

UNIVERSIDADE FEDERAL DO PARANÁ

LORENA LUCENA FURTADO

O CAPITAL NATURAL E SUA MENSURAÇÃO: CONHECIMENTO PARA ALÉM
DA CONTABILIDADE

CURITIBA

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DA CONTABILIDADE

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Orientador: Prof. Dr. Luiz Panhoca

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To my parents,
Zanuba e Francisco!

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RESUMO

Esta pesquisa discutiu o campo de estudo das variáveis ambientais presentes no capital natural, informando os usuários sobre os fundamentos econômicos, sociais, ecológicos, entre outros, que são relevantes à análise dos serviços fornecidos pela natureza ao longo do tempo e devem estar baseados em uma perspectiva que aponte o meio ambiente como objeto de valor. Avaliar as características das variáveis ambientais que, para sugerir uma abordagem interdisciplinar com foco no valor do meio ambiente e na relação homem-natureza captam o capital natural, veio, então, a ser o objetivo principal da tese. Para a consecução do trabalho, três etapas foram realizadas em artigos, a saber: i) identificaram-se as variáveis que captam o capital natural; ii) analisou-se o teor econômico, social e ecológico presente nos textos acadêmicos que identificaram variáveis de mensuração ambiental; iii) propôs-se uma abordagem interdisciplinar para auxiliar na construção das variáveis e atender às necessidades da relação homem e natureza. Abordar as variáveis relacionadas ao capital natural por meio de visões econômicas, sociais e ecológicas se justifica porque, na contabilidade, a mensuração dos recursos ambientais sob o aspecto apenas econômico possui suas limitações. Por isso, buscou-se realizar uma fundamentação para atender à responsabilidade social da ciência contábil, inserindo as variáveis ambientais em uma agenda de discussões com uma visão tanto quantitativa (monetária) quanto qualitativa (características dos recursos do ecossistema usados pelo homem). Apesar de os estudos serem elaborados por pesquisadores com formações diversificadas, existe um pensamento para identificar os impactos negativos causados à natureza, para assim elaborar a sua mensuração por variáveis que constituem o meio ambiente. Trata-se de uma visão que não traz conceitos sobre as variáveis que representam a natureza e os seus serviços ecossistêmicos, uma vez que as pesquisas apontaram a sustentabilidade como motivo de existir uma medição de variáveis que representam o capital natural. As pesquisas sugerem identificar estoques do meio ambiente a serem usufruídos pelo homem no decurso do tempo, o que indica uma visão antropológica sobre o tema. Diante dos resultados encontrados, defende-se a tese de uma abordagem interdisciplinar para conceituar variáveis ambientais que captam o capital natural que saia de um cenário em que a natureza é um estoque para o uso e absorção das necessidades do homem em um cenário em que não haja uma dissociação entre homem e natureza, visto que são partes que interagem e caminham em conjunto para a construção do futuro.

Palavras-chave: Capital natural. Interdisciplinaridade. Homem-natureza. Mensuração

ABSTRACT

This research discussed the field of study of environmental variables, informing users about the economic, social, ecological fundamentals, among others, which are relevant to the analysis of services provided by nature over time and must be based on a perspective that points to the environment as an object of value. Evaluating the characteristics of the environmental variables that capture natural capital, to suggest an interdisciplinary approach focusing on the value of the environment and the man-nature relationship, then, became the main objective of the Thesis. For the accomplishment of the work, three stages were accomplished in articles where: i) it identified the variables that capture natural capital; ii) analyzed the economic, social, and ecological content present in academic texts that identified variables of environmental measurement; iii) proposed an interdisciplinary approach to assist in the construction of variables and meet the needs of the relationship between man and nature. This is justified because, in accounting, the measurement of environmental resources, under the only economic aspect, has its limitations, leading to the search for other aspects of the study, such as social and ecological. For this reason, we sought to provide a basis for meeting the social responsibility of accounting science, inserting environmental variables in a discussion agenda with both a quantitative (monetary) and qualitative view (characteristics of ecosystem resources used by man). It was observed that, despite the studies being developed by researchers with diverse backgrounds, there is a thought to identify the negative impacts caused to nature, to elaborate analysis variables on the environment. It is a vision that does not contain concepts about the variables that represent nature and its ecosystem services. Furthermore, research has pointed to sustainability as a reason for measuring variables that represent natural capital. In these surveys, the aim was to identify stocks of the environment to be enjoyed by man over time, which indicates an anthropological view on the topic. Given the results found, the thesis of an interdisciplinary approach to conceptualizing environmental variables that capture natural capital that emerges from a scenario in which nature is a stock for the use and absorption of human needs in a scenario in which there is a dissociation between man and nature since they are parts that interact and walk together towards the construction of the future.

Keywords: Natural Capital. Interdisciplinary. Man-Nature. Measurement

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ABBREVIATION LIST

CDA –Critical Discourse Analysis

NC –Natural Capital

GRI – *Global Reporting Initiative*

UN – United Nations

MA – Millennium Assessment Report

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1 INTRODUCTION

In the trajectory of measurement in accounting, there are perspectives regarding the generation of information and its usefulness for the user (Clinch, 2000). In this discussion, there are reflections on the fact that it is not enough to just identify data for measurement but to know the relevance of the information to users and the responsibility of those who generate it (Ijiri, 1986). This is because the measurement must not only be limited to techniques but go further, applying accountability on the data formed for the analysis of capital. This idea is supported by the so-called measurement theory (Ijiri, 1986), whereby there is a need to define the variables for analysis and information. For accounting, this represents information that meets current wishes with new judgment measures that are relevant to the market (Clinch, 2000; Srivastava, 2014; Vasarhelyi, Kogan, & Tuttle, 2015).

The complexity in accounting measurement moves the discussion to other areas, such as those related to the relationship between accounting and the environment, mainly because the context is rooted in purely economic views (Callon, 2009; Morales & Sponem, 2017; Russell, Milne, & Dey, 2017). Focusing on environmental variables, there is a discussion on how it is measured, since natural capital, which includes forests, rivers, atmosphere, soil, among others defined in the Inclusive Wealth Report of 2018, is related to social and also environmental issues. Therefore, natural capital has specific characteristics for its recognition and control (Azqueta & Sotelsek, 2007; Fenichel et al., 2016).

These characteristics should not be limited only to economic factors (Morales & Sponem, 2017; Russell et al., 2017), as there are characteristics of natural capital that meet, for example, the disciplines Ecology and Sociology (Azqueta & Sotelsek, 2007; Brand, 2008). This is because it is a capital that has attributes built by different areas, which leads to an extended search for interdisciplinary studies (Fenichel & Abbott, 2014).

In the academic literature, studies dealing with natural capital and its measurement are still incipient, since the approach of natural resources as capital is recent. In the theory of capital, initially in its construction in the economy, there was an interest in the production relations of a capitalist society (Böhm-Bawerk, 1930; Usher, 1965), excluding the understanding of environmental resources as capital. There was a lapse in understanding that capital changes over time (Bigman, 1979). When the discussions returned to this perception, considerations about the scarcity of resources became

necessary. Thus, the approach to capital came to be broadened, then the so-called natural capital emerged (Brand, 2008; Collins & Headley, 1983; Gaffney, 1962).

Even with the expansion of studies on natural capital, this economic approach denotes the anthropocentric view (Arias - Maldonado, 2016). When the term “resources” is introduced, the focus is on serving the interests of man, to the detriment of nature's needs. Research is observed to infer, for example, about ecosystem services that are produced exclusively by nature and exploited by man (Goulder & Kennedy, 2013). This is a posture that separates man from nature, which leads to a limitation of approaches on the value that the environment has for the world (Küpers, 2020).

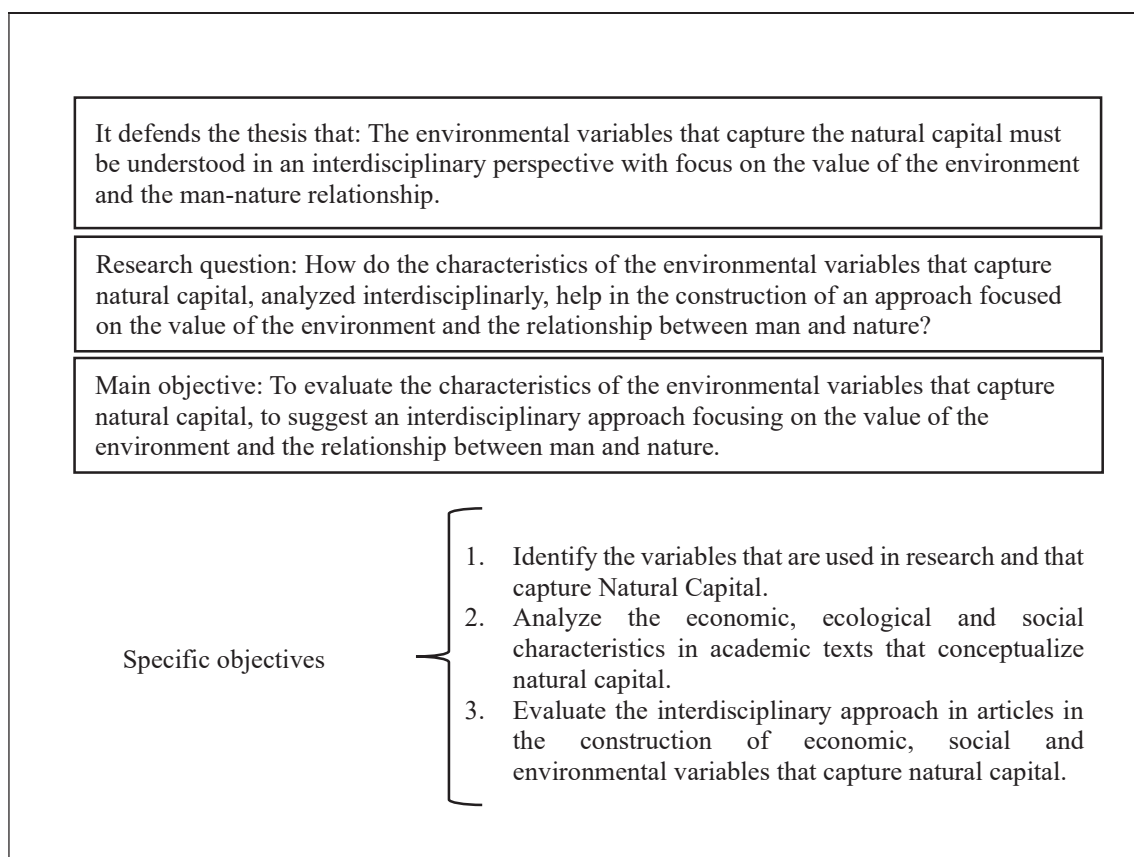
This value must be attributed to a man-nature view, in which the relationship must be based on an integrated approach. What is done in the research is to discuss the treatment of natural capital from the perspective of society, to attend to its conveniences, whether of a human, biological or economic nature, aiming at the well-being over time (Engelhard, 2009; Málovics, Csigéné, & Kraus, 2008).

In this area, accounting measurement is used as a tool to measure quantitative (currency, volume, hectares, among others) and qualitative (nature and characteristics of ecosystem elements) natural capital (Clayton et al., 1992). This is since accounting has a relevant role and is not limited to a conglomerate of only archival data, but to analyzes the responsibility for presenting them (Ijiri, 1968), which in turn assist in the elaboration of knowledge about social aspects, environmental and economic.

The qualitative aspect of accounting measurement allows a holistic view of natural capital, which makes it possible (i) to elaborate information in an interdisciplinary way (Chiesura & Groot, 2003), (ii) to understand the representativeness of Natural Capital (Daily et al., 2000; Gómez-Baggethun & Barton, 2013) and (iii) direct the best way to build environmental measurement (Fenichel & Abbott, 2014).

To observe how the thesis was constructed, Figure 1 illustrates its construct, the main objectives, and the defense of an approach to then elaborate environmental measurement variables that apprehend natural capital.

Figure 1 – Framework for the construction and discussion of the Thesis



Source: Elaborated by the author

The defense of this thesis is focused on inferring knowledge about variables that are used in environmental measurement and then capture natural capital through an interdisciplinary approach in which there is a dialogue between areas of research that share this capital as a common concern. Furthermore, the dialog about this concept must have as its essence the relationship between man and nature. Therefore, it is understood that man and nature are inseparable objects when one is dependent on the other, so there should be no overlapping of interests in this relationship.

As a research question, it is proposed: How do the characteristics of the environmental variables that capture natural capital, analyzed interdisciplinarily, help in the construction of an approach focused on the value of the environment and the relationship between man and nature?

In this perspective, the thesis aims, as a first objective, to point out the environmental measurement variables aligned with the measurement of sustainability. With the research identified, the second objective was proposed to carry out an analysis of the content of the measurement variables and to identify what these environmental

metrics refer to that capture the concept of natural capital. Finally, the third objective discussed, critically, the concepts reflected in the texts to appreciate the beliefs, the intertextual aspects, and the professional characteristics of the authors who research natural capital.

2 ARTICULATION OF ARTICLES AND THESIS

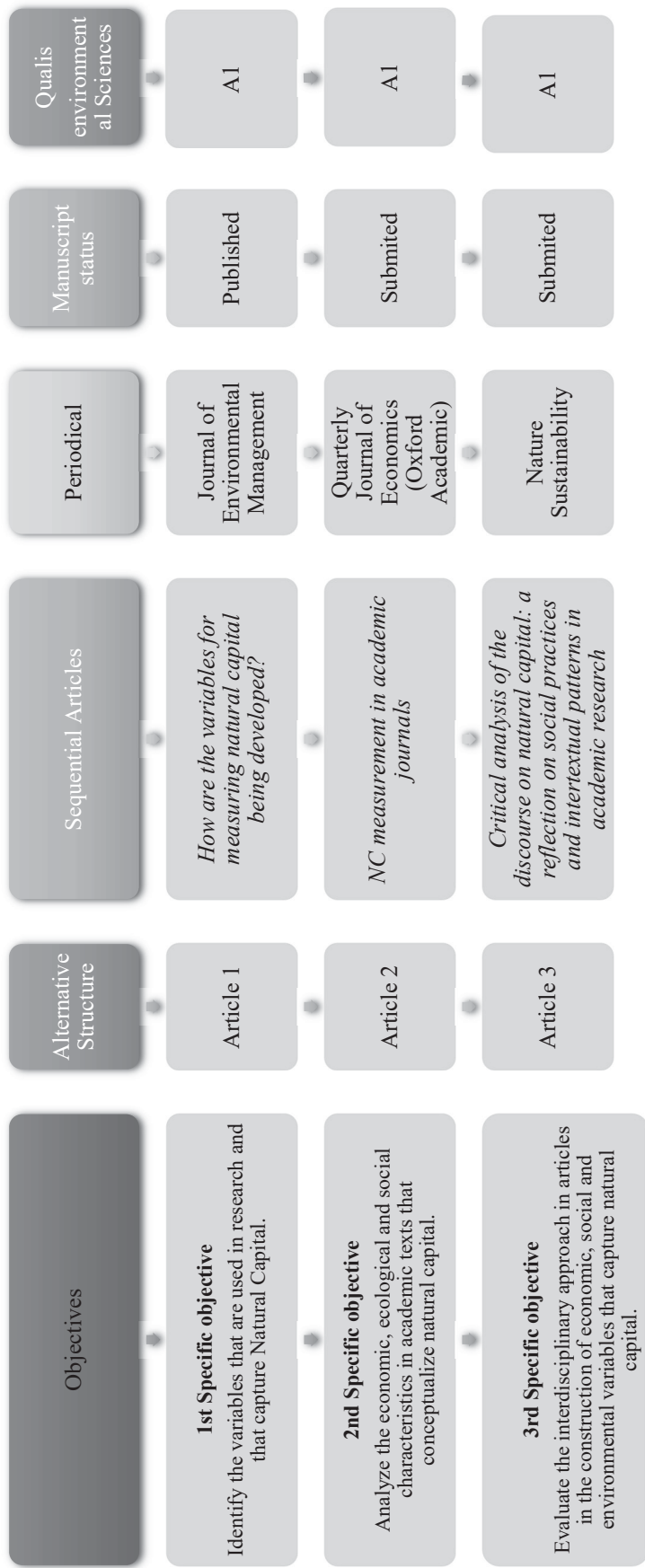
As it is a relevant sustainability theme, there is a historical context built overtime on the natural capital. Thus, there was a discussion based on academic research that deals with environmental measurement variables. To achieve the proposed objective for the defense of the Thesis, this work was constructed employing sequential articles. Figure 2 shows the list and how each article is found in terms of dissemination and is under the Classifications Of Periodicals Quadrennium 2013-2016.

