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Did the COVID-19 Crisis Reframe Public Awareness of Environmental Topics as Humanity's Existential Risks? A Case from the UK

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Abstract: The COVID-19 pandemic has not just gently nudged but forcefully thrust environmental issues into the forefront of public consciousness. This shift in awareness has been a long-time aspiration of conservation scientists, who have played a crucial role in advocating for recognizing nature's contributions to human life and a healthy environment. I explain the advantages of using newly available tools and sources of digital data, i.e., the absolute search volume in Google using the flag keywords biodiversity, climate change, and sustainability, The GDELT Project, which monitors the world's broadcast, print, and web news, and the difference-in-differences method comparing paired samples of public interest before and after the pandemic outbreak. We focus on the case of UK citizens' public interest. Public interest in the flag keywords in the UK showed a highly significant increase during the pandemic. The results contradict hypotheses or findings presented elsewhere that the public interest is attenuated during and because of the public health crisis. I support growing public awareness of the existential risks springing from human materialism misappropriating nature, environment, and resources. In conclusion, I advocate for a "new conservation narrative" that could be fostered by the increased public interest in environmental topics during the pandemic.

Keywords: existential risks; COVID-19; difference in differences; environmental topics; biodiversity; climate change; sustainability; UK

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1. Introduction

In 1998, J. Lubchenco referred to the 21st century as the "century of the environment", emphasizing the close connections between ecological systems and human health, the economy, social justice, and national security [1]. Ten years later, C. Anderson, then editor of *Wired* magazine, predicted that the sheer volume of data would eliminate the need for theory and the scientific method [2]. In the meantime, existential risks, which examine threats to human existence, have emerged as a rigorous and scientifically serious area of inquiry [3,4]. The need to better communicate scientific knowledge in conservation has become a common thread, with a call for new narrative strategies as communicative devices and conceptual tools [5].

This study investigates how people's experiences during the COVID-19 pandemic, such as fear, denial, and perceptions of environmentally driven risks, have changed as the disease's impact and global containment measures have evolved. I want to understand how these experiences have influenced people's awareness, understanding, and beliefs about potential risks to humanity, particularly since climate change and emergent diseases/biodiversity extinction are consistently ranked among the top three existential risks [3,4,6,7]. Examining how UK citizens' environmental awareness has evolved in response to the lessons of the COVID-19 pandemic provides a relevant and opportune example of this challenge. A plausible hypothesis is that answers may be found at the intersection of science–policy interaction, existential risks, and big data to develop more positive narratives [8], moving away from moralistic [9], apocalyptic [10], or utilitarian storylines [11] that have been ineffective [5,12].

To gather specific data about the pandemic, I will use sources like the Johns Hopkins Coronavirus Resource Center [13] and the Oxford COVID-19 Government Response Tracker [14,15]. Previous literature on existential risks [16,17] and the global risks reports of the World Economic Forum from 2010 to 2024 [18] provide the foundation for understanding existential risks. The common denominator of the existential risk literature is that climate change and emergent diseases/biodiversity extinction are ranked systematically in the top three positions.

The paragraphs below provide a summary of the literature and arguments supporting the scope of this contribution. Environment-related issues, such as environmental occupational health and environmental sciences, are among the top five disciplinary domains related to the extensive literature (Web of Science, a total of >580,000 publications as of the end of July 2024) on the COVID-19 pandemic. While pandemic research primarily focuses on medicine, epidemiology, and therapeutic aspects of COVID-19, 13.5% of the research is directed toward broader environmental issues. This significant amount of published research reflects the disruptive consequences in almost every aspect of human life and activity ([19], Figure 2), including interactions with nature and wildlife [20]. The reduced human presence, mobility, and slowing of human-made pressures worldwide during the pandemic have provided a "once in a lifetime", unplanned, serendipitous opportunity to gather and synthesize empirical evidence on human–wildlife or nature interactions, often referred to as the "global human confinement experiment" [19] or the "anthropause perturbation experiment" [21]. This has involved methodologically challenging field observation measurements [22], qualitative methods, often quite time- and resource-intensive, for evaluating people's perceptions [23] and big data for assessing public perceptions of this particular condition through culturomics-derived methods, technologies, and digital communities [24,25]. Most published empirical evidence on reduced human mobility during "lockdowns" contributes to conservation science through the accumulation of case studies and the search for statistical regularities [19,26,27]. A few have proposed to proceed from theoretical to singular explanations. Notable examples of this approach include the neological concepts of anthropause [28] and anthropulse [29], as well as "multiple human geographies" [30].

The evidence and data discussed here are based on protocols and techniques of conservation culturomics [25] and infodemiology (or infoveillance) [31–33]. These methods leverage the billions of internet users and the widespread use of social media to study public perceptions on emerging topics, e.g., health issues, at exponentially greater scales than was previously possible through targeted surveys and focus groups [34]. They also help widen the participation and the inclusion of underrepresented social groups in such studies. The search strings used in publication databases may vary, but the main corpus is almost similar. For example, a search string for "(COVID OR pandemic) AND Google Trends" yielded around 930 papers on Web of Science at the end of April 2024. This search string aimed to capture different aspects of "infodemiology" practice during and after the pandemic to measure public interest through individual searches on web search engines. On the other hand, a stricter search string like "(COVID OR pandemic) AND infodemiology" resulted in 335 papers in the same database. The difference is a medical-oriented subset of the first search, which includes papers focusing on the economy, policymaking, education, tourism, crime, home violence, addictions, environmental issues, and more.

The pandemic-related environmental literature has yielded several key but sporadic findings, whether connected to the "global human confinement experiment" [19], the "anthropause perturbation experiment" [21], or culturomics and "infodemiology" science practices [25,33]. However, as mentioned in [26] (p. 9), the "initial observations painting a rosy picture of wildlife "rebounding" (for a synthesis, [26,27]) are now being challenged by a return to pre-pandemic levels of human activity and perceptions, i.e., the "human post-pandemic materialism rebound" [35–37]. After carefully examining this particular oscillation [38] (see Section 4), one would realize that it is unsupported to conclude or attribute causal effects on potential shifts in the public's environmental awareness related to the postmodern concepts of sustainability, climate change, and biodiversity per se [39]. Instead, one might examine whether they are particularly due to or "activated" by the multiple impacts of the pandemic on society.

