



Policy analysis

The risk of fake controversies for Brazilian environmental policies

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ABSTRACT

Fake controversies have influenced policy making on health and environmental issues for decades, resulting in major implementation setbacks worldwide. As a case study, in this paper we examine fake controversies produced by a small group of active Brazilian researchers that have seriously impacted environmental conservation, particularly in issues related to deforestation and climate change. Based on the literature, we develop a typology of strategies deployed in fake controversies, which include manufacturing uncertainty, misusing scientific credentials, and disregarding scientific literature. Afterwards, we examine the influence of this group of contrarians at the National Congress. We then analyze the fake controversies promoted by these contrarians and argue that, to properly understand them, we need to consider a strategy so far overlooked in the literature: the manufacture of “pseudo-facts”, namely, affirmations at odds with the established literature but that strives to appear as scientific facts. Unlike other contexts, in which contrarians have mainly sought to cast doubt on consensual issues by arguing that there are still considerable uncertainties surrounding them, in Brazil pseudo-facts on deforestation have been produced and published outside the peer-reviewed literature. We conclude the study with recommendations on how to oppose fake scientific controversies that threaten environmental conservation in general.

1. Introduction

Fake scientific controversies consist of manufactured dissensus that seek to influence public opinion and policymakers, so as to prevent regulatory policies from being put in place (Ceccarelli, 2013). They are created sometimes by credentialed scientists, which give those outside the scientific community the impression that there are legitimate disagreements in science, in cases in which consensus has already been reached. The scientists promoting fake controversies are often called skeptics, denialists or contrarians interchangeably. Yet, those terms have different connotations. Skepticism, namely a questioning attitude or doubt towards knowledge, has been historically both a driver of scientific advancements and a safeguard against false claims, thus it may be inappropriate to consider the scientists that purposefully stir fake controversies as *skeptics*. Similarly, labeling these scientists as *denialists* is

too broad, since it may apply to other non-scientific issues such Holocaust denial or the inability of alcoholics to admit the truth or reality of the condition (O'Neill and Boykoff, 2010). The term *contrarian*, on the other hand, has a less ambiguous meaning and has been used to refer to those who strongly and systematically challenge mainstream science by claiming the existence of a false consensus, often with the direct support of sectors with economic interests in delaying policy action (O'Neill and Boykoff, 2010).

Over the past two decades, an important literature has emerged on the role of contrarians in stirring fake controversies and has shown their deleterious impacts on public health (Michaels, 2008; Michaels and Monforton, 2005; Weinel, 2007), and environmental conservation (McCright and Dunlap, 2000; Jacques et al., 2008; Dunlap and McCright, 2015; Lahsen, 2008; Oreskes and Conway, 2010). The most well-known case is that of climate contrarians in the USA who seriously

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affected public opinion and policymaking in this country. The USA is one of the world's main emitters of greenhouse gases to the atmosphere and, particularly during Republican administrations, have been reluctant to implement emissions reduction policies. As a result, global efforts to mitigate climate change have been strongly impacted. McCright and Dunlap (2000) have provided a detailed illustration of the influence of fake controversies propelled by contrarians aligned with the conservative movement in USA policymaking. According to them, in the years leading to the US Congress refusal to ratify the Kyoto Protocol, a considerable number of testimonials by climate contrarians took place in US Congress hearings. During the same period, climate contrarians received as many citations in articles on climate change published in widely circulated US newspapers as leading mainstream climate scientists. This resulted in a growing perception, particularly among Republican congresspeople, that there was remaining controversy over the reality of climate change. A few years later, Republican President George W. Bush rejected the Kyoto Protocol arguing that there was still uncertainty around the issue and that it would harm the US economy (Lahsen, 2008), while Donald Trump decided to quit the Paris Agreement based on "personal beliefs, lies ('alternative facts' in his view) and conspiracy theories" (Pryck and Gemenne, 2017: 8).

In this paper, we examine fake controversies that have emerged in Brazil over the past few decades, which have also harmed environmental conservation, particularly in the issues of climate change and deforestation (Diele-Viegas et al., 2021). An unprecedented reduction of deforestation by over 80% took place in this country between 2004 and 2012. However, at the end of this period, began the weakening of Brazil's environmental policies, which has been increasing the rate of Amazon's destruction (Artaxo, 2019; Kehoe et al., 2019). This process started with the approval, by the Brazilian Congress, of a revised version of the Brazilian Forest Code – the suite of laws regulating nature conservation on private land – in 2012 (Soares-Filho and Rajão, 2018). Later, the administration of Michel Temer (MDB party, 2016–2018) attempted to reduce and downgrade protected areas in the Amazon, sending a strong political signal to encourage deforestation (Rochedo et al., 2018). This deregulatory period, fueled by a strong political polarization, resulted in a 72% increase in annual deforestation rates from 2012 to 2018 (Kehoe et al., 2019). To make things worse, in October 2018 Jair Bolsonaro (at that time affiliated to the far-right PSL party) was elected as the new president with the promise to "end the 'industry' of environmental fines", indicating that illegal deforestation would go unpunished. To fulfill the campaign promise, Ricardo Salles, the first Minister of the Environment of the new administration, has extinguished the Ministry's climate change secretariat and substantially reduced law enforcement activities (Rajão et al., 2020). As a consequence, between August 2018 and July 2019 the Amazon lost 1 million ha of mature forests, the highest figure so far in more than a decade, followed by an even larger number (1.1 million ha) between August 2019 and July 2020 (INPE, 2021). These radical moves pose a tremendous threat not only to Brazil's own environment but to the global efforts against climate change, pushing the world even closer to exceeding 2 °C of warming (Rochedo et al., 2018; Soares-Filho et al., 2014).