For the first article (Chapter 3), a systematic analysis was used as a method, to support the survey of specific bibliographies that deal with the subject of environmental measurement for sustainability. There is an approach to natural capital in the economy based mainly on the theory of capital. The NC study has also been discussed to achieve the sustainability necessary for social well-being over time. The inference in the first article is that the variables for measuring natural capital are based on quantitative patterns.

In the second article (Chapter 4), to better investigate the content behind the environmental variables, through a content analysis of the texts from which the environmental variables were extracted, the economic, social, and ecological characteristics started to be investigated. The choice for these three contexts - economic, social, and environmental - emerged from the characteristics investigated in this thesis, which are an integral part of natural capital. However, it is concluded that there is still a limitation to show, with greater emphasis, qualitative attributes that subsidize the concept of natural capital.

In the third article (Chapter 5), research on the concept of natural capital is presented and a third survey was inserted. In this chapter, there is a critical study approach that addresses the construction of knowledge: critical discourse analysis. In addition to intertextual patterns, social practices become objects of analysis, because they can influence the texts constructed in research. It appears that the constructed texts that identify environmental variables are aligned with the researchers' social practices and that the discussions have an anthropocentric view.

Figure 2 – Articulation of articles and publication



Source: Elaborated by the author

The relationship between the three articles became, then, in the analysis of the texts object of analysis on environmental metrics; the informational content on the economic, social, and ecological aspects present in the environmental variables; and the discourse employed on the concept of the natural capital.

3 HOW ARE THE VARIABLES FOR THE MEASUREMENT OF NATURAL CAPITAL BEING ELABORATED?¹

3.1 INTRODUCTION

Measuring natural capital (NC) is an important issue for future generations (Schaefer et al., 2015) in the management of natural resources. NC is a paradigmatic core concept in ecological economics (Martini, 2006), and plays an important role in both national income accounting and evaluating the sustainability of development from an intertemporal perspective (Arrow et al., 2004). Additionally, NC includes renewable and nonrenewable resources; thus, there is a limited supply (Brand, 2008; Fenichel and Zhao, 2015).

The issue of NC analysis is beyond the use–preserve decision; it extends to finding the best decision between restoring the environmental resources used today or preserving them for the future (Maldonado et al., 2019). Measuring NC supplies is necessary, especially when a resource is required to meet human demands and provide social well-being (Dasgupta, 2009; Guerry et al., 2015).

NC is an asset that generates "dividends" or "interest" through the use of captured ecosystem resources (Woodworth, 2013). It is part of the wealth of a country and has representation in the economy (Fischer, 1979), and includes everything present in the ecosystem — forests, rivers, atmosphere, and soil, among others — as provided for in the Inclusive Wealth Report.

This study builds on strong sustainability and observes the measurement of NC through a lens that connects it to the definition of NC.

¹ Published article: Cit. Furtado, L. L., & Panhoca, L. (2020). How are the variables for the measurement of natural capital being elaborated? *Journal of Environmental Management*, 262, 110264. doi:10.1016/j.jenvman.2020.110264. References due to the norms established by the Library of the Federal University of Paraná at the link <https://www.portal.ufpr.br/normalizacao.html>, are at the end of the thesis and are in alphabetical order.

Measurement of NC is relevant to determine the wealth of a country (Duraiappah et al., 2014; Fenichel and Abbott, 2014), with the definition of assets, ecosystem services consumed, and what is restored and preserved (Guerry et al., 2015).

For Costanza et al. (1998) and Ijiri (1986), accounts in the accounting sciences must go beyond the simple identification of the assets, liabilities, and equity.

This scientific article asks the question, “What variables are used in the analysis of sustainability?” An attempt is made to identify the variables used by researchers for measuring NC. To do this, the approaches of different fields to NC and their contribution to the definition of variables for measurement purposes must be investigated (Boyd, Banzhaf, 2007). In addition to economic issues, there are ecological, social, physical, and biological aspects that are present in such environmental resources (Chiesura and Groot, 2003; Dierkes and Preston, 1977; Russell et al., 2017).

This research's contribution lies in studying NC to meet society's demand for conveniences (Engelbrecht, 2009; Málovics et al., 2008). This brings innovation in environmental accounting research that is currently only in an economic framework (Morales and Sponem, 2017). The measurement of NC flows that are important for analyzing the services and goods that a society can obtain from nature are included in accounting (Daily et al., 2000; Azqueta and Sotelsek, 2007).

3.2 LITERATURE REVIEW

3.2.1 NC and the quest for sustainability

Humanity depends on nature (Sieferle, 2011), using natural resources for its survival and then for raising monetary resources (Coelho et al., 2012; Erb et al., 2013).

In strong sustainability, it is necessary to preserve the NC (Arrow et al., 2003). The study of NC seeks to relate economic and social factors that are part of a country's structures (Dyllick and Hockerts, 2002) to achieve sustainable development for inclusive wealth (Duraiappah et al., 2014; Engelbrecht, 2009; Fenichel and Hashida, 2019; Málovics et al., 2008; Shokravi and Kurnia, 2015).

Sustainability is related to manufactured capital, human capital, and NC (Pearce and Atkinson, 1993). Society must adapt to the local reality to become sustainable, thus respecting spatial limitations (Fenichel and Hashida, 2019).

Sustainable development should not be limited to economic objectives (Dierkes and Preston, 1977); however, it should consider the social impacts of natural resources while striving for sustainability (Arrow et al., 2003; Daily and Ehrlich, 2019; Fenichel and Abbott, 2014). For Guerry et al. (2015, p. 7349) the NC "... refers to the living and inanimate components of ecosystems" beyond the human beings performing ecosystem services for social well-being (Schaefer et al., 2015).

Definitions for treating NC as an asset are complex, and they require information identifying the characteristics that can justify such NCs (Folke and Berkes, 1993; Ruggeri, 2009).

The limitations of the economic definitions of NC (Chiesura and Groot, 2003) lead to the need for studies that can contextualize NC (Freeman et al., 2000; Russell et al., 2017).

Measurement of NC and the need for interdisciplinary studies

Measurement of NC is required, and it must question the definitions (Barbier, 2014). Not to consider them is to jeopardize the wealth of countries and the well-being of future generations (Fenichel and Abbott, 2014). According to Daily et al. (2008), a model is necessary to identify the inventories of NC.

Valuing NC inventories for a fair and unique value is not an easy task (Shokravi and Kurnia, 2015). Market valuation fails (Fenichel and Abbott, 2014) and does not include the measurement of environmental data in general (Nordhaus and Kokkelenberg, 2000; Costanza et al., 1998). Another problem is the temporal scale and resilience of economic studies, usually very short-term, compared with nature's cycles (Maldonado et al., 2019; Chiesura and Groot, 2003).

For Folke and Berkes (1993), the NC is defined by the market price of commodities. The Inclusive Wealth Report issued by the United Nations in 2012 also requires the establishment of a systematic model that can be used broadly and that groups the NC accounts and their respective losses (Barbier, 2014).

NC measurement by the gross domestic product (GDP) qualifies the income of a country by production (Boyd and Banzhaf, 2007); however, it does not consider stocks and ecosystem services and social well-being linked to consumption (Dasgupta, 2001), and it does not focus on the features of the natural resources used. Interdisciplinary studies are required to highlight aspects of the NC definition and its measurement (Fenichel and Abbott, 2014; Fenichel et al., 2016).

Such studies are needed because identifying in isolation the value of an NC item is not relevant to *ceteris paribus* measurement, (Shokravi and Kurnia, 2015). Ecological scientists are concerned with identifying physical units of the environment, while sociologists analyze the interaction of society with the environment (Chiesura and Groot, 2003). Interdisciplinary studies are necessary so that the consideration of such areas leads to a value that references the NC (Daily et al., 2008).

The difficulty in measuring the natural assets of the economy results from the existing relationships between the physical aspects present in the ecosystem (Freeman et al., 2000; Brand, 2008; Chiesura and Groot, 2003).

In accounting, it is sought to improve the estimates of the accounts related to ecosystem services and the NC (Costanza et al., 1998), as well the losses of biodiversity (Ferreira, 2017), to improve the environmental balance (Morales and Sponem, 2017). Such definitions must be incorporated to better infer the metrics to be used in account analysis (Azqueta and Sotelsek, 2007) of environmental issues, going beyond purely economic issues (Dierkes and Preston, 1977).

3.2.2 Identifying accounting measurement in NC

Problems when measuring NC relate to the definitions of the study variables (Chiesura and Groot, 2003; Shokravi and Kurnia, 2015; Nordhaus and Kokkelenberg, 2000). Economics, sociology, ecology, and accounting, among other disciplines, together can solve such problems (Azqueta and Sotelsek, 2007; Daily et al., 2008; Freeman et al., 2000).

In studies related to environmental accounting, the economic factors of present accounts are sought (Morales and Sponem, 2017; Russell et al., 2017). However, studies should also look at the effects of the social and environmental aspects of time and the unit of measure (Ijiri, 2018; Kurniawan and Managi, 2017; Sugiawan et al., 2019). Melse (2008) emphasized the relationship between measurement and financial accounts. Before such interaction, it is necessary to identify the assets, liabilities, and shareholders' equity contained in the measurement. It is necessary to indicate the variables that are part of the measurement (Maldonado et al., 2019).

Ijiri et al. (1968) pointed out that three axioms define what is a variable to be measured in accounting: (i) the quantity axiom (the variable is measured by volume, time, weight, and other means), (ii) property (the subject and object to later know the relation

of properties between these two components), and (iii) the exchange (the exchange of the object that belonged to a subject, which causes changes concerning the property).

Ijiri (1968, 1986) stated that accounting should be performed in such a way as to provide a triple entry of information, and it should consider the outflows and inflows of resources generated by the activities of the organization and the ability to generate future wealth.

Changing time or speed variables with which they occur provides data that show changes related to the wealth created and linked to the NC and its use (Maldonado et al., 2019). Wealth can be allocated to the accounting measurement approach focusing on society's activities and ecosystem services (Chiesura and Groot, 2003; Fenichel et al., 2016) — that is, inferences are made about the variables used with qualitative aspects in the measurement of environmental resources by inserting them in the market (Gray, 1992).

3.3 METHODOLOGY

Systematic analysis and cumulative review (Templier and Paré, 2015) were used to consider and select the variables to measure NC. Attachment 1 identifies the stages of systematic analysis. In the selected studies, the frequencies of the variables used to measure the NC were identified, along with their classification patterns. The approaches used in defining the variables were also identified. The Scopus database (chosen for convenience) was consulted, and Microsoft Excel software was used for data analysis.

The keywords were those used in social ecology, and the material was interdisciplinary to identify the best environmental practices arising from the relationship between people and nature. The terms “environmental measurement” (1085 surveys), “sustainability measurement” (771 surveys), and “natural capital measurement” (nine surveys) were defined. In the analysis of those keywords, a combination with the terms “biology,” “chemistry,” “ecology,” and “human and social” (1856 articles) was identified. These areas were chosen because the focus was to research measurement through an interdisciplinary perspective. Attachment 2 identifies the number of studies.

For the keyword “natural capital measurement,” there was no return of searches when associated with the words highlighted, but nine surveys were identified. After this initial filter, the number of surveys was captured.

Next, the abstracts (904) and the variables on environmental resources used in the research were analyzed (the variables emerged from reading the full articles and not from

the author of this report as a researcher — they are in Attachment 3, and emerged from the analysis of the research) to investigate the existence of a relationship of measurement with the environment, natural resources, environmental sustainability issues, and NC. Six articles that were not available for reading were excluded. Finally, as a result of the concentrated reading about the variables, the focus of the present work was on the analysis of 17 sustainability measurement surveys and five NC measurement surveys.

3.4 FINDINGS AND ANALYSIS

The item “sustainability” stands out and has the investigative characteristic of natural resources that are considered replaceable and irreplaceable (Chiesura and Groot, 2003; Fenichel and Abbott, 2014; Fenichel and Zhao, 2015).

The term “sustainable” denotes something that will endure over time (Chiesura and Groot, 2003). This is observed in the research by Delai and Takahashi, (2011), Mondelaers et al. (2011), and Kaivo-oja et al. (2014).

There is a concern in areas with similar interests on the topic of environmental resource measurement, sustainability, and NC, mainly in engineering research (Hai et al., 2015; Moldavska and Welo, 2018), business (Dočekalová and Kocmanová, 2018), and future research (Kaivo-oja et al., 2014).

The interdisciplinary analysis makes the intersection of established concepts possible, and it provides an approach to the concepts related to NC and how it can be measured (Azqueta and Sotelsek, 2007; Daily et al., 2008; Freeman et al., 2000). Research on sustainability measurement has concentrated on empirical methods, while the NC measurement surveys are more related to qualitative methods, where the goal is to define the features to be measured and the importance for social well-being for present and future generations.

Regarding the measurement variables, in the sustainability measurement research, the analyzed variables are condensed into the soil, water, air, and biodiversity categories. There is also concern regarding energy consumption through environmental resources (Nikolaou et al., 2019; Van Beynen et al., 2018). This issue goes against the research by Folke and Berkes (1993), where they state that NC research is related to commodities.

Research on soil variables has resulted in proposals for measuring their use based on issues that have an impact on soil quality, such as erosion, land depletion, chemical sludge, health risks from agricultural sediment, protected areas, and the use of renewable

and nonrenewable resources. These items were evidenced, for example, in research by Mondelaers et al. (2011), Van Beynen et al. (2018), and Zijp et al. (2016).

Regarding the variables related to water, the amount consumed in production and domestic use, waste discharged into the water like pesticides and other types of pollutants, water depletion, population access to sanitation, and dependence on water from neighboring countries were identified.

For air quality, the analysis variables focus on carbon dioxide emission. For biodiversity, species protection areas, environmental and biological quality of the ecosystem, and bird and tree population were analyzed.

The metric for the land is the number of hectares. About water, the unit of measurement is the cubic meter. For air, the amount of gas emission in CO₂ equivalent is used. In the biodiversity analysis, the units of measurement are the volume of protected land and the number of existing species.

Although the studies indicate the variables to be used, their definitions were limited, as they did not emphasize the characteristics of what they are, as well as their limitations and their importance for policies focused on wealth and ecosystem issues. It is assumed that the definition is something important to know about the characteristics of the assets present in the environmental measurement (Azqueta and Sotelsek, 2007; Boyd and Banzhaf, 2007).

The existence of such metrics depends on what the country elaborates as data to be measured. The definitions serve as a way of controlling not only the use but the impact caused by the use. Thus, it is necessary to identify which NC the country should focus on, as well as the ecosystem services (Anielski, 2005; Dasgupta, 2009; Fenichel and Hashida, 2019).

Some problems were assessed, such as the use of depleted land being privately owned, which limits the control of such areas and the analysis of the NC metrics. However, the property factor is related to what Ijiri (1986) considered relevant to be able to prepare the accounting measurement. There must be a property axiom that identifies the subject and object to later observe the exchange relation.

However, accounting measurement must be linked to the triple entry of information — not only the issue of quantity but also the physical aspects that make information eligible and incorporate value in the analysis of environmental resources. These aspects are necessary to be able to frame the accounts belonging to NC (Nordhaus

and Kokkelenberg, 2000) and to indicate how social and environmental services should be part of the NC measurement method.

From knowing which services these are, it is possible to identify the NC and, from there, indicate economic programs for development and sustainability in a country (Fenichel et al., 2016; Fenichel and Hashida, 2019). The measurement of the NC depends on the choices of society: to use it in the present or to preserve it for the future.

It is believed that sustainability should be measured by starting from ecosystem services with the analysis of present use, observing the need for future generations (Dasgupta, 2001; Folke and Berkes, 1993; Guerry et al., 2015). This type of bottom-up approach also has the characteristic of measuring the interactions of several areas of study to determine the definition of the NC (Fenichel and Hashida, 2019).

Couharde et al. (2011) also argued that the NC should be measured by observing the need to use resources. The NC variables are those used by people and offered to the market as products from fishing, agriculture, hunting, and mining. Also, they come from the services provided by the ecosystem itself, such as the quality of water and soil, replenishing nutrients, and causing such resources to last over time.