Here, I adopt an alternative approach to address the potential downsides of conservation narratives related to the pandemic. These issues are often present in ecology and environmental science methods more generally [5,40–42]. The goal is to move away from the idea (or even paradigm) of "humans as custodians of biodiversity (or nature)" [26,27] and instead focus on humanity's dedication to studying, understanding, and preparing for the consequences of combined social and natural extremes and global crises [43].

The difference-in-differences (DiD) method is appropriate for this task [44,45]. Although originally developed at the end of the 19th century for epidemiological purposes, it is currently a widely used tool for estimating causal effects in various fields, such as econometrics [45]. An unbiased estimate of the treatment effect or various disruptive events such as a new policy intervention, novel economic measures, or a social or natural event—in this case, the pandemic outbreak—is needed. The challenge is to uncover if the change in the outcome variable in the treated group would have been the same as in the control group in the absence of treatment [44–46]. The DiD method compares changes in an outcome over time between an intervention and control group, making it useful for estimating causal effects at the group rather than at the individual level [46]. It is important to note that DiD estimates the average effect of the "treatment" or "intervention" on the outcome in the group exposed to the intervention [46].

An influential paper on applying the DiD method and its potential extensions in the relationship between the pandemic and environmental awareness is by Rousseau and Deschacht [47]. Despite the partial findings and the method's short time bandwidth (2 to 10 weeks), the study's linear regression modeling of the impact of the COVID-19 crisis on natural and environmental awareness utilizing the DiD method provides a new perspective on infodemiology [33] and conservation culturomics [25,48]. Rousseau and Deschacht [47] assumed that the time of switch (T = 0; Tuesday, 14 March 2020) between the pre-pandemic period (control) and the pandemic period (treatment) is the date that COVID-19 was declared a pandemic by the WHO, which was 11 March 2020. Their study focused on 20 European countries, and the regression analyses were based on 2400 observations, covering 10 weeks of data in 2020 and the same weeks of data in the control year, 2019. The study looked at six topics related to natural and environmental awareness, which were measured using the search volume on the web and the normalized Google Trends platform.

In the following sections, I will outline my approach to tackling the challenge outlined in the title. I will detail the technical and methodological solutions I have implemented, explain the rationale for selecting the UK as a model case, and explore the benefits of employing causal inference rather than providing a narrative explanation of empirical evidence.

2. Materials and Methods

In this section, I present four basic components of my methodology. First, a technique to control the effect of the COVID-19 crisis or disruption event on the environmental awareness descriptor is obtained by estimating the linear regression equation in its simplest form (formula matching Equation (3), p. 1153, [47]):

$$\mathrm{ASVG}_{i,t} = \beta_0 + \beta_1\, \mathrm{P}_{i,t} + \delta_{\mathrm{DiD}}\, \mathrm{x}(\mathrm{P}_{i,t} \times \mathrm{Y}_{i,t}) + \varepsilon_{i,t} \quad (1)$$

where ASVG is the absolute search volume in Google in week t for the descriptor i; P is a dummy variable indicating the control period (pre-pandemic) that equals 0 and the pandemic impact period (treatment or intervention period) that equals 1; and Y is a dummy variable distinguishing the control years (2016–2019) (Y = 0) from the years 2020–2023 in which the COVID-19 crisis occurred (Y = 1). The estimator δ_{DiD} might result in a coefficient of the linear regression (1).

Practically, DiD is a valuable statistical technique used to determine the causal effect of a treatment or intervention by comparing the changes in outcomes over time between a treatment group and a control group in observational studies where randomization is not possible. In the case of the current study, I measure the outcome for the same group both before and after the treatment event, which in this case is the COVID-19 outbreak. The DiD method can be represented theoretically using expectation notation (a simplified form of Formula (1), p. 89, [46]):

$$\mathrm{DiD} = E(\Delta[\mathrm{ASVG}]^{P=1}) - (\Delta[\mathrm{ASVG}]^{P=0}) \quad (2)$$

In simpler terms, it represents the average outcome that one would expect if one could repeat the process an infinite number of times. A simplified procedure of comparing the means of two paired samples is an acceptable alternative to treating the pre- vs. post-pandemic groups' environmental awareness descriptors.

Figure 1 offers an idealized presentation of the methodology, and the variables used in the equations.

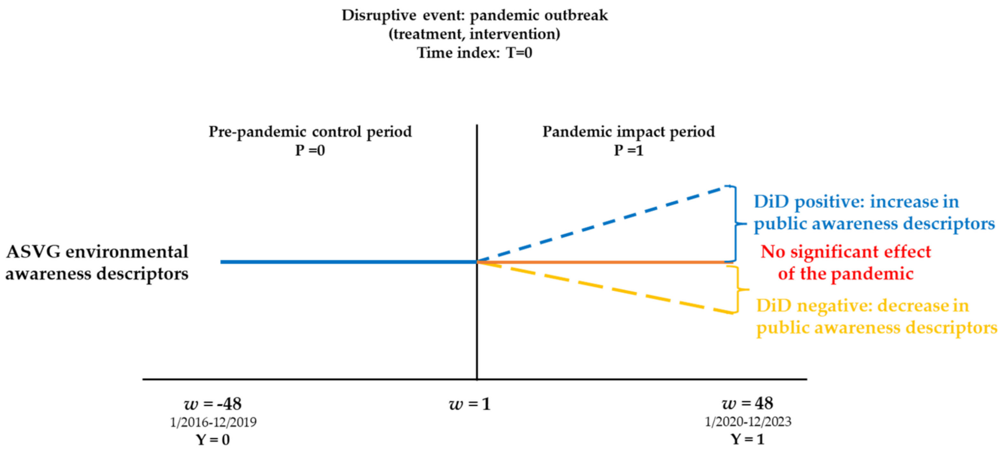

Figure 1. Depiction of an idealized "difference-in-differences" example graph. The lines in the graph illustrate the trends over time in outcome measures (ASVG descriptors) for two periods: the pre-pandemic control period (P = 0) and the pandemic impact period (P = 1). On the x-axis, time is represented in months, ranging from $w = -48$ months (pre-COVID baseline) to $w = 1$ (years 2016–2019) vs. w = 1 to w = 48 months (years 2020–2023). The vertical line marks the switch from the pre-disruptive event to the post-disruptive period. The slope of the extensions of the pre-pandemic trend of ASVGs corresponds to three different potential effects (details in the text).