What is less known in the case of Brazil is that the assault on environmental policies was boosted by a systematic and veiled effort by a small group of contrarians to misinform decision makers and society. In order to illustrate this issue in Brazil, this study provides a close look at the discourse and actions by part of the research team from Embrapa Territorial (hereafter ET), a branch of The Brazilian Agricultural Research Corporation (Embrapa), a federal enterprise for agricultural research and development. This specific group exerts significant political influence and systematically produced content used by the agribusiness caucus and Bolsonaro's government to dismiss concerns about deforestation in Brazil. In particular, this article argues that this group has been producing 'fake controversies' that have contributed to the dismantlement of environmental conservation policies in Brazil in the last decade. The coordinator of this research team, Dr. Evaristo de

Miranda, was part of Bolsonaro's transition team and proposed to drastically reduce law enforcement actions among other reforms that point towards the weakening of previously successful deforestation reduction policies as reported by the Brazilian media (Walendorff, 2018; Esteves, 2021). Different reports, newspaper articles, presentations, and videos produced by ET argue that the conservation of Brazil's vast expanses of native vegetation hinders the country's agricultural development, suggesting that protected areas should be reviewed and that international pressure concerning the rapid deforestation of the Amazon are misplaced. ET claims are being widely disseminated by landowner-oligarch lobbies and the current government in different instances, including high-level international meetings by the Brazilian Ministry of Foreign Affairs and in presidential speeches to the UN. As a consequence, Miranda and his group have already been exposed by journalists and researchers (BBC, 2019a; Esteves, 2021). For instance, Vacchiano et al. (2019: 119), based on a critical analysis of Miranda et al. claims, concluded that he and his group often "produces what might be called 'creative statistics': these data are biased by an ideological narrative that distorts the Brazilian environmental reality." ET is not the only group misinforming the public on environmental issues. Other groups have been active in denying climate change (often in alliance with alt-right groups in the United States), dismissing the negative effects of pesticides to human health, as well as acting in other health issues such as the Covid-19 pandemic (Miguel, 2020; Franco and Pelaez, 2016; Galhardi et al., 2020). Yet, in the context of the Brazilian environmental arena, ET has been the most influential contrarian group over a long period of time, and as such, provides a clear case that represents a wider issue.

In this article, we analyze the presence and the influence of this group of researchers and its coordinator in the executive and legislative branches of the Brazilian federal government. We investigate the extent to which fake scientific controversies promoted by them are able to reach the highest levels of the Brazilian legislature, possibly influencing public policies for agriculture and the environment. We also indicate how the claims made by these contrarians have influenced key positions from the Brazilian Ministry of Environment, Agriculture, Foreign Affairs as well as President Bolsonaro. Based on a review of the relevant literature and the case study of ET, we applied a typology of practices and strategies for promoting fake scientific controversies and used it to identify those deployed to influence environmental policy making in Brazil.

The remaining of this article is organized as follows: the next section provides an overview of previous studies on fake scientific controversies; the third section describes the influence of Dr. Miranda and his team from ET in environmental policy debates in the Brazilian government; the fourth section then discusses the strategies identified in our case study in stirring fake scientific controversies in Brazil, drawing some parallels with similar cases in other countries. The article then concludes with some remarks about the challenges related to fake scientific controversies and how to avoid the dismantling of environmental policies in Brazil and other countries.

2. Fake scientific controversies: definition and tactics

There is a growing body of literature that seeks to identify criteria to differentiate genuine scientific controversies from fake controversies stirred by contrarians to influence policymaking processes. Although disagreements between researchers are part of science, there are instances in which controversies are manufactured to generate a public and political perception that there is no consensus on particular scientific issues or that there are alternative views on the topic so as to delay or to prevent the implementation of specific policies (Michaels, 2008; Ceccarelli, 2011; Weinel, 2019). These fake controversies tend to arise in scientific fields that have a strong influence on policymaking, i.e., in fields of regulatory science (Jasanoff, 1990), particularly in environmental, climate, and public health sciences. A number of studies have examined, for instance, the action of tobacco industries to deny that

smoking or second-hand smoking is unhealthy, claims that azidothymidine (AZT) is a highly toxic substance, and efforts to cast doubt on the seriousness or even to question the existence of phenomena such as acid rain, ozone layer depletion, and climate change, among others (Oreskes and Conway, 2010; Michaels, 2008; Michaels and Monforton, 2005; Weinel, 2007; Lahsen, 2008). These studies have brought to light some of the rules that underpin scientific activity and that are strongly violated in contexts of fake controversies. Three tactics stand out as being widely deployed by contrarians: *manufacturing uncertainty*, *misusing scientific credentials*, and *disregarding the scientific literature*.

Manufacturing uncertainty: manufacturing uncertainty consists of deliberately casting doubt on consensual science with a view to delay, prevent or distort the implementation of public policy. Historical studies show that in some cases industry sectors have carried out campaigns to dispute consensual science that could have detrimental economic effects on their business (Michaels, 2008; Oreskes and Conway, 2010). As Michaels (2008: 9) pointed out when examining the manufacture of uncertainty by the tobacco industry, “the industry understood that the public is in no position to distinguish good science from bad. [The tactic was then to] Create doubt, uncertainty, and confusion”. Public campaigns were then carried out to discredit legitimate scientific evidence, label it ‘junk science’, and demand further research to prove that tobacco was actually harmful to human health. Similar storylines can be found in fake controversies produced on environmental issues (Oreskes and Conway, 2010).

Misusing scientific credentials: the misuse of scientific credentials takes place when contrarians deploy the epistemic authority acquired through academic degrees or through working in prestigious research institutions to promote controversies in fields in which they are not experts. Throughout the 20th century, science has become increasingly specialized so that mastering the technical knowledge to meaningfully contribute to a field takes time and effort (Collins and Evans, 2007; Collins, 2011; Duarte, 2017). As a result, scientists’ contributions to scientific knowledge tend to be to very narrow specialties. Giving policy advice outside these narrow specialties can therefore be considered a misuse of scientific credentials, as the scientific authority is deployed to talk about issues that the scientist does not master. A measure of whether a scientist is (mis)using his or her credentials in a public controversy is whether he or she has conducted original research and published papers in the peer-reviewed literature on the relevant topic. An iconic example of fake controversies promoted through the misuse of scientific credentials is that of a group of prominent retired American physicists who actively produced misinformation on issues such as smoking, acid rain, ozone layer depletion, and climate change (Oreskes and Conway, 2010). These scientists acquired prestige working on Cold War projects and had strong free-market and anti-regulatory views. They tended to oppose all types of environmental and public-health agendas in science and public policy (Oreskes and Conway, 2010; Lahsen, 2008). Although they had no expertise in environmental or public health issues, and no original research or peer-reviewed publications on these topics, their arguments were frequently taken seriously by the media and by politicians due to their scientific credentials in other knowledge fields.

