BIOSPHERE IMPACT BALANCE SHEET – MEASURING CORPORATE SUSTAINABILITY IN BOUNDED ECONOMY

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ABSTRACT

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Abstract

Ecosystem services are vital for humans and producing them in other ways is expensive, problematic, and in some cases even impossible. However, climate change and loss of nature threaten the natural capital which provides these services to humans. The way we produce and consume commodities plays a significant role in both the formation of the problem and its solution, but the way we measure e.g. economic development has been criticized for supporting mainly the formation of the problem.

The master's thesis claims that the way corporations operate is one of the key factors in terms of maintaining the value of natural capital, but our way of measuring a corporate sustainability and development does not sufficiently support the solutions. One of the fundamental factors that has been debated is the idea of whether our economic activity is part of nature's larger system, and whether nature then also creates limits for the corporation's activity. The Dasgupta Review (2021) starts from this idea based on the impact inequality formula created by Barrett et al., (2020) and the idea Rockstrom et al. (2009) develop on planetary boundaries. Together, these publications seem to create interfaces whereby the value of natural capital changes. Master’s thesis sets out to define the corporate sustainability through the balance sheet with the basic idea that when the value of natural capital changes due to the corporation's operations, the sustainability of the corporation's operations also changes.

The goal of the Master's thesis is to create a balance sheet – Biosphere Impact Balance sheet – in which the formation of four main groups of the balance sheet are examined: assets, receivables, liabilities, equity, and the connections between them. Although it is found that the created balance sheet can bring added value in measuring and monitoring the corporation's sustainability, especially from the point of view of how far the corporation's operations are from the defined sustainability, it also notes that the tools used to create the balance sheet are not without problems. There are several challenges for using them and not all the problems identified can be solved.

Key words
biosphere impact balance sheet, BIBs, corporate sustainability, strong sustainability

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TIIVISTELMÄ

Tekijä
Mia Nelimarkka

Työn nimi
Biosfäärivaikutusten Tase – yrityksen kestävyyden mittaaminen sidotussa taloudessa

Oppiaine	Työn laji
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Tiivistelmä

Luonnon tuottamat ekosysteemipalvelut ovat elintärkeitä ihmiselle ja niiden tuottaminen muilla tavoin on kallista, hankalaa sekä joissain tapauksissa myös mahdotonta. Kuitenkin ilmastonmuutos ja luontokato uhkaavat juuri luonnon pääomaa joka näitä palveluita ihmiselle ilmaiseksi tuottaa. Tapamme tuottaa ja kuluttaa hyödykkeitä on merkittävässä roolissa sekä ongelman muodostumisessa että sen ratkaisussa, mutta tapaamme mitata mm. taloudellista kehitystä on kritisoitu lähinnä tukevan ongelman muodostumista.

Pro gradu väittää, että yritysten tapa toimia on yksi luonnon pääoman arvon säilymisen kannalta oleva keskeinen tekijä, mutta tapamme mitata yrityksen kestävyyttä ja kehitystä ei tue riittävästi ongelmien ratkaisua. Yksi perustekijöistä josta on kiistelty, on ajatus siitä onko taloudellinen toimintamme osa luonnon suurempaa systeemiä ja luoko luonto silloin rajoja myös yrityksen toiminnalle. Vuonna 2021 julkaistu Dasgupta Review lähtee tästä ajatuksesta perustuen Barrett et al. (2020) luomaan impact inequality-formulaan sekä Rockstrom et al. (2009) kehittämään ajatukseen planetaarisista rajoista. Yhteensä nämä julkaisut näyttäisivät luovan rajapintoja, jolloin luonnon pääoman arvo muuttuu. Pro gradu lähteekin määrittelemään yrityksen kestävyyttä taseen kautta sillä perusajatuksella, että kun luonnon pääoman arvo muuttuu yrityksen toiminnan johdosta, myös yrityksen toiminnan kestävyys muuttuu.

Päämääränä Pro gradussa on muodostaa tase– Biosfäärivaikutusten Tase – jossa tarkastelun kohteena ovat taseen neljän pääryhmän muodostuminen: varat, saatavat, velat ja oma pääoma sekä näiden väliset yhteydet. Vaikka muodostetun taseen todetaan voivan tuovan lisäarvoa yrityksen kestävyyden mittaamisessa ja seurannassa erityisesti siltä kannalta, kuinka kaukana yrityksen toiminta on määritellystä kestävyydestä, todetaan myös että taseen muodostamiseen käytetyt työkalut eivät ole ongelmattomia, niissä on useita haasteita, eivätkä ne pysty ratkaisemaan kaikkia todettuja ongelmia.

Asiasanat
biosfäärivaikutusten tase, BIBs, yrityksen kestävyys, vahva kestävyys

Säilytyspaikka
Jyväskylän yliopiston kirjasto

CONTENTS

LIST OF FIGURES AND TABLES

Figures:

Tables:

1. INTRODUCTION

1.1. A call for a more holistic valuation and management of natural capital

Whilst the general public, corporations, and states try to mitigate and adapt to the consequences of climate change, from it's shadows has risen another threat, closely related to climate change, but much more difficult to define in terms of it's consequences and scale – the loss of nature. Around 10 000 years ago humans generated the potential to alter ecosystems significantly and since then the handprint of our operations has been increasingly visible in the structure and functioning of ecosystems to the point where we can now talk about the time of Anthropocene (IPBES, 2019). The list of indicators showing this is long: the trend in overall RLI in Red List Index is declining (IUCN, 2021), the stock of global natural capital per person has declined (Secretariat of the Convention on Biological Diversity, 2020), the levels of global pollution have increased (IPBES, 2019), the areas of wilderness continue to decline (Secretariat of the Convention on Biological Diversity, 2020), nearly 96% of global mammal biomass consists of humans and our livestock (Pörtner et al., 2021), and the anthropogenic mass is surpassing the amount of all global living biomass (Elhacham et. al., 2020), etc. However, the life as we know it-altering consequences start to rise when our actions cumulatively start to affect the biosphere's functioning in large scale. This is because when the biosphere is otherwise intact and functional, the loss of a few species or the deterioration of the few ecosystems can usually be replaced or compensated in other ways. But when our cumulative impacts – regarding amount-, scale- and time wise – have been large enough to have weakened the biosphere's resilience, each further action starts to impact biosphere's functioning more clearly. Some of these impacts might cause positive and/or negative consequences, affecting disproportionately different individuals. As a consequence, the risk of crossing a tipping point and causing a regime shift increases (Dasgupta, 2019), which could lead us to the new operating environment with potentially high negative risks to human well-being. This is the crossroad that several assessments consider us to be: Millennium Ecosystem Assessment (2005), The Global Assessment Report on Biodiversity and Ecosystem Services (IPBES, 2019), Global Biodiversity Outlook 5 (Secretariat of the Convention on Biological Diversity, 2020), Living Planet Report 2020 (WWF, 2020), and The Changing Wealth of Nations 2021 (World Bank, 2021).

Nature's goods and services are essential for human existence and well-being (IPBES, 2019) for which we rely directly and indirectly from food that we eat, air that we breath, to building materials for our houses and infrastructure. Some of these nature's services can be substituted, but most are not fully replaceable, and some are even irreplaceable (IPBES, 2019). Preface in the Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change (Pörtner et al., 2021) notes that although the biodiversity loss and climate change are the two most urgent issues of an Anthropocene and that their interaction is acknowledged among the scientific and policy-making circles, they are nevertheless mostly considered in their respective fields to the point where each have their own international convention and intergovernmental

body for knowledge assessment. The workshop continues that this functional separation creates a risk that the measures taken to solve another issue will, in worst case scenario, prevent by oversight to solve another or even both issues, because of an imperfect recognition and processing of connections between these two. For example, emissions from the energy section is a major component in the Kyoto Protocol and the production and consumption of energy in different sections of the economy account over 75% of the EU's greenhouse gas emissions (Kyoto Protocol; COM/2019/640). Therefore, European Commission communicated The European Green Deal (COM/2019/640) in order to, among other things, guide EU's member states towards net zero greenhouse gas emissions by 2050. Rare earth elements, however, play a major role in transition to greener energy (Jyothi et al., 2020), but acquiring them has raised concerns from other environmental risks (Talan & Huang, 2022; EEB, 2021), and even about the adequacy of some of the needed mineral reserves (Michaux, 2021). At its best, a comprehensive assessment of synergies will mean that actions taken in order, for example, to strengthen biodiversity will also facilitate mitigation to climate change (Pörtner et al., 2021). Similarly, ignoring negative trade-offs can lead, for example, to an attempt to improve climate change in a way that causes a decline in biodiversity and the depletion of ecosystem services (Pörtner et al., 2021).

