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OPINION PIECE

Information and misinformation about climate change: lessons from Brazil

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ABSTRACT: There is a growing movement in online social networks and within some governments to deny the long-established scientific consensus regarding climate change. Scientific research has shown that a series of climatic events in Latin America, and especially in Brazil, are being exacerbated by global warming. These events have had a profound impact on populations. Disruptions to Brazilian rainfall patterns with their devastating environmental and economic effects on agriculture have been directly linked with Amazonian deforestation. Furthermore, the Bolsonaro government, with its erratic environmental policies and ardent followers, has promoted misinformation about climate change and conservation of the Amazon. It is necessary to simultaneously inform society about scientific misunderstandings regarding the environment and the way these misunderstandings are amplified via the internet and social networks.

KEY WORDS: Global warming · Effects · Brazil · Rain

1. INTRODUCTION

There is a very well-founded consensus supported by multiple lines of scientific evidence that climate change, especially global warming, is an ongoing phenomenon (Thuiller 2007). On the other hand, and contradictory to the scientific evidence, some changes in the world's political circumstances have precluded governments from taking the necessary measures to attenuate phenomena leading to devastating impacts (Benegal & Scruggs 2018). Brazil's current administration, in a similar fashion to the USA under the recent Trump administration, has adopted a new stance on this environmental issue, namely denial of its urgency (Phillips 2019). This is particularly evident in the exit of the USA's large global economy from a concerted effort to avert disaster, the Paris Agreement (Saad 2018).

However, regardless of a country's denial, or its political and ideological prejudice, climate change is an undeniable reality. Examples abound and affect various sectors of society, including health (St Louis & Hess 2008), agriculture (Calzadilla et al. 2013) (and access to food; Wheeler & Von Braun 2013), and the economy (Tol 2020) as a whole. Brazil is a country that feels its effects (Viola & Franchini 2017), no matter how much disinformation is spread by movements on social media (Williamson 2016).

These impacts are especially marked in the field of human health, and they relate directly to environmental factors: increases in vector-borne diseases; irregular access to water and food (affecting malnutrition); deaths caused by extreme events such as unpredictable and uncharacteristic heat waves (McMichael et al. 2004). Some may argue that there will be positive effects, especially in cold countries, such as decreased deaths from lower temperatures. But it is always worth considering that climate change will generate extremes of both high and low temperatures, so the overall effects are likely to be negative. The devastating effects in developing and poor countries, notably in sub-Saharan Africa, are already evident (Markandya & Chiabai 2009).

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This essay seeks to analyze, based on recent examples, the spread of false information about the environment (Treen et al. 2020) and deconstruct the rhetoric that guides this dissemination. To this end, examples of this phenomenon in Latin America, and especially in Brazil, are discussed. It is assumed that the perception of climate change (Schellnhuber et al. 2006) related to human actions, especially in relation to the use of fossil fuels (Johnsson et al. 2019), is supported by scientific consensus. Among the myriad impacts of climate change, global warming (Harvey 2016) is highlighted, which is presented based on scientific data and represents a worldwide emergency impacting food security and generating extreme weather events (Planton et al. 2008). Finally, the essay discusses how the Brazilian government and its ardent supporters benefit from the organized movements in social networks to spread and confuse the population with false information on environmental issues, a relatively new phenomenon and one that still needs to be analyzed.

2. LATIN AMERICAN EXAMPLES

Various manifestations of climate change in South America seem to be occurring simultaneously: one that seems to be more directly connected to global warming and another that could be perceived as a side effect but that strongly impacts Brazilian urban populations. First, the extremely hot summer in Antarctica and subsequent changes experienced by this polar region (Lee et al. 2017). In 2020, daily temperature records were routinely broken in Antarctica. It has never been this hot in this region, and the temperature increases cannot be attributed to normal seasonal changes or the continent's remote, inhospitable location.

