

O Use of Big Data and Data Analysis not studied Climate Changes

The Usage of Big Data and Data Analytics in the Study of Climate Change

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summary— In a world increasingly linked to the digital, where the possibility of generating and analyzing large amounts of information is increasingly valuable to society, every day we discover new opportunities and strategies that do not study issues that involve or deal with large volumes of data. It is full was that big data and consequent data analyses are effectively used in different topics, as these have behaved in the face of one of the two greatest challenges that human beings face, climatic alterations. This literature review allows us to demonstrate how big data and analysis of data also interacted with the theme of climatic changes and as well as recounting or using them through examples of their application in the investigation of climatic questions. It is intended to demonstrate that climatic changes, a much-studied topic, were also affected by the introduction of big data and that through this application it was possible to obtain a better knowledge about this topic that is important for the preparation and adaptation of society.

Palavras-Chave - Big Data; Climate Changes; Data analysis.

Abstract— In a world more and more connected with digital where the possibility of generating and analyzing large quantities of data is becoming increasingly valuable for society, every day there are new findings on opportunities and strategies in studies that cover a great treatment of data. In the era where Big Data and consequential data analysis are utilized effectively in a variety of topics, how have these behaved towards that which is one of the biggest challenges that human beings face: climate change. This literature review shows how Big Data and data analysis have interacted with the subject-matter and relate the use of these by referring to examples of how it has been implemented in the investigation of climate issues, aiming to reveal how climate change, a subject that has been exhaustively studied,

Keywords - Big Data; Climate Change; Data Analytics.

I INTRODUCTION

During the last decades it was possible to verify that big data The analysis of data is starting to arouse more and more interest, as well as these needs are coming to emerge in various technological points that are the center of attention these days, because we have seen a growing increase in studies in more varied topics [one].

The study of climatic alterations is a topic that has been much discussed and has been a subject of study for many years. In the last decades, we have verified an exponential increase (and, possibly, irreversible) of changes in our planet due to climatic alterations. Considering the complexity of the study of these phenomena on our planet, there are numerous opportunities for the application of big data study of climatic alterations [2]. Today it becomes possible, through various means, to collect and store large volumes of data. These givens, when analyzed, will allow obtaining a more extensive knowledge about the subject and, in this way, develop answers that allow an adaptation to the new existing realities, due to complex climatic alterations, and we can formulate strategies that make it possible to adapt to these events [3].

The objective of this work is to carry out a review of the existing literature that details the use of big data and analysis of data in the study of climatic alterations, highlighting some of the two topics studied, opportunities and challenges generated.

This article finds itself organized in the following way. In section II we will present the research method used to carry out the study. In section III we will make a brief approach to the issues of big data, Analysis of Data and Climatic Alterations. In section IV we will present the results obtained in our research. In section V we introduce the discussion of the topic and finally in section VI we present the main conclusions of this study.

II. METHOD OF PSCHISE

For this review, an initial phase was carried out, a research through portals of access to scientific publications that address the issue of the use of *big data* e Data Analysis in the context of climatic alterations. For such, forum, in the first place, we investigated the portals referring to B-ON (Online Knowledge Library) and Google Scholar (Google Scholar) to Google's article research platform. This research was focused on articles published between 2015 and 2020 and related to the aforementioned topics. The reason why this time interval was chosen was to focus on the review of the literature in the most recent articles that address the issue of the application of *big data* to the study of climatic alterations. For such, forum introduzidas palavras-chave "Big Data Climate Change", "Data Analytics and Climate Change". All the research necessary for this review was carried out using the English language, seen through it that we can find a greater variety of articles on various topics. Due to the fact of the research through the two previously indicated terms, we are not allowed to reach a number of articles considered relevant, we open to research articles in our data bases, namely, to IEEE (*Xplore Digital Library*) ea DBLP (*Computer Science Bibliography*). This research allowed us to obtain articles related to the theme in order to conclude the review, with articles that relate the theme in the study with the already existing subjects of *big data* and analysis of data, as well as others that are reported or value associated with *big data*. It is the way to have an impact in areas related to climatic alterations.

III. ANDNQUADRAMENT

In order to carry out a more complete study of the subject, it is necessary that, in the first place, two subjects discussed in this literature review be framed.

For this we must introduce, in the first place, the topics to be discussed in this review. starting by *big data* which, although it can present various definitions, is usually described through two 5 Vs: Variety, Volume, Veracity, Speed and Value. Assim, *big data* It implies the use of a large amount of data, whose access requires that it be fast, dealing with different formats of data, collected from various sources, necessarily reliable and, above all, that represents value for the organization [4].

data analytics (or data analysis) corresponds to the analysis process that allows to discover hidden patterns, unknown correlations, trends, customer preferences and other important and relevant information for different businesses, representing, as well, an extremely useful tool when used for decision making [5].