The consequences of not solving both of these issues, nature loss and climate change, could be dire. Diamond (2005) states in his book that nature-related problems have been, at least partly, the cause of the disintegration of past civilizations; the activities of the community have led to the destruction of nature, to the destruction of the very capital on which their lives were depended on. He continues that the process that has lead to this unintended ecological suicide can be dived into eight categories whose relative importance has varied from case to case: overhunting, overfishing, soil problems (soil fertility losses, salinization, and erosion), deforestation and habitat destruction, water management problems, effects of introduced species to native species, increased per capita of people, and human population growth. Demarest and Victor (2022) on the other hand note that all societies eventually collapse. However, the authors argue that a collapse rarely means complete political, economical, and ideological breakdown, but instead it should be understood as a rapid disintegration of logic and institutional arrangements that hold together the economic system's elements and networks that are grounded in political economy. All of the themes that Diamond (2005) mentions as undermining past societies are familiar in today's debates, the difference is that many of the problems today are global and not merely local. In addition, we also have four new human caused problems: climate change, energy shortage, buildup of toxic chemicals, and human's full utilization of the Earth's photosynthetic capacity (Diamond, 2005). Demarest and Victor (2022) note that civilizations can survive different forms of calamities like floods, droughts, and war. But, according to authors, historically there has been one form of calamity from which civilization has not been able to survive and that is the collapse of legitimacy. Legitimacy can be defined in many ways, but for example Suchman (1995, p. 574) has defined it in a strategic and institutional setting as "...generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions". Diamond (2005) notes that despite our similar problems with former societies, we also have considerable differences. Some of these differences are our strengths for solving the problems, others hinder them, and some can be either or both. Author mentions globalization and

technology belonging to the latter. Globalization means that temporal and local problems, like bad harvest year, can be overcome with the help of globalization. However, globalization also means that the problems might not be merely local, nor temporal, and that the risks might spread through a globalized supply chain. New technological solutions like geoengineering, on the other hand, might bring us unprecedented solutions, but can also cause unprecedented problems (Thiele, 2018). Diamond (2005) though comments that none of the societies he examined had disappeared solely for environmental reasons, but there were other factors involved as well; when one factor puts the resilience of the community to the test, the simultaneous appearance of another or a third actor may lead to collapse. Today, for example, Europe is facing not only consequences of climate change (EEA, 2022b) and biodiversity loss (EEA, 2021a), but also consequences of global financial crises (Ehnts & Paetz, 2021), covid-19 (Ehnts & Paetz, 2021), and most recently also consequences of high inflation as well as Russia's aggression in Ukraine (ECB, 2022). Demarest and Victor (2022) also talk about both the risks and success that coherence and entanglement brings, and point out that historically we are living a time of extensive hypercoherence and infrastructural entanglement. This might mean that serious problems in one area can lead to a domino effect, hence leading to more problems and/or spreading to other areas. What is interesting above all is why some societies overcame their problems. Diamond's (2005) own assessment is that the societies that survived the problems were united by two things: long-term planning and the ability to question and change their core values as needed. Also Demarest and Victor (2022) highlight the problem of the immutability of basic values and the short-term decision making resulting from status rivalry. Short-term decision-making is problematic in regards of natural systems already because the changes made in the operation are slowly reflected in them. Because of this, monitoring in periods of a year, or nowadays even shorter terms like quarter of a year, is not sufficient and might not produce the kind of information that would necessarily lead to real improvements. In addition, phenomenons called "creeping normalcy" and "landscape amnesia"[1] can be considered to require long-term monitoring so that the slowly occurring erosion does not go unnoticed. The more problematic is the question of core values: identifying those core values that need to be changed and identifying those ideas that would better work for our purposes. According to Demarest and Victor (2022) the policy changes can be successful when they are made keeping in mind the paradoxes and the narrow path that must be walked on between innovation and legitimation of achieving ones own positive outcome. Diamond (2005) brings up an interesting idea to redefine what is usually meant with "breach of fiduciary responsibility". The author states that in his country it is usually considered to mean a case where directors have knowingly managed a company in a way that has reduced profits. What would happen if it would be redefined to mean a case where the company has been knowingly managed in way that has reduced its asset values?

Because Nature provides so vital services to human beings, it is no wonder that demands for measurements for growth and progress exceeding GDP have risen in resent years. For example, World Bank (2021) has raised the importance of measuring Total Wealth and Dasgupta (2021) Inclusive Wealth. Similarly they include to the measure of

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1 "creeping normalcy" is used to describe a slow trend that is concealed within noisy fluctuation and "landscape amnesia" to describe how one forgets how different everything looked 50 years age (Diamond, 2005)

wealth, in addition of produced capital, also the natural and human capital. But where as World Bank and Dasgupta talk about measuring wealth in national and global level, this paper argues that corporations play a vital role in the formation of natural capital and that our current measurements of sustainability, profit and loss, nor balance sheet reflect this fact. A new way of measuring corporation's value is also important in terms of corporation's own continuance, as corporations on average usually prosper better in stable operating environments. Therefore, it is not surprising that when the concerns of the consequences of climate change and loss of nature rise, the risks brought by climate change and the loss of nature are also reflected in business risk reviews (World Economic Forum, 2021; 2022). In addition, Meyer and Rowan (1977, p. 349-350) remark that organizations become more vulnerable to the claims of negligence, irrationality, and unnecessary when they lack "acceptable legitimated accounts of their activities". In order for the corporation to maintain its social right to operate, it needs to appear to be part of the solution or at least neutral in its operations. Above all, it must try to avoid a situation where it cannot defend itself from accusations of being part of the problem. When the demands for a more versatile and comprehensive examination of impacts to natural capital in society rise, so does the pressure on corporations to respond to them. Time is of essence. The Doomsday clock's handles', which can be argued to represent the risk of global catastrophe, were set to 100 seconds in 2020 (Bulletin of the Atomic Scientists, 2022) and they stayed in that position – closest to midnight than ever before in the clock's history – 2022 too.

1.2. Research question and it's aim

Motivation for the research comes from the personal quest to find answers, or at least idea of, to the fundamental question of when, at the minimum requirements, can a corporation, and in extension its products and service, considered to be sustainable – not more sustainable than previously or compared to competitors, or sustainable in regards of few indicators like emissions and water usage – but sustainable holistically on its own? What kind of choices and boundary settings we would then face? The quest is an ongoing process and the views gained from it will certainly change as scientific knowledge develops and different perspectives are emphasized. During the journey, however, it is good to stop now and then and to reflect the holistic picture that is forming from the information that is available and how our way of operating meets the society's demands. Holistic monitoring, however, requires taking into account also trade-offs and based on the numerous reports on biodiversity and climate change, there also seems to be some minimum requirements for sustainable human activity. This requires that different impacts need to be made co-measurable in some way. In addition, there is also a question of how effective it is to require consumers to switch to more sustainable consumption if there is no way to find a comprehensive comparison between different products, services, the ways in which they are produced, and how far their ecological footprint is from sustainable?

The idea that we need a balance sheet -like monitoring for nature has risen in recent years (World Bank, 2021; United Nations et al., 2014; United Nations et. al., 2021). The idea seems to be to have a more comprehensive picture of the impacts that we have on nature, and through it also achieve better natural capital management. But traditional economic balance sheet is more than just assets – it also deals with liabilities

and equity. Both are interesting concepts in regards of nature and corporations: when a corporation can be considered to be indebted to nature (or more precisely to the benefits of nature), and when a corporation can be considered to have "positive equity"? What would this all mean – could a balance sheet -like, lets call it Biosphere Impact Balance sheet (BIBs), reporting be a way to monitor corporation's sustainability more holistically? If we consider that in traditional balance sheet the shareholder's equity represents the corporation's solvency at the end of the fiscal year, could the BIBs' equity show corporation's sustainability at the end of the fiscal year? Is holistic monitoring even possible this way? Based on this, the paper raises the question of if the corporation's sustainability were to be measured in the form of a balance sheet, what would that balance sheet look like?

1. How to measure a corporation's sustainability in a form of a balance sheet?

The main question of the research is how to measure a corporation's sustainability in a form of a balance sheet, and it sets out to answer that question by building a corporation's Biosphere Impact Balance sheet (BIBs) through the selected theories and emphases, and using the traditional balance sheet formula. When forming BIBs, however, we inevitably find ourselves in a situation where we have to define interfaces, for example, to with what kind of values BIBs are formed on, and when a debt according to BIBs has been materialized from the corporation's operations. For this, the paper uses another recently publicized report, The Dasgupta report (Dasgupta, 2021) whose central themes of the Impact Inequality formula and planetary boundaries seems to give us a basis, especially a mathematical basis, for forming interfaces between, for example, debt and receivables. The definition of the interfaces is strongly linked to the question of what kind of information or what kind of questions BIBs should answer. From the traditional balance sheet one can, for example, conclude the corporation's solvency, profitability, anticipation of future liabilities, investments for the company's future, etc. Because we also know the principles on the basis of which the balance sheet is formed, we can also make educated predictions to where the corporation is heading. Due to this, the paper also asks what is the information that is sought from BIBs and what kind of determinations and line drawing we may then have to make about the principles of forming BIBs. In the traditional compilation of the balance sheet, for example, the division of long-term expenses and write-downs and increases in value are provided for in Chapter 5 of the Bookkeeping Act (KPL 1336/1997). What could be the basic principles of BIBs?

2. What is the information that is sought from the BIBs?

3. What kind of principles we might need to establish so that the BIBs provides the desired information?

Finally, the paper also considers what BIBs and the principles formed for it could mean in practice: what kind of problems can be encountered, what are the weaknesses of the chosen tools, how, for example, the formed principles can be reflected to society's demands, and could the BIB's equity actually be used to measure a corporation's sustainability?