Disregarding the scientific literature: whenever there is a genuine scientific controversy, one should expect to find a significant number of papers published in peer-reviewed academic journals addressing the controversial issue, with publications defending both sides of the argument. Once controversies are settled, however, mainstream journals become less receptive to articles still defending arguments overcome by accumulated pieces of evidence, i.e., editors and peer-reviewers will typically not consider papers that try to continue controversies that are widely regarded as settled (Collins and Evans, 2017: 87–88). Scientists will then turn their attention to improving

the accepted theory rather than spend further time trying to disprove new arguments and seeking to revive the controversy. A key tactic deployed by ‘fake controversy makers’ to influence public debate and prevent the implementation of public policy consists of addressing actors outside academia rather than engaging with peers who are part of the core set of a controversy (Collins, 1992). As Weinel (2019) pointed out, it is not uncommon that those who have ‘lost’ a controversy or those who fabricate it from scratch address audiences outside science in an attempt to generate among policy-makers and the public the impression that controversy is still taking place. They might do this through publications or appearances in the media (e.g. newspaper editorials, letters, interviews etc.), or on the internet (e.g. websites, blogs and social networks), through the publication of booklets, or through the publication of supposedly academic papers in fringe or predatory scientific journals (i.e., journals that have the appearance of being mainstream or specialized scientific journals, but publish material that would not get past scientific peer-review if submitted to serious scrutiny). A similar strategy to promote fake controversies is to publish books through commercial publishers or think-tank publishers who do not submit manuscripts to a qualified peer-review process. Examples of this can be found in fake controversies related to climate change. Oreskes (2004) carried out a survey of the peer-reviewed literature on climate change and did not find a single paper making a case against the anthropogenic climate change thesis, which indicates that the scientific peer-reviewed literature had then already been closed to climate contrarians. Yet, in the USA climate contrarians still find ways of publicizing their ideas by publishing books and other materials through free-market think-tanks (McCright and Dunlap, 2000; Jacques et al., 2008; Dunlap and McCright, 2015). These publications can be confusing for laypeople and policymakers as they sometimes deploy technical jargon and have a style similar to those of mainstream science (Collins, 2014; Collins et al., 2017). However, they lack key characteristics of academic publications, neither addressing the scientific community via a peer-review process nor engaging in a systematic dialogue with the scientific literature by citing peer-reviewed papers.

3. Contrarians’ access to power

The Brazilian National Congress is bicameral, composed of the Federal Senate (the upper house) and the Chamber of Deputies (the lower house). Each house runs its own website (respectively <https://www12.senado.leg.br> and <https://www.camara.leg.br>), where legislative documents are made public. In our case study, to assess Miranda’s and his associated group’s influence on environmental policy debates, we used the search engines available in each of these websites to query for “*evaristo eduardo de miranda*” (his full name) and “*evaristo de miranda*” (his publication name). Considering that he is not a politician, the number of results is noteworthy: as of June 2021, his name appeared in 135 query results on both websites. After careful analysis to exclude duplicates and errors, this number dropped to 119 documents distributed between the Chamber of Deputies (64 records) and the Federal Senate (55 records).

In Fig. 1, we observe the number of mentions of Dr. Miranda’s name per year, considering only the period from 2005 to 2020 (113 records). The highest number of appearances was in 2009 (29 mentions), the year in which the discussions around the weakening of the Forest Code in Brazil gained traction. We also observe a recent increase in 2017 (13 mentions) and 2018 (10 mentions), years marked by strong attacks on environmental policies by President Temer key allies, particularly questioning the size and legitimacy of protected areas and indigenous lands (Rochedo et al., 2018).

We then evaluated the content of the documents retrieved from the online query. From 1997 to 2020, we found nine occurrences of his direct participation in Congress events. We analyzed the content of the

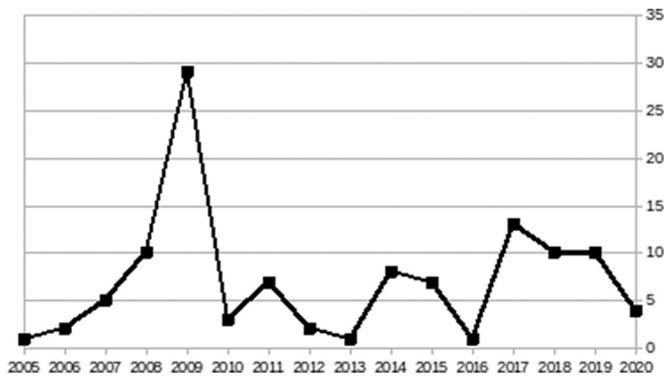


Fig. 1. Number of mentions of Dr. Miranda's name per year, from 2005 to 2020, in the National Congress' websites.

119 legislative documents in which the Congress debates and communications were officially transcribed and made publicly available. Our analysis aimed at investigating where and in which context the researcher's name appears, mentioned by whom, as well as the position taken by the interlocutor mentioning his name and work. We sought to understand who are the ones supporting (or getting support from) his work in the Congress, and why and how they do it. In addition, we searched for evidence of partnerships or networks among those supporting or disagreeing with his work.

While evaluating these contents, we coded only the text excerpts that mentioned Dr. Evaristo de Miranda's name, sorting them into the following categories: (1) *agreement*: statements expressing approval, acceptance, or praise; (2) *disagreement*: statements expressing refusal, rejection, dispute, objection, criticism; (3) *inquisitive*: statements raising doubts, critical questions or points, statements interrogating or seeking for verification; (4) *requesting*: expressions of request for additional input/information/studies, invitations for presentation and meetings; (5) *neutral*: news pieces, official registries of presence in the Congress, official statements, statements without normative/supporting/rejection contents. We also coded the excerpts by their main content topic.

After examining these text excerpts, we concluded that news articles from the Congress should be taken out of our analysis as they are only reproductions of past events by the official press/communication staff. After excluding these news articles (19 from the Chamber of Deputies, 22 from the Senate), the list of documents was reduced to 78. Within those documents, all the sections in which Dr. Miranda is mentioned were analyzed, and the short entries in which the interlocutor was solely calling him to take a seat, and to start or end a speech were discarded. Excerpts that were copies of previously registered discourses were also removed. In total 136 text excerpts from these documents were analyzed, 107 of which from congressional members and the remaining 29 from a variety of organization representatives, including government agencies, non-government organizations (NGOs), consultants etc.

We counted 84 agreeing, 17 disagreeing, 4 inquisitive, 22 requesting, and 9 neutral statements. Most of the agreeing statements came from the agribusiness caucus, a legislative group representing mostly the interests of large landowners that could benefit from the weakening of the Forest Code. In terms of speech topics, we found that from the 136 text excerpts, the majority was related to the discussions around "forest code" ($n = 77$; 56.6%); a general debate about "agriculture" was held in 38 occurrences (27.9%); "protected areas" was the main topic in 7 occurrences (5.1%); "Amazon" was discussed in 5 text excerpts (3.7%); and the rest was related to a variety of other topics.