Finally, the study of climatic alterations, considered one of the two greatest challenges of the twenty-first century. The impact of climatic alterations on the planet has been studied for several decades, but the damage caused by these, currently verified, has increased on a scale and effects are possibly irreversible. Such tem raised to search for new ways of dealing with these effects, having been verified, in recent years, or interest in including *big data* and *big data analytics* I did not study climatic alterations [2].

IV. RRESULTS

In order to start the literature review, a research was carried out on articles related to the theme. Proceed to read the summary of two articles in order to determine if they should be included in the review. The focus of this research was in search of articles that reported experiences or practical applications of *big data* and data analysis in order to guarantee a better understanding of the effect of climatic changes at different levels, namely: economic, health, disaster prevention and weather forecasting. Forum excluded the articles that were not available or two that were barely possible to consult or summarize. After we have chosen the articles that relate these applications, they were read in their entirety in order to verify that they are not only found within two themes, but also, we continue with fundamental information on how *big data* and data analysis help me not study the subject. Na Figure 1 it is possible to consult the purpose of framework of classification of studies in *big data* and climatic alterations proposed by Hassani, Huang and Silva [4], named as regards application (5 areas: energy efficiency & intelligence, *smart farming*, agriculture, forestry, sustainable urban planning and infrastructure, natural disasters, assessment of services and other support topics) and value creation related to Observation and Monitoring, Understanding, Prediction and Optimizing.

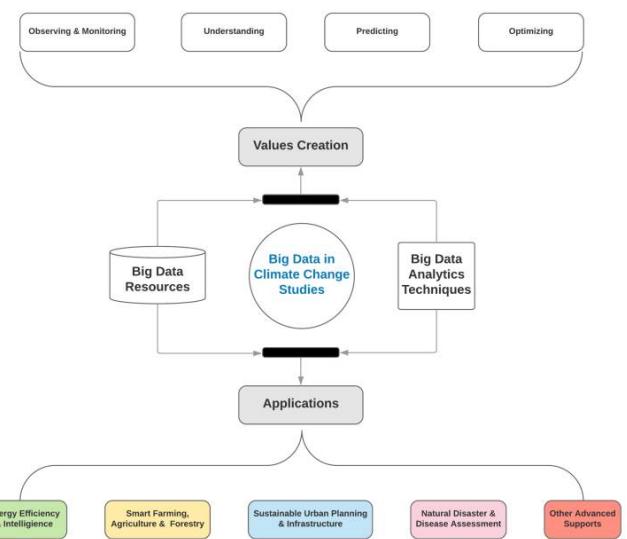


Figure 1: Framework of *big data* in climate change studies [4]

This reading revealed that all the articles that comprise this review contain a part of the knowledge about *big data* and data analysis, indicating the potential for value creation and the importance of this for a better understanding of climatic changes. Some two articles will reveal that they have been developed with the idea of exploring other themes associated with the research that has been carried out, through part of possible applications in situations similar to those described. Through Table 1 we can highlight the articles, authors and areas focused on the articles that will integrate this literature review.

In order to guarantee a greater coherence not touching on the part of two results observed through this review of the literature, we decided to divide the topics to be addressed in three

categories. These categories are: (a) Or value that *big data* map for the study of climatic alterations; (b) As applications of *big data* e Data Analysis to the study of climatic alterations; (c) Opportunities and challenges in the study of climatic alterations.

Table 1 – List of articles analyzed

Titulo	Data	Autor	Tema
<i>Big data driven smart energy management: From big data to big insights</i>	2016	Zhou, Fu & Yang	Energy Management
<i>Big Data in Weather forecasting: Applications and Challenges</i>	2017	Himanshi Jain, Raksha Jain	Weather Forecasting
<i>Predictive Analytics for Climate Change Detection and Disease Diagnosis</i>	2019	V. Nandhini, M.S Geetha Devasena	Health
<i>Big Data in Climate Change Research: Opportunities and Challenges</i>	2020	Prateek Mangal, Anupama Rajesh & Richa Misra	Climate Science
<i>Spatial cumulative sum algorithm with Big Data analytics for climate change detection</i>	2017	Gunasekaran Manogaran, Daphne Lopez	IT
<i>Earth observation Big Data for Climate Change research</i>	2015	Hua-Dong Guo, Li Zhang & Lan-Wei Zhu	Climate Science
<i>Big data for Big Problems – Climate Change, Water Availability and Food Safety</i>	2015	Walter Armbruster, Margaret Macdonell	Environment & Climate Science
<i>Big data and Climate Change</i>	2019	Hossein Hassani, Xu Huang & Emmanuel Silva	Climate Change

A. The value that the Big Data traces for the study of climatic alterations.

Being the study of climatic alterations a topic that allows the possibility of studying large volumes of data, generated in short time intervals and whose results need to be available in a timely manner, it is necessary that we possess the necessary tools and techniques for such.

