

# Is interest toward the environment really declining? The complexity of analysing trends using internet search data

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**Abstract** Recent analyses of internet search volume hypothesized a decline of public interest toward themes related to environment, biodiversity conservation and fishery. These analyses were based on Google Trends, which is a measure of how frequently a term is searched in Google, in proportion to the total of searches performed. Google Trends is a measure of relative search, and this may make difficult assessing temporal trends. I evaluated whether relative declines in internet search volumes represent genuine decline in interest toward environmental-related themes, by comparing trends of terms representing various themes, including environment, computer science, other disciplines (astrophysics) and leisure. Similar values of relative decline were detected for environmental terms, for computer science terms, and for other scientific disciplines. Conversely, an increase was observed for leisure related terms. This suggests that interest toward the environment is not truly decreasing. The apparent decline of environmental and scientific terms is most likely caused by the increasing use of internet for aims unrelated to science and technology, such as leisure. Internet search tools are a powerful source of information, but users should be aware of the complexity of analysing their data: using unrelated terms as benchmark may help to identify genuine trends.

**Keywords** Climate change · Environment · Google trends · Public opinion · Sustainability · Time series

## Introduction

Interest toward environmental themes is pivotal for conservation success, as public awareness, engagement and endorsement are necessary to support conservation plans and strategies of environmental management, particularly in the long term. Recently, McCallum and Bury (2013) examined Google search patterns, and observed that many

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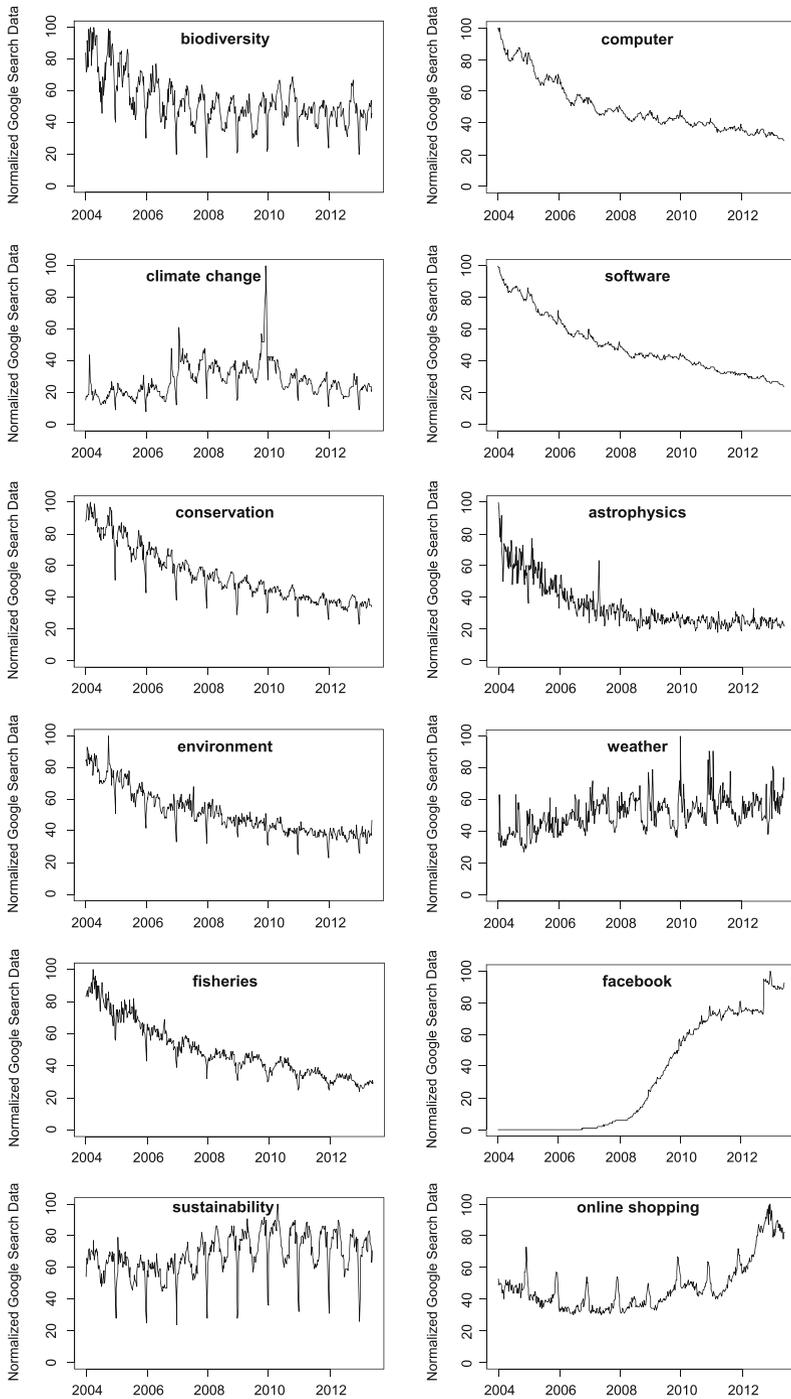
conservation-related search-terms, such as “environment”, “biodiversity” or “wildlife”, are currently searched at a much lower frequency than 5–10 years ago. For several terms, the decline was sudden and impressive. For instance, in 2010 the frequency of search of the word “biodiversity” was just 50 % than the frequency of search in 2004 (McCallum and Bury 2013) (Fig. 1). Analogous decline was detected for terms related to fishery (Wilde and Pope 2013). Decline of interest toward environment-related themes by internet users is potentially alarming, as it might indicate less interest toward the issues related to environment and biodiversity conservation.