In another strand of study, Engelbrecht's research (2009) was based on the World Bank measurement of NC wealth, using renewable and nonrenewable resources. The resources considered were lands for agriculture, pastures, and other forest and preservation areas. Other resources were minerals and metals. These are part of a country's wealth for the World Bank. They are a source of social well-being and, for this reason, should not be excluded from sustainability measurement (Arrow et al., 2003; Dasgupta, 2009; Engelbrecht, 2009).

Ruggeri's research (2009) mainly uses air, water, forest resources, and agricultural lands, as well as energy sources and fossil resources as variables for analysis of quality aspects, once again the concern is linked to commodities.

3.5 DISCUSSION

The studies identified in this research have similarities because they are interested in the measurement of natural resources. They represent current sources of information because the capital perspective changes in time and value as a result of economic trends (Ferguson, 1972).

There is a concentration of the analysis variables in the sustainability measurement works related to air, water, land, and biodiversity quality, as well as a focus

on negative impacts on environmental resources. The research did not present ecosystem services as the basis for choosing variables — that is, air pollution, unbalanced water consumption, land degradation (its use and the use of pesticides), and biodiversity preservation factors to identify what has already been extinguished, as highlighted in Ruggeri's research (2009).

In other words, the definition starts from a model in which the negative impacts on environmental resources are first observed, and then the measurement is performed, indicating which resources are involved, resulting in a measurement metric. In this model, the treatment included in the environmental variables requires definitions that go beyond the indications of its importance for the ecosystem. The ecosystem services enjoyed by the social environment provide an important analysis tool according to the works of Schaeffer et al. (2015), Anielsk (2005), and Dasgupta (2009). Such a form of measurement can be compared with that provided by the GRI (Global Reporting Initiative). Consequently, there may be a limitation of policy actions related to state activities (Costanza et al., 1998; Karl-goran, 1991) in knowing what should be measured, because of the importance of NC for the consumed ecosystem services.

Regarding natural capital measurement, the tendency is to recognize the need for bottom-up analysis, defining measurement variables with the observance of the socioeconomic services provided by the environment. In addition to focusing on measuring the wealth of a country, it depends on clear definitions of what resources fall within such wealth (Duraiappah et al., 2014; Fenichel et al., 2016). Research has not identified the costs associated with using such services, and it is important to measure inclusive wealth.

The contextualized aspects in NC research, in general, provide an approach to qualify (Folke and Berkes, 1992; Ruggeri, 2009), and, from this, to define the variables to determine the richness of a country (Arrow et al., 2003). Thus, it is possible to carry out an analysis of the heritage against what Ijiri (1986) highlights about the triple entry in accounting.

Research on sustainability measurement tends to characterize variables only in terms of the indication of the amount (Ijiri, 2018) to be inferred and the property factor because it directs the variables used by people. However, the exchange factor is not yet clear; neither is the qualitative characteristic indicated by the triple entry for decision-making purposes (Ijiri, 1986).

The interdisciplinary question is common to both the subjects researched (Haberl et al., 2016), especially in the context of the sciences related to economics, environment, engineering, business, and agriculture selected for the present research.

Thus, there is evidence of cooperation among the various areas, because researchers with diverse research areas were found. Their works focused on reaching specific answers related to the environmental measurement for sustainability, which is linked to people's relationship to nature (Freeman et al., 2000).

3.6 CONCLUSION

The present study aimed to select examples from NC measurement studies and to examine the variables used in the sustainability analysis.

There are a variety of areas that are concerned with the measurement of the NC. These include economy, engineering, sustainability, environment, and business. Such strands of study may have different definitions in their analysis of NC. However, they aim to find better metrics to achieve sustainability, and this may be possible through interdisciplinary studies (Fenichel and Abbott, 2014; Fenichel et al., 2016; Haberl et al., 2016).

The study of the variables is concentrated on the negative impacts caused by the use. There is no discussion of the variables for later definition, which demonstrates a limitation in the studies on NC.

There are quantitative definitions of the variables, but not qualitative ones, which leads to a deficiency in the indication of assets and their analysis for subsequent decision-making focused on accounting measurement. In measuring sustainability, there is no discussion of what is considered strong, mainly because the substitution of environmental resources is not emphasized. Only the variables already highlighted are used — for example, in such documents as the GRI and the Inclusive Wealth Report. However, such sustainability is dealt with in studies on the measurement of the NC, but those studies only focus on questions of the substitution or lack thereof of natural resources. There are no further treatments on how to achieve such sustainability. This raises the question of whether there is a clear definition of what should be framed within the deemed sustainability regarded as “strong.”

Through the selected studies and considering the importance of defining assets, the research reviewed here can be viewed as a means to construct variables today. These works mainly identify components that belong to the land, atmosphere, water, and

biodiversity that are attributes present in the definition of the Inclusive Wealth Report and should be placed in the practice of NC measurement. However, this is only part of the content of natural assets.

Besides, this study, proposes that the identification and measurement of variables should be designed in the following order: 1) indication of ecosystem services, 2) identification of variables, 3) method of measuring variables, and 4) public policy objectives that must be met (conservation, preservation, and restoration). Subsequently, comparisons of countries or locations that have the same ecosystem service and the same NC may emerge, thus contributing to not only local but also global policies.

This research coincides with accounting science because it identifies qualitative aspects that should be part of accounting measurement. It also brings convergence on how services are related to the measurement of NC and, finally, public policies. From the proposed design, research can collaborate with local analyses providing globally applicable solutions on what practices society should follow to preserve, conserve, or restore NC.

This study is limited to the sample chosen. For future research, creating an interdisciplinary model with a definition of NC variables for further measurement is recommended. Additionally, there may be further analysis of what strong sustainability represents in the context of NC.

SUPPLEMENTARY MATERIALS

ATTACHMENT - 1

Table 1- Table of steps for systematic analysis

Stage
1 - Choice of the collection base of scientific papers
2 - Keyword Identification
3 - Collection of data using the keyword and other necessary terms
4 - Deletion of duplicate and non-standard jobs (no abstracts, unpublished, among other attributes)
5 - Reading abstracts to identify those dealing with the subject of interest, measuring natural capital
6 - Deletion of files that are not suitable for the previous item

7 - Reading of articles identifying only the variables used to measure natural capital

8 - Selection of articles with variables that are associated with the asset definition of the 2018 UNO Inclusive Wealth Report and the GRI (forests, atmosphere, soil, water, among others)

9 - Discussion of the main findings

ATTACHMENT - 2

Table 2 - Table of selected articles for the analysis of Natural Capital measurement variables for sustainability

Article title Authors	• Local (1) • Study area • Year	Analysis variables	Keywords (2)
Article title: Sustainability measurement system: A reference model proposal Authors: Delai I., Takahashi S.	• BRA • Economy; Business • 2011	Soil: Land use Water: Total water consumption Air: Emissions of carbon dioxide Biodiversity: Protection areas; Ecosystem; Species	M. S./ECO
Article title: Sustainable Value Analysis: Sustainability in a New Light Authors: Mondelaers K., Van Huylenbroeck G., Lauwers L.	• BEL • Agriculture; Fishing; economy • 2011	Water: Analysis of water in the environment Air: Emissions of carbon dioxide	M. S./SOC
Article title: Relationships of the dimensions of sustainability as measured by the sustainable society index framework Authors: Kaivo-Oja J., Panula-Ontto J., Vehmas J., Luukkanen J.	• FIN • Future research • 2014	Water: Renewable water resource Air: Emissions of carbon dioxide Biodiversity: Biodiversity analysis	M. S./ECO
Article title: Urban Metabolism: A Review of Current Knowledge and Directions for Future Study Authors: Zhang Y., Yang Z., Yu X.	• CHN • Environment; Chemistry • 2015	Others: The need for a multilevel definition to improve models for measuring urban metabolism.	M. S./BIO
Article title: Transitions dynamics in context: Key factors and alternative paths in the sustainable development of nations Authors: Rodrigo P., Muñoz P., Wright A.	• CHL • Sustainability • 2015	Water: Improved access to the water source; Access to improved sanitation facilities Air: Emissions of carbon dioxide	M. S./SOC

Article title Authors	• Local (1) • Study area • Year	Analysis variables	Keywords (2)
Article title: Definition and use of Solution-focused Sustainability Assessment: A novel approach to generate, explore and decide on sustainable solutions for wicked problems Authors: Zijp M.C., Posthuma L., Wintersen A., Devilee J., Swartjes F.A.	• HOL • Sustainability; Environment; Cheers • 2016	Soil: Chemical destination of contaminants in the soil; Risks to human health of sediments of agricultural products	M. S./BIO
Article title: Sustainable Development and Performance Measurement: Global Productivity Decomposition Authors: Kurniawan R., Managi S.	• JPN; IND • Environment; Natural resources; Energy; Engineering • 2017	Soil: Fossil fuels (oil, gas, coal), Minerals (bauxite, nickel, copper, phosphate, gold, silver, iron, tin, lead, zinc), Forest and Non-forest resources Agricultural land	M. S./BIO
Article title: Multi-criteria group decision-making based sustainability measurement of wastewater treatment processes Authors: Ren J., Liang H.	• CHN • Engineering; Climate analysis • 2017	Soil: Land use Water: Improving water quality	M. S./QUI
Article title Development and piloting of sustainability assessment metrics for arctic process industry in Finland-The biorefinery investment and slag processing service cases Authors Husgafvel R., Poikela K., Honkatukia J., Dahl O.	• FIN • Technologies; economy • 2017	Soil: Solid residues Air: Pollution Others: Environmental innovations to reduce greenhouse and supply chain. Consumption and production of energy.	M. S./ECO
Article title: An ecological information analysis-based approach for assessing the sustainability of water use systems: a case study of the Huaihe River Basin, China Authors: Hai R., Shi H., Zhang B., Zhai Y., Li Y., Wang W.	• CHN • Engineering • 2017	Water: Quantity of water resources per capita; Average water resources per hectare; Development and use of water resources efficiency	M. S./ECO
Article title: Method selection for sustainability assessments: The case of recovery of resources from wastewater	• HOL	Soil: Depletion of fossil fuels Land use Mineral Depletion	M. S./SOC

Article title Authors	<ul style="list-style-type: none"> • Local (1) • Study area • Year 	Analysis variables	Keywords (2)
Authors: Zijp M.C., Waaijers-van der Loop S.L., Heijungs R., Broeren M.L.M., Peeters R., Van Nieuwenhuijzen A., Shen L., Heugens E.H.W., Posthuma L. Article title: Sustainability indicators for improved assessment of the effects of agricultural policy across the EU: Is FADN the answer? Authors: Kelly E., Latruffe L., Desjeux Y., Ryan M., Uthes S., Diazabakana A., Dillon E., Finn J.	<ul style="list-style-type: none"> • Health; • Environment; • Engineering; • Natural resources; • Energy; • Economy • 2017 • IRL; FRA • Agriculture; • economy • 2018 	Water: Water depletion Biodiversity: Environmental and biological quality of the ecosystem Others: Efficiency in use Soil: Areas at risk of erosion Water: Balance of nutrients in the water Water pollution (nitrates and pesticides) Air: Greenhouse gas emissions Biodiversity: High-value agricultural land and forestry The population of land birds Tree species composition Others: Climate change: Renewable energy production agriculture and forestry	M. S./BIO
Article title: Testing and verification of a new corporate sustainability assessment method for manufacturing: A multiple case research study Authors: Moldavska A., Welo T.	<ul style="list-style-type: none"> • NOR • Engineering • 2018 	Water: Total water discharge Waste in water. Air: Pollution	M. S./QUI
Article title: Comparison of Sustainable Environmental, Social, and Corporate Governance Value Added Models for investors decision making Authors: Dočekalová M.P., Kocmanová A.	<ul style="list-style-type: none"> • RCH • Economy; • Business; • Administration • 2018 	Water: Annual water consumption Annual waste production Annual production of hazardous waste	M. S./QUI
Article title: Comparing sustainable development measurement based on different priorities: sustainable development goals, economics, and human well-being—Southeast Europe case	<ul style="list-style-type: none"> • EUA; SER • Safety; economy • 2018 	Soil: Arable; Land and marine protected areas; Forest area Water: Improved water source; Dependence on water from neighboring countries	M. S./ECO

Article title Authors	• Local (1) • Study area • Year	Analysis variables	Keywords (2)
Authors: Lior N., Radovanović M., Filipović S.		Air: Emissions of carbon dioxide Others: Supply of primary energy by fossil fuels	
Article title: A sustainability index for small island developing states Authors: Van Beynen P., Akiwumi F.A., Van Beyne K.	• USA • Geoscience • 2018	Water: Total coverage of drinking water in households; Total household sanitation coverage Air: Emissions of carbon dioxide Others: Energy consumption in transportation (motorized gasoline) as part of the total consumption of crude oil	M. S./ECO
Article title: A framework to measure corporate sustainability performance: A strong sustainability-based view of the firm. Authors: Nikolaou I.E., Tsalis T.A., Evangelinos K.I.	• GRE • Economy; • Technology; • Environment • 2019	Water: Quantity of water consumption; the quantity of water Air: Emissions of carbon dioxide	M. S./ECO
Article title: Choices and the value of natural capital Authors: Fenichel E.P., Hashida Y.	• USA • Environment • 2019	Others: Measuring Natural Capital for Sustainability	M.C.N.
Article title: Measuring the value of groundwater and other forms of natural capital Authors: Fenichel E.P., Abbott J.K., Bayham J., Boone W., Haacker E.M.K., Pfeiffer L.	• USA • Environment; • Sustainability; • Agriculture; • Geology; Fishing • 2016	Others: Measuring Natural Capital and Inclusive Wealth	M.C.N.
Article title: Issues related to the measurement of natural capital: The example of New Caledonia Authors: Couharde C., Géronimi V., D'Hotel E.M., Taranco A.	• USA • Environment; • Agronomy • 2011	Soil: Nickel; Agricultural Protection Areas Biodiversity: Aquaculture, Activity Others: Tourism	Forest; lands; M.C.N.

Article title Authors	• Local (1) • Study area • Year	Analysis variables	Keywords (2)
Article title: Natural capital, subjective well-being, and the new welfare economics of sustainability: Some evidence from cross-country regressions	• NZL • Economy; Business • 2009	Others: Natural Capital and analysis of social welfare measures	M.C.N.
Authors: Engelbrecht H.-J.			
Article title: Government investment in natural capital	• CAN • Economy • 2009	Others: Perspective of public investment in Natural Capital	M.C.N.
Authors: Ruggeri J.			

Source: Elaborated by the author

- (1) *Legend Location*: BRA - Brazil; BEL - Belgium; CAN - Canada; CHL - Chile; CHN - China; USA - United States of America; FIN - Finland; FRA - France; GRE - Greece; HOL - the Netherlands; IND - Indonesia; IRL - Ireland; JPN - Japan; NOR - Norway; NZL - New Zealand; RCH - Czech Republic; SER - Serbia.
- (2) *Legend Keywords*: M.S./ECO - Measurement of sustainability / Ecology; M.S./BIO - Measurement of sustainability / Biology; M.S./ECO - Sustainability measurement / QUI - Chemistry; M.S./SOC - Sustainability / Social Measurement; M.C.N. - Measurement of Natural Capital. Type: All articles mentioned in this Attachment are Empirical.

4 MEASUREMENT OF NATURAL CAPITAL IN ACADEMIC JOURNALS²

4.1 INTRODUCTION

Sustainability has pillars interconnected to economic, social, and ecological areas. To be sustainable, natural resources must be present over time in a way that does not compromise the survival of future generations, which includes the life of man and the permanence of the ecosystem. For this, the measurement of Natural Capital (NC) is relevant to such sustainability (Elkington, 2020).

Throughout history, the NC stands out in economic discussions as it integrates models and the observation of production and work (Callon 2009; Morales & Sponem 2017; Russell et al. 2017) and its episteme comprises social and ecological aspects in its body of analysis (Morales & Sponem 2017; Russell et al. 2017).