Evidence of ET and Dr. Miranda's influence in the executive branch can be found in different governments. Through his career Miranda has fostered close ties directly with elected presidents, often acting as an advisor on agricultural and environmental matters in both right and left wing governments. He received recognitions from the Order of Military

Merit in various moments: 1998 (under Fernando Henrique Cardoso's government), 2012 (under Dilma Rousseff's government), and 2019 (under Bolsonaro's government) (Exército Brasileiro, 2021). Dr. Miranda was also invited by right-wing President Jair Bolsonaro (at that time a PSL party affiliate) to lead the transition team on environmental matters and to define the policy guidelines for the Ministry of Environment (Esteves, 2021). The claims made by Dr. Miranda can be found in key speeches by President Bolsonaro, including the statement made in the opening of the UN General Assembly in 2019. On that occasion, Bolsonaro followed Dr. Miranda's ideas in claims such as "Our Amazon is larger than the whole Western Europe and stands almost untouched. That proves that we are one of the nations that protects the environment the most" (BBC, 2019b). He also mentioned claims disseminated by Dr. Miranda: "... Brazil uses only 8% of its land for food production. 61% of our territory is preserved!" (BBC, 2019b; United Nations, 2019). A month earlier, when large-scale wildfires in the Amazon spread through the international media, a telegram from the Secretary of International Affairs of Brazil was sent to all diplomats abroad with guidelines on the arguments they should use in order to defeat criticism regarding environmental policies. The line of arguments followed Dr. Miranda's (Miranda et al., 2018; Miranda et al., 2017) claims as well (BBC, 2019a). Again in August 2021 Miranda's opinion article claiming that there were no forest fires in July in the Amazon (only controlled agricultural burnings) was distributed by the Brazilian Embassy in Washington, contradicting the scientific consensus regarding the widespread use of fire in deforestation and Brazil's own official monitoring systems (INPE, 2021; Lima et al., 2012; Aguiar et al., 2020).

4. Promoting fake scientific controversies

Having established the proximity between Dr. Miranda and his group at ET and key decision makers at the legislative and executive branches, it is important now to examine in more detail how their *modus operandi* impacts specific environmental conservation policies. We have identified the adoption of two of the strategies already described in the literature, namely, misusing scientific credentials and disregarding the scientific literature. But in addition, it was possible to notice that Dr. Miranda was engaged not only in manufacturing uncertainty in relation to consensual science but also in producing pseudo-facts, namely, affirmations with the appearance of scientific facts but that are at odds with the established consensus.

4.1. Manufacturing uncertainty and producing pseudo-facts

As mentioned earlier, one of the main tactics adopted by climate deniers and other groups attempting to promote fake scientific controversies is to manufacture uncertainties. In a slightly different manner, what we observed in our case study was the influence on the public debate mostly by promoting alternative versions of the facts and figures despite the overwhelming evidence in the opposite direction. This tactic was particularly visible during the discussion that led to the approval of the revised version of Brazil's Forest Code in 2012, weakening environmental protection in different ways. The Forest Code (FC) originally approved in 1965 established that every private property should conserve between 20 and 80% of its native vegetation as legal reserves, as well as protect a buffer area between 30 and 500 m of riparian forests as permanent protection areas (PPAs). Historically, the strict enforcement of the FC was often imperfect and ineffective, resulting in rampant deforestation in the Amazon and other major biomes. However, since 2004, the federal government has begun implementing coordinated policies to combat environmental crimes, helped by a very effective land cover remote-sensing monitoring-system developed at the National Institute for Space Research (INPE) (Rochedo et al., 2018). To counteract the strengthening of law enforcement, the congressional agribusiness caucus increased pressure to relax the FC. But to be successful, the agribusiness caucus would need to mobilize a large number of votes

from different political parties based on the argument that the current legislation, if fully implemented, would cripple Brazil's agricultural production by substantially reducing its area. Yet, the published literature on the potential of Brazil's agriculture in the 1990s and early 2000s pointed in the opposite direction, emphasizing the possibilities for increasing productivity via cattle ranching intensification, no-tillage agriculture, and the large extension of low-productivity pastures that could be intensified or converted to crops. Furthermore, together with the drastic reduction of deforestation rates in the Amazon, there has been an increase in production by 78% between 2006 and 2010, showing very clearly that environmental restrictions were not hindering Brazil's agribusiness (Macedo et al., 2012).

The misinformation presented by Miranda and collaborators played a central role in the weakening of the FC by creating a fake controversy concerning the potential limits for the growth of Brazil's agriculture under the current legislation. In public hearings held in Congress, Miranda was invited by congressional members from the agribusiness caucus to present a study that, according to him, demonstrated that the full enforcement of the Forest Code would not only prevent future growth but would also render illegal a substantial share of current production. To support this claim, Miranda et al. (2008a) calculated the total area in private properties by considering the entire country area and excluding the protected areas (i.e., indigenous lands and conservation units). Then, they applied the rules of the FC related to permanent protected areas (PPAs, including riparian and relief-associated) and legal reserves (LRs). Based on this, Miranda et al. claimed that the full implementation of the original FC would restrict agricultural use to only 29% of the country's territorial area, considering a scenario with a more flexible interpretation of the legislation (Miranda et al., 2008a). In the scenario with a more stringent interpretation of the FC, whereby riparian forests must be accounted separately from legal reserves, the area available for agriculture in the Amazon and Pantanal biomes would be negative, implying that all agriculture and cattle ranching would need to be expelled. As a consequence, Miranda suggests that the enforcement of the original Forest Code was a threat to Brazilian agriculture (Miranda et al., 2008b; Miranda, 2010).

The presentation of this study in the hearings of the National Congress caused a strong reaction from the scientific community in Brazil. The Brazilian Society for the Advancement of Science (SBPC) and the Brazilian Academy of Science (ABC) published an open letter reinforcing the need to conduct a science-based discussion for the revision of the Forest Code (ABC, 2010). Later on, they also published a joint review that showed the existence of a scientific consensus on the importance of maintaining the rules of the FC (SBPC and ABC, 2012). Afterward, other peer-reviewed studies also calculated the total area available for agricultural production and found very different figures from the ones presented by Miranda et al. (2008a, 2008b). In contrast to the "negative numbers" in Pantanal and the Amazon (Miranda et al., 2008b), Soares-Filho et al. (2014) and Sparovek et al. (2011) identify in this two biomes 96 and 120 million ha of land available for agricultural production, respectively.