The idealized presentation (Figure 1) presents three hypotheses. The first hypothesis (the red extension in the figure) indicates no significant effect of the pandemic on the environmental awareness of citizens (for one or all descriptors)—the disruptive event did not affect people's environmental awareness. The second hypothesis (the blue dotted line) suggests an increase in the environmental awareness of citizens. The third hypothesis (the orange dotted line) suggests a decrease in the environmental awareness of citizens.

The outcome of the ASVG (absolute search volume, Google Trends) data series is used here to measure the absolute number of individual searches instead of using a normalized scale of 0–100. These data are made available through the Enhanced Google Trends Super-charged extension Glimpse tool 0.180.1, which provides the real-time search volume for any keyword, and the traditional normalized Google Trends tool. This topic has been the subject of extensive discussion in conservation culturomics and infodemiology research for over a decade (for further analysis, refer to Section 4). ASVG time signatures were created for the environmental awareness keywords "biodiversity", "climate change", and "sustainability". The data series for all keywords show peaks and troughs, some of which are outliers (Figure 2). Due to significant fluctuations in search volumes over different periods, I smoothed the data using the adjacent-averaging method. A 4th-degree polynomial trend line, 95% confidence interval, and 95% prediction band were fitted to the smoothed data. Specifically, for the climate change keyword, which attracts the highest public interest, I created an additional modified distribution to impute three outliers significantly departing from the smoothed distribution's 95% prediction band limits (Figure 5C1). Imputation or replacement of these outliers with a more typical value, here the overall mean of the data series, is preferable to other methods of handling outliers, such as removal or transformation.

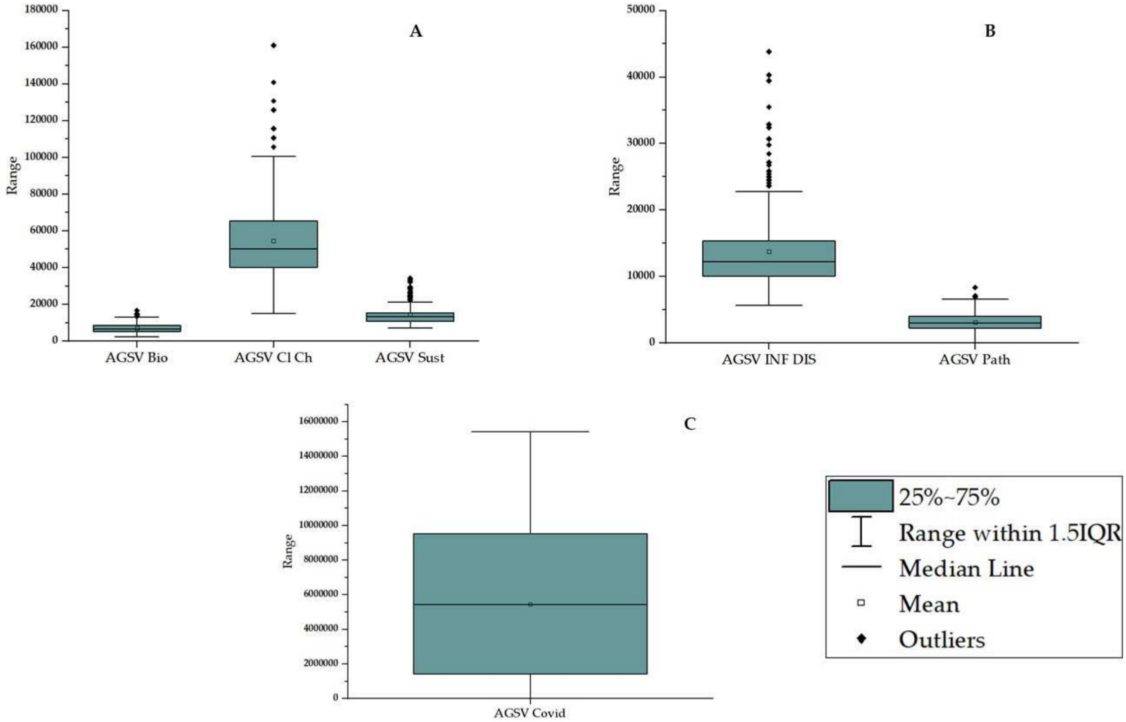

Figure 2. Box-and-whisker plots of the Google absolute search volumes, representing UK public opinion interest in environmental, public health, and pandemic keywords (2004–2023). (**A**) ASVGs for biodiversity, climate change, and sustainability; (**B**) ASVGs for infectious diseases and pathogens as proxies for the "emergent diseases" keyword; (**C**) ASVG for COVID-19. Symbols are explained in the legend.

The expectation notation simplifies the statistical treatment of the data, since each descriptor is controlled separately here. The data series for each ASVG was split into two equal parts, with the first week of January 2020 as the dividing line. For comparison, each data point from January 2020 to December 2023 was matched with its equivalent from January 2016 to December 2019. Control checks were carried out to ensure that the differences between the paired samples were within acceptable limits, including checks for normality and outlier numbers.

The second component was choosing the UK and English language as solid examples for the methodology. We chose the UK as a model country and English as a language to reduce information noise and biases on public interest regarding the symbolic keywords of environmental awareness being examined. Approximately 59% of internet websites are in English. About 2 billion internet users (out of a total of 5.35 billion users globally in 2024) search in English, indicating that it is the lingua franca of modern times. The UK internet user community represents over 96% of the country's population, and the Office for National Statistics (ONS) provides detailed information on the socio-demographics of internet users. Furthermore, UK citizens have a strong cultural connection and tradition with nature, landscapes, and environmentally friendly activities, such as birdwatching, horticulture, gardening, and so on [49]. However, using English as the only search criterion in the Google engine, regardless of the country, would significantly obscure the international cultural factors of public interest (for further analysis, refer to Section 4).