Segundo Hassani, Huang e Silva [4], or value that or *big data* produced for the study of climatic alterations can be translated through five points: Observation, Monitoring, Comprehension, Prevision and Optimization. According to the same authors, one of the major advantages of using *big data* It is the possibility of revealing new realities on the large amount of available data. These given contain, many times, non-obvious answers to problems. In order for it to be possible to understand these data, our parents, effects in the way we define the climatic system, it is necessary to proceed to the observation and monitoring of this information, in a rigorous way to, as well, guarantee a better understanding about the alterations caused by global warming . Not that it concerns the remaining three points of understanding, forecasting and optimization, the nature of the climate issue raises the need for the application of these points due to its degree of complexity, dimension and uncertainty.

In order for a better understanding of this subject to be possible, entities such as the Global Climate Observing System (GCOS), the National Center for Atmospheric Research (NCAR), among others that are dedicated exclusively to the study of climatic alterations, have been established for a long time. . Data created and shared by these entities as well as how to apply *big data* The role that they play in forecasting and understanding both has been revealed to be fundamental in different areas related to climate science,

allowing optimization of processes while also guaranteeing a maximization of utility and efficiency.

B. As Applications of Big Data and Data Analysis to the study of climatic alterations

According to the information present in Figure 1, the applications of *big data* I do not study the climatic alterations, we are focused on articles related to: energy efficiency and intelligence, *smartfarming*, agriculture, forestry, sustainable urban planning and infrastructure, natural disasters, assessment of services and other support topics. A research of articles carried out outside the scope of this study confirms this classification.

No case of study of use of *big data* As a forecast of time, Himanshi and Raksha Jain [6] believe we do not know how to use it *big data* Data analysis also when applied to time forecasting, as through the analysis of large amounts of data it becomes possible to anticipate problems caused by the time state before they occur. The authors of the article explore how various industries, such as the agricultural industry, tourism, construction, sports, disaster management and energy, can benefit from the forecast of time and the role that *big data* and *big data analytics* têm nessa previsão. According to the authors of the cited study, this is a fundamental sin to make it possible to analyze large volumes of generated data. It is also highlighted not artigo a form as several models that use *big data* For their forecasts, the precision of the forecasts made has increased, making, as well, the society more sensitive to these forecasts, increasing the number of people who use this information does not change from day to day.

Nandhine and Devasena [7] present the way in which the application developed by the authors and applied to the study of climatic alterations allows obtaining large amounts of data that help in the process of analyzing changes and seasonal actions, allowing, as well, to improve public health. The authors reflect on the advantages that *big data* tem guaranteed for the health of society and how it can help in the study of climatic alterations, presenting the form of forecasting through pattern detection techniques using data analysis, where the process is initiated through the aggregation of large quantities of related data with time, representing the starting point to carry out data analysis using an algorithm that allows detecting significant alterations in the climate.

Manogaran and Lopez [8] present a more practical perspective of the study of the subject. No article is referred to importance that *big data* tem for the study of large volumes of structured and unstructured data, data that become complex or the use of traditional data processing techniques, for which it is proposed, not studied by two authors, an algorithm developed for the calculation of different climate parameters such as maximum, minimum temperature, precipitation, wind, humidity and others to be used in monitoring the climate changes.

Guo, Zhang & Zhu [9] disbelieve the potential use of *big data* and analysis of data in the development and improvement of the management and treatment of two data created by the technologies of

existing observations, to which they have been applied in order to guarantee a better view of biological, physical and chemical parameters. According to the authors, in order to be able to combat the problems associated with climatic alterations, or the study of climatic alterations needs only large amounts of data, starting from varied sources through real-time analysis, but also information about the relationships between *big data* and terrestrial observation. The same authors also discuss the description of the form as data collected from satellites contribute to the study of climatic changes at different levels: atmospheric, oceanic and terrestrial.

The authors refer that all the data generated have an associated value, therefore, in order to promote or study the climatic alterations, these data must be analyzed through models capable of colmating, using large volume data, something that, according to the authors, we Existing analysis models are still not able to do it efficiently.