Miranda et al. did not publish their findings and methods in a peer-reviewed journal, and the only guidances about their study are to be found in a now-discontinued page hosted at the ET website (Miranda et al., 2008b), a printed book chapter (Miranda, 2010), and a brief discussion in an article published in *Agroanalysis*, a non-indexed and non-peer reviewed business magazine (Miranda et al., 2008a). Yet, a comparison between Miranda et al. results and the published and peer-reviewed literature suggests that the main source of discrepancy lies in the way they modeled the PPAs around streams and rivers. In their website, Miranda et al. recognize that the FC mandates the protection of buffers ranging from 30 to 500 m depending on the river's width (Miranda et al., 2008b). The maximum protection buffer of 500 m could be applied only to rivers wider than 600 m, which represent no more than 0.21% in length of the Brazilian river network, whereas the other prescribed buffers of 30 m, 50 m, 100 m, and 200 m represented

respectively 86%, 10%, 3%, and 0.44% of the river network (Nobre et al., personal communication). Nonetheless, the only way we could reproduce Miranda et al. (2008a) figures was to impose a 500-meter buffer on all rivers using the Brazilian Institute of Geography and Statistics (IBGE)'s river network dataset, regardless of their width. As a result, the Miranda et al. figures are very different from the ones presented in peer-reviewed articles that also used IBGE data. For instance, Soares-Filho et al. (2014) show that, taking into account PPAs (riparian and relief-associated) as well as LRs, the original FC protected an area of about 240 million ha. Another 2018 study indicates a protected area under the law of approximately 191 million ha (Freitas et al., 2018). By Miranda's accounts, this area would be around 402 million ha, a value between 67% and 210% higher than the numbers verified, validated, and published in scientific journals.

Confirming these findings and going a step further, Nobre et al. (personal communication) verified Miranda et al.'s allegation that there could not be a decent analysis of riparian PPAs because good maps of the Brazilian hydrography would be lacking. Indeed, IBGE's river network is a dataset that tends to ignore most small-order streams and it is not adequate to estimate stream widths. Yet, Miranda et al. carried a biased analysis using IBGE data, while omitting key information about their assumptions and methods. Applying the state-of-the-art in geospatial methods, Nobre et al. produced high-resolution digital hydrography for large areas of Brazil using well-established methods for river network extraction (O'Callaghan and Mark, 1984; Tarboton, 1997), employing the same digital elevation model (SRTM) data that Miranda et al. discarded for computing the hydrography but used for computing hilltop protection areas. In the same study, Nobre et al. emulated the inferred method of Miranda et al. (2008b) for calculating PPAs, confirming that Miranda et al. would get their results by ascribing a 500 m buffer around all rivers of the IBGE hydrography, indistinctly of their widths. Comparing actual buffers around the digital hydrography following the multiple buffers established by the 1965 FC rules, Nobre et al. found that Miranda et al. numbers overestimated riparian PPAs by 309%.

Unfortunately, these questionable figures were instrumental for promoting the interests of the agribusiness caucus and decisive for relaxing the law, since they provided the convenient technical argument needed to justify the changes, offering and justifying an amnesty of 58% of illegal deforestation that took place prior to 2008, allowing de-facto freezing of the restoration requirement of the remaining areas (Soares-Filho et al., 2014). Despite an unprecedented mobilization of Brazilian society, in 2012 the Brazilian Congress passed major changes to the FC. The text by Congressional Member Paulo Piau (MDB/MG) in the Chamber of Deputies was approved with an advantage of 90 votes (out of 461), while in the Senate the difference was even more expressive as 59 voted in favor and only seven against, uniting both right and left-wing parties. The approved amnesty to past illegal deforestation signaled that a similar benefit may be given in the future. As a consequence, the approval of the new FC marked an inversion of the downward trend in deforestation. By signaling that past illegal deforestation may be pardoned in the future, the rate of clearings in the Amazon, mostly done illegally, more than doubled between 2012 and 2019. In this way, it is becoming increasingly unlikely that Brazil is going to be able to meet its nationally determined contribution to the Paris Agreement (Rochedo et al., 2018).

More recently, as deforestation rates in the Amazon rose substantially under the Bolsonaro government, the Brazilian government came under scrutiny of its commercial partners. Furthermore, the agribusiness caucus has endeavored to approve bills that facilitate land grabbing and reduce protected areas in favor of large infrastructure projects. Again, Dr. Miranda has opposed the scientific consensus on the matter by claiming in a popular YouTube video that Brazil is the country that preserves its forest the most, and that its agricultural practices are the most sustainable in the world. The video also suggested, as before, that unnecessary protected areas are blocking the expansion of agricultural production (Miranda et al., 2018; Trigueiro, 2019). Needless to say that

it is well established in the scientific literature that the expansion of crops and cattle are one of the main drivers of deforestation. Furthermore, while Brazil still has a high percentage of forest cover, this has taken place as a consequence of the isolation of the Amazon region until the 1970s, not thanks to conservationist agricultural practices (Dean, 1997; Fearnside, 2005; Margulis, 2004; Vacchiano et al., 2019). Nevertheless, Miranda's claims remain highly influential in policy circles and are often cited in official discourses by the president, ministries and other leaders from the agricultural sector. Their impacts may also be seen in the fact that since Bolsonaro took office no new protected area was created in Brazil, despite the many biodiversity conservation gaps in different biomes (Oliveira et al., 2017). At the same time, the government of Rondônia, in southwestern Amazonia, a close ally of Bolsonaro, has aggressively reduced its protected areas in more than 300 thousand ha (Menegassi, 2021), while the lower house of the National Congress has approved a new legislation that removes the obligation of environmental licenses to large infrastructure projects such as the paving of roads and the building of power lines crossing protected areas. The proposal still has to be approved in the Brazilian Senate (Câmara dos Deputados, 2021; Instituto Socioambiental, 2021).