The third component was creating the ASVG signature for UK citizens regarding health issues, specifically contagious diseases. This signature is a reference point for citizens' attitudes and interests in public health issues. The targeted keywords used in this effort were "pathogens" and "infectious diseases". However, no data for the more relevant keyword "emerging diseases" were available. The assumption is that "pathogens" represent general knowledge of viruses and microbes, while "infectious diseases" indicate a significant public health concern. In addition to controlling the AVGS signatures, I adjusted the recorded search volumes to account for changes in the size of the UK population and internet usage rates. This calibration was undertaken to align the ASVG signatures with the actual UK population conducting searches (from 2004 to 2023, according to ONS data).

The fourth component involved analyzing the ASVG signal related to "infectious diseases" to identify significant trends in COVID-19, particularly focusing on the development of the pandemic in the UK. This was based on the weekly aggregated data of new cases and deaths recorded from December 2019 to December 2023 obtained from the World Health Organization's COVID-19 dashboard data [50]. Additionally, I tracked the daily flow of information in the UK, including broadcast, print, and web news, using data from the GDELT project [51] between 1 January 2020 and 31 December 2023 specifically related to COVID-19 and "new deaths". It is important to note that the focus was on articles with predominantly negative content regarding these topics.

Downloaded data from various sources were organized in Excel 365, signal analysis treatments were performed using OriginPro 2024, and statistical analysis was performed on SPSS v. 28.

3. Results

The results are presented in four sections. The first section compares factors of interest using box-and-whisker plots (Figure 2). In addition to providing a summary of descriptive statistics for each descriptor, these plots effectively visualize the comparisons between them and indicate the extent of outliers. The focus here is on the range of values representing the level of public interest in the UK for each descriptor. Public interest in environmental awareness concepts peaks at approximately 15,000, while interest in health issues reaches around 5000, with outliers occurring in specific time periods. However, under extreme conditions such as the COVID-19 pandemic, public interest in health issues reaches approximately 15×10^6. Within each descriptor category, differences are clearly displayed. For example, while climate change generates significant public interest, sustainability—despite being a global strategy for human activities—and biodiversity, the biotic basis for quality of life and human well-being, lag behind, likely appealing to some specific "niche" public (Figure 2A).

The second section examines the UK public's interest level in emerging diseases. This complex concept is important for medicine and public health and is influenced by biological, ecological, and environmental processes. Understanding the UK public's opinions on the pandemic and public health issues could help us better grasp their sensitivity and responsiveness to environmental concerns. This study provides an overview of public interest in pathogens and infectious diseases, as shown in Figures 2B and 3. Figure 2B indicates a baseline level of interest in pathogens, with an average of about 3180 monthly searches over 20 years. We can also observe peaks in public interest in infectious diseases (Figure 3A), particularly during global epidemics such as SARS, swine flu, MERS, Zika virus, COVID-19, children's hepatitis adenovirus AF41, and monkeypox. Notably, this list does not include cases like the HIV pandemic, Ebola outbreaks, or avian influenza H5N1.

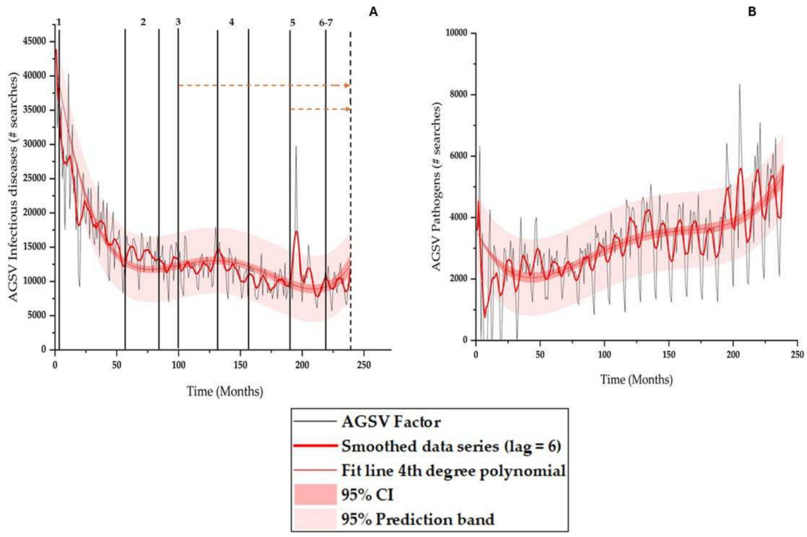

Figure 3. AGSVs for infectious diseases (**A**) and pathogens (**B**) in the UK, 1 January 2004–31 December 2023. The legend explains symbols. In Figure 2A, numbered lines correspond to 1: SARS; 2: swine flu; 3: MERS (extending to 2023); 4: Zika virus; 5: COVID-19 (extending to 2023); 6–7: adenovirus hepatitis and monkeypox. The dotted lines represent continuing public interest after the initial outbreak of the disease.

The third section discusses the level of public interest in the COVID-19 pandemic in the UK. Figure 4 provides a summary of the findings from this study. Figure 4A presents a fourth-degree polynomial fit line of the weekly AGSV COVID-19, using smoothing after the adjacent-averaging method with a lag = 2. The polynomial fitting of the AGSV shows an R^2 value of 0.98 and a highly significant ANOVA result (a = 0.05, $p < 0.0001$). Figure 4B shows the Gaussian deconvolution of the AGSV COVID-19 at a monthly scale. The AGSV was constructed based on a series of hidden secondary peaks on a general truncated Gaussian distribution from December 2019 to December 2023. During this period, five significant secondary peaks were identified, leading to overall observed peaks and drops in public interest response. These secondary peaks may be explained by the epidemiological evolution of the disease, such as the announcement of new cases and deaths by public health authorities in the UK, which are reflected in the population's emotions, sentiments, and other psychological effects [44].

The fourth section of this contribution is particularly interesting. Rousseau and Deschacht's approach [47] was extended to cover the entire COVID-19 period, and 48 months for web searches on biodiversity, climate change, and sustainability before the pandemic. These findings might offer a different perspective on the relationship between public interest in public health and environmental issues. The separator date is set at month 192 of the AGSV data period, week 4 of December 2019, when the news of the Wuhan outbreak first appeared.