In the academic environment, the NC is discussed and the interest in this reinforced subject in the economy is evidenced as information for investment decision (Dierkes & Preston, 1977) and is explained in this article from the Theory of Capital which, throughout history, has placed as evidence of the need to measure environmental resources as it is part of production activities (Böhm-Bawerk 1930; Usher 1965; Brand 2008). Callon (2007) says that an intrinsic value from the perspective of neoclassical anthropology. However, NC is a material issue for accounting bodies and companies (ACCA 2013). The term (NC) activates a specific frame of reference (Lakoff 2010). In the economically attributed interpretation, there is a separation of subjects and objects that perpetuates a fractured epistemology (Castree 2003).

Measuring the NC takes us to a specific unit of measurement of this capital (Ijiri 1986; Robinson 1970) and puts economic analyzes in a situation of doubt concerning measurement since natural resources require a different treatment from other metrics that not only measure monetary policy to be measured objectively (Clayton et al. 1992). Measuring NC requires multidisciplinary quantitative and qualitative knowledge that embodies knowing the degree of importance for human life, society, ecosystem, and development of a region in determining variables and units of measurement (Brand 2008; Chiesura & Groot 2003; Daily et al. 2000; Gómez-Baggethun & Barton 2013). Knowing whether research on NC is advancing in this direction requires a detailed analysis, for this purpose, it aimed to deepen us in academic research to infer about the messages brought

² References due to the norms established by the Library of the Federal University of Paraná at the link <https://www.portal.ufpr.br/normalizacao.html>, are at the end of the thesis and are in alphabetical order.

in the variables and their measurement regarding the measurement of NC (Krippendorff 2004; Neuendorf 2002; Proctor et al. 2010).

The purpose of this study is to evaluate the texts of the articles for presenting characteristics that represent the published research are important sources of analysis on a particular subject (Creswell 2007) and the text is seen as an array of meanings that worked analytically presents meanings discovered by researchers (Krippendorff 2004). Observe the texts and then answer the following research question: what content is being investigated in academic research to conceptualize Natural Capital?

The objective of this study is to analyze the economic, ecological, and social characteristics in academic texts that conceptualize natural capital. The analysis will seek to identify patterns and frequencies in the body of the texts and infer about the evolution and contextualization of the metrics explored in the NC.

The structuring of this article describes previous understandings of the phenomena under study and in the topic of methodology summarizes the research project, including collection strategies and analytical strategy, and interpretative investigation approach.

4.2 LITERATURE REVIEW

4.2.1 Natural Capital (NC) and its economic foundation

NC, as a research field, brings two main approaches: (i) the conservationist, nature is something that must last over time and therefore must be preserved (Ehrlich & Tobias 2014; Pieck 2018), and (ii) the approach the restoration of renewable natural resources, which treats the NC as an asset that generates “dividends” or “interest” for the use of services and goods captured from ecosystems (Bartelmus 2018; Gray 2018; Norton et al. 2018; Turner & Daily 2007; Woodworth 2013). Even so, there is a need to improve the information on natural resources used to analyze national wealth and its subsequent measurement (Flores et al. 2018; Maldonado et al. 2019).

Understanding NC involves many interdependencies (Bodin 2019). Knowing its value, which directs the discussion to its importance, for the production of wealth through not only economic development (Alvim et al. 2020; Stenmark 2017). The value, in this case, is not only limited to what is paid for work (Ricardo, 1817) but also supported by issues related to its scarcity (Faber & Proops 1993), of the production that makes up the capital value, such as land use, biological factors of ecosystems and human needs when using natural resources (Bartelmus 2018; Leff 2015; Stenmark 2017).

Fisher (1977) states that there should be a rental fee for the use of the NC that should serve not only to guarantee wages but also to support the rent for the use of the land. Even with the incorporation of such rent, the fact is that there is no guarantee that production will meet future generations over time, since the NC may become scarce. Lo and Power (2010) based on the model proposed by Fisher (1977) affirm that additional factors may influence determining the supply chain strategy.

Riha (1985) stated that German economic science is the result of a development process for more than 400 years and that it is evolutionary and maintained its conscious respect for tradition allowing it to respond to changes in socioeconomic conditions, and its characteristic features that include a sense of social purpose where the economy can be consciously oriented to meet not only material needs and the role of the State.

Thus, the importance given to NC and human capital was to demonstrate that these are essential factors for production (Kurniawan & Managi 2019; Robinson 1970; Teachman et al. 1997). These are capitals that should not be matched, for example, the machines used in production (means to obtain a product) (ISSC et al. 2016).

More specifically regarding the NC, the fact that it is limited leads to concerns, such as the way it is being consumed by society and impacts future needs, both economic and human (Scott 1956; Barbier 2019). Based on agriculture, these future concerns bring perspectives on soil conservation and depletion (Clark & Furtan 1983; Dazzi et al. 2019). The concept that the earth is a resource linked only to work, passes those associated with other factors that are present in its structure (mineral resources, oxygen, ecosystem) that generate food (solar energy, rain, nutrients, among others) (Gaffney 1964). Natural limitations start to be observed due to the risk of compromising quality due to use over time (Collins & Headley 1983).

The flow of natural resources for future generations may not be possible (Brand 2008). The value of the NC does not depend only on observing what it represents for the production, but also, to whom it affects in an intertemporal perspective and, what changes in the normal course of nature, then comes the approach on local sustainability and globally, seeking to identify policies that maintain NC levels over time (Arrow et al. 2003; Engelbrecht 2009).

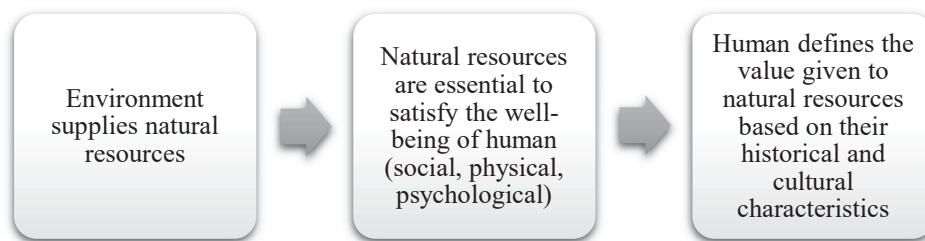
4.2.2 Understanding the qualitative characteristics of the NC

For social sciences, natural resources are supported by the so-called Social Ecology. In 1926 the topic was addressed by Radhakamal Mukerjee where there is an

association between capital and ecology (Oommen, 2015). This aspect identifies the relationship between man and nature through a historical and cultural lens, stating that there are impacts to be considered that affect the way of living and environmental patterns over time (Barbier 2019; Fischer-Kowalski 2011). Social Ecology is interdisciplinary, emphasizes identifying the characteristics of society and takes into account cultural and historical aspects, considers that there is a complex and autopoietic system in which living beings are not limited to issues related to groups and their symbols (Haberl et al 2016; Hausknost et al. 2016; Parboteeah & Jackson 2011).

One possibility of interpretation (Figure 3) is that the symbols introduced and constructed in society over time give meaning to their existence and are in the environment to organize the physical structure, laws, way of life among other aspects, satisfying their demands and planning how nature will be treated by man (Fischer-Kowalski & Weisz 2016; Luhmann et al. 2012). Man establishes, through their culture, how actions are practiced, identifies behaviors of a social system, what is the limit between beings and their way of living (Orlove 1980; Siefertle 2011), defining how the social body will behave and fixing their form of housing, food, animal husbandry, among other characteristics that will be limited by legal and historical issues (Erb et al. 2013; Haberl et al. 2016). Civilization itself identifies aspects that shape a particular society, language, knowledge about symbols, currency, among other characteristics, shape the way the social system came to be granted, in addition to characterizing the culture of a people (Wiedenhofer et al. 2016). Other needs in the personal sphere (freedom, self-development, recreation, psychophysical health, etc.) and in the collective levels (social contacts, norms and values, ideals, cultural identity, and others) provoke "questions about the results obtained and caused, positive or negative, over time and the impact they have on NC." (Chiesura & Groot 2003, p. 224).

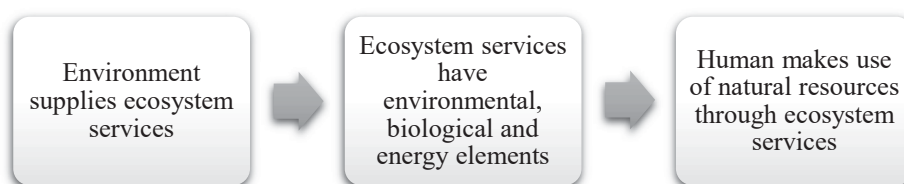
Figure 3 - NC fundamentals from a social perspective



Note. Symbols built on society through time in the environment, satisfying their demands and planning how nature will be treated, confronting the limits between beings and their way of living, which will be limited by legal and historical issues, as well as at the collective levels, cause questions about the results obtained and caused, positive or negative, over time and the impact they cause on the NC.

Another interpretation (Figure 4) is the focus on ecology, metabolic changes are discussed to explain the motivation of problems involving sustainability. Krausmann et al. (2016) argue that "maintain the functioning of society's metabolism without destroying the resource base and without damaging the natural environment, exceeding its capacity to absorb the flow of our metabolism is a basic requirement for sustainability" (p.63). Physical changes in natural components cause social changes and impact man's way of life (White 2000). Components of nature have biological, energetic, and environmental issues at their core, linked to population dynamics, making the characteristics of such resources worthy of attention (Huffaker & Wilen 1991; Tisdell 1997; White 2000).

Figure 4 - NC fundamentals from an ecological perspective



Note. The use of natural resources is possible thanks to the ecosystem services that the environment provides to man thanks to the metabolism of environmental components.

Analyzing these natural components makes it possible to establish local policies appropriate to economic and sustainable development (Dasgupta 2009; Swallow 1996). These changes also impact the political and economic issues of a locality (Victor 1991).

Ecology is in this sense because it considers the qualitative aspects of the environment with the biological, ecosystemic, chemical, and structural observation of natural resources (Chapin et al. 2011). And this appreciation is in line with the social well-being presented by the Millennium Assessment of Ecosystems (AM) in 2005, which advocates an accurate survey of the various ecosystems (exploited or not) to guarantee basic services for man.

4.3 METHODOLOGY

This phase of the work as recommended by Fink (2020) presents how the content of the selected literature was treated and how the analysis was conducted. The exploratory study is based on content analysis (Neuendorf 2002) to check the attributes of the messages in context articles that form the basis for analysis.

In a preliminary stage, a Systematic analysis and cumulative review were used to consider and select the variables to measure NC (Attachment 1) The Scopus database (chosen for convenience) was consulted. The initial sample in the analysis of those keywords, in combination with the terms "biology," "chemistry," "ecology," and "human and social" (1856 articles) was identified. The abstracts (904) and the variables emerged from the analysis to investigate the existence of a relationship of measurement with the environment, natural resources, environmental sustainability issues, and NC. Six articles that were not available for reading were excluded. Then the surveys were captured and the variables on environmental resources used in the research were analyzed, then as a result of the concentrated reading about the variables, the focus of the present work was on the analysis of 17 sustainability measurement surveys and five NC measurement surveys, with the available sample consisting of 22 articles. A list of the 22 articles can be seen in Annex 2 of Furtado and Panhoca, 2020.

The content analysis was conducted to examine whether there is stability in the texts produced during the reading, important for the inductive technique (Triviños 1987; Neuendorf 2002). As written messages are means of communication, they make it possible to extract objective structured information, grouping topics about a social context through systematic procedures, with a pragmatic structure enabling replication (Kronberger & Wagner 2002; Triviños 1987).

The content analysis process consists of (i) pre-analysis, observation of the word frequencies present in the 22 articles (ii) analytical description, an indication of the word

frequencies present in the articles that will be grouped by year, and (iii) inferential interpretation, verification of the frequency of words per article.

The pre-analysis consists of making an organized arrangement of the material by readings and investigations. The analytical description allows you to code, classify terms, and perform further categorizations. Inferential interpretation consists of reflecting on theoretical grounds to conclude the findings already codified and grouped (Bardin 1977).

In a first step (pre-analysis), contextual terms and patterns become objects of analysis to describe and understand the meaning of the metrics described for the measurement of NC. After all, "... texts are always the observable parts of a chosen context". (Krippendorff 2004, p. 87). It is expected an understanding of the research environment related to NC measurement.

4.4 FINDING AND ANALYSIS

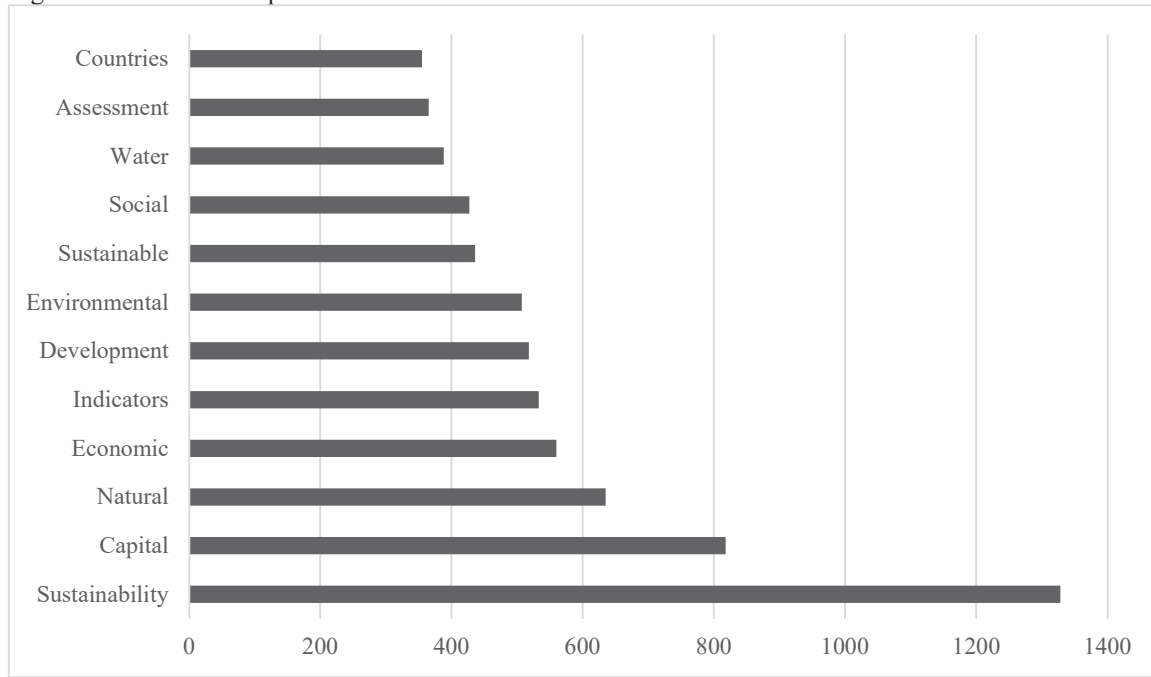
First, the global analysis was carried out, and then the cross-sectional analysis.

4.4.1 Global Analysis

The analyzes were performed using version 7.5 of ATLAS.ti. Before placing the 22 texts in the system, the structure was organized into new files, excluding bibliographic references and figures. Subsequently, the texts were converted to PDF and transferred to the ATLAS.ti system. When performing word frequency analysis, the system itself tends to exclude characters such as commas, periods, asterisks, among others. Thus, after such exclusion, the words and their frequencies are extracted and compressed in an excel spreadsheet. The content analyzes were separated into three stages: (i) Frequency of the words contained in the 22 articles; (ii) Frequencies of words present in the articles that will be grouped by year, and; (iii) Frequency of words per article.

To optimize this step, those words that contained only 4 syllables and were limited to pronouns were excluded, mainly. Words were excluded with a frequency of 100 to 299 words, and the presence of pronouns and adjectives used to make sense of the sentences and not to contextualize them was also observed. The analyzed interval was the one with a frequency of at least 300 and at most 1300 times in the analyzed texts. Figure 5 shows the words and frequency in the texts.

Figure 5 - Identified frequencies for words



Source: Elaborated by the author

The term “Sustainability” with 1328 repetitions is present in all articles. Subsequently, the word “Capital” appeared 834 times in a total of 14 articles. The word “Natural” in 20 articles, identified 635 times in the texts.

The words “Economic” (frequency of 560 words), “Indicators” (frequency of 533 words), Sustainable ”(frequency of 436 words), and“ Social ”(frequency of 427 words), were also highlighted. present in all analyzed articles.