4.2. Misusing scientific credentials

One of the main strategies employed in the debates on land use and conservation by Congress representatives from the agribusiness caucus to promote fake controversies is to emphasize the higher epistemic ground of researchers supporting their agenda in comparison to other voices from the Brazilian scientific community. The agribusiness caucus, in the process of lobbying for the weakening of environmental policies, has often framed the debate as a fight between “ideology” and “science”. For that purpose, it is crucial to dismiss the pro-environmental claims as tainted by ideology and money from international organizations, often portrayed as a manifestation of international interests against national interest. This statement by Senator Ivo Cassol (PP/RO) provides an example: “Because of that, several times I beat hard on those fake environmentalists, those environmentalists moved by Euros, those environmentalists moved by Dollars, or those environmentalists moved by Reais [Brazilian currency] at the expenses of public money that goes to those fake NGOs, only to sustain those environmentalists” (Senado Federal, 2018, free translation). At the same time, the work by Miranda et al. is presented as an example of rigorous and worldly renowned scientific achievement. With that purpose, congressional members from the agribusiness caucus also often artificially boost Miranda's scientific publication record in order to sustain the validity of his claims, as in this statement by Paulo Feijó (PR/RJ) during the concession of an award by the Chamber of Deputies: “The large curriculum of Dr. Evaristo, full of contributions for the sustainable development of agriculture in Brazil (...) attests the right choice made regarding our honored ones” (Câmara dos Deputados, 2014, free translation). Given this track record, he is presented by some congressional members as a “worldwide famous agronomist and ecologist” (Congressional Member Lael Varella (DEM/MG)) (Câmara dos Deputados, 2013, free translation).

Yet, a comparative analysis of Dr. Miranda's CV in terms of high-impact publication contradicts this evaluation. Brazilian scientists are required to keep an up-to-date CV in a public repository (the *Lattes Platform*), maintained by the Brazilian National Council for Scientific and Technological Development (CNPq). The *Lattes Platform* allows for the inclusion of a wide variety of intellectual productions, ranging from newspaper and magazine articles to scientific articles. As of February 1, 2021, Dr. Evaristo de Miranda had in his official *Lattes Curriculum* 83 articles under the section “Complete articles published in journals”. A thorough analysis revealed that 66 documents listed in this section were actually essays published in news magazines focused on politics or particular economic sectors, such as agribusiness and industry, or are book chapters. For those magazines that are still running, we contacted the editorial team by phone and/or email to check the review process.

All those that we were able to reach replied that the editor chooses what to publish or not, meaning no review process by peers. Three additional items from the list, although published in national scientific journals, were only book chapter reproductions or opinion essays. Therefore, only 17 documents were actually published in scientific journals and required peer review. Among those, only eight were published in journals indexed at the Web of Science and two were published in national journals indexed by the Scielo Library, a Brazilian database. We counted citations via Google Scholar and among those 17 articles, 14 were cited somewhere. Considering only the ten indexed articles with actual measured journal impact factor, Dr. Evaristo de Miranda produced on average only one scientific paper every 3.8 years since 1982. He is the first author of only three of these ten articles, all of them published before 1994 and only one published in a journal with considerable impact factor (Miranda and Mattos, 1992). Also, Miranda has been systematically misrepresenting his role in the articles published in collaboration with other authors. In his official *Lattes Curriculum* (as of February 1, 2021) he wrongly appeared as the lead author in 8 scientific papers. These include the two most-cited publications listed there (Mayaux et al., 2006; Eva et al., 2004). But most importantly, none of the 10 indexed and peer-reviewed scientific articles listed in Miranda's CV provided the methodological details of his work related to the Forest Code and other controversies, remaining only inside internal reports, YouTube videos or non peer-reviewed book chapters.

The institutional affiliation is also often mobilized as evidence of scientific authority. In our case study, the ET is one of the 46 centers of the Brazilian Agricultural Research Corporation (Embrapa), a prestigious applied research institute created in 1973 under the Ministry of Agriculture. Given the importance of Embrapa as a whole in creating new techniques to increase yields, especially in relation to soy and corn crops, the public company is rightly praised for its contribution to the development of Brazil's agriculture. It is based on this background that Congressional Member Moreira Mendes (PSD/RO), when giving a public award to Miranda, stated that: “The first praised one was Prof. Dr. Evaristo Eduardo de Miranda, a brilliant technical expert from Embrapa that served and has been serving this country – I highlight here the help that he gave us here, at the Chamber of Deputies, by guiding and discussing what became law: the new Brazilian Forest Code. Born in São Paulo, the capital [of SP state], he studied in France, he was and is professor, and is one of the most renowned persons from our Embrapa, an organization that makes us all proud” (Câmara dos Deputados, 2014, free translation). Here, Congressional Member Valdir Colatto (PMDB/SC), once leader of the agribusiness caucus, opposes a criticism brought by the Amazon Research Institute (Instituto de Pesquisa Ambiental da Amazônia – IPAM), a scientific non-governmental organization: “By raising this data, I cannot, and I already made the question to Dr. André [André Lima, from IPAM], understand and admit that somebody from an IPAM – I don't know what IPAM is, where it comes from, who are the associates, who compose that team, WWF, I don't know what... that a group has stood up and contested data from Embrapa (...). Faced with technical surveys – Dr. Evaristo is here, he is a qualified man, a prepared one –, someone comes here and contests, shamelessly, an institute like Embrapa, to which Brazil owes so much, the world owes so much, agriculture owes so much, the fight against hunger in the world owes so much (...)” (Câmara dos Deputados, 2008, free translation).

In many cases, ET has been an isolated voice as many researchers from Embrapa have tried to distance themselves from the fake scientific controversies associated with researchers from this center. For instance, in 2019 Senators Flávio Bolsonaro (PSL/RJ) and Marcio Bittar (MDB/AC) have proposed to change the FC approved in 2012 by eliminating the legal reserves (the requirement to conserve a share between 20 and 80% of the native vegetation within private properties) and allowing the legal clearing of additional 162 million ha of native vegetation. As in 2012, non peer-reviewed studies by Miranda et al., speaking in the name of Embrapa, were again used to justify the weakening of the FC. As a reaction, researchers from 31 other Embrapa centers have strongly

rejected the proposed legislation by reaffirming the scientific consensus around the importance of the legal reserve for maintaining the environmental services needed for agricultural production (Salomão, 2019). The above shows that even though the claims of scientific authority from Miranda et al. and their agribusiness allies do not resist closer scrutiny, it nevertheless remains an important strategy to establish fake scientific controversies in the public arena.