Figure 5 presents the corresponding AGSVs, which are smoothed and fitted to a fourth-degree polynomial. A visual inspection of AGSV trajectories suggests that public interest in biodiversity, climate change, and sustainability increased significantly during the pandemic. Special attention is given to the AGSV climate change. Sporadic search peaks before or after the separator date are depicted in Figure 5C1, which may affect the comparison of means. To address this, outliers in the AGSV climate change distribution were replaced by the average of the entire distribution, including the outliers in the calculation (Figure 5C2).

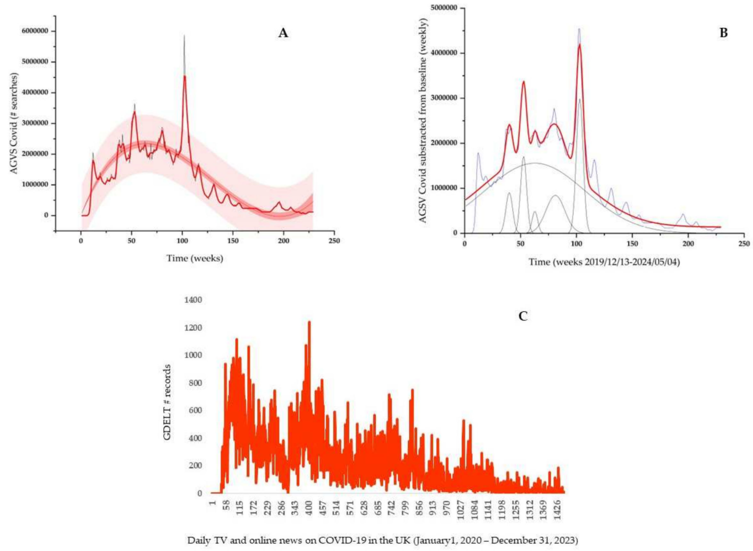

Figure 4. A synoptic visualization of UK public interest in the evolution of the COVID-19 pandemic. (**A**) Fourth-degree polynomial fit line of the AGSV COVID-19 weekly scale (smoothing after adjacent-averaging method, lag = 2); (**B**) Gaussian deconvolution of the smoothed AGSV COVID-19 (red line) monthly scale; thin gray lines represent the hidden peaks of public interest; (**C**) mass of information (broadcast, print, and web news) flow in the UK, according to the daily records of the GDELT Project (period: 1 January 2020–31 December 2023). For more details on data of the GDELT Project, refer to Appendix A.

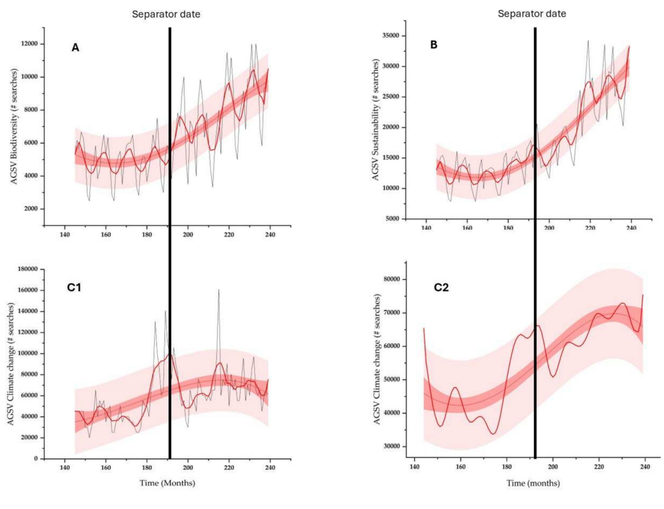

Figure 5. Comparison of the difference in differences in environment-related AGSVs before and after the COVID-19 outbreak. It covers 96 months, with the separator date (black line) being month 192 of the AGSV data series starting January 2004 and ending December 2023. (**A**) Biodiversity; (**B**) sustainability; (**C1**) climate change, including the outlier peaks on either side of the separator date; (**C2**) climate change; the outliers are replaced by the overall average of AGSV climate change 2004–2023, including the outliers. The meaning of the lines and colors are presented in the legend of Figure 2.

Table 1 presents a statistical summary of the previous data. Table 2 compares the average values of AGSVs before and after the separator date. In all cases, Cohen's effect size was greater than 1, indicating that approximately 90% of the control group (AGSVs before the pandemic) fell below the mean of the experimental group (AGSVs after the onset of the pandemic). This suggests that the group means differed by more than one standard deviation. Pearson's correlation coefficient showed that all correlations were approximately 0.3 or less, indicating a weak association between the two sets of AGSVs.

Table 1. Summary statistics of the analysis of environment-related AGSVs, the form of the 4th-degree polynomial fit line $Y = \beta_0 + \beta_1 X^4 + \beta_2 X^3 + \beta_3 X^2 + \beta_4 X + \varepsilon$, smoothing (lags per factor), R^2, and the significance of the ANOVA test.

AGSV Factor Smoothed (Lag = 6), Monthly Scale	4th-Degree Polynomial Fit Line						
	β_0	β_1	β_2	β_3	β_4	R^2	ANOVA
COVID-19 (weekly scale, lag = 2)	0	5.3×10^7 (3.3×10^6)	7.3×10^5 (4.6×10^4)	−3333.4 (216.1)	5.05 (0.33)	0.978	$p < 0.0001$
Pathogens	3600	−84.7 (5.85)	1.47 (0.13)	−0.008 (9.35×10^{-4})	1.71×10^{-5} (2.06×10^{-6})	0.964	$p < 0.0001$
Infectious diseases	42,500	1111.1 (22.6)	14.1 (0.51)	−0.073 (0.003)	1.32×10^{-4} (7.96×10^{-6})	0.973	$p < 0.0001$
Biodiversity	5000	486.8 (185.8)	−7.576 (2.93)	0.038 (0.015)	6.02×10^{-5} (2.61×10^{-5})	0.986	$p < 0.0001$
Sustainability	12,500	1565.2 (424.9)	−24.092 (6.701)	0.119 (0.034)	-1.85×10^{-4} (5.98×10^{-5})	0.991	$p < 0.0001$
Climate change	50,000	4060.5 (3404.3)	−78.795 (53.835)	0.472 (0.280)	-8.95×10^{-4} (4.83×10^{-4})	0.947	$p < 0.0001$
Climate change (outliers corrected)	65,000	5524 (1521.3)	−94.9 (24.06)	0.517 (0.125)	-9.04×10^{-4} (2.16×10^{-4})	0.986	$p < 0.0001$

Table 2. Summary statistics of pairwise comparison of means of Environment-related AGSVs before and after the separator date. Each sample is 48 months long on either side of the separator date. Nor-mality and outliers are controlled by the difference between the monthly values of each AGSV/descriptor. Normality is controlled with the Shapiro–Wilk test (^{ns}: non-significant). The data presented are the sample's means with standard error in parentheses. *t*-value is accompanied by its significance (p_1: one side; p_2: two-sides).