4. What BIBs and the principles formed for it could mean in practice?

1.3. Delineation of the report's point of view

The perspective discussed in the paper has been limited in a way that inevitably leads to a simplified and limited perspective on the corporation's sustainability. The first one relates to the technical approach. Regardless of whether the purpose is to examine whether balance sheet-type reporting would be conducive to achieving a holistic view of the impacts of a corporation's operations on natural capital, since the topic is addressed by building BIBs with the help of a few selected tools, the work does not take a position on how another tool or theory would affect the conclusions. Instead, an effort has been made to address the possible problems or disadvantages of the tools used. By choosing different theories and approaches very different considerations could be reached. Secondly, the perspective has been greatly narrowed by delimiting e.g. ethical issues about the intrinsic value of nature and the rights and needs of future generations. For example, future generations are considered to be an important stakeholder group by some scholars (see e.g. Zsolnai, 2006; Anderson et. al., 2012) for the corporations' sustainable stakeholder management. This view, however, raises complex questions of future generation's needs concerning the amount of natural capital that is needed and natural capital's substitutability between another type of capital forms. Instead, the paper approaches the selected tools from purely mathematical perspective and does not take a stand on ethical choices except when it is inevitably faced in practice. Thirdly, the research excludes the social and economic aspects. Conflicts might arise, for example, on the rights of the today's poor (see e.g. Arenas & Rodrigo, 2016), the rights of the shareholders, and the corporation's purpose[2]. Lastly, and perhaps the biggest limitation, is that even if we start from the assumption that the theories used would be able to comprehensively describe the desired end result, which they are hardly able to do, we are still not fully aware of what all we should take into account, and how the systems of nature as a whole actually work (United Nations et. al., 2014). Therefore, the thesis even at it's best, will only start the discussion of the framework of measuring corporate sustainability in a way as described in the thesis. At a minimum, it uses the language of financial management adding its perspective to the discussion of corporate sustainability and it's measurement.

1.4. Report's structure

The report is structured into five sections. The first section, introduction, describes the extent of the social pressure on which the report tries to respond to, research questions, and delineation of the perspective used in the report, and it's task is to give an overall picture of the aim of the research. The second section describes the theoretical framework. The theoretical reference framework of the research is formed by what the

2 For example according to Finnish Companies Act (osakeyhtiölaki 624/2006) 1:5, the purpose of the company is to generate profit for the shareholders, unless otherwise stipulated in the articles of association.

sum of the theories reviewed in the research are trying to measure, i.e. the corporation's sustainability, and some background to the previous studies. The methodology-section describes the research approach and data collection. Since the goal of the research is to build a balance sheet that would give information on a corporation’s sustainability, the main data of the research is the review of the selected theories and the answers to the research questions derived from them. Due to this, the methodology section also goes through why the chosen approaches have been selected for the study. The data section itself can be seen to be divided into three larger entities: the first one seeks answer to the questions of what is the information that we are seeking from the BIBs, and the second considers what is the bottom line, and what kind of principles could be created for BIBs based on them. The third entity is based on the balance sheet ideology, and its main objective is to build up an outline for BIBs. The last section, discussion, goes through the possibilities of using the BIBs, and the weaknesses and strengths of the BIBs that is created in the report.

2. THEORETICAL FRAMEWORK

2.1. Corporate sustainability as a concept

One of the United Nation's Sustainability goals – goal 12 – is to ensure sustainable consumption and production patterns (United Nation, 2015). Yet, despite the growing research in corporate sustainability, the concept has remained vague (Meuer et al., 2020) and corporations have struggled to implement it in a way that would meet the stakeholder's expectations (Silva et al., 2019). Corporate sustainability research has risen from scientific fields such as environmental engineering, management research, and environmental economics (Meuer et al., 2020). It is related to other concepts such as corporate citizenship and corporate social responsibility (CSR), but nevertheless differs significantly from them (Meuer et al., 2020). Early corporate responsibility research focused on to the question of "corporate value versus stakeholder rights" (Bansal & Song, 2017, page 107), and considered social issues such as product recalls and labor disputes (Bansal & Song, 2017). Early sustainability research, on the other hand, rose to meet the concern of economic development breaching the limits of natural resources, and the contrast was often between the development of the economy and the preservation of nature (Bansal & Song, 2017). In the early 2000s, these two movements began to intertwine by discussing both the issues of natural environment and the society in their respective theoretical frames (Bansal & Song, 2017). In 1994 Elkington had introduced a philosophy called a triple bottom line (TBL), which is a sustainability framework where a corporation's environmental-, social- and economic impacts are examined, and its influence can be seen for example in Dow Jones Sustainability Indexes (DJSI) and Global Reporting Initiative (GRI) (Elkington, 2018). In 2020, Meuer et al. conducted a literature review and identified 33 definitions for corporate sustainability from which they detected four components. The first one being genus, where corporate sustainability was seen as belonging to either family of specific component of a company's design (e.g. processes, practices, strategies) or ways of doing business (e.g. concept, approach, paradigm). The second, third, and fourth were attributes that helped to identify how particular corporate sustainability conceptualizations differs from family's other variants: level of ambition, level of integration, and specificity of sustainable development. The authors found out that the way the scholars had conceptualized the corporate sustainability genus also influenced to the strictness of the inclusion criteria definitions. The definitions where corporate sustainability was defined merely as business practices were less strict in inclusion criteria than definitions where corporate sustainability was seen as a new management paradigm (Meuer et al., 2020). Around half of the definitions used high level of ambition were corporations were required to not only to plan, but also to achieve change, and the rest used either medium (corporations were required to "pursue, "respond" or "apply") or low (corporations were required to "contribute", "demonstrate" of "find ways") levels of ambition (Meuer et al., 2020). The second differentia measured "the level of integration", were the highest level was considered in definitions were sustainability was considered to be a key factor in corporation's core business (around half of definitions included full integration), and therefore was also a

guiding principle in the corporation's main functional areas (such as operations, strategy and human resources) (Meuer et al., 2020). In low levels of integration the sustainability was seen as separate (e.g. philanthropic activities) from the core business (Meuer et al., 2020). In the third differentia the authors measured whether the definition of sustainable development included ecological, economic, social, and intergenerational dimensions. The intergenerational dimension emerges from another well known definition of sustainability, defined in so called Brundland's report: "... meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p. 54). Meuer et al. (2020) found out that most definitions did not mention the intergenerational dimension, but most definitions did include the ecological and social dimensions. This would suggest, according to authors, that the Elkington's (1997) "triple bottom line" has received more attention than Brundland's report (United Nation, 1987) in academic literature.

The triple bottom line has also received criticism. For example, Milne and Gray (2013, page 13) have argued that "incorporating an entity's economic, environmental and social performance indicators into its management and reporting processes,…, has become synonymous with corporate sustainability; in the process, concern for ecology has become sidelined". Srivastava et al. (2021) in turn argue that triple bottom line's most significant role is that it enables corporations to form a strategy where they create an illusion of reality to sell their products. Norman and MacDonald (2004) raise the question of what *is* the definition of the company's *bottom line* concerning social and environmental matters? Even Elkington (2018) has raised concerns of how the triple bottom line has been understood, and notes that from a broader perspective it's purpose was to provoke discussion of the future of the capitalism, and it wasn't suppose to be just an accounting tool – especially with the approach of balancing act with the trade-off mentality. One controversial view that is closely related to triple bottom line is the concept of weak and strong sustainability. In a weak sustainability, one form of capital (natural, human, produced) can largely be relapsed with another type of capital form (Anderson et al., 2012; Arenas & Rodrigo, 2013, 2016). The idea in a weak sustainability thinking is that the total sum of different capital forms is important and future generations will be in a better position if theirs is larger than their predecessors; even with heavier environmental problems they also have better solving capabilities because of larger financial and technical capital. Strong sustainability, on the other hand, questions this stand especially with when substituting natural capital with human and/or produced capital forms (Anderson et. al, 2012). The rationale behind strong sustainability is that natural assets produce complex life-sustaining functions that cannot be replaced with any other form of capital (Atkinson, 2000). With weak sustainability the problems arise especially from the ethical questions of whether the future generations would be agreeable with this substitution and what would be the correct amount of compensation (Arenas & Rodrigo, 2016). In strong sustainability, on the other hand, we are faced with the question of how far the current generation should commit to the non-substitutability of natural capital (Arenas & Rodrigo, 2016). In both concepts, however, it should be taken into account that, presumably, future generations still need at least some amount of natural capital.

Brundland's definition (United Nations, 1987) of sustainable development has also been criticized for avoiding taking a clear stance on whether human activity should remain within certain limits when concerning natural capital, and leaving open the question of what can and should be preserved for future generations (Milne & Gray,

2013). It is considered to provide no guides for actions (Marshall & Brown, 2003), and is even argued to be just a slogan where development is basically seen through a capitalist perspective (Banerjee, 2003). As Banerjee (2003) asks, if the debate around sustainable development truly was around social and environmental sustainability, wouldn't development be assumed to proceed within the limits and constraints of the biophysical environment?

In 2021, Dasgupta published a review called The Economics of Biodiversity which received attention e.g. in The International Monetary Fund (IMF, 2021), The Finnish Innovation Fund Sitra (SITRA, 2021), and Finnish Environment Institute (SYKE, 2021). In his work, Dasgupta sets out a framework on how to include nature in economic thinking and it's main message would seem to correspond to the concern expressed in the debate of sustainability that the limits set by nature have not been clearly taken into account when defining sustainable operations and development. Dasgupta aimed the review to someone he calls "social evaluator" or the "citizen investor"; a person who is "...curious to know what sustainable development should mean; what criteria governments and private companies should use when choosing investment projects; what rules private investors such as herself should use to compare alternative asset portfolios; what she should insist be the practices of companies producing the goods and services she purchases and consumes..." (Dasgupta, 2021, page 4). It is note worthy that Dasgupta can be considered to have extended the basic ideas of the review to the basic operating principles of the companies as well. One of the key elements of the Dasgupta's (2021) review is the Impact Inequality-formula, which was originally formulated in a form that is used in the review in the Barrett et al. (2020). It is a formula which represents the balance between human populations' use of biosphere's goods and services per unit of time and the biosphere's ability to supply them (Barrett et al., 2020). When our demand surpasses the biosphere's regeneration rate, depreciation in biosphere happens (Dasgupta, 2021), which leads to decline in natural capital and eventually decline in biosphere's ability to provide goods and services. Barrett et al. (2020) argue that the minimum requirement of the sustainability in the long run is that the humanity's ecological footprint, i.e. demand, is equal with the biosphere's regenerative rate. The idea behind impact inequality is not new, as for example in the 90s, there are publications where ecological sustainability is defined as achieved in a situation where it is specifically talked about staying within the carrying capacity of ecological systems (Jennings & Zandbergen, 1995). Costanza and Daly (1992) presented their case a bit differently, and argued that as long as there are no evidence that lower amount of natural stock is indeed sustainable and does not cause huge risks, the minimum requirement of sustainability should be that the current natural capital stock is maintained at or above current levels. In 2020 European Commission gave a communication to the European Parliament, The Council, The European Economic and social Committee and the Committee of the Regions (COM(2020)380) which states quite clearly that, in their opinion, world should commit to the net-gain principle; meaning that at least for sometime demand should be lower than supply.