4.4.2 Cross-Sectional Analysis

The temporal distribution of words by the articles was observed to verify if there was a focus of study per year. The articles were grouped by year to then perform the word frequency analysis. The results are identified in figure 6 where the number of times it was repeated is broken down beyond the word:

Figura 6 - Word frequency per year



Source: Elaborated by the author

The articles were published in the years 2009, 2011, 2014, 2015, 2016, 2017, 2018, and 2019. The term sustainability was present in the 6 years analyzed.

In 2009 (02 articles), there were 218 repetitions of the term “NC” being a relevant factor for the analysis of research related to the accounting of environmental resources. The presence of the word “capital” was present in 2011 (03 articles). In 2014 (01 articles) the term “Well-being” was mentioned 71 times in the article. For the year 2015 (02 articles) “analysis” and “urban” are present in the articles and aligned with the theme of sustainability and the urban environment. In 2016 (02 articles), the presence of the word “management” presents the core of sustainable management.

The years 2017 (05 articles) and 2018 (05 articles) were the years with the highest number of articles. The focus of the articles for the year 2017 was sustainability and water. For the year 2018, the articles presented a frequency concerning the word “indicators”.

Finally, in 2019 the detail is in the word “economic” in which the studies are aligned with the theme of corporate development of companies.

4.4.3 Analysis by article

As an analysis of the content of the texts individually, the words with the highest frequencies in each article were selected. Subsequently, one more reading of each article was performed to identify the focus of the selected words. Table 3 shows the results ordered by year:

Table 3 - Content analysis by article

Study	Words or term *	Frequency
Analysis of focus		
<hr/>		
Engelbrecht (2009)		
	• Natural Capital	47
	• Well-being	71
Correlation between natural capital and social well-being		
Ruggeri (2009)		
	• Natural Capital	87
	• Investments	98
Government investments in Natural Capital as a way of measuring		
Couharde et al. (2011)		
	• Natural Capital	88
	• Caledonia	65
New Caledonia Natural Capital Assessment		
Delai I., Takahashi S. (2011)		
	• Sustainability	166
	• Company	77
Measurement of corporate sustainability, focusing on performance analysis in companies.		
Mondelaers et al. (2011)		
	• Value	24
	• Method	24
Sustainability performance based on the value that is created through the resources and environmental impacts used in alternative (agricultural) production processes using the SV method.		
Kaivo-oja et al. (2014)		
	• Well-being	71
	• Sustainability	56

Study	Words or term *	Frequency
Analysis of focus		
Sustainability analysis with indexes, focusing on human well-being, social well-being, and economic welfare.		
Zhang et al. (2015)		
	• Flow	110
	• Urban metabolism	76
Urban metabolism and the flows of energy and materials that are present in the environment.		
Rodrigo et al. (2015)		
	• Nations	54
	• Environment	47
Analysis of the sustainability of the environment in nations.		
Hai et al. (2015)		
	• Water	148
	• Network	76
Sustainability in the use of water, focusing on the use of efficient network systems		
Fenichel et al. (2016)		
	• Natural Capital	82
	• Value	49
Value assessment of natural capital		
Zijp et al. (2016)		
	• Sediments	88
	• Evaluation	70
Sustainable management and assessment of low-contaminated sediments formed continuously in agricultural areas		
Kurniawan and Managi (2017)		
	• Countries	87
	• Natural Capital	57
Sustainability performance in countries focusing on Natural Capital		
Ren and Liang (2017)		
	• Processes	53
	• Sustainability in wastewater treatment	32
Sustainability analysis in the wastewater treatment process		
Husgafvel et al. (2017)		
	• Sustainability	81

Study	
Words or term *	Frequency
Analysis of focus	
• Social	47
Assessment and performance of sustainability in companies, observing social, environmental, and economic indicators in industrial processes in Finland	
Zipj <i>et al.</i> (2017)	
• Method	145
• Sustainability	61
Wastewater sustainability analysis methods /	
Kelly <i>et al.</i> (2018)	
• Sustainability	88
• Level	62
Analysis of the level of agricultural sustainability using Farm Accountancy	
Moldavska e Welo (2018)	
• Sustainability	151
• Company	125
Evaluation and performance of sustainability in companies, observing social, environmental, and economic indicators /	
Dočekalová and Kocmanová (2018)	
• Value	79
• Indicators	38
Analysis of sustainability in companies through the use of non-financial indicators that observe added value /	
Lior, Radovanovic and Filipovic (2018)	
• Countries	109
• Indicators	74
Measurement of sustainable development using indicators in southeastern European countries	
Van Beynen, Akiwumi & Van Beynen (2018)	
• Development	54
• Sustainable	41
Sustainable development on the island of the Republic of Trinidad and Tobago based on Sustainable Development Goals 2030	
Nikolaou, Tsalis e Evangelinos (2019)	
• Sustainability	284
• Corporate	145
Measuring strong corporate sustainability of companies through indicators	
Fenichel e Hashida (2019)	
• Natural Capital	64

Study	Words or term *	Frequency
Analysis of focus		
	• Economic programs	61
Measurement of natural capital using elements of economic programs		

Note: * The words or terms, marked with a bullet, are the two that registered the highest frequency in each of the texts.

Observing the table above, there is an emphasis on corporate sustainability by organizations (Moldavska & Welo 2018; Nikolaou et al. 2019; Van Beynen et al. 2018; Delai 2011; Husgafvel et al. 2017; Dočekalová & Kocmanová 2018).

It is also possible to observe evaluations about the term NC as the focus of 6 types of research (Fenichel & Hashida 2019; Fenichel et al. 2016; Couharde et al. 2011; Engelbrecht 2009; Ruggeri 2009; Kurniawan & Managi 2017). Furthermore, in the research by Zijp et al. (2016) and Mondelaers, van Huylenbroeck and Lauwers (2012), and Kelly et al., 2018 the theme of sustainability, related to the agricultural process, had an emphasis. Furthermore, water analysis was observed as an important research factor by Ren and Liang (2017), Hai et al. (2015), and Zijp et al. (2017). These surveys emphasize sustainability with an aspect focused on environmental management.

Sustainable development has gained greater relevance in the research by Husgafvel et al. (2017), Lior, Radovanovic, and Filipovic (2018), and Van Beynen et al. (2018). On social well-being, such term called attention to the research Kaivo-oja et al. (2014) and Engelbrecht (2009).

Finally, urban metabolism became a prominent content in the research by Zhang, Yang & Yu (2015). It is worth mentioning that the researches listed here have the characteristic of bringing the theme of sustainability as a point of study for the development of its analysis objectives.

4.5 DISCUSSION

In the analyzed texts, sustainability has its prominence, which would be expected since the 22 articles were selected using the keyword "environmental sustainability". It is now necessary to identify what such Sustainability refers to.

Two strands of studies were observed in the texts on the theme of sustainability: one to address corporate aspects to identify a balance between economy, society, and the environment, and the other directed to environmental aspects to manage natural resources

to meet human demands. Corporate sustainability goes against the studies invoked in the economic area (Robinson 1970; Usher 1965; Brand 2008) rooted in the observation of production and its nuances in the discussion of the relationship between capital and labor. Sustainability, which places the environment as an object of study, seeks to improve research practices beyond economics, invoking attributes such as forests, agriculture, and water as centers of analysis (Huffaker & Wilen 1991; White 2000).

Regarding social emblems in the texts, the focus is on social well-being (Kaivo-oja et al. 2014; Engelbrecht 2009) necessary for man's life in the present and the future and which is related to the NC offered by the environment. This focus is absorbed by Strong Sustainability (Arrow et al. 2003) in which the NC must be studied to meet human life in the present and the future. Kurniawan and Managi (2017) emphasized the use of NC as a source of analysis and regional efficiency.

Regarding ecological attributes, the center of the analysis is in the environment, especially about water quality (Delai 2011; Zhang, Yang & Yu 2015; Hai et. Al. 2015; Zijp et al. 2017; Fenichel et al. 2016; Ruggeri 2009; Ren & Liang, 2017), against what was presented as relevant in terms of biological analysis (White 2000; Tisdell 1997). These items are contextualized as variables that are part of the NC.

It was also possible to identify in one of the works an analysis of energy sources, which includes non-renewable resources discussed in the work of Zhang, Yang, and Yu 2015. Policies aimed at discussing best practices in the use of environmental resources are also featured in the works by Zijp et al. (2017), Kelly et al. (2018), and Van Beynen et al. (2018).

4.6 CONCLUSION

The purpose of this work was to identify the content of the research being carried out by the academic community on the measurement of NC, to understand the concept of NC. Through an analysis of the contents of academic texts, it was possible to identify which economic, social, and ecological attributes have been used to contextualize the NC and its subsequent measurement and are placed as structures for discussions in the academic environment.

On economic issues, the NC study highlights corporate sustainability, that is, that which prioritizes production geared to economic growth, highlighting the discussion of the relationship between capital and labor. Notes that the NC is part of the productive activity and therefore needs to be measured.

Regarding social issues, research brings guided content on social well-being (Kaivo-oja et al 2014; Engelbrecht 2009), meeting the study Sustainability Strong presenting the search for environmental resources that occur over time (Arrow et al. 2003). NC must be identified to meet social well-being. The messages about ecological characteristics are limited to the field of study mainly of qualitative water analysis. It was also possible to identify contents that conceptualize the NC based on sources of energy and agriculture.

In the texts, there is a search for indicators as ways to measure the environment (Delai 2011; Rodrigo, Munoz & Wright 2015; Husgafvel et al. 2017; Kelly et al. 2018; Moldavska & Welo 2018; Dočekalová & Kocmanová 2018; Lior, Radovanović & Filipović 2018; Nikolaou, Tsalis & Evangelinos 2019; Fenichel & Hashida 2019). These indicators give rise to the variables related to NC to meet, mainly, the needs of the economy.

With the conclusions of the work, to expand the content for the construction of the variables of natural capital, it is proposed: i) interdisciplinary analysis on natural capital; ii) survey of social and ecological factors present in natural capital; iii) proposing indicators measuring bases consistent with its social and ecological factors.

There is a limitation of the sample placed here in the work, since there may be other researchers with prominence in such an area of study. Furthermore, it is worth making a more critical observation of the speech of such authors to learn about intertextual aspects, that is, dialogues that are being constructed based on other texts present in the literature on the measurement of NC. For future research, it is proposed to identify the qualitative characteristics in more detail involving mainly the social and ecological fields, improving thus the attributes of nature that are essential for man and that need to be inserted in the context of inferences about the NC for measurement purposes.

5 CRITICAL ANALYSIS OF THE DISCOURSE ON NATURAL CAPITAL: A REFLECTION ON SOCIAL PRACTICES AND INTERTEXTUAL PATTERNS IN ACADEMIC RESEARCH³

5.1 INTRODUCTION

Natural capital (NC) is a topic of the study discussed in the literature, given the importance it has for man since it impacts economic, social, and ecosystem services activities (Wilén, 2001). For this reason, there are studies in the literature that present characteristics of how environmental resource management should be and its relationship with mankind (Allan, 2007; Gómez-Baggethun & Barton, 2013).

When analyzing the theory of capital, it is possible to infer its development throughout the history of the NC (Bigman, 1979; Fisher, 1977). In this theory, this capital goes through a process in which characteristics related to the use of natural resources in production are created (Clark & Furtan, 1983; Robinson, 1970). Thus, with other capitals, production and social, they represent an important source of inputs needed for economic production (Arrow, Dasgupta, & Mäler, 2003).

This line of analysis is attributed to the area of economic studies. However, other areas of study are interested in approaches to what can be understood as the environment (Bell, 2005). In the accounting literature, the NC is seen as a metaphor used in the speeches (Åkerman, 2005). It is the case of ecology that observes biotic and abiotic items present in the ecosystem that play a fundamental role in the survival of both man and the beings that inhabit the natural environment (Chapin, Matson, & Vitousek, 2011). Besides, social studies discuss different notions of the economy of this capital, when they analyze cultural and historical characteristics (Sieferle, 2011) in the use of natural resources that are important to human health (Chiesura & Groot, 2003) and their interaction in society (Gómez-Baggethun & Barton, 2013).

Therefore, the term “natural capital” provokes other areas for the dialogue of what should actually be attributed to its context (Málovics, Csigéné, & Kraus, 2008), since there is an overload of the use of natural resources by man (Küpers, 2020). Therefore, it is worth noting, in academic research, what is believed to be a natural resource for measuring and achieving sustainability, as this term has been discussed to understand

³ References due to the norms established by the Library of the Federal University of Paraná at the link <https://www.portal.ufpr.br/normalizacao.html>, are at the end of the thesis and are in alphabetical order.

which postulates should be practiced, to achieve sustainable development (Åkerman, 2005) and then critically analyze this system of knowledge and beliefs to know which characteristics of analysis are present and to infer the lack of information about natural capital.

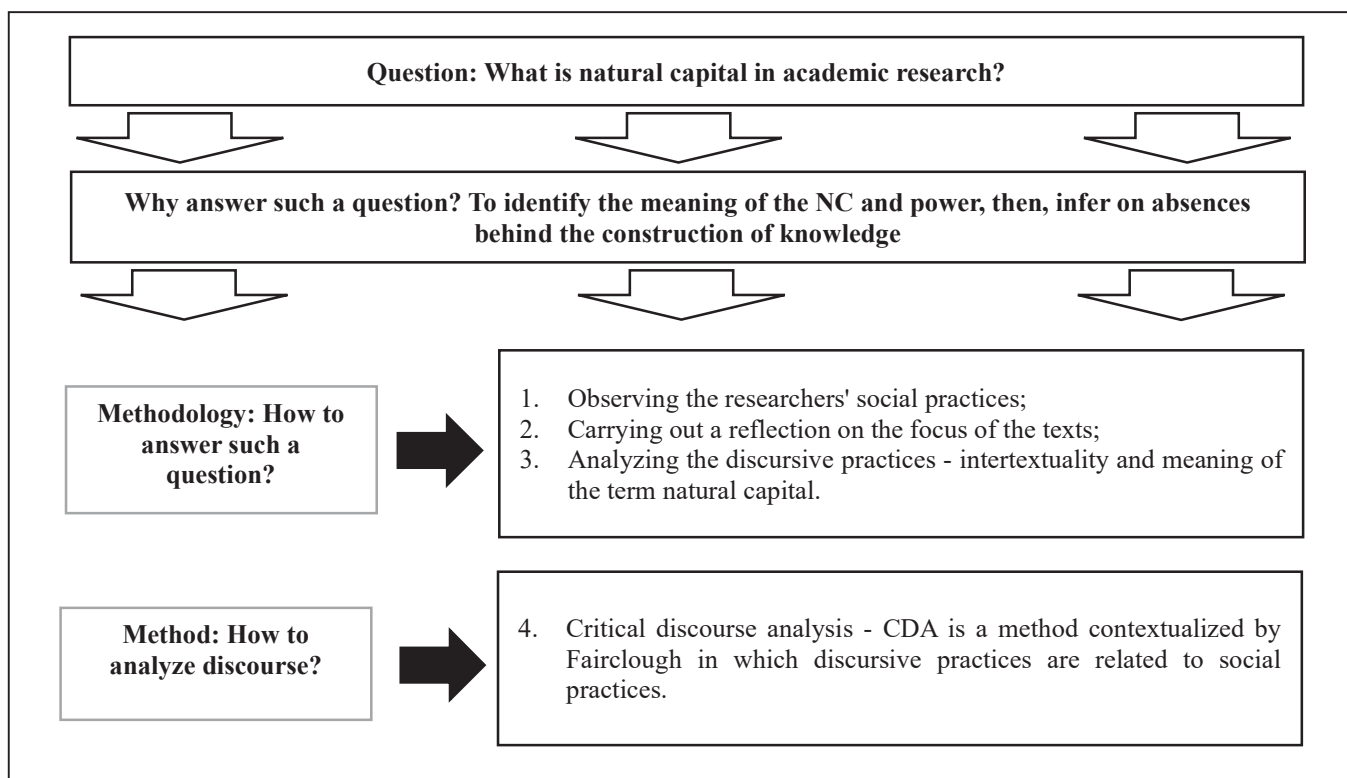
Regarding critical research, the discourse serves as an important means of communication on the part of researchers and brings with it information about the social practices that are related to the construction of knowledge (Chouliaraki & Fairclough, 2010; Wodak & Meyer, 2001). The term “critic” denotes the choice to go beyond theory, as it seeks to present positions on social problems, political opinions, and philosophical thoughts defended in a given context (Wodak & Chilton, 2005; Batista Jr., 2018). In other words, it seeks to dialogue and reflect on the epistemology behind the construction of knowledge in discursive practice. The critical question, therefore, is relevant to understand the connection between discursive and social practices (Wodak & Meyer, 2001).