AGSV Descriptor Smoothed (Lag = 6), Monthly Scale	Paired Samples Mean Comparison				
	Difference Pairwise	Normality S-W	Mean "Before'	Mean "After'	t (p_1; p_2)
Biodiversity	−2963.7 (418.1)	0.228	4937.7 (185.7)	7901.4 (335,3)	−7.088 (<0.001; <0.001)
Sustainability	−9496.6 (1075.7)	0.301	12,562.6 (358.6)	22,059.2 (954.4)	−8.828 (<0.001; <0.001)
Climate change	−19,594.6 (4792)	0.02 ^{ns}	47,406.8 (3102.8)	67,001.4 (3072.9)	−4.089 (<0.001; <0.001)
Climate change (outliers corrected)	−18,879.2 (2648.5)	0.327	45,129.8 (2068.2)	64,009.1 (2075.1)	−7.128 (<0.001; <0.001)

Additionally, quantile regression estimated the relationship between the time predictor and the AGSV response across all distribution parts (Figure 6). The regular residuals of the fourth-degree polynomial model for environment-related keywords (AGSVs) against theoretical percentiles indicated that the fundamental assumption in regression analysis, i.e., the variance in the response variables of AGSVs of all regions of the distributions (percentiles 10–90%), was not heterogeneous, in addition to their means.

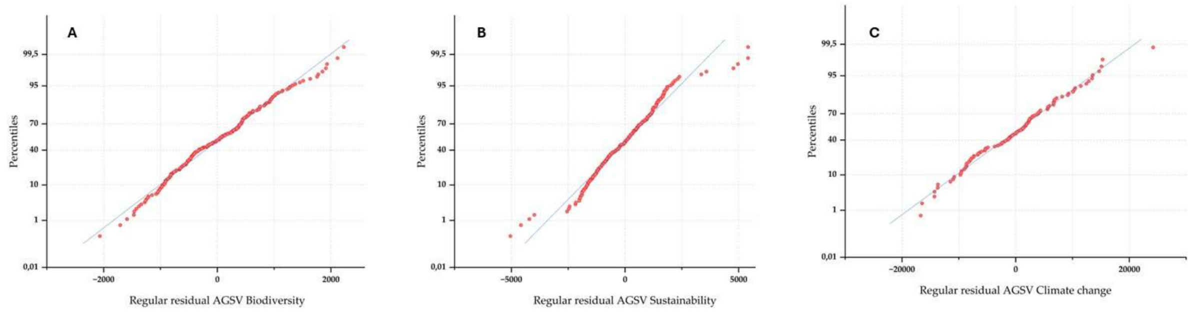

Figure 6. Illustration of the distribution of the residuals of the 4th-degree polynomial model against theoretical percentiles. In addition to the visual check for normality, i.e., a fundamental assumption in regression analysis, it shows the variance in the response variables, AGSVs. (**A**) biodiversity; (**B**) sustainability; (**C**) climate change (outliers corrected), not heterogeneous (percentiles 10–90%).

4. Discussion

The Discussion is organized into three main points. The first part builds on the "double rebound" narrative [25,26,29,33–36] introduced in the Introduction section and includes additional important considerations: circular arguments and the disconnect between health and environmental priorities. The second part is technical and outlines potential improvements or variations from the previous paper by Rousseau and Deschacht [47]. The third part aims to use this study's findings as a catalyst for developing a new, positive narrative for environmental and biodiversity conservation [5,8].

"Argument circularity" is indirectly emerging in hundreds of publications. Somehow, it is connected to the rosy picture of wildlife "rebounding" [26]. Simplistically, it can be read as "fewer humans or activities, fewer impacts or pressures on wildlife or nature" [52]. Examples refer to a decrease in animal road mortality, extension of species territories, changes in relative abundance of species in communities, reduction of noise pollution, hunting or fishing, etc. Some argue this perspective aligns with neo-Malthusian [53] and de-growth [54] narratives. The genuine question is whether this pattern constitutes an unavoidable tautology [55] vs. [56] and whether it could hinder conservation efforts in the post-pandemic era [57].

The extensive literature ultimately emphasizes the "dissociation between health and environmental priorities." In their comprehensive review, Bates et al. [26] (p. 15) acknowledge that "both positive and negative impacts of human confinement do not support the view that biodiversity and the environment will predominantly benefit from reduced human activity during the lockdown." According to the authors, "the negative impacts of the lockdown on biodiversity result from the disruption of human efforts to conserve nature through research, restoration, conservation interventions, and enforcement." Similar statements can be found in other literature. For instance, the severity of the COVID-19 pandemic has consistently reduced public interest in climate change in the USA [58]. Furthermore, interest in conservation actions, particularly searches related to national parks, has decreased since 2019, likely due to the pandemic [59]. While the increased public awareness of health–environment connections during the pandemic could theoretically benefit conservation efforts, there are misleading negative associations between wildlife and zoonotic diseases that may harm the role of biodiversity in disease spillover and outbreak in the long term [60]. However, contrary findings have been reported from traditional polling exercises, showing that the experience of the COVID-19 pandemic has led to an increased concern for climate change and public support for green recovery policies [61]. For example, before the SARS-CoV-2 outbreak, a study estimated that more than 5,000,000 deaths per year globally were attributable to non-optimal temperatures over 20 years, accounting for 9.43% of all annual deaths [62]. In comparison, COVID-19 caused approximately 6,880,000 deaths globally over three years. During the same period, it was projected that more than 15,000,000 deaths would occur due to climate change-related non-optimal temperatures. Furthermore, a dynamic DiD study on individuals' beliefs about extreme events found that only fires had a small but statistically significant effect on recognizing the existence of climate change and supporting the need for action. However, this effect diminished over time [63].