The work by McCallum and Bury (2013) was extremely interesting and provided one of the first studies aimed at quantifying the global interest toward conservation and environment-related issues. However, detecting genuine temporal changes may be challenging, for instance if detection probability is not constant through time (Schmidt 2004; Sauer et al. 2010; Bonardi et al. 2011). Internet plays an increasingly important role for scientific communication and popular science, therefore Google search patterns can be an excellent source of information on public interests (e.g. Yang et al. 2010; McCallum and Bury 2013; Wilde and Pope 2013; Willard and Nguyen 2013). Google currently measures search patterns using Google Trends ([www.google.com/trends](http://www.google.com/trends)), which is a measure of how frequently a term is searched in Google, in proportion to the total of Google searches performed. Nevertheless, it should be remarked that Google Trends is a measure of *relative* search patterns. Therefore, trends detected with this tool might be caused by both genuine variation of search volume for target search-terms, or by variation of search patterns in other, unrelated fields (e.g. apparent decreases of a given search-term emerge arise because of steep increases of unrelated terms). Therefore, comparing temporal trends of multiple, unrelated search-terms may provide useful insights on the actual variation of terms of interest. Here I re-analyse the temporal trends of search of some terms representing environmental issues (McCallum and Bury 2013), and compare them with the trends of unrelated search-terms belonging to completely different fields (informatics, astrophysics and leisure). This comparison allows to better understanding whether a decrease in relative search volume implies a genuine decline of interest.

## Methods

I evaluated internet activity from 2004 to 2013 using Google Trends ([www.google.com/trends](http://www.google.com/trends)). Google Trends is a free service showing how frequently a search-term is entered in Google during each week. Google Trends provides a relative measure of search patterns, as it scales the number of searches to the total number of all Google searches performed during a given period (relative search volume). Relative search volume values are normalized to a scale ranging from zero to 100 over the selected time period.

I queried Google Trends for 12 search-terms and phrases. Six search-terms were related to environmental issues (“biodiversity”, “climate change”, “conservation”, “environment”, “fisheries”, “sustainability”). These were terms already included in the analysis by McCallum and Bury (2013), which showed a clear decline in relative search volume for some of them (see also Wilde and Pope 2013 for a similar analysis of fishery-related terms). Six additional search-terms were unrelated to environmental issues. Two are related to information sciences (“computer” and “software”) and one to a completely different academic discipline (“astrophysics”). Three additional terms represented leisure usage of internet: “weather”, “facebook” and “online shopping”. This list does not



**Fig. 1** Relative search volume in Google for six environment-related terms (*left panels*) and six terms not related to environment (*right panel*)

purport to be an exhaustive or comprehensive assessment of internet search. However, these are popular search-terms, and their trends may help to understand variation in internet search by users.

I then used linear regression to assess the relationship between time (week) and the relative search volume for the 12 terms. For easier interpretation of results, regression coefficients representing weekly rates of changes were converted to values of annual changes in relative search volume, by assuming that there are 52.18 weeks per year. Time series analysis may be affected by autocorrelation, which may cause overestimation of significance. However, performing auto-regressive models using generalised least squares (Zuur et al. 2009) yielded to essentially the same conclusions (not shown).