Climate change in Antarctica is particularly intense, and these changes reverberate around the world, especially in neighboring Latin America. Data show that important changes are underway (Turney et al. 2020). Actions to contain climate change, such as those outlined in the Paris Agreement, may be insufficient to contain Antarctic warming and its consequences, such as rising sea levels (Li et al. 2020), but the Agreement is the best option that we have for now. In the last 50 yr, the Antarctic Peninsula has warmed significantly, with data from 11 temperature-measuring stations showing rates of 0.56 °C yr^{-1} and 1.09°C during winter, which empirically and consistently demonstrates the growing problem (Turner et al. 2005). Therefore, the scenarios for Antarctica are gloomy and projections point to a continuation of this warming, with or without mitigating actions for the reduction of greenhouse gas emissions over the coming decades (Rintoul et al. 2018).

The negative impacts these changes may have on the health of the people of Latin America are seen in, for example, the spread of mosquito-borne diseases, which are already occurring and not simply a pessimistic forecast. I emphasize the reappearance and resurgence of dengue virus in Buenos Aires (Tittarelli et al. 2017). Until recently, the temperature of that city seemed to make it difficult for the *Aedes aegpty* mosquito to reproduce and consequently spread the virus (Seijo et al. 2000), one of the most dangerous human arboviruses (Rigau-Pérez et al. 1998). This serious disease seemed to be hampered by latitude and temperature, but the climate is changing (Guzman & Istúriz 2010) and the consequences are noticeable in this large cosmopolitan city, which experienced a strong and unexpected dengue epidemic in 2016 (Bolzan et al. 2019).

In early 2022, Argentina experienced record high temperatures; Buenos Aires has never recorded a higher temperature since measurements began there. The Argentine Patagonia, famous for its low temperatures, experienced 45°C in the same period. The consequences of these new, strong heat waves will have rapid and unexpected impacts, for example, on the glaciers in that region (Kargel et al. 2012). It is possible that the entire Andean region of Latin America, with many regions dependent on water supplies from the once-frozen high altitudes, may have their water supply compromised earlier than anticipated (Hardoy & Pandiella 2009).

It is also known that cold fronts coming from Antarctica influence the rainfall patterns in Brazil, especially in the southeast region (Alves et al. 2017). Therefore, it could be inferred that the climatic extremes of Antarctica in 2020 would have important repercussions in Brazil. This prediction has already become a reality (Tundisi et al. 2010). The rains in the summer of early 2020 were completely abnormal in some regions of southeastern Brazil[1]. Belo Horizonte, one of the most populous and economically progressive Brazilian cities, had never registered such a large volume of precipitation in so short a time, with catastrophic effects such as the destruction of houses and public property displacing many families and generating great financial and human losses.

[1]https://g1.globo.com/mg/minas-gerais/noticia/2020/01/29/apos-mais-um-temporal-com-enchentes-bh-e-regiao-metropolitana-contabilizam-mais-estragos.ghtml

The total accumulated rainfall in 29 d in January 2020 was an unbelievable 932.3 mm, an all-time monthly record in 110 yr of measurements dating back to 1910[2]. São Paulo, the largest and most economically important city in Brazil, faced a day of chaos after a sequence of rains with historical intensity. In February of the same year, the abnormal volume of precipitation continued with all the expected consequences in a metropolis like São Paulo. The human and economic damages were incalculable.

Scientific evidence shows that climatic phenomena are all interrelated (Bronstert 2003) and that the effects of climate change and global warming are very difficult to reliably predict. One certainty is undeniable — the consequences are already present on a global scale and are affecting different regions with different intensities, impacting all spheres of society (Adger et al. 2013).

The Brazilian winter of 2020 serves to clearly demonstrate these various devastating impacts of the global phenomenon on a specific region. At the beginning of this season, average rainfall and humidity were extremely low — much lower than average for the period, revealing an intense contrast to what happened in the summer of the same year, in a cycle that has repeated itself in recent decades (Ferreira Filho 2020). In 2020, a sequence of extreme events in Brazil's largest city, São Paulo, generated water insecurity; these involved a major winter drought, which caused water-supply problems, and excessive summer rainfall which caused floods (Johnsson & Melo 2018).

Brazil's agriculture sector is the most significant economic driver in the country and is highly dependent on the regularity of rainfall, something now in jeopardy from the increase in deforestation in the Amazon and the intensification of climate change (Ferrante & Fearnside 2019). As Brazil is a major food producer, the cost and difficulty of adapting to changing climate patterns are inestimable (Nelson et al. 2009). In addition, Brazilian, regional, and indeed global food insecurity might result from the intense and new climatic phenomena (Wheeler & Von Braun 2013).