Within this context, research on NC can be characterized as sources of discursive practices. In his Critical Discourse Analysis (CDA), he considers that texts are important sources of knowledge reproduction (Mair & Fairclough, 1997). Therefore, the CDA becomes relevant for the analysis of specific concepts dialogued and considered as social practices. For this, dimensions are presented to develop the CDA: analysis of discursive practice, analysis of the text, and analysis of social practice (Fairclough, 2013).

Therefore, the research question will be to evaluate what is the interdisciplinary approach of the articles in the construction of the economic, social, and environmental variables that capture the natural capital. Therefore, it consists of observing the social and discourse practices present in the research on environmental resources in the texts, identifying the NC, making critical inquiries about the context of the research. From that point on, it will be possible to address the absence of dialogues about the significance of this capital.

In this article, first, the literature review on the topic will be considered; later, the methodology will be explained; and, in the next step, the results and discussions will be aligned to then be able to respond to the meaning of natural capital. The methodological design of the present research is structured in figure 07.

Figura 7 - Desenho metodológico da pesquisa



Source: Elaborated by the author

5.2 LITERATURE REVIEW

5.2.1 The meaning of natural capital

Natural capital is an item of analysis and interaction with economic issues to achieve sustainability (Pearce, 1988). There is a search for greater efficiency in the use of this capital with a focus on development that is sustainable, for which it is necessary to develop public policies for its better management (Swallow, 1996).

However, over time, this term has been developed and integrated with scientific research. For the theory of capital, NC is a resource for production that is limited (Scott, 1956), which leads to concerns, according to the way it is being consumed by society, and impacts future needs, both economic and human.

Some issues, such as soil conservation and depletion (Clark & Furtan, 1983) and scarcity of environmental resources (Faber & Proops, 1993), are some of the attributes discussed. There is research that asks about the perpetuity of natural capital that depends on the maintenance of services provided by the ecosystem (Folke & Berkes, 1993). There is also a focus on the measurement of such capital in the long term (Barbier, 2014) so that the NC does not only meet the current demands of human needs for goods, services, and

their way of life (Brand, 2008; Guerry, Polasky, Lubchenco, Chaplin-kramer, & Daily, 2015).

There are indicators to measure sustainability, to be able to know to what extent the scarcity of natural capital causes damage to the economy and to society (Stern, 1997; Victor, 1991), incorporating issues related to the substitution of environmental resources, as well as public policies the State (Boyd, & Banzhaf, 2007; Dasgupta, 2001) that should be adopted to foster sustainable development and technological changes that change the prospects of the natural capital stock.

In this sense, it is observed that the direction given by the research presented on natural capital is limited in terms of observance of the stock as an analysis variable for the economy (Pearce, 1988). Such capital, when interpreted as a resource for production, denotes the concern only of its use, meeting the needs of man. This is an anthropocentric view (Küpers, 2020) and can be highlighted, denoting the idea that "... human beings colonized nature" (Arias-Maldonado, 2016, p.01).

However, this view is limited, as it does not have a perspective that observes the value that the environment has and that is relevant to the relationship between man and nature (Bell, 2005). In environmental economics, varied debates about NC have made discourse distant from what nature represents (Åkerman, 2005).

Although research seeks indicators, analyze a state's wealth and capital stock, there is an observation that one should not only discuss such capital (Barbier, 2014), but also promote its significance through interdisciplinary research (Chiesura & Groot, 2003; Dierkes & Preston, 1977; Russell, Milne, & Dey, 2017), to capture the elements arising from nature that are connected to social approaches (Luhmann, Niklas, Barrett, 2012; Siefertle, 2011), ecological (Alexandratos & Bruisma, 2012; Fischer-Kowalski & Weisz, 2016) and natural capital.

Thus, it seeks, then, not to bring a view of domestication of nature attributed to the usual practices of capitalism (Küpers, 2020). Instead of focusing on purely monetary issues of natural capital, bring up factors that are found within the relationship between man and nature (Åkerman, 2005). This is justified as the actions of man are linked to the actions of nature (Zalasiewicz, Williams, Steffen, & Crutzen, 2010).

It is interesting to make the concept of environmental resources understood to understand the meaning of natural capital (Bell, 2005), as well as the qualitative aspects that can serve as a basis for alignment with the concept referring to the asset that represents the environmental resource (Clayton et al., 1992; Oguri, 2005).

5.2.2 Critical discourse analysis

One way of building knowledge is through inferences about a given subject, observing speeches developed by researchers who have similar interests. This is because research practices are part of the social and economic context, so they serve as guidelines for theorizing (Merkl-Davies & Koller, 2012; Wodak & Chilton, 2005).

One way of building knowledge is through inferences about a given subject, observing speeches developed by researchers who have similar interests. This is because research practices are part of the social and economic context, so they serve as guidelines for theorizing (Merkl-Davies & Koller, 2012; Wodak & Chilton, 2005).

So the idea of conducting a discourse analysis is not to identify an objective and stable form in the texts but observe how the power relations and the presence of ideologies may be absorbed in the texts (Wodak & Meyer, 2001). To present, then, the relationship between language and the power it has over social practices, later identifying the naturalization of conventions imposed on society (Wodak & Chilton, 2005).

Fairclough's critical analysis is a way of approaching the discourse and social practices related to a certain context. For the aforementioned author, the object of analysis will always be the text, that is, analyzing texts to observe linguistic concepts or aspects related to cultural, historical perceptions, and the logical coherence found in the speeches of those who elaborate the texts (Batista Jr., 2018).

From the perspective of organizational studies, Chouliaraki and Fairclough (2010) indicate that CDA can be an important instrument in the practice of interdisciplinary studies. This is because it not only brings the pure analysis of an organizational context as a foundation but also discusses other dimensions, such as the practices of power and social practices, presenting an ontology with historical bases and an epistemology with subjective purposes (Merkl-Davies & Koller, 2012).

Through the discourses inserted in research, there is a concentration of traditions that are brought and refer to new knowledge which are built, based on the production context and the socio-economic context, to which the texts are directed (Merkl-Davies & Koller, 2012; Fairclough, 2016).

Therefore, CDA is a strand of dialectical-relational approach, in which social practices are the result of discourses through a system of verbal (texts) and non-verbal (actions) languages, thus building a reality to be practiced by social actors (Chouliaraki & Fairclough, 2010; Locke, 2004; Wodak & Chilton, 2005).

5.3 METHODOLOGY

This research goes deeper into an analysis of the texts, putting into practice observation of discourse present in academic writings, to then identify the world through the perspective of the subjects who are interested in knowledge about natural capital (Wodak & Chilton, 2005).

Through the discourse, the domain built on the truth of natural capital was analyzed, which characterizes the power constituted on the subject in question, since it makes it possible to understand what is contextualized as an environmental resource (Bell, 2005). Such analysis for this work was developed through observations on the professional context and the works elaborated by the authors identified in the systematic review present in the article.

The texts analyzed here were selected based on systematic analysis. Observing the keyword environmental measurement, the article “How are the variables for the measurement of Natural Capital being elaborated?” identified 1,856 searches in the Scopus database. After carrying out the initial analysis to capture those articles that presented approaches on measurement, natural capital, and measurement variables, 904 articles were selected, of which 22 presented environmental measures.

Since the works focus on environmental variables, in this work the 22 articles will be analyzed to reflect on the discourse built on the truth of natural capital and to understand what is contextualized as an environmental resource (Bell, 2005). Such an approach to this work will be developed through observations on the professional context and the works prepared by the authors identified in the systematic review present in the article.

Thus, through a theoretical observation focused on social constructionism, the aim is to understand the concept of natural capital for later inclusion in the framework that involves measurement within the context of accounting. This means that the construction of knowledge starts from the texts elaborated by specific researchers, in which, after the interpretation by a researcher who reads these texts, it brings a conclusion about the social reality (Wodak & Meyer, 2001). In this way, external discourse issues are taken into account, so it is not limited to just seeing the meaning of words in a given text (Fairclough, 2016; Chouliaraki & Fairclough, 2010).

Firstly, the social context experienced by the authors will be analyzed, which will indicate their social practices so that they can then understand the universe of the research

they have done on natural capital; later, there will be an analysis of the texts to observe the focus of their analysis; finally, the discursive practices will be analyzed considering the intertextuality and the meaning of the term natural capital.

With these steps built, the aim is to obtain, in the most analytical way possible, the construction of knowledge related to the variables of natural capital, for later measurement. This construction impacts the discursive practice in the field of research on natural capital.

5.4 FINDING AND ANALYSIS

5.4.1 Analysis of the context of social actors

In this first moment, the practices of professionals who have the environmental measurement as a research theme definition will be identified. This verifies the condition of the authors within the production regarding such measurement. That is, if the interest, for example, is in broadening the discussion or defending a specific aspect of analysis within the context of natural capital. This social practice has an important tool for critical analysis since it supports what the authors defend within their speeches in the academic environment.

5.4.1.1 Social practices

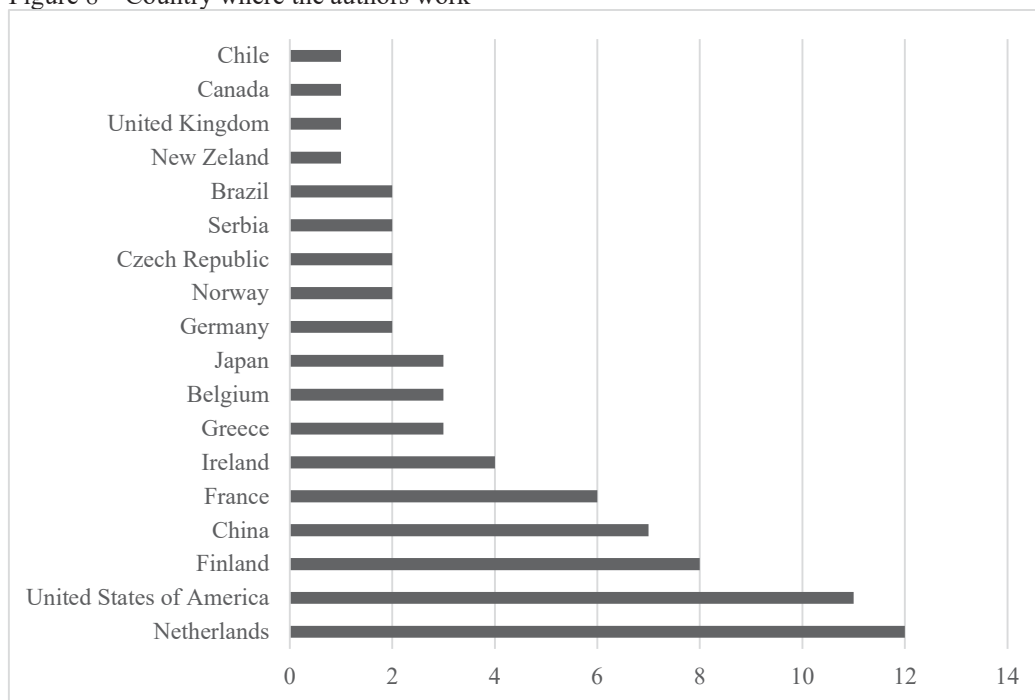
Professional performance

The 22 articles were written by 74 authors. The professional relationship of the authors was observed on the date of publication of the article and the institution of professional performance, the country of the institution, professional activities, and academic training were identified.

Among the authors, only three did not identify their professional information. 71 authors were analyzed, collected from the institution's website informed in the article or from the digital curriculum, published through websites or on LinkedIn.

Note that the institutions are present in the Netherlands (12 researchers), the United States (11 researchers), and Finland (8 researchers), as shown in figure 8:

Figure 8 – Country where the authors work



Source: Elaborated by the author

The countries that presented the highlights were the United States and the Netherlands. In figure 9, it is possible to identify the main institutions and the number of authors present in each one. It is also important to highlight Beijing University in China with four researchers; Ghent University in Belgium; Teagasc - Rural Economy & Development Program in Ireland; and INRA - French National Institute for Agricultural Research in France - all with three authors each; and the University of São Paulo (USP) with two authors.

Figure 9 - Map of the main institutions by country

Netherlands			Finland	
RIVM - National Institute for Public Health and the Environment, 7			University of Turku, 3	Finland Futures Research Centre (FFRC), 3
Utrecht University, 1	Amsterdam University, 1	Radboud University - Faculty of Science Aquatic Ecology & Environmental Biology, 1	Aalto University, 1	University of Lapland, 1
			University of Helsinki, 1	LUT University, 1
United States of America		Center for Environmental Economics and Sustainability Policy at Arizona State University, 1	Northwest Fisheries Science Center, 1	University of Pennsylvania, 1
School of Geosciences, University of South, 2	Yale School of Forestry and Environmental Studies, 1	Department of Agricultural and Resource Economics at Colorado State University, 1	Agricultural and Applied Economics University of Georgia, 1	
		University of Nebraska-Lincoln, 1		

Source: Elaborated by the author

To identify the professional activities of the authors, such information was collected in their curricula. It was possible to identify their primary and secondary activities. In figure 10, their primary activities are highlighted in the interval that starts in the activity of "Professor" and ends in the activity of "Planning Analyst".

Figure 10 – Professional Activity

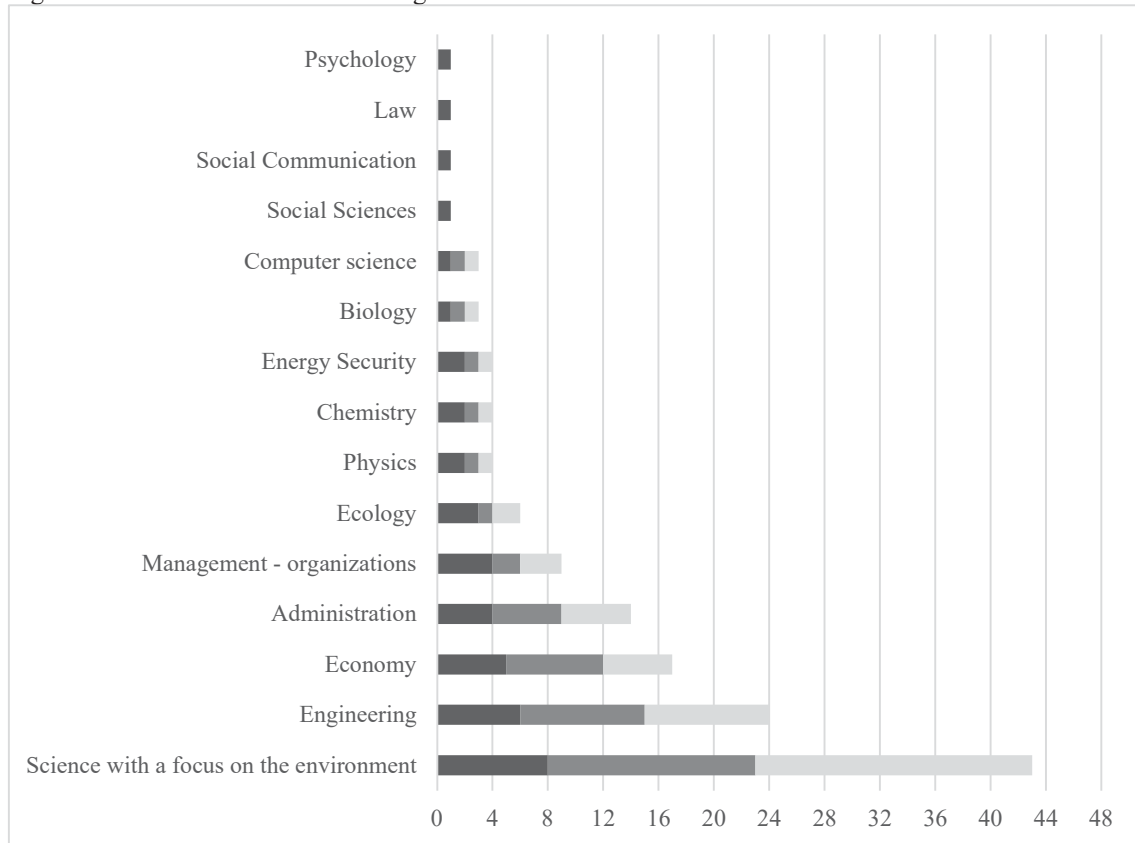


Source: Elaborated by the author

It is noticed that there is a concentration in the activity of the professor (46 researchers). Being a member of a study group is the second most practiced activity by the authors (6 researchers).