4.3. Disregarding scientific literature

Researcher credentials are evaluated by peer-reviewed articles and open engagement in the scientific debate with the academic community. The peer-review process has been the cornerstone of scientific rigor and credibility since the late 19th century (Spier, 2002). However, producers of fake scientific controversies systematically ignore the existing peer-reviewed literature in order to advance their own arguments. A legal battle involving the banning of sugar cane burning in São Paulo illustrates this issue well. Since the production of low-tech sugar cane relies on straw burning, this problem has drawn the attention of North American and Brazilian researchers. These studies clearly demonstrate the environmental damage from burning and also the damage to health, especially of children up to 5 years old (Kirchhoff et al., 1991; Urquiaga et al., 1991; Boeniger et al., 1991; Newman, 1986; Rothschild and Mulvey, 1982; Alessi and Navarro, 1997; Delgado, 1985). Among these studies, we highlight Kirchhoff et al. (1991) and Urquiaga et al. (1991), led by researchers from INPE and Embrapa, respectively. Based on this scientific evidence already present in the early 1990s, the São Paulo Public Attorney's Office (MPSP) filed a public civil action establishing a timetable for sugarcane producers to substitute burning for mechanization of crops to ensure clean and healthy air for the population. However, the action of the MPSP was blocked by sugarcane producers based on two studies carried out by Miranda and his team. These studies contained a lot of false information, beginning with the statement of "lack of more detailed information", which ignores the studies mentioned above, including Embrapa's own publications. At the same time, contrary to the results of the other studies, Miranda et al. state that the ecological impact of burning cane production is "positive" (Miranda et al., 1997: pages 2 and 13). A second study led by Miranda concludes that the "level of risk of respiratory disease crises occurrences are [sic] identical in Atibaia and Ribeirão Preto", despite the fact that Atibaia is a climatic health resort while sugarcane predominates in the lands of Ribeirão Preto (Miranda et al., 1994: pg 6). Based on these studies, the Usina Açucareira Paredão S.A. obtained in court the rejection of the embargo on the burning of sugarcane straw requested by the Public Prosecutor of São Paulo. In the decision, the judge explicitly cites the report of (Miranda et al., 1994), stating that "falling sooth has only effects of discomfort and aesthetics" and that the "burning must be maintained, hence the quantification of the damage does not yet have any type of scientific evidence for deterioration of health" (TJSP, 1999: pages 2–3, free translation). The burning of sugarcane was eventually prohibited in São Paulo in 2016 (Jornal Nacional, 2016), but the above suggests that by ignoring the scientific literature, Miranda was able to influence a decision that has delayed for many years a conservation policy with clear environmental and social benefits.

The lack of scientific rigor of studies supporting the weakening of environmental legislation in the Brazilian case has already been lashed out in public on different occasions. During the debates on Brazil's Forest Code, for instance, Dr. Gilberto Câmara, then director of INPE, hailed congressional members to listen to the mainstream scientists that publish their results in a transparent manner:

"But it is important that in the environmental legislation reform the scientific community is heard. We heard a lot about one scientist who, by the way, does not publish his data. What did Braulio [Braulio Ferreira de Souza Dias] say? It is not possible, in reality, to make a judgement about Evaristo's work because, unlike what INPE and

IBGE do, Evaristo's data are not published. I cannot take the data. Today, anyone can claim that INPE made an error. I cannot even judge the work done at ET because the data is not even available on the internet. There is only a report. Therefore, there is no way to make a judgement. I will not position here against or in favor of Evaristo. I will go for the plurality, in order to avoid saying that today who thinks about the environment in Brazil is an NGO. The scientists from a diversity of fields are the ones who will have a lot to say. Evaristo is one of them. But there are lots that eventually disagree or agree. This is a detail that does not matter here, but I think that the Chamber [of Deputies] should listen to them and think about the consequences that the studies are showing"

(Câmara dos Deputados, 2009, free translation)

Following the same argument, in the same hearing, Dr. Braulio Ferreira de Souza Dias, then a representative of the Brazilian Ministry of Environment and later General Secretary of the UN Convention of Biological Diversity, expressed his concerns related to the reproducibility of the research made by Dr. Miranda: "I want to make it very clear, as I already did and the Minister too, that I did not criticize neither Embrapa nor researchers from Embrapa; I criticized the data presented to a study. This is our right. We understand that many results presented there are inconsistent. We are drawing your attention to this fact: it is important that this Chamber of Deputies takes decisions based on consolidated scientific data. This study by Dr. Evaristo de Miranda was not published in a scientific journal with peer review, was not validated, the original data are not available on the internet for those who want to repeat the study and validate them. We are manifesting our concern and alerting the Chamber of Deputies about important divergences in those data and we advise you to consult other experts to set a judgment about these data made public through Mr. Evaristo de Miranda's research" (Câmara dos Deputados, 2009, free translation).

A systematic analysis of Miranda's appearances at the National Congress demonstrates that most of them are in panels alongside politicians who are supportive of the agribusiness caucus. The lack of engagement with academic peers is, however, replaced by a strong presence in social media. At least one of his videos (available at <https://youtu.be/oDixTvtEsx8>, accessed on February 19, 2021), presenting controversial data, reached a large audience, having received more than 340k visualizations as of February 2021. In this video, Miranda claims that "a quarter of the country is preserved by the farmers". There is also strong evidence that a similar video from Miranda has been widely circulating in WhatsApp as a way to demonstrate that the criticisms that Brazil has been facing internationally are unjustified. This illustrates how such misinformation can spread among the general population and influence the wider public debate.

5. How to oppose fake scientific controversies

In this article we have presented the case study of a group of contrarians led by an influential public figure in Brazil. In a period ranging around three decades Dr. Miranda and his group have systematically opposed the scientific consensus in order to contribute to political movements aiming at postponing action or dismantling key conservation policies. These include delaying the ban of the use of fire in sugarcane plantations, the provision of amenity for illegal deforestation by changing the Brazilian Forest Code, the dismantling of protected areas, and arguing for the end of the prohibition of the use of fire even during the dry season (Table 1). However, the situation presented here is not isolated. The typology of strategies described above may as well fit a wide range of actors in Brazil and abroad that actively produce fake controversies and promote the dismantlement of environmental policies. But as important as diagnosing this issue, is to reflect on how to deal with contrarians and their influence in the public debate. The risk to the global environment posed by contrarians that promote fake

Table 1

Fake controversies promoted by ET group in Brazil, implications to conservation policies, and scientific publications opposing those claims.

