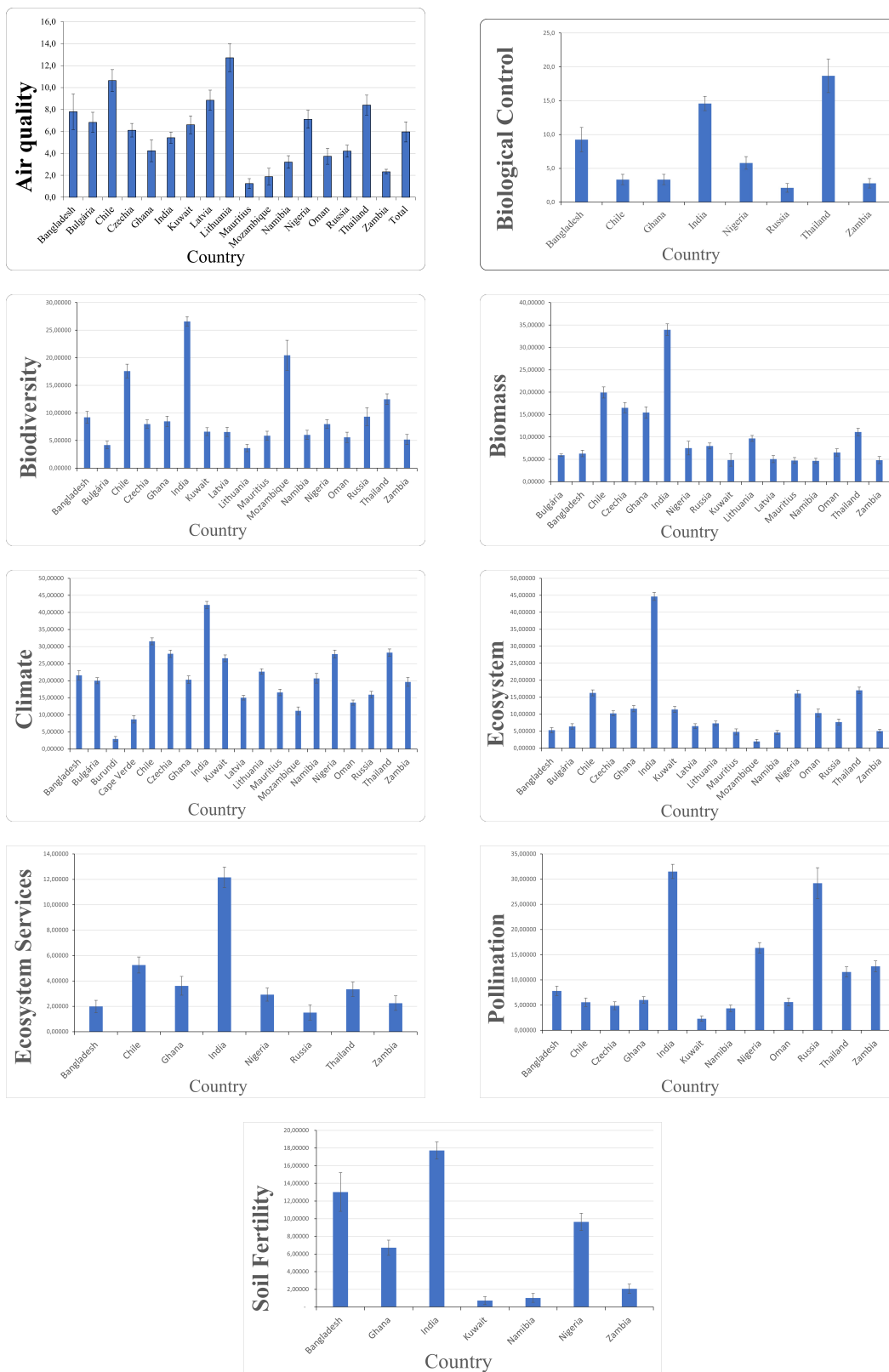
Figure 4.1 – Correlation between Search Volume and % of Terrestrial Protected Area.