Regarding the titles, 49 authors presented the respective information in their resumes. Among them, 42 authors highlighted their graduation; 44 authors identified master's degree information; concerning doctorate, 49 authors indicated their qualification. Figure 11 shows the data presented on such information.

Figure 11 – Authors' academic training courses



Source: Elaborated by the author

It appears that the main areas of academic training are in Science with a focus on the environment, followed by Engineering, Economics, and Administration.

5.4.2 Analysis of texts and discursive practices

In this item, the discussions in each of the 22 articles will be observed. The aim is to observe the focus of the texts and intertextuality present in the body of research on environmental measurement and thus find building bases of the variables and arguments to give meaning to natural capital.

The results were separated into two stages: the first concerns the analysis of texts and intertextuality through important documents provided by international organizations; the second focuses on discourse based on the use of specific literature found in academic texts.

5.4.2.1 Analysis of texts and intertextuality with the use of international documents and the meaning of natural capital

Regarding intertextuality to elaborate concepts related to natural capital or related

to environmental indicators, it was possible to observe patterns related to the use of documents arranged by world organizations, which are used as a reference.

Among the documents used are those mainly contextualized by the UN (United Nations), FADN (The Farm Accountancy Data Network of the European Union), World Bank, Global Reporting Initiative (GRI), and Sustainable Society Foundation (SSF). Besides, concepts about environmental variables were developed based on theoretical discussions, through which specific works by authors were selected.

After identifying the texts associated with the definition, there was an approach to the concepts of natural capital. The concept of natural capital is the object of study and analysis of this work. Therefore, the intention is to identify how this capital is contextualized in academic articles and what they are intended for. Thus, it will be possible to identify whether there is any domain as to the proposed meaning of natural capital.

- UN

Intertextual patterns

Regarding articles that used documents prepared with UN support, the highlight is the use of the Inclusive Wealth Report (IWR), Millennium Development Goals (2011), United Nations Global Compact, Sustainable Development Goals (SDG), Commission for Sustainable Development (2002), Agenda 2030 for Sustainable Development and United Nations Environment Program. The authors defend the use of these documents since they support their analyzes of sustainability.

Kurniawan & Managi (2017) used the IWR as a base, while Fenichel et al. (2016) applied guidelines to the United Nations Environment Program. The authors noted that there is a need to address undesirable measures due to the extraction of forests, sources of energy, and agriculture. Delai (2011) presents an approach focused on social well-being when addressing the guidelines of the Commission for Sustainable Development.

Beynen, Akiwumi, and Beynen (2018) argue that Agenda 2030 approaches are supported and should be used in the analysis of sustainable development when looking at developing countries. Zijp et al. (2016) also included the 2030 Agenda because it is an existing structure for analysis. Lior, Radovanović, and Filipović (2018), when researching the SDGs, bring the theme of quality of life as an integral factor of measurements, to identify sustainable development with a focus on socioeconomic attributes. Husgafvel et

al. (2017) address that it is possible to identify business practices to achieve sustainable development through the United Nations Global Compact. Finally, Rodrigo, Muñoz, and Wright (2015) point out that, in the Millennium Development Goals (2011), there are variables that can analyze the relationship between health quality and sanitation.

Meaning of natural capital

The definitions, even using documents constructed by the UN, vary according to the objectives of the work. However, it is possible to identify approaches to a country's wealth and metrics to address issues related to human health.

Rodrigo, Muñoz, and Wright (2015) argue that the metrics employed "... represent standards of living indirectly linked to the levels of poverty" (p. 224). Zijp et al. (2016) emphasize soil contaminants to support the environmental variables used in their analysis, as these "... determine the impacts on human health, ecosystems and the quality of agricultural products" (page and year).

Delai (2011) argues that the variables used are the basis for companies to be evaluated concerning sustainable development. And points to the guidelines that are defined by the Commission for Sustainable Development (2002) as support for measurements.

Kurniawan & Managi (2017), Fenichel et al. (2016), and Beynen, Akiwumi, and Beynen (2018) state that the measurement variables identify inclusive wealth to analyze sustainability. It is important to note that Beynen, Akiwumi, and Beynen only addressed sustainability related to coastal and maritime resources.

The work of Fenichel et al. (2016), despite being focused on inclusive wealth, approaches the topic as follows:

“Natural capital is a powerful metaphor that conveys the importance of the Earth's biotic and abiotic natural resources as a basis for society's productivity, capable of providing continuous flows of socially valuable services.” (p. 2382).

The research was focused on the analysis of hydrological resources to analyze groundwater.

Finally, Lior, Radovanović, and Filipović (2018) and Husgafvel et al. (2017) only pointed out the variables used as the basis for analysis in their research. They did not deal with meaning about the variables that they believe to be capitals coming from nature.

- **FADN**

Intertextual patterns

About FADN, which is a database with information on agriculture, Mondelaers, Huylenbroeck, and Lauwers (2011) recognize its use, as it absorbs important actions on environmental sustainability and emphasizes the fact that agriculture is one of the activities that most negatively impact global warming. Kelly et al. (2018), in their study, argue that, in addition to being an important instrument for the analysis of environmental sustainability, it has a promising database, since information is collected from the Member States annually for more than 40 years.

Meaning of words

Mondelaers, Huylenbroeck, and Lauwers (2011) present the reason for using natural capital to assess sustainable production. They emphasize that the use of such resources should not compromise the needs of future generations, so they must be considered as metrics of analysis. Kelly et al. (2018) identify environmental variables without an interpretation in which they are defined as items of natural capital. Table 4 provides a summary of the criteria discussed below.

- **World Bank**

Intertextual Patterns

Regarding the World Bank, the metrics are pointed out in the speeches to support a country's inclusive wealth to verify its sustainability. Fenichel et al. (2016), Couharde et al. (2011), and Engelbrecht (2009) were the authors who highlighted the use of information provided by the World Bank.

Meaning of natural capital

Fenichel et al. (2016) in terms of definition have already highlighted in the item that talks about the UN, in which it highlights natural capital as an abiotic and biotic resource that is present in productivity and brings continuous flows of services to man.

Couharde et al. (2011) highlight that “the World Bank has developed an analytical structure in which natural capital is one of the components of the countries' total wealth” (p. 151). Therefore, they emphasize natural capital as wealth.

Engelbrecht (2009), similarly to what was approached by previous authors about wealth, highlights only that natural capital is one of the main riches and, with production capital and intangible capital, forms the total wealth of a country.

- **GRI**

Intertextual patterns

Concerning the GRI, Delai (2011) emphasizes that information on biodiversity is found in this document and has their emphasis to be important to social well-being. In addition to these documents, Delai's work cited the Organization for Economic Cooperation and Development (OECD) as a source that points to environmental variables attested by the literature that discusses environmental measurement.

Husgafvel et al. (2017), in addition to citing United Nations Global Compact, indicate the timely use of GRI, as it identifies sustainability practices in companies, which can help in the analysis of sustainable development.

Nikolaou, Tsalis, and Evangelinos (2019) only point to strong sustainability when analyzing corporate sustainability in organizations. They assume that a sustainable company works to protect environmental resources.

Meaning of natural capital

Delai (2011), despite defining the GRI as a basis for supporting environmental variables, uses the guidelines of the Commission for Sustainable Development (2002) as concepts. Husgafvel et al. (2017) address environmental variables without a precise definition.

Nikolaou, Tsalis, and Evangelinos (2019), in the text of the study, after discussion with the literature, point out that strong sustainability in companies observes "... their ability to work annually below specific limits that are associated with the reproduction rate of renewable resources and the support capacity of ecosystems "(p.04). In this way, the variables are ensured and meant to meet strong sustainability and protect environmental resources.

- **SSF**

Intertextual patterns

Finalizing the studies with the use of specific documents, the research by Kaivo-oja, Panula-ontto, Vehmas, and Luukkanen (2014) brings as structure the variables data provided by the Sustainable Society Foundation (SSF), confirming that it is a non-profit organization. Besides, the index practiced by the SSF follows the guidelines of the Brundtland Commission, which is also entitled the World Commission on Environment and Development, created in 1983.

Meaning of natural capital

The research by Kaivo-oja et al. (2014) points out that the environment is part of the dimensions to compose the social well-being index. The definition of natural capital is based, then, on social well-being.

Table 4- Intertextuality with international documents

Studies	International Organization
<ul style="list-style-type: none"> • Kurniawan & Managi (2017) • Fenichel et al. (2016) • Delai (2011) • Beynen, Akiwumi e Beynen (2018) • Zijp et al. (2016) • Lior, Radovanović e Filipović (2018) • Husgafvel et al. (2017) • Rodrigo, Muñoz e Wright (2015) 	United Nations (UN)
<ul style="list-style-type: none"> • Mondelaers, Huylenbroeck e Lauwers (2011) • Kelly et al. (2018) 	<i>FADN (The Farm Accountancy Data Network of the European Union)</i>
<ul style="list-style-type: none"> • Fenichel et al. (2016) • Couharde et al. (2011) e Engelbrecht (2009) 	World Bank
<ul style="list-style-type: none"> • Delai (2011), Husgafvel et al. (2017) • Nikolaou, Tsalis e Evangelinos (2019) 	Global Reporting Initiative (GRI)
<ul style="list-style-type: none"> • Kaivo-oja, Panula-ontto, Vehmas e Luukkanen (2014) 	Sustainable Society Foundation (SSF)

Source: Elaborated by the author

5.4.2.2 Analysis of texts and intertextuality based on academic texts and the meaning of natural capital

In the texts with literary base, there are two foci to characterize the variables of natural capital: the first refers to the use of methods already highlighted in other academic works in which they operate based on environmental variables to measure; the second is directly related to discussions present in academic works, to explain what should be explored as an environmental metric.

Following are the explanations referring to the two focuses used by the authors, to support the environmental variables and the statements brought to the use of the methods or theoretical bases for the conceptualization of the environmental variables.

5.4.2.2.1 Focus on sustainability analysis methods

- ***Solution-focused Sustainability Assessment (SfSA)***

Intertextual patterns

In the research by Zijp et al. (2016), the authors defend the use of the Solution-focused Sustainability Assessment (SfSA) method as a way of measuring sustainability, focusing primarily on the problem. Such an approach suggested by the authors is based on the fact that different points of view of society must be observed and thus be able to identify an adequate methodology for measuring sustainability, focusing on a specific problem. The article by Zijp et al. (2017) follows an approach already sustained in the 2016 work, but it aimed to improve the information for the application of sustainability measurement, and the opinion of experts from organizations that mainly address biological, chemical, and health issues was then argued and applied in the research. life cycle assessment.

Meaning of natural capital

Zijp et al. (2016) focam o uso de variáveis que venham a “...determinar os impactos na saúde humana, nos ecossistemas e na qualidade dos produtos agrícolas” (p. 326). Ou seja, o que define uma variável ambiental é o que pode ser medido em termos de impactos à saúde humana. Já Zijp et al. (2017) observam o esgotamento de recursos ambientais para que sejam apontadas restrições na produção de determinada localidade. Desse modo, o significado específico sobre as variáveis ambientais está no que pode ser medido em termos de esgotamento.

- **Multi-Criteria Decision Analysis (MCDA)**

Intertextual patterns

Ren & Liang (2017) made use of specific method indicators asking that they were important for measuring sustainable water use, taking the study already developed by Ling and Hang (1998), which is entitled Application of fuzzy decision method for process selection of urban WTP.

Meaning of natural capital

The variables used in that study aimed to investigate the processes related to

wastewater treatment. Therefore, these variables are contextualized to identify the efficiency of the processes for the removal of waste in the waters and, thus, achieve the desired sustainability. For this reason, the meaning of natural capital is indirectly concentrated on definitions of the efficiency of processes for the extraction of contaminating and contaminated waste.

- ***Sustainable Environmental, Social, and Corporate Governance Value Added (SESGVA)***

Intertextual patterns

Dočekalová and Kocmanová (2018) observed variables presented in Sustainable Environmental, Social, and Corporate Governance Value Added (SESGVA), focusing on corporate sustainability, to form a study model.

Meaning of natural capital

This work makes use of environmental, social, and corporate governance indicators. Within the standards related to environmental variables, it highlights investments for the protection of the environment, water consumption, and waste production. The subjects presented previously support the definition of variables used in the research.

- **Methods of analysis of urban metabolism**

Intertextual patterns

Zhang, Yang, and Yu (2015), when carrying out a literature review, adopt a position that the methods and systems of analysis of urban metabolism must be improved. They highlight various methods and projects that study environmental variables to investigate urban metabolism and emphasize that there is a relationship between the processes developed by nature and urban actions.

Meaning of natural capital

The work highlights that the environmental variables are based on energy and material flows. In other words, the concept of an environmental variable must be explored before observing the exchange between material flow and energy in an urban environment.

- **Manufacturing sustainability corporate analysis methods**

Intertextual patterns

Moldavska & Welo (2018) concentrated the work on discussions by different authors, believing that they were opportune since they represented “scientific requirements” for the assessment of sustainability.

Meaning of natural capital

The authors point out that, for global sustainability, variables were used to have negative impacts on natural resources that cause harm to human health.

Table 5 provides a summary of the characteristics previously discussed the use of methods and the NC.

Table 5 - Intertextuality using methods

Studies	Methods
<ul style="list-style-type: none"> • Zijp et al. (2016) • Zijp et al. (2017) 	<i>Solution-focused Sustainability Assessment (SfSA)</i>
<ul style="list-style-type: none"> • Ren & Liang (2017) 	Multi-Criteria Decision Analysis (MCDA)
<ul style="list-style-type: none"> • Dočekalová e Kocmanová (2018) 	<i>Sustainable Environmental, Social, and Corporate Governance Value Added (SESGVA)</i>
<ul style="list-style-type: none"> • Zhang, Yang e Yu (2015) 	Methods of analysis of urban metabolism
<ul style="list-style-type: none"> • Moldavska & Welo (2018) 	Methods of analysis of corporate sustainability manufacturing

Source: Elaborated by the author

5.4.2.2.2 Focus on academic discussions

Intertextual patterns

Fenichel and Hashida (2019) emphasize, in their text, the lack of data on natural capital and its treatment. In this way, they discuss the literature and identify the need to improve natural capital concerning its definitions. Ruggeri (2009) uses literature to present his definition of natural capital. In his research, he highlights that he intended to present criteria and approaches to identify natural capital, in addition to indicators and a clear approach on the connection between ecological definitions and economic elements.

Meaning of natural capital

For Fenichel and Hashida (2019), capital assets are important for future generations and emphasize: “Nature provides an important class of these assets, but

markets rarely reveal the marginal value of natural capital” (p.120). Therefore, for the authors, natural capital is an asset in which the value is not yet defined by the market.

Ruggeri (2009, p. 1726) elaborates his own meaning about natural capital:

“In summary, a natural resource or an element of the ecosystem will be treated as the capital when it meets the following criteria: (a) It is a tangible or intangible asset (b) It is reproducible by man or by nature (c) It is not destroyed in production nor is it incorporated into a product (d) can be used repeatedly over an extended period (at least one year) (e) it generates utility directly or indirectly as a factor in the production of other goods and services once an asset is defined as a capital asset, any direct or indirect government expenditure related to its production, sale, installation, and financing will be treated as an investment.”

The author explains that the resources that should be considered as capital are those used in production and are part of government expenditures. They have an economic focus on their definition.

5.5 DISCUSSION

Demonstrating the academic environment of the authors aimed to highlight their particular interests for the development of arguments on certain subjects when analyzing social practices.

The discussions on the part of the authors are focused on questions about sustainability. Their academic degrees are in line with that theme since they are concentrated in science with an emphasis on environmental studies. Besides, the area of finance that involves management, economics, and administration also has its differential in the curriculum of the authors, making the study on corporate analysis to be adhered to as an object of study.

The organizations in which these authors are inserted professionally have a bias towards studies on sustainability and analyzes of land use. It is possible to observe because the main institutions of professional practices of such authors are RIVM - National Institute for Public Health and the Environment in the Netherlands, Teagasc - Rural Economy & Development Program - in Ireland, and INRA - French National Institute for Agricultural Research - in France.