Armbruster and McDonnell [10] believe or confirm that climatic alterations in agriculture and in *supply chain* this domain. In order to meet the growing demand for agricultural products and reconcile the production of products in large quantities and diversity and, at the same time, be aware of the impacts of climate change, it becomes necessary to adopt a strategy of *climate-smart-agriculture*. With a growing application of *big data*, upon analysis becomes possible, according to the authors, allowing to reach a higher level of productivity, when compared to traditional techniques, through the performance of precision agriculture and the study of solutions to assess the impact of the variation in climate and efeito das secas. Through the use of *big data* it becomes possible to monitor the regional and national levels in order to adapt the practices of food production.

Zhou, Fu and Yang [11] describe how climatic data such as the angle of the sun, wind speed and temperature, have an important role in supporting energy management and how these data contribute to the creation of a breeding forecast system of renewable energy or paper that or *big data* tem in the identification of faults in the system and in the forecast of energy consumption by two users. According to the authors, the data from the climate study fazem part of the forms as *big data* is to affect energy, since the authors believe that the climatic data will be part of the next generation of energy poupança service platforms and applications, as it is now possible to observe in relation to the maps and geographical location data that are a basic platform of many services.

C. Opportunities and challenges in the study of climate change

Mangal, Rajesh & Misra [12] identify more opportunities and challenges that *big data* breeding did not study the climatic alterations. How many opportunities, I have in mind the nature of the fact of the climatic alterations will be one of the two most important issues in our time, whose effects are visible in any place and taking into account the impact that we have on our lives, the research promoted by existing data can prove solutions or ways to alleviate the verified effects. According to the authors, some opportunities that *big data*

presents as reasons for its adoption no study of climatic alterations is: the fact of being inevitable and abundant as many years given, due to the fact of all digital devices creating a digital glue or that makes it possible to create and access multiple sources of data at a lower cost than the traditional sources of dice. With the possibility of saving all the values in real time or with desired intervals, it also allows obtaining more accurate information. The fact of the data will be accessible in real time, by any person who has access via telemóvel or computer, also is a positive point. Additionally, the fact of allowing information from different sources to be gathered, which allows obtaining more accurate, useful and consistent data compared to those that come from a single data source. Finally,

There are two challenges, these are divided into 3 categories: dice challenges, methods challenges and technological challenges. The first challenge goes through the processes of acquiring the data necessary for any scientific research. Before starting the study itself, it is necessary to proceed to add, locate and exclude data and clean two data to certify that we are not going to use incorrect, outdated, incoherent or incomplete data. The nature of two climatic data, because of the fact that we will be constantly changing, defines the climatic variables as voláteis, because the algorithm used must be constantly updated or altered by programs capable of providing more accurate data. In order to understand the data generated in the alterations, it is important to know the processes of how these originated, or what, In the context of climatic alterations, it is quite complex. Or fact of or study of *big data* related to the climate being relatively recent - there is already evidence, for decades, of the study of climatic alterations - the fact of technological advances in *big data* Although they are still relatively recent, they can cause difficulties in the analysis. Considering the complexity underlying the subject and the need to have many variables, it is also important to consider that the representation of two data in a quantitative way requires the attribution of a value and, however, many climatic phenomena cannot be attributed numerical values , making, assim, difficult to its representation.

How many methods to consider, I do not study the climatic alterations or the challenge is to create robust and accurate forecasting models. However, currently the focus is more focused on understanding the data – since the spatio-temporal nature of two climatic data creates difficulties – rather than on the actual realization of the forecast. The climate study has an exploratory nature. Due to the complex nature of two data coming from two systems, there may be situations in which the same climatic phenomena are caused by different reasons, as well as how two people can use the same set of data and reach different conclusions. There is also a certain difficulty regarding the evaluation of the two methods used, being, therefore, challenging to translate the model used or have no impact on the optimization of the two generated data.

Finally, the technological challenges: sooner or later, this area increases every day, due to the nature of the subject and its

Complexity of origin with the need to transfer, diversify, guarantee security and access over the years, many times in order of two thousand records, because researchers in this area continuously work on ways to develop sensors, improve the image of two satellites, develop more forms fast and efficient data storage, better programs and equipment and intelligent systems that support the investigation of the subject.

v. DISCUSSÃO

Through the analysis of two articles we can verify that *big data* It represents an advantage for the study of climatic alterations, considering the nature of both areas. However, or in fact, in the context of climatic alterations, the production of data being constant, with different variations, and the fact of being a subject that is in constant evolution, means that *big data* It should not be seen as an advantage for the study, but simply as a necessity. The characteristics of the alterations from the origin to the production of various data analyzes that, due to their complexity and size, can lead to different explanations to justify two same events. It becomes, as well, fundamental or development of more studies deepening the subject and supporting or development of new ways of obtaining data and treatment of the same [13][14].