The Dasgupta review, although uses the same terminology as triple bottom line, nevertheless would seem to replace them in a different order. If you google the word "triple bottom line" and look for a picture section, triple bottom line is usually represented as three overlapping circles representing the three pillars of TBL: people, profit, and planet. The area where these three circles overlap, is the area where the sustainability lies (see figure 1). What Dasgupta (2021, abr.) argues is that the economy

is embedded in the biosphere (i.e. natural capital), which also means that transforming biosphere's goods and services into final goods and services is bounded by it. This would suggest that, instead of circles (pillars) on the same plane, we have nested circles (see figures 2 and 3).

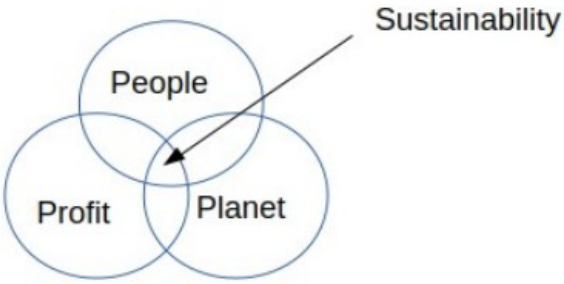

Figure 1: Triple bottom line and sustainability

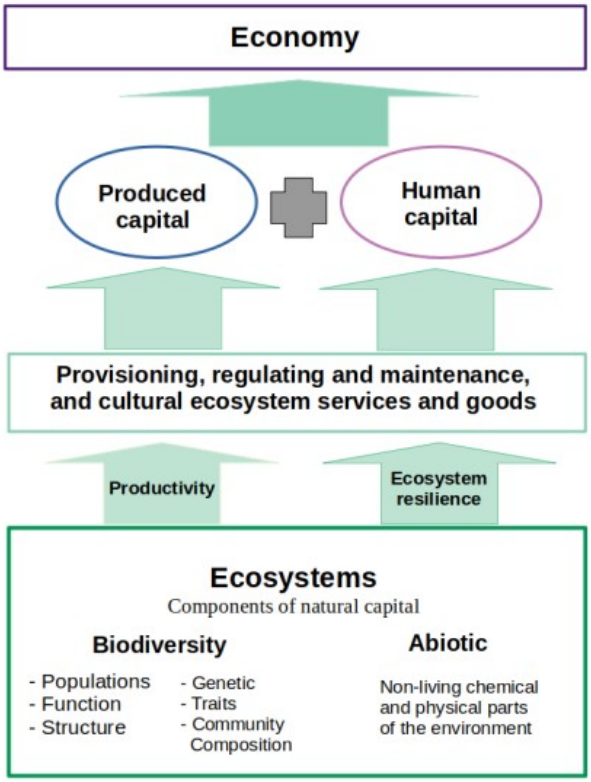

Figure 2: Links from ecosystems to the economy (Modified from Dasgupta, 2021, abr., p. 17

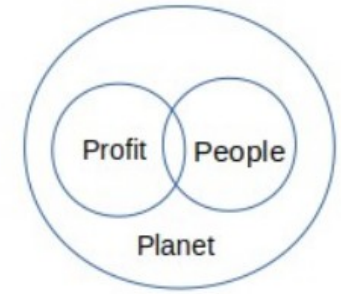

Figure 3: TBL from Dasgupta Review's point of view

Dasgupta's view, which reflects also many environmentalists' views, considers that economy is part of the much larger natural system. There are also other views. For example, Cairns (2006) considers that although physically all economic activity takes place in the system of nature, from an analytical point of view, nature is part of the economy. What Dasgupta review would seem to indicate is that we first need to fulfill the minimum requirements of natural capital sustainability before we can say that we are sustainable in regarding other capital forms. The sustainability requirements of human- and produced capital, when they are based on unsustainable natural capital methods, cannot be sustainable. From this point of view, the Dasgupta Review can be considered to have returned to the roots of sustainability thinking.

From the corporation's point of view, even Cairns' (2006) view does not remove the fact that corporations also ultimately operate in the natural system and thus also within its boundary conditions. When we start from the perspective that sustainable operations and development have clear limits given from the "outside", those constraints must be taken into account in the corporation's operations and the corporation's development paths must be planned within their limits. As such, restrictions in the corporation's operations are already quite common; society sets limits e.g. to minimum wages, product safety, consumer protection, occupational safety, and to some extent also to the impacts on nature. But what Dasgupta Review indicates is that corporations' sustainability and even continuance are fundamentally tied to the natural capital and therefore natural capital also essentially sets limits on to the activities of corporations as well. In essence, this means that laws of natural systems create the fundamental principles and limits of sustainable operations and development, and in one way or another they should also be reflected in how we measure and report our activities.

2.2. Measuring sustainability

2.2.1. Measuring sustainability

There can be argued to be a difference between reporting and measuring sustainability. Reporting can be defined as an activity to provide necessary information to different stakeholders, while measurement can also mean activity intended for internal control. The difference between the two is that the reporting is controlled by e.g. legislation, while internal control is regulated by the company's principles and purpose. For example, directive 2014/95/EU defines that when the company is obliged to report other than financial information as well, detailed explanations must be given e.g. regarding environmental issues from the company's environmental and foreseeable environmental impacts to greenhouse emissions, water consumption, and air pollution. That is not to say that the rules that affect reporting do not also affect internal measurement, because at the end of the day, they also have to serve reporting purposes. However, the purpose of the measurement steers that of what and how we measure. Artiach et al. (2010) considers that the corporate sustainability performance measures the extent to which the corporation takes into account in its operations the economic, social, environmental, and governance factors. Similarly, Labuschagne et al. (2005) considers that business sustainability entails incorporation of social equity, environmental performance, and economic efficiency objectives. Maas et al. (2016) see that when the organization's sustainable development is set to be improved, the basis is to provide information on desired and undesired environmental and social impacts, ideas for improving the positive impacts, and provide information on whether the changes made have led to the desired improvement on sustainable development.

From management perspective, a common way in corporate sustainability assessment literature to describe the measurement of performance is through the use of sustainability indicators (Pranugrahaning et al., 2021). Labuschagne et al. (2005), for example, proposed a framework using criteria with indicators for assessing the sustainability performance of manufacturing industries in countries like South Africa, and de Olde et al. (2016) compared indicator-based assessment tools in the contexts of Danish farms. Global Reporting Initiative (GRI, 2022) also includes more than 100 indicators (Labuschagne et al., 2005), and United Nations' Sustainable Development Goals include 17 goals with multiple targets (i.e. indicators) like "12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse" (United Nations, 2022). At a corporation level, measuring corporate sustainability performance would seem to be heavily linked to how utilized indicators are monitored and reported (Pranugrahaning et al., 2021).

2.2.2. Measuring environmental sustainability

There are different kind of indicators for environmental sustainability. Doĉekalovà and Kocmanovà (2016) mention 9 environmental indicators including things like energy efficiency, water consumption, biodiversity, and compliance with legal requirements. Pranugrahaning et al. (2021) also mention greenhouse gas emission, electricity usage,

water consumption, and waste management indicators. Similar things than for example EU's directive 2014/95/EU requires. According to some researches, companies should focus to the most material issues of their sustainability challenges (Wu et al., 2018), and some studies have found out that those companies with the greatest exposure to, for example biodiversity, have also the most explicit policies regarding them (Bhattacharya & Managi, 2013). However, for example Rimmel and Jonäll's (2013) study shows that this might not be the case. Although sustainability indicators simplify the comparison, communication, and discussion of complex systems (Lu et al., 2019), limited reporting requirements and poorly understood objects are argued to lead easily to minimal and low quality outputs (Jones & Solomon, 2013). Without effective and easy ways to measure progress and overall sustainability, the likelihood of incorporation of environmentally sustainable practices in practice is small (Handfield et al, 2001).

One of the major problems in measuring the sustainability are the trade-offs, for which for example Handfield et al. (2001) came across in their study, but which are at the center when we measure sustainability impacts to natural systems. This dilemma comes up especially when we are considering reductions in CO_2-emissions. The frequently heard critic is that we are destroying the nature in order to save it. Meaning that in the name of reducing emissions and therefore reducing our impacts to natural capital, we simultaneously are reducing natural capital in other ways due to our chosen methods. Indeed, unless we choose our indicators well, we might show sustainability progress even though our overall sustainability position has reduced. Some indicators might give us the wrong impression. For example, water consumption per se might not be the problem, the problem arises when it is overused and especially when it is overused in water scarcity areas. If, for example, plant cultivation is moved to another area in order to reduce CO_2-emissions, overall sustainability may decrease despite the indicators because water consumption in a water-scarce area causes a greater impact on the natural system than what has been achieved by reducing emissions, despite the same amount of water consumption in liters. Therefore, it is worth considering that when we measure our impacts to natural systems, we also measure overall impacts. The 12 principles of green engineering (Anastas & Zimmermann, 2003) is one of the frameworks which strives for holistic approach by emphasizing life cycle consideration and inherency, but it too strives to products and system to be *more* sustainable. However, we should be able to assess also when the corporation's operations can be considered to be sustainable from the point of view of *natural systems*. Surely that should be the bottom line of environmental sustainability, as the profitability is the bottom line for economic activity?