## Results and discussion

Google Trends provided weekly data on internet access from 4 January 2004 to 8 June 2013 (492 weeks, Fig. 1). As shown by previous analyses (McCallum and Bury 2013; Wilde and Pope 2013), there was a clear decrease in relative search volume for several environment-related terms, such as “biodiversity”, “conservation”, “environment” and “fisheries” (Fig. 1; Table 1). For these terms, the annual variation in relative search volume indicated average decreases of about 3–6 % per year (Table 1). For the term “climate change” there was a very weak increase, while for “sustainability” there was a significant increase in search volume, with an average increase of 2 % per year.

Significant decrease in relative search volumes was also observed for the two information science terms (“computer” and “software”) and for the scientific term representing a completely different discipline (“astrophysics”) (Fig. 1; Table 1). For these terms, average decrease in relative search volume was about 4–6 % per year, so it was comparable (or even stronger) than the trend detected of environment-related terms. Conversely, a strong positive trend was detected for the leisure-related terms, with increases of about 2–12 % per year. The term “online shopping” showed a very steep increase during the last years (Fig. 1).

Recent studies using Google Trends suggested that the relative volume of search of themes related to environment, biodiversity and fishery is globally declining, with

**Table 1** Change over time in relative Google-search volume, for six environment-related terms, and six terms not related to environment

Term	$R^2$	Annual change	$P$
Biodiversity	0.333	−3.11	<0.001
Climate change	0.028	+0.63	<0.001
Conservation	0.845	−5.79	<0.001
Environment	0.802	−4.68	<0.001
Fisheries	0.896	−5.77	<0.001
Sustainability	0.186	+2.03	<0.001
Computer	0.836	−5.55	<0.001
Software	0.908	−6.36	<0.001
Astrophysics	0.646	−4.32	<0.001
Weather	0.271	+2.00	<0.001
Facebook	0.886	+11.84	<0.001
Online shopping	0.401	+3.67	<0.001

potentially alarming implications in term of interest toward environmental issues (McCallum and Bury 2013; Wilde and Pope 2013). However, an analogous decline is detectable for different, completely unrelated search-terms, such as computer science and astrophysics (Fig. 1; Table 1). Instead of a simultaneous decline in interest toward these completely independent topics, I suggest that the decreasing relative importance of these search-terms is mostly related to a broadening of internet use. While at its beginning internet was mostly exploited by academics and computer scientists, it is increasingly used for a multiplicity of topics, covering all aspects of our life, and leisure is now a fundamental component of internet use (Gillies and Cailliau 2000; Waller 2011). Therefore, despite internet remains heavily used for science, education and informatics, new topics accumulate and have increasingly importance. In other words, it is unlikely that completely different themes such as environment, fishery, computer science and astrophysics are suffering a sudden and synchronous decline. It is more likely that the relative importance of all these themes decreases, just because new topics, that did not exist 10 years ago, are now the main focus of internet searches. For instance, major social networks (e.g. [www.facebook.com](http://www.facebook.com)) or video-sharing websites (e.g. [www.youtube.com](http://www.youtube.com)) currently account for nearly one billion of unique users each (see <http://www.google.com/adplanner/static/top1000/>), and these services simply did not exist 10 years ago.

The number of personal computers sold and available at the global scale is steadily increasing (International Telecommunications Union 2013). We do not know the actual temporal variation of interest toward the computer science terms, but we can assume that the interest toward computers and software is not declining, and we may use these terms as benchmark to show variation of relative interest for the other terms. For all the “declining” environment-related search terms, the decline was 6–3 % per year. Such a relative decline was analogous or slightly shallower than the one of computer science terms, suggesting a lack of genuine decline. Using computer science terms as benchmark yields very interesting patterns for the other terms. For instance, the increase of interest toward sustainability or climate change is likely to be genuine, as the trends of these terms are much more positive than the computer science terms (Table 1), confirming the analyses that suggested increasing interest toward this topic (McCallum and Bury 2013).

Tools such as Google Trends are powerful source of information, and are increasingly exploited to explore search patterns for many disciplines, ranging from environmental sciences to human health (Yang et al. 2010; McCallum and Bury 2013; Wilde and Pope 2013; Willard and Nguyen 2013). However, users should be aware of the complexity of analysing these data, and particularly of the fact that they provide a measure of relative search volume. As internet users and search volumes are steadily increasing over time (International Telecommunications Union 2013), analysing patterns of individual search-terms may be challenging: using unrelated terms as benchmark may help to identify trends that are not genuine. For instance, if computer science is used as bench mark, the decline of interest toward environmental and fishery related terms is not apparent, and interest is likely growing toward specific themes such as climate change and sustainability. This interest may be a good news, still conservationists must continue to be engaged and develop communications to the broader public, to keep the pace with the fast changes in information technologies and societal concerns (McCallum and Bury 2013).

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