As Soulé [54] (p. 727) pointed out, "Conservation biology is often a crisis discipline". This almost axiomatic statement has never been more relevant than during the COVID-19 pandemic. Human mobility, activities, and the intensity of pressures on the environment and nature have been significantly reduced or disrupted for public health reasons. This temporary disruption has challenged conservation science and pro-conservation storytelling [12]. Terms and concepts such as the Anthropocene, biodiversity, sustainability, climate change, and methods related to scenario construction and big data exploration can be considered "postmodern" and seen as ushering in a different historical era and type of society [39]. These concepts did not exist when Soulé envisioned conservation as a crisis discipline based on coupled functional and normative postulates. Unsurprisingly, publications emphasizing changes, shifts, and advances over Soulé's original vision appeared decades later [11,64]. However, although it was humanly impossible to examine the nearly 40,000 publications listed on the Web of Science with the search string "(COVID OR pandemic) AND (conservation OR environment*)" as of the end of April 2024 for this study, unless through bibliometric techniques [65], two significant components of this massive literature emerged. The first is the replication crisis, and the other is the "existentialist narrative crisis", which revolves around nature's implicit values, extended to eco-centric, spiritual, or ethical arguments on the one hand vs. anthropocentric or utilitarian on the other.

The replication crisis is clearly evident. Almost none of the reported empirical evidence or observations on the impacts or effects of pandemic conditions on biodiversity, sustainability, or climate change is replicable or reproducible, as elementarily required within the noble Popperian paradigm. On the contrary, even positive effects, however temporary, can be seen as anomalies compared to widely entrenched trends or predictions regarding the decline of human life-support systems and the Earth system. One might argue that the transition toward Kuhn's [66] interpretation of paradigm shift, i.e., accumulation of contradictory data that the existing explanation cannot predict, remains incomplete or has not been fully realized regarding the call for a "new narrative" for conservation after the lessons of the pandemic [36,38,43,67].

Analyzing a considerable number of discussion sections of the relevant literature, a motif emerges when prescribing, mobilizing, and inspiring action for the future. This is often accompanied by arguments about why destructive, ineffective, or unjust conservation or environmental policies persist [5]. Expressive differences or variations in narrative shape unavoidably exist. For example, an emblematic paper by Bates et al. [26] resumes the synthesis of the "global human confinement experiment", calling for "strengthen[-ing] the important role of people as custodians of biodiversity, with benefits in reducing the risks of future pandemics". One could position this call at the interface of spiritual and ethical conservation narratives [5] and anthropocentrism in the sense of the Millennium Ecosystem Assessment [68], i.e., nature underpins human society and the economy and therefore must be conserved. Rutz et al. [28], when introducing the concept of anthropause, refer to the drastic, sudden, and widespread, i.e., unprecedented, circumstances of human confinement as "providing important guidance on how best to share space [with animals] on this crowded planet" and "shaping a sustainable future". There are elements of the nature-based solutions perspective [69] and even aspects of eco-modernization [70]. Overall, the narratives of the pandemic conservation- and environment-related literature insist on how relevant problems are defined, which actors should do what, what solutions are desirable, and how laws, programs, policies, and funding streams flow. Social sciences, cognitive science, or development studies specialists would easily have recognized such narrative constructs decades ago [71,72].

I believe the paper by Rousseau and Deschacht [47] provides an appealing and commendable example of the analysis mentioned earlier. Their introduction of the DiD approach is an innovative way to address public awareness of nature-related and environmental topics during the pandemic. Their findings could contribute to developing much-needed optimistic messaging in the search for a new conservation narrative [6] if they connect their positive findings with messaging perspectives that encourage people's engagement and action. Inspired by Rousseau and Deschacht's [47] methodological approach, I tried (1) to diversify the technical potential of the DiD approach and (2), most importantly, to develop arguments on what Louder and Wyborn [5] conclude: "The stories of old are not achieving the goals they were meant to, and conservationists need to think critically about the narratives that they deploy".

First, the main variable I focus on in my analysis is the absolute Google search volume (AGSV) per keyword instead of the search popularity indicator (SPI) per keyword used by Rousseau and Deschacht [47]. The key difference between AGSVs and SPIs lies in using data on actual search volumes (per time unit, country, or language) in the former format, as opposed to relative normalized (on a scale of 0–100) search volumes in the latter. As explained in the Methods section, this was made possible after the release of the Enhanced Google Trends Supercharged extension Glimpse tool. There have been doubts or objections to the results obtained on public interest estimates using the standard Google Trends algorithms, especially in conservation topics, environment-related issues [73], and infodemiology [74,75], which have been debated until recently. Among the limitations of this methodology [76], the main one is related to the fact that the classic Google Trends algorithm normalizes the search volumes, making it unlikely to produce accurate results for longer-term trends [77,78]. Additionally, Google Trends requires a minimum number of searches to create a trend line, but Google did not initially disclose the specific threshold.

Second, I consider an AGSV keyword (or topic) trajectory representing public interest in a particular country, language, and period. This representation is measured in terms of searches recorded in Google engines. Similarly to how signals are often distorted or altered when instrumentally recorded in physics, biology, or Earth sciences, the actual signal in Google searches can be affected somehow. Errors in Google searches can result from typos or users' misunderstandings. Therefore, mathematical processes such as deconvolution or Fourier transform could be applied and commonly used, as in signal or image processing. However, deconvolution is a complex process that can be influenced by noise in the data, and it may not always lead to the perfect recovery of the original signal.

In the case of the COVID-19 AGSV signal, repetitive searches by the same individuals at different times as the pandemic and epidemiological conditions evolved rapidly might distort the signal. As depicted in Figure 4B, the deconvolution operation helped unveil many hidden public interest peaks using the convoluted signal's second derivative. The second derivative changes sign at the location of a peak: it is positive just before the peak and negative just after. This condition may differ, in at least an intuitive but plausible manner, in the cases of AGSVs for the keywords biodiversity, climate change, and sustainability. For example, an individual interested in biodiversity might conduct a new search for the same keyword under exceptional conditions. Therefore, we support the idea that the increases in AGSVs/keywords we identified in this research reflect the engagement of new, additional population segments.