Contrarians' claims	Implications to conservation policies	Scientific objection
The full implementation of the Forest Code would make Brazilian agriculture unviable in most of Brazilian territory because in "a scenario in which the permanent preservation areas cannot be considered part of the legal reserves, [the full implementation of the Forest Code] would lead to negative numbers [areas available for agriculture] in the Amazon and Pantanal" (Miranda, 2010, pg. 388), free translation.	The approval of the revised Forest Code in 2012 has led to an amnesty of 58% of all illegal deforestation prior to 2008, promoting a steady growth in deforestation rates thereafter (Soares-Filho et al., 2014).	The Forest Code is crucial for maintaining key ecosystem services necessary for agricultural production. Deforestation in the Amazon affects precipitation patterns and reduces agricultural revenues in Brazil (Spera et al., 2020; Leite-Filho et al., 2021). The total area with land use restrictions does not significantly impact agricultural production (Skorupa, 2003; Aquino and de Oliveira, 2006; Soares-Filho et al., 2014; Sparovek et al., 2011; ABC, 2010).
"There is a lot of arbitrariness. Fines are created based on satellite images, flying over helicopters, without listening to the producer, without setting foot on the property to find out if the person who was fined had authorization." - Miranda's words in an interview (Walendorf, 2018), free translation.	Bolsonaro's government - which invited Dr. Miranda to develop guidelines for environmental policy - drastically decreased the number of environmental fines related to illegal deforestation (Vale et al., 2021).	Between 2005 and 2007, fines and embargoes helped to drastically reduce deforestation in the Amazon (Nepstad et al., 2014). Law enforcement has been undertaken in the Amazon with the support of sophisticated monitoring technology (such as DETER), but with the central role of field-based enforcement which has proven to be a highly cost-effective conservation instrument with effects on large-scale deforestation (Börner et al., 2014, 2015; Sousa, 2016; Assunção and Rocha, 2019; Saraiva et al., 2020).
"If these demands [indigenist, rural settlement, and quilombola] were quantified and properly mapped, it is likely that the sum would exceed the dimensions of the national territory, not to mention the existing occupation" (Miranda et al., 2008a: p. 30), free translation. "The problems of territorial planning and legal use of land in Brazil are the result of a process through which, in recent years, a significant number of areas were destined to environmental protection and the exclusive use of some populations, while a series of legal measures severely restricted the possibility of removing natural vegetation, demanding its restoration and the end of agricultural activities in these areas" (Miranda et al., 2008b), free translation.	The creation of new conservation areas and demarcation of indigenous lands has reduced drastically since 2010, and stopped in 2018. Also, the state of Rondônia (aligned with President Bolsonaro) has reduced its protected areas and the government has presented different proposals to the National Congress in order to enable large infrastructure projects and mining inside protected areas. During his presidential campaign, Bolsonaro said publicly that he would not demarcate even one centimeter of land for indigenous peoples (Raposo, 2021). Indigenous lands have been exposed to increasing attacks in recent years, many of them with the use of violence (Conceição et al., 2021; Raposo, 2021).	Indigenous population density is higher inside Indigenous Lands than in neighbouring areas outside, and population size is usually proportional to territory size, indicating that indigenous lands are effectively used by these traditional populations (Begotti and Peres, 2020). Sufficiently large indigenous lands are fundamental for their sustainable use (Begotti and Peres, 2020). Indigenous lands are one of the most important deforestation barriers in the Amazon (Nepstad et al., 2006). Granting collective property rights to indigenous peoples significantly reduces the levels of deforestation inside their territories (Baragwanath and Bayi, 2020). Titled indigenous lands reduce both deforestation and carbon emissions (Blackman and Veit, 2018).
Burning sugarcane crops is positive for the environment and its smoke has no impact on human health, (Miranda et al., 1994, 1997).	The Public Attorney's request to stop burning sugarcane was denied by a Judge based on Miranda's study, delaying by two decades the prohibition of this practice in the state of São Paulo.	The smoke from burning sugarcane has serious consequences for human health, increasing the hospitalization of children and elderly. Burning also reduces soil fertility and provokes erosion (Kirchhoff et al., 1991; Boeniger et al., 1991; Newman, 1986; Rothschild and Mulvey, 1982; Alessi and Navarro, 1997; Delgado, 1985; Urquiaga et al., 1991).
The majority of fires detected in South America in July 2021 were from controlled agricultural burnings, not forest fires linked to deforestation. E.M. opposed law enforcement with sanctions to punish illegal agricultural burnings and forest fires (Miranda, 2021).	Dismantling of deforestation and fire control policies, while giving legitimacy to the use of fire even during the highly flammable dry season. Fuel conspiracy theories that depict environmental sciences as part of a "narrative war" aiming at preventing Brazil's economic development.	51% of fire alerts coincide with deforested areas from 2017 to 2019. Specifically in July 2021 only 39% of fire hotspots occurred in consolidated areas (i.e. deforested prior to 2017), while 48% and 6% took place in areas with recent deforestation (i.e. clearings after 2017) and with forest cover in 2020, respectively (INPE, 2021; Aguiar et al., 2020).

controversies in Brazil and in other countries calls for the need to rethink how the scientific community, civil society, and media should deal with these researchers and their trendsetting unpublished materials (Murdian and Pascual, 2020).

Peer-review processes and the possibility of contesting published articles via rebuttals have proven to be a reliable mechanism to produce knowledge. However, the scientific community is not well prepared to deal with fake scientific controversies and diffusion of pseudo-facts. By regarding them as unworthy of attention, the scientific community has allowed fake scientific claims to remain unchallenged. As such, academia is also to blame for fake scientific controversies' longstanding and growing ability to influence policy. While it would be quite strenuous to fact-check all of the allegations that are made public by such "scientists", more space should be opened in scientific journals (i.e., special commentary sections or rebuttal papers such as ours) to pin down and discuss fake scientific controversies in a rigorous manner. Additionally, articles such as this one, in which the production of biased science and its impact on policymaking are identified and rigorously analyzed should be encouraged.

Fake controversies should also lead to a reflection on how science is

taught and communicated to wider and different audiences. The increasing pervasiveness of conspiracy theories and anti-intellectualism in right and left wing populism leads citizens to perceive epistemic authority with suspicion and to question established facts (Ylä-Anttila, 2018; Eberl et al., 2021). In this context, it is important to teach and communicate not only the content of scientific theories, but also the way science is produced and the provisional character of all evolving scientific knowledge and the associated uncertainties (Shapin, 1992; Collins and Pinch, 1998; Lynch et al., 2015). By increasing the awareness of scientific practices, the general public may be able to better appreciate the difference between unfounded claims circulating in social media and actual rigorous research efforts. Most importantly, by understanding the amount of work behind proper research, society will be prone to appreciate that science is, above all, a collective enterprise, so that the best theories and data emerge from dialogue and criticism within the scientific community. The public understanding of science could potentially prevent taking for granted fake scientific controversies put forward by groups of interest at the expense of the social good, sustainable development and environmental conservation. In addition to promoting a better understanding of science by society, it is crucial that

policy makers avoid “cherry picking” and the adoption of politically useful but scientific flawed pseudo-facts. For that purpose it is crucial to ensure greater participation of scientists in public debates, selected based on their research record and respect among their peers instead of personal and political ties.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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