Therefore, what is perceived is a discourse primarily constructed related to the academic realities of the authors analyzed here. This makes the study patterns follow particular questions of beliefs and ideologies based on the professional environment. They are social actors who have the intention of the research, since, in their curricula,

they self-identify as professors and researchers, mainly.

Another issue observed about discursive practices was the intertextual patterns in the articles. To identify, then, in addition to social reality, what the authors use in their texts as structures for the formation of their speeches.

The creation of knowledge about environmental variables to measure and contextualize natural capital is related to the use of international documents (Couharde et al., 2011; Engelbrecht, 2009). These documents are considered important for environmental measurement since they support the calculation of inclusive wealth, actions aimed at social well-being and sustainable development (Delai I., 2011; Husgafvel et al., 2017; Kaivo-Oja et al., 2014; Nikolaou et al., 2019; Van Beynen et al., 2018). Thus, there is heterogeneity in the discourse on measuring sustainability and different beliefs in the construction of variables that should be measured on natural capital by the authors. The beliefs that signify natural capital refer to variables allusive to human health, waste in water, agricultural production, ecosystem resources, and material and energy flows (Fenichel et al., 2016; Kurniawan & Managi, 2017; Lior et al., 2018; Rodrigo et al., 2015).

Just as there are different beliefs about the knowledge of environmental measurement and concepts about variables, there are also significant differences in the way of measuring. Study methods (Moldavska & Welo, 2018; Zhang et al., 2015; Kelly et al., 2018) have been used and discussed to address what would be the best way to put the measurement into practice: indicating a specific problem; focusing on a single attribute in the environment, such as water analysis; using as a basis what specialists in different areas believe to be feasible to measure sustainability in the corporate environment; or else observing what is understood between flows of inputs and outputs of materials arising from the interaction of man with nature. Besides, metrics used in research are varied.

In these studies on methods, the variables indicated were aimed at harmful effects on the environment and variables were present on the depletion of environmental resources, contaminating residues, environmental protections, and pollution (Dočekalová and Kocmanová, 2018; Ren & Liang, 2017; Zijp et al., 2016; Zijp et al., 2017). This leads to the question that the discourse employed does not present a dialogue about definitions or significance of natural capital, as they indicate the negative actions that are plaguing the environment.

Consequently, the researches that made a discussion based on the literature presented a different concern from the others. They paid attention to definitions and

improvements on natural capital (Fenichel & Hashida, 2019; Ruggeri, 2009). They bring, then, a discourse based on the question that natural capital is an object of analysis and observation for the scientific environment. Thus, there was a definition of natural capital in such research. However, the definitions are based only on economic analysis, since they employ concepts such as assets not valued by the market and capital resources used in production.

5.5.1 What is natural capital?

Texts are important sources of information and the formation of social practices. First, the authors' points of analysis are in line with their professional practices and encompass, in research on environmental resources, their ideas experienced in their areas of study: sciences with a focus on the environment, engineering, economics, finance, ecology, among others.

What can be inferred is that there is an interest in such an area of study in several areas of research. This is an important fact for the issue of interdisciplinary research aimed at expanding qualitative questions about environmental variables.

However, there is a concentration of studies that use international documents as a basis for their research, because they are available sources, which facilitates research. The approaches brought are related to social well-being, inclusive wealth, and sustainable development, which are topics discussed and integrated with the analysis of the use and stocks of environmental resources to achieve sustainability. A perspective contextualized by the environmental economy (Åkerman, 2005), but which has flaws, as it does not infer about the value that this nature has for the relationship between nature and man, which allows us to place, in the same context and on an equal basis, nature and man.

Improving methods, despite being relevant to academic research, requires the establishment of criteria on variables. Addressing only negative questions about the use of the environment is limited and does not have a meaning of what nature represents. It should be noted the need behind these studies, since they seek to carry out experiments with existing variables, to expand the practice of the methods and highlight their relevance, for example, to infer about public policies.

For those studies that sought a definition, there is an intention to consider science as a means of defining natural capital. However, there is still a strong economic aspect to these definitions. The view that this is a resource attributed to production still has its

relevance in the scientific environment. Significance, in this sense, brings, once again, the need to value nature, considering its qualitative aspects as objects of study.

Therefore, based on the discussions presented here, the natural capital encompassed in the research are environmental resources invoked by several areas of study that are directed to the analysis of their use, to meet the demands of man who require proven methods of measurement.

5.6 CONCLUSION

This research aimed to carry out a critical analysis of the meaning of natural capital in scientific research. For that, it used as a basis the CDA contextualized by Fairclough.

Social actors follow a research approach in line with their social practices. The speeches are inserted in the context of the professional practices of the authors, who are researchers and teachers present in several teaching centers. Its diversified research areas lead to the importance of attributing, in academia, analyzes with different perspectives, and not being limited to a restricted view (Barbier, 2014) on a single characteristic present in natural capital.

Regarding the speeches constructed, it should be noted the alignment of the texts with the search to bring a verifiable agenda about the future of the environment, which is necessary for human life (Fenichel et al., 2016; Moldavska & Welo, 2018). In the approaches, the focus on observing the stock of natural resources and how they are used is seen when there is a need for measures and analysis on inclusive wealth and practices that lead to the permanence of environmental resources for future generations - social well-fare. They are categorized as essential items to sustainability over time (Delai I., 2011; Husgafvel et al., 2017; Kaivo-oja et al., 2014; Van Beynen et al., 2018).

However, it is worth asking that this economic view based on observing man as an object that drives research on natural capital, a view then anthropocentric (Zalasiewicz et al., 2011; Arias-Maldonado, 2015), brings limitations since it ends up not focusing on the importance of nature as an item of value (Åkerman, 2005; Bell, 2005). This causes a separation between man and nature when what must be addressed are parts that cannot be disassociated (Zalasiewicz et al., 2010).

Based on the previous questions, an approach on the concept of natural capital is proposed, taking as principles: i) interdisciplinary discussion focusing on the relationship

between man and nature; ii) indication of variables that represent the environment; iii) presentation of the importance of variables for both man and nature.

If nature is a valuable object, its contextualization is necessary to know not only what it has to offer, but what its needs and its meaning for the world are (Küpers, 2020). Therefore, giving the proper meaning of natural capital requires recognizing its value to the world. From then on, metrics can be taken into account for your future measurement.

6 INTEGRATED DISCUSSION OF THE THESIS

In the systematic review, keywords were first identified to indicate works that dealt with the subject of measuring environmental resources. Thus, in Scopus, studies were found on environmental measurement (815 surveys), measurement of the environment (270), measurement of sustainability (771 surveys), and measurement of natural capital (09).

After reading the abstracts and the content on the variables, the focus of this work was at the end concentrated on the analysis of 17 surveys on the measurement of sustainability and 5 on the measurement of natural capital.

The metrics are observed in a field of quantitative study, which limits the definition of variables as to qualitative attributes on the social and ecological characteristics present. The results found indicate that the study variables are concentrated on the negative impacts caused to environmental resources.

With the identification of these studies, an observation about the content of the texts came to be elaborated. Thus, through content analysis, the texts contained specific characteristics, to identify and discuss sustainability, which is characterized as “corporate”, in which the economic area is focused (Robinson 1970; Usher 1965; Brand 2008), questioning the discussion of the relationship between capital and labor.

There is sustainability with a perception on which the basis is the management of the environment, discussing attributes such as forests, agriculture, and water analysis (Huffaker & Wilen 1991; White 2000). The analyzed texts address environmental issues related to the study of water, considered as a necessary factor for man's life (Delai 2011; Zang, Yang & Yu 2015; Hai et al., 2015; Zipj et al., 2017).

However, it is worth observing the ecological vision going beyond the factors identified, since biological elements are essential items for ecology. Ecology brings with it an approach to understand the interaction between organisms and their environment. The ecology of the ecosystem seeks to understand the factors that regulate pools (quantities) and flows (flows) of materials and energy through ecological systems. These materials include carbon, water, nitrogen, elements derived from rocks, such as phosphorus, and new chemicals, such as pesticides or radionuclides, which people have added to the environment. These materials are found in abiotic pools (non-biological), such as soils, rocks, water, and atmosphere, and biotic pools, such as plants, animals, and soil micro-organisms (microbes). An ecosystem consists of all organisms and the abiotic pools with which they interact (Chapin, Matson, and Vitousek, 2011, p. 04).

The content analysis portrayed the presence of the social vision of natural capital since the measurement of the environment has as one of its objectives to attend to social well-being (Kaivo-oja et al., 2014; Engelbrecht, 2009), necessary to man's life over time.

Regarding the social aspect, the fact is that man depends on nature (Sieferle, 2011), primarily in history. To meet his personal need, he hunted animals and used natural resources for his survival. Subsequently, nature became a converted resource to raise monetary resources (Coelho et al., 2012; Erb et al., 2013). In this context, it is worth launching the perception that man brings about nature and affects the way of living and environmental standards over time (Fischer-Kowalski & Weisz, 2016).

Through this lens, the view called social ecology brings an important perspective to understand changes in species, in man, and in the environment in which they interact (Oommen, 2015). Besides, characteristics such as survival, affective needs, protection, cultural identity are artifacts to be used in this ecological and human perspective on nature emphasized in the work of Pierre Dansereau (1972, 2000).

To continue a textual analysis, a critical analysis was used, because it observes social issues that may influence discursive practices. When approaching the social practices of researchers through their curricula, a relevant characteristic was the formation in sciences with an emphasis on the environment as professional knowledge.

Also, the institutions in which the researchers belong to research sustainability. Thus, the speeches of the researchers are directed to their professional practices, considering the environmental variables as resources that must be measured for the analysis of sustainability.

As for intertextual issues, the research deals with a meaning aimed at meeting the definitions of international documents and supporting analysis models created for measurement. Such documents are extracted from the United Nations (UN), the World Bank, and the Global Reporting Initiative (GRI). The studies highlight these documents for environmental measurement, being characterized as important for inclusive wealth, actions related to social well-being and sustainable development (Delai, 2011; Husgafvel et al, 2017; Kaivo-oja et al., 2014; Nikolaou et al., 2019; Van Beynen et al., 2018).

There is a view that sustainability must be measured first, analyzing the use of natural resources in the present, and then identifying the needs of future generations (Dasgupta, 2001; Folke & Berkes, 1993; Guerry et al., 2015) - a view to serve the interests of man. In research, the focus of analysis of variables of natural capital constitutes those used by man and offered to the market as products from fishing, agriculture, hunting, and

mining. An economic vision that characterizes nature as a product sold by man.

Measurement is aligned with observing the impacts caused to the environment, with the perspective of meeting economic interests. This is a vision based on the school of environmental economics and ecological economics, as, first, it aims to observe the negative impacts and, then, it understands that there is an economic dependence of man on the use of environmental resources (Cechin, 2010).

Even with these limitations, there is evidence of assistance between the different areas, since authors with diverse training areas were found. This characterizes the interest in interdisciplinary research on the topic related to the measurement of environmental resources.

The variables in general focus on meeting the needs of man, this anthropocentric view, so that, afterward, it can use resources from nature, causing less impact to it. However, there is still an asymmetry in this man-nature relationship, thus excluding the ecocentric view. In the ecocentric view, nature becomes the center of value and is associated with an ecological view (Gladwin, Kennelly, and Krause, 1995).

Within this scenario, such an ecocentric view becomes relevant, as it brings to the discussion of environmental measurement the appropriation of studies based on variables that also meet the perspective of nature: considering man and nature as inseparable elements within an environment based on ethics (Naess and Rothenberg, 1989). Therefore, economic and social interests must be associated with the ecological attributes present in the environment, to meet a collective interest, visualizing the need for future generations (Parks, Joireman and Lange, 2013).

Although economic issues are relevant, accounting science has its social responsibility. For this reason, accounting research must go beyond the economic atmosphere and broaden your view of how man observes nature. Climate change, species extinction, unrestrained land use for cultivation purposes, in addition to explorations, are limits to the survival of the environment over time. Therefore, it must be reflected what extent the harm must be caused at the expense of only economic values.

It is known that nature has its limitations and it needs time to continue ecosystem services. Furthermore, nature needs to be present over time for future generations. However, an anthropocentric view prevails, and the interests of the environment are minimized when measuring natural capital.

6.1 PERCEPTIONS EMERGED FROM RESEARCH ON NATURAL CAPITAL

Throughout the research, important aspects related to the definitions of social capital can be interpreted. These are approaches that give meaning to the increasingly contextualized study of natural capital.

The first to be highlighted are ecosystem services (Schaeffer et al., 2015; Anielsk, 2005), as they bring the importance of what nature offers. However, for this offer not to be harmed or extinguished, one must address what services these are and what their value is for the biological system.

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7 FINAL THESIS CONSIDERATIONS

The theoretical field on the capital carries a mirror view of the economy. The importance of making definitions of capital was concentrated on models for identifying economic development (Usher, 1965).

In this line of thought, accounting is developed by bringing into practice the technique of inferring resources used in the economy with monetary parameters. The indication of monetary amounts becomes more relevant than clear definitions of qualitative aspects of assets, liabilities, income, and expenses (Oguri, 2005).

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To link theoretical knowledge, the interdisciplinary methodological field brings with it the practice of knowledge through methods, to create answers to be discussed, bringing into this field what the theory expects as a definition of capital. Thus, the social, the environmental and the economic become associated elements that aim at the same object, introducing concepts that go beyond the line related to production (Arrow et al., 2003; Engelhard, 2009). Furthermore, this knowledge takes into account that observation must also be in the field of social and human relations with the environment (Brand, 2008).

Therefore, accounting as a social science denotes its responsibility to practice the measurement of environmental resources, to bring updated and grounded information with quantitative and qualitative characteristics that absorb the current needs that are present in the relationship of the human being with nature and to make it possible to minimize the communication asymmetry between both elements, human and nature, thus expanding the field of studies on environmental accounting, more specifically concerning the measurement of natural capital (Fenichel & Abbott, 2014; Málovics, Csigéné, Kraus, et al., 2008).

The work was focused on identifying the conceptual issues of natural capital in the research. This question was intended to contribute to the inclusion of qualitative aspects valuable to accounting measurement, taking as a starting point the discussion about natural capital. Thus, it aimed to contribute to studies in environmental accounting, as they still need a concomitant social and economic look, to analyze the services and goods that a society can obtain with nature.

The perspective presented in this work brings important findings to contextualize natural capital, among which is the question that there is a quest to perform measurements, as sustainability and society are important over time. However, the anthropocentric view is a fact that limits the recognition of the environment as an item of value and leads Nature to have the attribute of serving man, that is, the environment is a subservient object of society. Taking the ecocentric view against the discussion of natural capital makes the valorization of nature relevant while being inseparable from man.

Even with this limiting view on the recognition of the environment, areas of study, such as economics, engineering, environment, and business, present their concern with the treatment in research about NC. It is understood that the concepts are limited to observing, first, the negative impacts caused to the environment and, second, considering the quantitative characteristics to be able to measure variables of nature. However, approaches that demonstrate qualitative characteristics are attributes not discussed in the research.

For this purpose, interdisciplinary researches are relevant to be able to frame thoughts from different areas in the same discussion about natural capital and, thus, to be able, in a qualitative way, to infer on the metrics relevant to the environment, as well as to observe the ecosystem services present in it.

With the questions presented, a construction of measurement variables is advocated through the following steps: i) interdisciplinary discussion of natural capital

with an emphasis on the relationship between man and nature; ii) indication of ecosystem services; iii) presentation of the analysis variables; iv) demonstration of the importance of the variable for man and nature; v) elaboration of analysis methods; vi) public policy proposals.

This research is in line with accounting science because it discusses measurement. Furthermore, it seeks to collaborate with the social sciences, when discussing the relationship between man and nature. It is worth emphasizing that this relationship needs to be explored in a philosophical and sociological view: philosophical in the sense of understanding what nature is for man; sociological to discuss the relevance that man dedicates to nature because it is important for his survival.

There is a limitation of this work, as it is directed to the chosen sample. For underlying research, intertwining accounting science with social and ecological areas becomes relevant for the continuity of discussions. Besides, assistance is expected through research into local public policies, when the quantitative and qualitative definitions of natural capital become evident. Finally, in addition to the questions suggested above, expanding the ecological debate in the social sciences with a focus on the value of nature in social sciences becomes a relevant object of future research.

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