Third, in their work, Rousseau and Deschacht [47] emphasized the importance of the DiD approach and the time bandwidth they utilized, aiming at identifying causal effects in regression-based strategies following [79]. In their study, the "treatment group" comprised the general public after the onset of the pandemic. In contrast, the control group consisted of the "same" public before the virus outbreak, during a similar short period (2–10 weeks in spring 2020 vs. spring 2019). The metric used was the SPI measured in normalized Google Trends searches. They employed linear regression to address the assumption of parallel trends and included confounders such as controls for country-fixed effects.

It is important to note that this study aimed to mitigate cultural and experiential variations within the pool of 20 countries in the sample [47]. For example, [47] combined the UK's response to the Italian reaction during the Bergamo plague. However, the time-bandwidth was identified as a significant factor affecting the accuracy of their predictions. The short-term nature of the observations is unlikely to yield realistic results. Additionally, even in May 2024, Google Trends continues to record individual searches, one year after the WHO declared an end to the global health emergency of COVID-19. As a variation of this approach, I extended the time bandwidth to 96 weeks, from January 2016 to December 2023. Besides using AGSVs for the environment-related flag keywords, I compared the means of paired samples for one country, emphasizing Cohen's d measure of effect size and Pearson's *r* correlation. Although Cohen's d may be overinflated because the size of the samples is <50, the effect size is large, i.e., >0.8, and significant differences are uncovered by the *t*-test and ANOVA results (Table 2). Pearson's r corroborates these results.

The findings on environmental issues allow us to deliver an encouraging message that resonates with the public and a wide audience [80]. The way the environment is portrayed in public discussions, and discourse involves facts and language. Following the ideas of Lakoff [81], one can better understand how the repetition of certain words (e.g., sixth mass extinction, precipice) or the use of narrative symbols (e.g., custodian or steward of nature) and metaphors (e.g., anthropause) can function as a type of ideological language that reinforces certain beliefs in a listener's mind. They will likely be disregarded if these facts do not align with their ideology or frame of reference. Seeking to align facts and evidence and appealing to reason and rationality when it comes to conservation may, in reality, be a defensive response stemming from concerns among conservationists that the focus on climate change might overshadow the equally critical issue of biodiversity loss [82–85]. Attributing such concerns to typical academic discipline rivalry would be an oversimplification. According to the "Literature review on contemporary public views of climate change and biodiversity loss in the UK" (2023) commissioned by the Royal Society, over 83% of UK citizens are concerned about climate change, while only 49% of the public is aware of biodiversity loss. The report's conclusion emphasizes the need for collective action, informed public engagement, and prioritization of conservation efforts to address climate change and protect biodiversity.

Optimistic messaging is not a unique, sui generis version of the new conservation narrative. Langhammer et al. [86] provided meta-analytical evidence showing that conservation actions worldwide are effective in halting and reversing biodiversity loss in 66% of cases compared to taking no action. Rousseau and Deschacht [47] reported a precise and rapid increase in the search for nature-related topics during the COVID-19 crisis after 14 March 2020. However, they mentioned limitations in their data and time frame. They found that environment-related issues did not significantly increase after the COVID-19 crisis.

This paper focuses exclusively on environment-related topics, and the results appear robust. Public interest in biodiversity and sustainability increased exponentially during the pandemic (Figure 5A,B). If instead of the fourth-degree polynomial fitting, we used it for reasons of comparison of AGSVs of all keywords controlled, including climate change, and applied nonlinear exponential fit, biodiversity presents $R^2 = 0.93$ (ANOVA significant at $p < 0.001$) and sustainability, $R^2 = 0.94$ (ANOVA significant at $p < 0.001$). On the contrary, the climate change AGSV (with corrected outliers) fits a waveform non-linear function ($R^2 = 0.72$; ANOVA significant at $p < 0.001$).

It is important to determine whether this is a unique cultural trend in the UK or if there are similar shifts in public opinion on a broader scale and in different languages and cultures. But before making comparisons or generalizations, we need to standardize the data, such as population size, internet usage, demographics, literacy rates, economic status, and freedom of speech. Social research, especially sentiment analysis, should investigate the sudden increase in public interest in biodiversity and sustainability. Is it just a temporary coincidence unrelated to the pandemic, or is it a serendipitous reframing of environmental issues as crucial aspects of the growing discussion on existential risks? Various distressing events, such as global economic downturns, emerging diseases, war, unregulated technologies like AI, and even Brexit in the case of the UK, amplify feelings of uncertainty among citizens. The findings of this study should be cautiously interpreted as a sign of hidden or secondary thought processes that traditional qualitative social research methods may overlook. While it is clear that climate change dominates public interest in the UK, with approximately 13.5 million searches, compared to biodiversity, with about 1.7 million, and sustainability, with roughly 3.5 million searches from 2004 to 2023, the long-term trends I have observed show significant fluctuations in public interest in climate change. This presents an opportunity to understand better the importance of biodiversity and sustainability in human well-being and as a pathway to securing a sustainable future.

The pandemic has made the concept of crisis more relatable and immediate for individuals. However, there is limited literature on environmental awareness and perceptions of existential risk. While the COVID-19 pandemic has been devastating, it could also serve as a wake-up call to highlight the connection between global health and planetary changes, such as climate issues, loss of biodiversity, and the emergence of new diseases. New narratives and approaches to environmental policymaking could improve if grounded in insights like those presented here. Although the study's findings are specific to one country and its unique cultural context, they offer a promising perspective for understanding future shifts in public conversations about human–nature interactions, specifically regarding existential safety versus risks.

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Appendix A

The Global Database of Events, Language, and Tone (GDELT) is a searchable database of news articles published in multiple languages worldwide. Instructions are presented on the GDELT Project's home website. Form-based tools for querying the GDELT database instead of URL-based commands are added here: https://api.gdeltproject.org/api/v2/summary/summary?d=web&t=compare, (accessed on 20–24 September 2024). A helpful summary of instructions by Professor Ken Blake can be found on the project's website.

In this paper, the search form used focused on (1) the UK as the target country, (2) the English language, (3) the raw data option, and (4) the negative presentation style for the period 2017–2023 for the keywords of interest.

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