2.2.3. Holistic measuring-frameworks

One of the ways to measure sustainability more holistically is the concept of ecological footprint. Ecological footprint measures the demand that we place on biosphere regarding resource consuming, waste generation, and nature's supply changes due to technology, resource management, land use changes, and cumulative damages (Wackernagel et al, 2002). As such, it covers a wider range of impacts. However, for example The National Footprint Accounts is considered to be underestimated due to lack of tracking e.g. soil erosion and other than CO_2-emissions (Borucke et al., 2013). Ecological footprint is argued to make no difference between sustainable and non-

sustainable land use (Van den Bergh & Verbruggen, 1999) and Giampietro and Saltelli (2014, page 610) even argue that “ecological footprint assessment … is fraught with internal contradictions”.

Another way to asses environmental impacts more holistically is the life-cycle assessment (LCA), which considers for example product’s impacts to environment from 'cradle to cradle' or 'cradle to grave' (Reap et al., 2008). It combines two concepts: defining all the activities caused by the object under review and calculating the environmental impacts of those activities (Kirchain et al., 2017). However, Reap et al. (2008) identified 15 problem areas in life-cycle assessment, from which 6 were considered of paramount importance. One of them is the boundary selection, which includes what processes and activities are included in the assessment (including geographical and time horizontal boundary), and might lead to incorrect reflection of reality if boundaries are not selected appropriately (Reap et al., 2008). In addition, life-cycle assessment requires large amounts of information which is not only time-consuming but also needs resources (Kirchain et al., 2017).

In 2000, Reinhardt published a paper called Sustainability and the Firm which uses balance sheet and sustainability in the same definition. He started the paper by stating that corporate sustainability can be defined through macroeconomics: “to be sustainable, a company must maintain on its balance sheet an undiminished level of total net assets, measured at their social cost” (Reinhardt, 2000, page 26). However, the author mixes economical and environmental aspects in a way that raises the question of whether the bottom line is maintaining the natural capital level at all. Indeed, the author states that corporate sustainability test should consider the profit and investments as well as resource usage and pollution.

In 2015, Ogilvy introduced an idea of ecological balance sheet (EBS) to measure agricultural sustainability. The paper follows Farley and Costanza’s (2010) perception of ecosystems as configuration of stock-flow resources that generate economic benefit inflows and outflows (Ogilvy, 2015). Farley and Costanza (2010) differentiated ecosystem goods (like wood) as stock-flow resources and ecosystem services (like reproduction of plant) as a fund-services. The difference, according to authors, is that goods are quantitatively used, they can be used at the rate we choose, and as long as the inflow exceeds the outflow, they can be stockpiled. Ecosystem services, on the other hand, are particular type of flows that are generated from particular set of stock-flow resources, are available at the certain time, and cannot be stockpiled. As a result, according to authors, they cannot be mathematically modeled same way. In her paper, Ogilvy (2015) considers the decrease caused for an ecosystem’s future flows as a debt (or liability), which should affect the owner’s equity also. Due to this, the paper seems to find important that the value of the natural capital does not decrease. However, the paper also seems to focus on particular set of flows that are important to continuance of the production, which raises the question of whether the economic sustainability on the long run is an ecological balance sheet’s driving force.

Sustainable Balance Sheet (SBS)-framework was introduced by Fagerström et al. in 2021. The balance sheet is divided into two sections like traditional balance sheet called funds and restriction on funds. Both sides are further divided into five sections: human and social capital, environmental capital, technological capital, financial capital, and externalities. The conceptual tools for the framework come from the parts of resource theory and Vatter’s fund theory that the author considered relevant (Fagerström et al., 2021). The Vatter’s fund theory considers that the base for the accounting is the

set of assets and activities or functions (i.e. funds) that generate the resources, and it's not defined by corporations or proprietors (Vatter, 1947 as cited in Fagerström et al., 2021). The framework would seem to calculate each capital's equity (i.e. opening capital + positive transaction – opening restrictions – increased restriction) separately. The restrictions are considered broadly including environmental and social liabilities as well as negative externalities (Fagerström et al., 2021). Also third party impacts, from which the company might not be legally liable for, like for example pollution, are included in the framework as externalities. Although the paper does not specify in more detail how the balance sheet would work, it would nevertheless seems to better highlight, for example, if the increase in financial capital has been achieved by reducing the natural capital or diminishing social capital.

In 2021, the System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) (United Nations et al., 2021) was adopted by the UN Statistical Commission (UNSC) and it provides a guide to measure the condition and extent of ecosystems, and how to quantify it's services (Edens et al., 2022). In SEEA EA, the ecosystems are considered from the system perspective where they form assets which provides services as a functional unit (Edens et al., 2022). The monetary valuation describes the opening- and closing stock as well as the their changes during the accounting period (Edens et al., 2022). The changes in value can be caused by ecosystem conversion, degradation, enhancement and/or price changes (Edens et al., 2022).

The holistic measuring-frameworks mentioned above would seem to either measure the impacts caused to nature without defining how much that impact has exceeded the limit of sustainability (like ecological footprint or life cycle assessment), or when they do take this into account, they focus on a limited amount of impacts (like ecological balance sheet EBS). Some, like Reinhardt (2000), would seem to represent weak sustainability -thinking, meaning that decrease in natural capital can be replaced by, for example, increase in produced capital, without decease in sustainability position. BIBs tries to bridge this gap by taking into account both a wide range of impacts but also the change in the sustainability in terms of exceeding the use of natural capital sustainable use.

2.3. Thesis' theoretical framework

Thesis starts to build the BIBs from the Dasgupta Review's core view that economy is embedded in natural systems and therefore it is also bounded by it's well-being. The presentation uses the traditional balance sheet formula and its basic principles when applicable. Due to the way of presentation, balance sheet items are treated as capital goods that produce wealth for society as a whole. Thus, their appreciation should also be based on the overall wealth they produce for society and the cost of using them is the caused decrease in that wealth.

2.3.1. Natural capital

A word asset has a positive echo: assets are something that we value and desire (Dasgupta, 2021). A nation's assets could be considered to consist of tangible and intangible assets which generate well-being for it's citizens: natural reserves, functional infrastructure, educated citizens, etc. For individuals assets might consist of owned home and car, good education, investments for stocks, and so on. For corporations assets are something that has value and can create income either as a part of the production, or as an asset that can be sold later one, or which can reduce expenses: buildings, machinery, raw materials, land, know-how, patents, etc. For all of the above, assets represents something that brings value or has value of its own for us tomorrow; it is an investment for future in a sense, as without them, we would be poorer and with fewer options. Capital can be in general sense seen as a stock of materials and/or information at a given time (Costanze et al., 1998), which would lead to a temptation to lapel all assets as capital goods (Dasgupta, 2021).

Dasgupta (2021) describes the development of capital goods content as follows:

> Firstly, the economists are more reticent when they use the term capital goods as they consider it to include only those assets which are measurable. Secondly, historically, term capital goods was reserved by the economists only to those assets that were tangible (material) and alienable (ownership transferable), which today form what is called produced capital. Since then, the term has broadened to include also intangible and non-alienable assets such as education and know-how, which today form something what is called human capital. Extension of the term was made when the economists discovered a way to measure human capital's value to the individual as well as to the society at large. As for the past decade the economists have also been able to come up a way to measure value that the individuals set on natural reserves, the third category of capital goods was born – natural capital. The natural capital can manifest in variety of ways: it can be tangible and alienable like plants, tangible and non-alienable like pollinators, intangible and alienable like view from the balcony, or intangible and non-alienable like a global climate. (Dasgupta, 2021)

Although the natural capital is usually considered to be relative new concept, Missemer (2018) argues that its origin can be traced back to Alvin S. Johnson' writings in 1900s-1910s. The definition of natural capital might have changed since Johnson's (1909, as cited in Missemer, 2018), but the core concepts of it have stayed relatively same: the distinction to artificial, i.e. man-made and natural capital, and the idea of capital of being the source of wealth. Since Johnson's writings, the natural capital concepts seems to have developed up until 1930s after which it was nearly unused until 1980s when Pearce gave it a re-launch (Missemer, 2018). Pearce (1988) saw that natural environment can be seen as a stock of assets which contribute to human welfare. Further, the author argues that it is likely that decline in natural capital correlates in reduction in sustainability. According to Pearce (1988) reduction in global welfare that

can be labeled as reduction in natural capital are, for example, ocean pollution and global warming. By 1992, the natural capital was seen as creating a constrains to economic activity (see e.g. Costanza, 1992) (Missemer, 2018).

Because the paper tries to answer to the concern that is raised especially in IPBES' Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) and Millennium Ecosystem Assessment (MA, 2005), and because those papers' core concept is ecosystem service, the thesis also defines natural capital through them. Natural capital can be considered to consist of ecosystems and biodiversity, and interest that we received from the are the ecosystem services (Costanza & Daly, 1992). The issue is discussed more in chapter 4.1. What are we actually measuring?

2.3.2. Wealth-based approach

The definition of wealth in economics is: "... the sum of types of productive capital goods, measured in physical units, valued in monetary units..." (Hamilton & Hartwick, 2014, page 170). Stock implies that there is a potential to future flows of income and well-being, and therefore wealth can be argued to be a stock of capital goods that generate those future flows (Hamilton & Hepburn, 2014). Wealth also changes when there is a change in capital goods' physical amounts, shadow prices[3,] or valuation (Hamilton & Hartwick, 2014). Hamilton and Hepburn (2014) argue that if we focus to the wealth and the changes in it, we also focus more on the assets and their sustainable use.