Through our research and as we present our results, some two articles published on the topic follow applications that can be classified in areas of known applications of *big data* and analysis of data on climatic alterations. We can observe or summarize these applications in Figure 2, where it was used or *framework* proposed by Hassani, Huang e Silva [4].

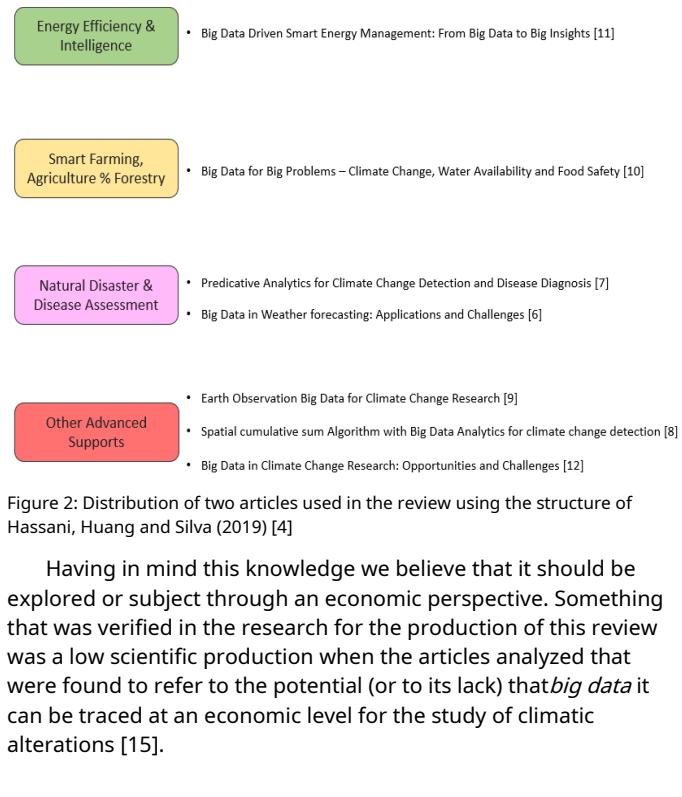


Figure 2: Distribution of two articles used in the review using the structure of Hassani, Huang and Silva (2019) [4]

Having in mind this knowledge we believe that it should be explored or subject through an economic perspective. Something that was verified in the research for the production of this review was a low scientific production when the articles analyzed that were found to refer to the potential (or to its lack) that *big data* it can be traced at an economic level for the study of climatic alterations [15].

During the investigation of two selected articles, it is highlighted that the exploration gives opportunities that *big data* manage to trace the study of climatic alterations still in a very embryonic state, since it is verified that many ideas of opportunities do not translate, de facto, into opportunities that *big data* I managed to trace the study of the subject, more than just opportunities *big data* I managed to deliver em geral.

SAW. CONCLUSION

The central theme of this review was to verify how or use of *big data* The analysis of data has been used to face one of the two greatest challenges of the century that we live: the climatic alterations. For this, a review of the literature was carried out. In the search for articles that reflect these aspects, it stands out how *big data* and analysis of interagem data as the subject of climatic alterations, it has also been possible to add and present the value that *big data* manage to trace the study of topics with a high complexity, such as the case of climatic alterations, as well as present opportunities and challenges associated with this topic.

With the research and reflection carried out, it becomes essential to indicate that the use and scientific research of *big data* It is still very recent when compared to the study of climatic changes in general, it is already easy to understand its applicability to other areas, such as social networks or the Internet of Things, IoT, not that it touches on the understanding of two data, the creation of analyzes and strategies. Due to the volatile characteristics associated with the climate, there is always a degree of increased complexity facing other issues. The study of two articles analyzed allows us to conclude that it is necessary to have this volatility accounted for and that *big data* applied to climatic alterations can be relevant in the generation of *insights* valuable that serve as support to various areas such as health, energy, agriculture, among others.

This implies the need to carry out more studies, in various topics where the focus is not on the use of *big data* and analysis of large amounts of data linked to climatic alterations in order to be possible to assess other realities for those already referred to affected by alterations, such as, for example, the economic effects associated with a business that is affected by climatic alterations, such as tourism, to *triple-bottom-line*, ou seja, focus on environment and sustainability instead of exclusively non-profit, and as the use of *big data* It can be useful for the understanding of these alterations, allowing these businesses to formulate strategies in order to mitigate possible losses due to climatic alterations.

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