The recent drought in southeastern Brazil serves as another actual and current exemplar of the consequences of intense climatic variations. This region, one of the most economically important, recently suffered an unprecedented drought, with water rationing in several cities and great economic and social repercussions in states like São Paulo (Coelho et al. 2016). This happened far away from the northeast which, with its semi-arid climate constituting the caatinga biome, is the region that is usually hit by severe droughts in Brazil (Marengo et al. 2017).

We thus have strong evidence of climate change reverberating throughout Brazil. In some years severe drought and in others, abundant, abnormal, excessive rains. However, it is difficult to convince ideologically dogmatic governments and social networks infected with conspiracy theories which insist there is no evidence that something different and harmful is happening to our climate (van der Linden et al. 2017). It is essential that we address these issues alongside the scientific evidence, and we do so in the next section.

3. MISINFORMATION OVER THE INTERNET (SOCIAL NETWORKS)

Concomitantly with all these signs of climate change, in 2019 there was a substantial increase in deforestation of the Amazon, which was made worse in 2020 by the insistent denial of the increase in deforestation by the Brazilian government (Escobar 2019) and the misinformation disseminated by the hosts of social networks. It is necessary to highlight that in addition to the intrinsic value of the Amazon rainforest for its biological diversity and maintenance of the soil, the tropical forest also influences the Brazilian rain regime, regulating humidity in the largest Brazilian agricultural regions (Plotkin 2020).

The numbers and facts show that the current government has no commitment to the preservation of the Amazon. On the contrary, it keeps its promises to support deforestation (Silva Junior et al. 2021). The targets set for the reduction of greenhouse gas emissions, established in 2009 as part of the National Policy on Climate Change (da Motta 2011), which indicated a reduction in the rate of deforestation of the Amazon by 80% by 2020 were (and are) being summarily ignored. Contradictorily, since 2013, deforestation has shown an upward trend, which has become much more pronounced under the Bolsonaro administration.

In 2019 there was a 34% increase in deforestation in the Amazon compared to the previous year (7536–10 129 km^2); in 2020 it was worse, with a 45% increase, and the data for 2021 signal an even greater disaster. To illustrate the failure to achieve the goals assumed by Brazil, in 2020 the deforestation rate was 182% higher than the established target. This in-

[2]https://www.climatempo.com.br/noticia/2020/01/29/bh-em-100-anos-n-nunca-choveu-tanto-como-em-janeiro-de-2020-1563

crease in deforestation caused a chain reaction of increased greenhouse gas emissions, more frequent forest fires, and declining respiratory health, especially among indigenous and riverine populations (Reddington et al. 2015).

The intense diffusion of false information by social networks, which has penetrated Brazilian society (Chao 2013), has led to environmental preservation, especially of the Brazilian Amazon forest (Silva 2021d), being relegated to second place on the government agenda. Few Brazilians are aware of this deliberate move. The consensus regarding climate change was disseminated on the internet as a conspiracy theory of developed countries against the Brazilian nation, which would aim to prevent Brazil from exploiting the almost infinite resources of the Amazon. Judging from Bolsonaro's statements, Brazilian ecologists are considered liars and traitors of the country, as if they would intend to hand over the riches of the Brazilian Amazon to other people, a view shared by many of Brazil's military (Phillips 2019, Gagliardi et al. 2021).

This support by part of the population for the government's erratic policy has harmful effects and is one reason why the Bolsonaro government is considered a 'tsunami' against the preservation of the Amazon. The consequences will be felt for many years to come. One example is the boldness of the Brazilian environment minister who said emphatically, in a meeting reported by the media, that the government should take advantage of the COVID-19 pandemic and the distraction it causes in the press to implement its set of laws and measures to loosen environmental preservation (Pelicice & Castello 2021). Something indescribably inhuman in the face of the suffering caused by the disease and unbelievably contrary to the mission expected of this ministry, but a statement which prompted little response from a population intensely polarized by false information about the environment.