2.3.3. Sustainable (full) cost approach

According to Gray (1994, page 33) sustainable cost approach is based on the "accounting concepts of capital maintenance and the need, within all the definitions of sustainability, to maintain the natural capital for future generations". Based on this, the sustainable organization, according to author, could be understood to be the one that leaves the biosphere no worse off at the end of fiscal year than what it was at the beginning. Theoretically, according to Gray (1994), it could be possible to calculate what it would cost for the organization to put the biosphere "back to what it was" at the beginning of the fiscal year, however, it would be the cost, not the value. Another approach of the same type is full cost accounting and, although according to Atkinson (2000) there is no clear definition of it, e.g. he talks about the internal cost brought by the pollution, which is already included in the accounts, as well as the cost caused to third parties, which is not included in the company's accounts, but which was caused by the company's operations. European Environmental Agency (EEA, 2022) defines full cost accounting as a tool which can be used to identify, calculate, and allocate the direct and indirect environmental costs caused by the corporation's operations.

Because the purpose of the paper is to examine the corporation's sustainability in the context of natural capital and the impacts are considered widely both in terms of targets, spatially and temporally, the impacts are considered in the line of how Gray

3 Shadow prices = market price – marginal cost of extraction (Hamilton & Hartwick, 2014)

(1994) defines the impacts to biosphere. However, because the paper examines the issue in the form of a balance sheet and by looking at balance sheet values, unlike Gray, the paper defines sustainable (full) cost as a change in value caused to the value of the biosphere on a societal level. The difference between these may be slim, but paper's starting point is the preservation of value, regardless of what its costs are to the corporation.

2.3.4. Traditional balance sheet

According to the Changing Wealth of the Nations 2021 (World Bank, 2021) our material well-being is being threatened not only by lack of the collective efforts in all levels, nature's unsustainable exploitation, asset's mispricing, but also by mismanagement. Accounting is a corporation's key tool for managing operations. It is a systematic system for recording financial events, and can be used to generate reports for a variety of purposes (Leppiniemi & Kykkänen, 2019). Two reports form the backbone of the financial statements, profit and loss and balance sheet, the cornerstones of a corporation's financial management. Together with the report of the activities they also create an image of the corporation's operations, financial standing, and continuity mandates to outsiders. From these, the profit and loss statement describes the company's fiscal year's result and, from an administrative point of view, it also describes of what kind of income streams the corporation's result consists of and what the corporation's cost structure is (Leppiniemi & Kykkänen, 2019). Two or more profit and loss statements can be compared in order to create a picture of how a corporation's operations has developed and also possibly to predict to where it is heading. If we compare the profit and loss –statements basic idea to the way corporations inform their impacts to the environment, the statement could look like the following:

> In a fiscal year 2021, the corporation's CO_2-emissions were X-amount and water consumption Y-amount. Reduction compared to the previous fiscal year was Z-amount in CO_2-emissions and N-amount in water consumption, and when viewed over a 10-year period, the downward trend in both has been approximately 5% annually.

This kind of reporting does indicate that corporation's operations are, at least concerning for the two indicators monitored, more sustainable than previously, and they can be compared to the industry's average amounts to make a comparison to the corporation's sustainability position regarding others in that same field. However, they do not tell us whether the corporation's operations are actually sustainable or not.

The World Bank gave recommendations for government priorities, the first of which is as follows: "Measure and monitor wealth to boost sustainability and prosperity" (World Bank, 2021, page XXXi) by using for example the System of Environmental-Economic accounting (SEEA) standards and the System on National Account (SEA) framework in order to integrate wealth accounting into the national *balance sheets*. However, this paper does not deal with existing systems for measuring the balance of nature, but focuses on considering what the traditional corporation's balance sheet-approach adds to a corporation's sustainability thinking when it is

combined with the Dasgupta Review's core components of impact inequality-formula and planetary boundaries, and when it's purpose is to find answers to the questions raised from the ecosystem functioning-perspective.

The balance sheet's purpose is to show the corporation's financial position at the end of the fiscal year, and act as a link between two different fiscal years (Leppiniemi & Kykkynän, 2019). The balance sheet normally roughly consists of the following balance sheet items showing current and previous year as a comparison: non-current assets, current assets, shareholder's equity, appropriations, provisions for liabilities and charges, long-term liabilities, and short-term liabilities[4] (see table 1) (KPA 1:6, Accounting Committee, 2016). Non-current assets concerns items which are meant to bring income over two or more fiscal years, and current assets no more than 12 months (Leppiniemi & Kykkänen, 2019). These two batches form the assets (and receivables) that have a value, and which a corporation has at a given time. Liabilities consist of debts and other liabilities from which the corporation is accountable for. The liabilities are divided similarly as assets into long-term and short-term liabilities. Appropriations is related to tax profit arrangements, and provisions for liabilities and charges are future inevitable costs and expenses but from which corresponding incomes aren't received (Leppiniemi & Kykkänen, 2019). These two balance sheet items have not been taken into account when constructing BIBs. The difference between assets and liabilities is shareholder's equity, which is the basis of a company's solvency (Leppiniemi & Kykkänen, 2019).

Table 1: Balance sheet formula according to the general guidelines of the Accounting committee for the presentation of the profit and loss statement and balance sheet

Assets		**Equity and liabilities**	
Non-current assets		Equity	
Intangible assets	xxx	Share- or other capital	xxx
Tangible assets	xxx	Revaluation reserve	xxx
Investments	xxx	Other funds	xxx
Current assets		Previous fiscal years profit (loss)	xxx
Inventory	xxx	Fiscal year's profit (loss)	xxx
Receivables	xxx	Appropriations	xxx
Financial securities	xxx	Provisions for liabilities and charges	xxx
Cash and bank receivables	xxx	Liabilities	
		Long-term liabilities	xxx
		Short-term liabilities	xxx
	XXX		XXX

4 Balance sheet is processed through Finnish accounting regulation KPA 1339/1997 1:6 and the general guidelines of the Kirjanpitolautakunta (Accounting committee) for the presentation of the profit and loss statement and balance sheet dated 21.11.2016

3. DATA AND METHODOLOGY

3.1. Research method and design

Research methodology is usually divided into two main approaches, a qualitative and quantitative research. Although there can be mentioned some general differences between them, the distinction is not clear cut. On the surface, the difference would seem to be the quality of the data: quantitative research relies on numbers where as qualitative research deals with words and visuals (Lichtman, 2014). But this distinction might be misleading as qualitative researchers frequently use numbers and quantitative researcher words for interpretation. In the traditional qualitative research the focus is often on the impact of the combination of variables, and it rarely focuses on individual variable unless they have a substantial effect on their own (Mahoney & Goertz, 2006). Focusing on the net effect of individual variable is, however, more likely in traditional quantitative research (Mahoney & Goertz, 2006). Qualitative researches' purpose might be to understand and describe social and human phenomenon, where as quantitative research provides descriptive information and test hypothesis (Lichtman, 2014). Mahoney and Goertz (2006) argue that the qualitative researches approach is "causes-of-effect" i.e. explaining individual cases, were as the quantitative research approach is "effect-of-causes", i.e. estimating independent variable's average effect, and therefore results are usually also more widely applicable. In order to avoid causal heterogeneity the qualitative researchers usually adopt a narrow scope, where's quantitative researchers adopt wide scope in order to achieve statistical leverage and generalization (Mahoney & Goertz, 2006). One of the clear differences is that in quantitative research researcher aims for the neutrality, where's in qualitative research researcher's role in all phases of research is acknowledged (Lichtman, 2014).

Methodology used in this thesis is not pure qualitative research approach in its strictness form, nor is it quantitative regardless of the centrality of the numerical values. It starts with worlds and ideas and moves to numerical format, it considers combination of variables (albeit condensed into a few factors), but tries to find widely applicable results, and it can even be considered to test a theory on whether equity could be used to measure corporation's sustainability. In addition, the additional main data used for balance sheet-section, which aim is to add inside to previously found results, is inherently different from other sources, and therefore research uses a slightly different method and approach to it. Because of this, the research can be considered to lean towards a mixed method, or even methodology without methodology, instead of being purely qualitative content analysis. Despite the narrowing of the mixed-method definition to include only a combination of qualitative and quantitative methods in some research circles, historically the method has also included combinations of qualitative and qualitative methods, quantitative and quantitative methods, as well as using more than two methods (Morse, 2017). Morse (2017) points out that different methods have been developed by disciplines with certain theoretical interests, perspectives, and assumptions. The author argues that because research methods are tools, but tools that are not value-free or unbiased, they also in part determine what is import and relevant, and what could be even ignored. A mixed method brings enrichment to description and

furthers understanding, and allows measurement of concepts, and even testing a theory (Morse, 2017). Mixed-method is chosen in cases were the research's aim is so complex, that a single method cannot reach the depth or the scope needed in order to reach the aim (Morse, 2017). According to Morse (2017) qualitative driven mixed-method contains a core component, which is dominant, and the additional components bring richness to core component's findings. Koro-Ljungberg (2016) describes a methodology as a kind of journey without clear beginning or ending, and with multiple paths to take. The author continues that methodologies without methodology can be seen in a situation where researchers are working concurrently within and against prevailing methodological ideas, structures, and established literature, causing lines between methodologies to blur. The same structure does not fit all situation and in order to avoid repeating "the same", Koro-Ljungberg (2016) urges the scholars to become confused, disoriented, uncomfortable, and surprised. Methodology without methodology does not however mean that anything goes, but it does mean that methodology order might not be linear or logical (Koro-Ljungberg, 2016). According to Koro-Ljungberg (2016) fluid and incorporeal methodology space's one of the main purposes is to resonate and add to the reality.