% Protected Area versus SV (Avg)

Source: From the Author, 2022

Figure 4.2 – Search Volume (Mean) with Standard Error per Keyword per Country

Source: From the Author, 2022

5 DISCUSSION

We observed that there is a positive correlation between the volume of searches and the percentage of the terrestrial protected areas, suggesting that the public awareness of a population is positively related to the percentage of protected areas.

This correlation indicates that the percentage of protected areas can influence public awareness and, therefore, may influence the public capacity to protect and steward natural resources. The correlation may also indicate that the public awareness of natural resources importance influences the stewardship of these resources by public authorities, which may be a reinforcing factor.

The relevance of the keywords varies among countries, indicating that the environmental and social conjuncture influence the awareness of a related topic and, therefore, the volume of searches.

The results are very important since the relevance of the keywords may represent a key to understanding the overall feelings and awareness of a population. Social listening tools are widely used for understanding market trends but are still under-used by scientists and ecologists.

Internet access may play a key role as a tool for analyzing behavior and, therefore, to help improve public awareness regarding the ecosystem and the climate, bringing important insights for public and private sector actions.

However, there are still some limitations regarding the tools and what we can achieve as agronomists and agroecologists.

5.1 AnswerThePublic Limitations

AnswerThePublic is helpful to understand the relevance of keywords but it might also be possible to relate this to inducing people's behavior when querying the internet by suggesting autocomplete words, which is not a feature of AnswerThePublic but of every web search tool like Google or Bing.

When tested for native languages though, the number of suggestions was very low or, sometimes, zero, suggesting that either the mainstream keywords are searched by people who understand English, no

matter the country, or the lack of sufficient information for the search tools for suggesting autocomplete words.

5.2 Google Trends Limitations

As with almost every web tool, we cannot know the motives behind the internet search records or the intricacies of their tool's code and, therefore, the volume of searches might not form a representative (random, unbiased) sample of a region.

Although there may be a direct causal association between terrestrial protected area and the terms considered for this study, a cross-validation of these data might be necessary to counterbalance the lack of understanding of a keyword relevance in other cultures and conjunctures and reduce any dubious correspondence within the keywords (e.g. polysemic words).

5.3 Advantages of Using Social Listening Tools over conventional field programs for conservation

The cost-effectiveness of using the internet for assessing public awareness is one of the major advantages compared to conventional field programs. Connected to other online tools, like public databases, GIS, social media web scrapping, exponentiate the possibilities of studies and assessments that can be conducted remotely, with multiple spatial and temporal scales (Proulx, 2014).

Nonetheless, further research is needed to understand the role of all these tools in the research landscape and I) the relevance of the terms for the population of a given country; II) the impact of the language used for queries, and III) the percentage of the population with internet access, as well as social media data analysis to improve the understanding of behavior and feelings regarding natural resources conservation.

6 CONCLUSION

This research evaluated the correlation between the volume of searches on the internet for keywords related to ecosystem services and the percentage of terrestrial protected area of 20 coutries. The analysis were conducted in order to evaluate the presence and strengh of the correlation, aiming at understanding how internet search behavior and public awareness can be connected to the conservation state of a country.

The results indicate that public awareness and internet search behavior are correlated to the percentage of terrestrial protected area and may influence one another. Some terms are more relevant to some countries than others, indicating that the current environmental state of a country may influence search behavior.

Further research is needed to understand the relevance of the terms in a given country as well as the impact some events might have (e.g. extreme events like tsunamis or typhoons) in the internet search behavior. Beyond that, the use of native languages opposed to English might represent a key understanding when connected to the percentage of the population with internet access.

As agronomists and agroecologists, it is important to consider all tools available for understanding public awareness and conservation as society affect and is affected by natural resources. Public awareness is now live on the internet and this kind of data might present itself as a good opportunity for fostering biodiversity as we increase our understanding of the relationships between conservation and public action.

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