4. THE OFFICIAL DISINFORMATION

The Brazilian government has played a central role in spreading this disinformation via social networks, but it is important that the population and organized society find ways to protect themselves. Misinformation at times comes from the internet, through the so-called 'fake news'. A recent example related to health is noteworthy. After the confirmation of the first case of COVID-19 in Brazil, the government of Brazil determined that most of the information on this disease on the internet was false (Cuan-Baltazar et al. 2020), and that it was generating an unfounded panic which forced the Ministry of Brazilian Health to create a virtual channel to indicate what was fake news and what was not.

Unfortunately, this same Ministry of Health has become the frontline not only spreading false news regarding COVID-19 but also for going further and spreading treatments without scientific proof (Silva 2021b). This shows that scientific fake news in Brazil goes beyond the environmental issues; it has become an official government action with the support (or at least the acceptance) of part of society, such as many doctors (Silva 2021a). This movement coordinated by groups that call themselves 'conservatives' in Brazil has been constantly mobilizing on the internet and social networks, often using scientific sources, purposefully obfuscating these with conspiracy theories, and generating a cabal of lies that appear true to laymen (and often) non-laymen. Parallel to the dissemination of false news, these groups also disqualify scientific research and the traditional press (Canavilhas & Jorge 2022).

One can see the effects on the environment of this misinformation by the Bolsonaro government through 2 recent examples with global relevance. At the 76th UN General Assembly, the Brazilian president was the first to speak; environmental issues and 'fake news' dominated his speech. Using the trick of mixing truths and lies, he affirmed that Brazil has one of the world's most comprehensive set of environmental laws (Sparovek et al. 2010) — which is true — but, as usual, he distorted scientific data regarding deforestation and forest fires to exalt his environmental policy (Ferrante & Fearnside 2019). At the 2021 United Nations Climate Change Conference (COP26), President Bolsonaro was heavily criticized for his erratic stance on environmental issues. However, in line with his misleading narratives, he claimed that Brazil has been an example to the world, pointing out that it is the other countries that are not doing their part. Finally, he threatened that no boycott can force Brazil to change its stance because other countries depend on the food sold by Brazil (Martinelli et al. 2010). All this rhetoric was widely disseminated on the internet and social networks (Ricard & Medeiros 2020), feeding a whole set of fake news that support the false discourse of his followers and organized groups.

5. CONCLUSIONS

It is necessary to unite the efforts of all sectors of society committed to environmental issues to simul-

taneously face the lack of information and the pernicious spread of misinformation. It will also be necessary for scientists to understand that they need to enter new arenas to disseminate their work, as there is a large portion of the population receiving information of terrible quality — and it is this large portion of the population that will vote, elect, and consequently choose the public environmental policies that will be a priority. How can this be done? There is no easy answer, but scientific associations and organizations need to look for ways to do it. Perhaps by seeking the help of those who understand these new media processes and how to 'viralize' information. We must reflect on how it is possible to disseminate scientific knowledge, face up to the idea of 'conspiracy theories', and make sure that erroneous reports do not become prominent, and thus potentially generate unpredictably damaging future consequences.

It is important to highlight that there are already initiatives in Brazil to confront the phenomenon of fake news, because fake news is spread even by the government, and by some journalists linked to Bolsonaro, who were once respected in Brazil (Silva 2021c). The Supreme Court, the highest instance of justice in Brazil, already has an ongoing investigation into the dissemination of fake news in an orchestrated manner, including by the Bolsonaro government and its supporters. In addition, a Brazilian reaction movement that should be highlighted has 2 proponents coming from the academic world, using the internet and social networks. Átila Iamarino (PhD in microbiology) uses his YouTube channel (with over 1 million followers), a column in one of the main Brazilian newspapers, and other channels of contact with society. He has had great success and generated counter-reactions from denialist groups (de Oliveira Mendes et al. 2020). It is also worth mentioning the work of doctor Natália Pasternak (Taschner 2018) from the 'Question of Science' Institute, who uses the tools of the internet to challenge fake news and search for clarification for the people. However, these initiatives are more focused on health issues rather than environmental ones. As noble as these actions are, society will need to find ways of regulation and punishment for those who spread false news.

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