In the initial layout of the thesis, the measurement of the corporation's sustainability has been examined from two different points of view concerning the content – to what kind of social questions concerning the sustainability the measuring method should answer for and how, from an ecological point of view, a value change in natural capital would seem to take place – and from one method of measuring the value of a corporation that is widely used in the business world (see figure 4).

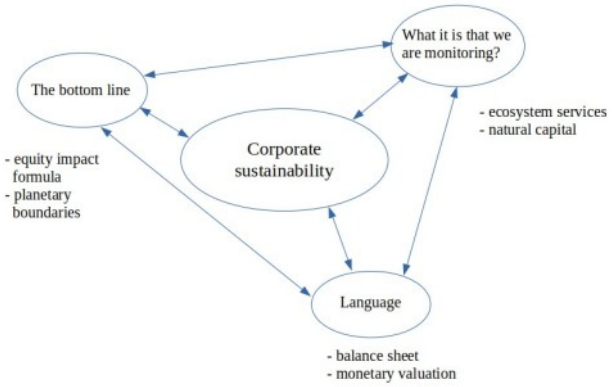

Figure 4: Thesis's methodology

The thesis speaks of the language of the accounts, controllers – financial people. This is not just because of the author's background, but also because financial department plays a central role in corporation's decision making. The financial papers – profit and loss, balance sheet – create a foundation of financial decisions. More broadly, accounting is the database from which several different corporate reports are created. In that sense, accounting creates a reality as Hines (1988) describes as it inevitably creates limits to what and with what values it takes things into account, and thus creates a value base for decision-making. Inspired by Diamond's (2005) question about what would happen if fiduciary responsibility were redefined to mean the preservation of balance sheet assets, this paper sets out to define sustainability from the balance sheet point of view. The

starting point assumed in the paper is that when the value of the natural capital assets changes due to corporation's activities, a change occurs also in the corporation's ecological sustainability. The difference, for example to ecological footprint and life-cycle-analysis, is that instead of looking at what kind of change the change in the "profit and loss" has had on the balance sheet, we measure what kind of effect the change in the balance sheet could have on the future "profit and loss" – i.e. did the “footprint” actually leave a permanent impact. Because corporation’s environmental decisions are fundamentally also financial decisions, Norman and MacDonald’s (2004) question of corporation’s environmental bottom line can be argued to need to be in the same level field as economic bottom line’s. Because of this, the thesis uses monetary valuation, but it also uses the principles of traditional balance sheet.

The methodology can be divided into two sub-processes that were used simultaneously: the process of formation of BIBs (see figure 5) and the process of processing the content (see figure 6).

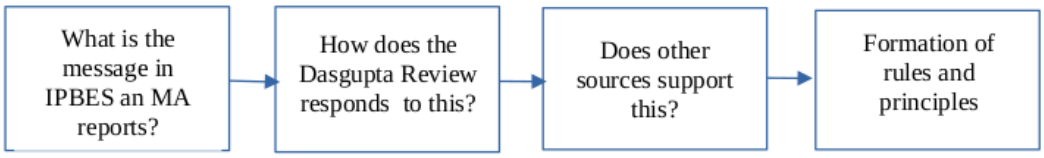

Figure 5: Process of BIBs formation

First, the leading scientific papers concerning the nature were examined from the point of view of what they tell about its condition and what should be paid particular attention to. After this, it has been looked at how the Dasgupta Review has responded to this from the point of view of economy and how the corporation's sustainability can be formed on the basis of this. This view has then been challenged by searching for more information from scientific publications with a focus on natural capital and sustainability. Finally, the rules and principles for BIBs have been formed.

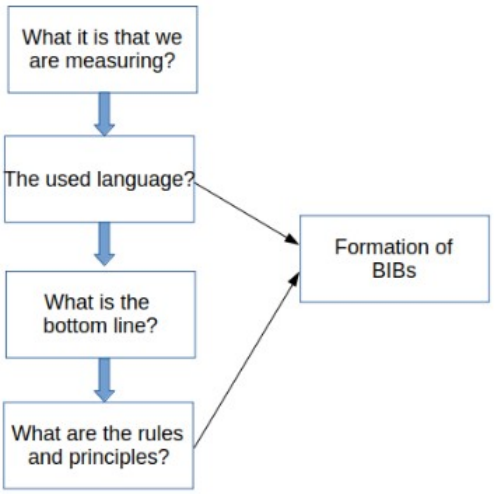

Figure 6: The method used in processing the content

In terms of content, first was defined what is being measured and how the value of the balance sheet items is determined. After that, the interfaces were searched for when the value of the balance sheet item changes, and when receivables and liabilities are formed (i.e. bottom line). Then the relationship between the four main groupings of the balance sheet items (assets, receivables, liabilities and capital) were considered (rules and principles). And finally, consideration was made on whether equity can measure a corporation's sustainability and if it does, how it could be used.

3.2. Data collection

For the balance sheet formula and it's basic principles Finnish accounting regulation (KPA 1339/1997), bookkeeping act (KPL 1336/1997), and the general guidelines of the Accounting committee are used. Additional depth has be sought from Leppiniemi & Kykkänen's (2019) book concerning accounting, financial statements and interpretation of financial statements, as well as Finnish companies act (OYL 624/2006). Leppiniemi & Kykkänen's book was chosen due to Jarmo Leppinimi, who had a wide-ranging expertise e.g. in Accounting committee (Aalto University, 2020). If we consider the core reports of financial paper – profit and loss and balance sheet – profit and loss represent the history of the corporation, were as the balance sheet represents the corporation's future. It contains the information – reality – of the assets that the corporation can use to create income, but also the liabilities from which the corporation is accountable for. But what would this Biosphere Impact Balance sheet (BIBs) measure; what is the information that we are expecting from it; what is the corporation's future reality? To find answers to this, the thesis considers what is said from ecosystem services and natural capital. The data for these are gathered from leading scientific reports like from IPBES' Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) and Millennium Ecosystem Assessment (MA, 2005). These reports are used because they represent the kind of natural capital information on the basis of which the corporation's continuance legitimacy can be questioned. For this question, as well as the bottom line, the Dasgupta Review and it's core components of impact inequality formula and planetary boundaries play a significant role. The Dasgupta Report is selected because of it's topicality, a wide-ranging and in-depth scientific summary, and because it seem to provide measurable interfaces. However, additional depth has been sought for both questions e.g. by retrieving papers from Scopus and the Web of Science with the following keywords: Natural capital, Ecosystem services + value, Planetary boundar*, tipping points, and also with Dasgupta Review in order to find critic.

From the added material obtained during searches, the materials included in the thesis have been selected based on diagram in figure 7. The first criteria was that the information in the source was generally applicable, papers that were for example applications for a specific industry were excluded. The second criteria was that the source needed to either support, challenge, or add information. The third criteria was that the source processed the concept of strong sustainability. In addition to added sources, the thesis also used other sources with various search definitions in order to find, for example, more information or different angle to issues that rose during the process. The material used for data analysis is summarized in table 2, where main sources include the papers that form the "backbone" of the thesis, the added sources the

papers that were sought as described in figure 7, and other sources those sources that rose during the process.

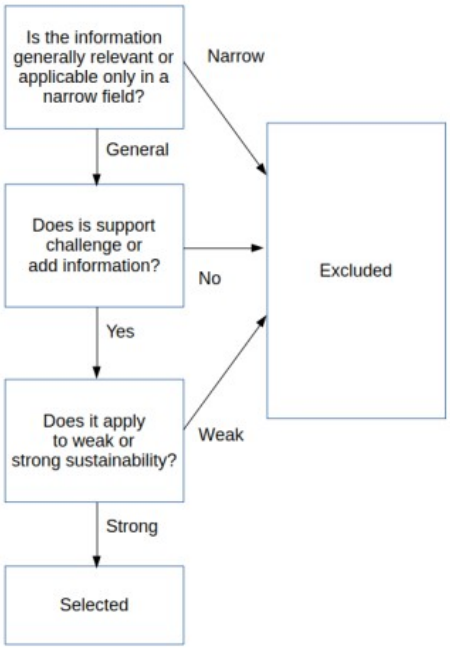

Figure 7: Selection criteria for additional sources

Table 2: The sources used for data analysis

What are we measuring?	Main sources	Dasgupta, (2021). The Economics of Biodiversity: The Dasgupta Review
		IPBES, (2019), Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
		Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis.
	Additional sources	Addicott & Fenichel, (2019). Spatial aggregation and the value of natural capital.
		Boumans et al., (2002). Modeling the dynamics of the integrated earth system and the value of global ecosystem services using the GUMBO model.
		Constanza & Daly, (1992). Natural Capital and Sustainable Development.
		Costanza et al., (1998). The value of the world's ecosystem services and natural capital.
		Costanza et al., (2014). Changes in the global value of ecosystem services.
		Ekins et al., (2003). A framework for the practical application of the concepts of critical natural capital and strong sustainability.
	Other sources	Batavia & Nelson, (2017). For goodness sake! What is intrinsic value and why should we care?
		Campbell et al., (2021). Biology: A global approach
		Carrera, L., (2010), Two ex situ fungal technologies to treat contaminated soil
		Chichilnisky & Heal, (1998). Economic returns from the biosphere
		Chomsky & Waterstone, (2021). Consequences of Capitalism: Manufacturing discontent and resistance.
		Hamilton & Hartwick, (2014). Wealth and sustainability
		Radermacher et al., (2014). Do we need natural capital accounts, and if so, which ones?.
		Saastamoinen et al., (2014), Yhdistävä luonto: ekosysteemipalvelut Suomessa (Connecting nature: ecosystem services in Finland)
		Thompson, (2016). GDP a poor measurement of progress, say Davos economist
		United Nations. (1987). Report of the World Commission on Environment and Development: Our Common Future A/42/427
		United Nations, European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development & The World Bank. (2014). System of Environmental-Economic Accounting 2012 – Central Framework
		United Nations et al., (2021). System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing
		World Bank. (2021). The Changing Wealth of Nations 2021: Managing Assets for the Future
		Yle. 2021. Susia ja ihmisiä (wolves and humans)

Bottom line	Added main sources	Barrett et al., (2020). Social dimensions of fertility behavior and consumption patterns in the Anthropocene.
		Dasgupta, (2021), abr., The Economics of Biodiversity: The Dasgupta Review. Abridged Version.
		Rockstrom et al., (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity
	Added additional sources	Bennett et al., (2009). Understanding relationships among multiple ecosystem services.
		Kareiv et al., (2011). Natural Capital: Theory and Practice of Mapping Ecosystem Services.
		Lenton, (2013). Environmental Tipping Points.
		Lenton et al.. (2019). Climate tipping points - too risky to bet against.
		Martins, (2021). The economics of biodiversity: Accounting for human impact in the biosphere
		Persson et al., (2022). Outside the Safe Operating Space of the Planetary Boundary for Novel Entities.
		Richardson et al., (2017). From local change comes a global tipping point
		Schägner et al., (2013). Mapping ecosystem services' values: Current practice and future prospects
		Spash, & Hache, (2021). The Dasgupta Review deconstructed: an exposé of biodiversity economics,
		Steffen et al., (2015). Planetary boundaries: Guiding human development on a changing planet
		Wackernagel & Beyers, (2019). Ecological footprint: Managing our biocapacity budget
		Wackernagel et al., (2002). Tracking the Ecological Overshoot of the Human Economy
		Whiteman et al., (2013). Planetary Boundaries: Ecological Foundations for Corporate Sustainability
	Added other sources	Allen et al., (2019). Atmospheric transport and deposition of microplastics in a remote mountain catchment.
		Chami et al., (2019). Nature's Solution TO CLIMATE CHANGE
		COM(2019)640. The European Green Deal
		Díaz et al., (2020). Set ambitious goals for biodiversity and sustainability
		EEB. (2021). Green mining' is a myth: the case for cutting EU resource consumption
		Ellstrand, (2001). When Transgenes Wander, Should We Worry?
		Gardnier, (2010). Ethics and Global Climate Change. Climate ethics: Essential reading
		Haddad et al., (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems.
		KHO 2019:166
		Mori et al., (2013). Soil greenhouse gas fluxes and C stocks as affected by phosphorus addition in a newly established Acacia mangium plantation in Indonesia
		Munda, (2014). On the Use of Shadow Prices for Sustainable Well-Being Measurement
		Newton, A(2011). Implications of Goodhart's Law for monitoring global biodiversity loss
		Sadhukhan, (2022). Net-Zero Action Recommendations for Scope 3 Emission Mitigation Using Life Cycle Assessment
		Sala et al., (2012). Life cycle sustainability assessment in the context of sustainability science progress (part 2)
		Smil, (2011). Harvesting the Biosphere: The Human Impact
		Spash, (2015). Bulldozing biodiversity: The economics of offsets and trading-in Nature
		Strohman, (2001). The complexity of bioethics.
		Thompson, (2021). Corporate Payments for Ecosystem Services in Theory and Practice: Links to Economics, Business, and Sustainability
		United Nations. (2019). Probabilistic Population Projections Rev. 1 Based on the World Population Prospects 2019 Rev. 1
		Utrio et al., (2010). Kotirintama kestää (the home front lasts)
		Valtonen et al., (2021). Suomen susikannan suotuisen suojelutason viitearvojen määrittäminen: väliraportti syyskuu 2021 (Determination of reference values for the favorable conservation status of the Finnish wolf population: interim report September 2021)
Balance sheet	Added main sources	KPA 1339/1997
		KPL 1336/1997
		Leppiniemi & Kykkänen, (2019). Kirjanpito, tilinpäätös ja tilinpäätöksen tulkinta (accounting, financial statements and interpretation of financial statements)
		OYL 624/2006 (Companies Act)
	Added other sources	COM(2020)380. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions – EU Biodiversity Strategy for 2030.
		Josefsson et al., (2021). Compensating for lost nature values through biodiversity offsetting – Where is the evidence?
		Karlsson & Edvardsson Björnberg, (2021). Ethics and biodiversity offsetting

3.3. Data analysis

Formulation of BIBs is like a forming a theory. There are considered to be three main types of reasoning: deduction, induction, and abduction. In general, deduction is used for prediction, confirmation, and dis-confirmation, induction for generalization, and abduction to theorize (Mantere & Ketokivi, 2013). Timmermans and Tavory (2012) argue that when an empirically based theory is constructed, abduction should be a guiding principle in order to reach novel theoretical insights. Abduction is considered to be the weakest of these three reasoning types as it uses incomplete data and relies on intelligent "ques", and therefore the conclusion might change as new evidence comes to light (Walton & Project Muse, 2014). However, abduction is used widely in fields such as law and medicine, where from "intellectual ques" one transfers through elimination and supporting facts towards conclusion that is usually described as the most simplest and likely. Peirce (1965V, as cited in Walton & Project Muse, 2014, page 13) describes abductive inference as:

> The surprising fact, C, is observed.
> But if A were true, C would be a matter of course.
> Hence, there is a reason to suspect that A is true.

If we follow the Peirce's logic, the thesis interfaces would be:

> The wealth that the nature provides is decreasing and our socioeconomic activity is largely the cause (observation C)
>
> But if corporate sustainability were tied to Dasgupta Review's core messages and they we true (A), C would become relevant.
>
> Therefore, there is a reason to suspect, that the A's sustainability "indicators" are true.

Mantere and Ketokivi (2013) note that labeling the entire research as using one of these reasoning types is misleading, as usually all three types of reasoning methods are used. In addition, the line between induction and abduction might be hard to define, but for example Peirce (1965 II, as cited in Walton & Project Muse, 2014) has described in a way where abduction explores the situation beyond the data. Therefore, according to Mantere and Ketokivi (2013) we should focus on how these three reasoning types are used instead of labeling research as using just one. Causal reasoning tries to find relationships between causes and effects (Goertzel et al., 2011), and causal explanation usually start with the why-question (Walton & Project Muse, 2014). This is also true in this master's thesis, it too starts with the question of why the quantity and quality of ecosystem services has decreased. As the thesis's main components are considered to be part of a functional mathematical formula, causality can be explored between its different parts. However, abductive causal arguments are meant to be questioned, and by answering critical questions, one gains more certainty to conclusions (Walton &

Project Muse, 2014). Therefore other sources have also been used to challenge and support the conclusions.

The basic component of the master's thesis is a mathematical formula which "functionality" produces ecosystem services. The data analysis has examined how each part of the formula affects its functionality and outcome, as well as in which "direction" each part is heading, and where, according to scientific knowledge, we would like it to move. When the quantity and quality of ecosystem services and their reliability remain at least the same or even increase, the wealth – or if we use income and expenses – or income has increased. On the other hand, if the quantity, quality, or reliability of ecosystem services deteriorates, wealth has decreased or expenses increased. From these basic assumptions, the interfaces where the value of natural capital changes, and with it also the sustainability of the corporation's operations, have been derived as conclusions. Finally, these interfaces have been used to create a measurement for the company sustainability using traditional balance sheet principles. The process is described in figure 8.

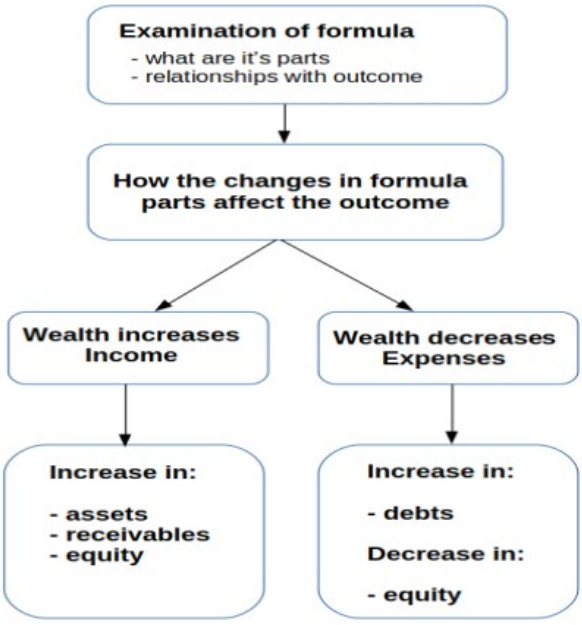

Figure 8: The process of formulating conclusions

4. RESULTS AND ANALYSIS

The purpose of this section is to define the BIBs' value formation, basic principles, and the interfaces for the formation of it's different items. Value formation is done by identifying asset's (i.e. natural capital) characteristics, as well as its ability to generate wealth. Principles and interfaces are done by examining the concept of planetary boundaries and different components of the impact inequality-formula; concepts that form the mathematical formula of the creation of that same wealth. Ultimately, the idea is that when we know the value of each component, how changes in them affect other components, the value of what we would prefer them to be or where we hope they would move in terms of the overall wealth produced by the system, we can form the basic principles, and identify the interfaces between different balance sheet items.

4.1. What are we measuring?

4.1.1. Definition of nature

In the IPBES's Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019), nature has been defined as the nonhuman world. For this, the report includes also co-produced features with a special emphasis on living organisms: their diversity, as well as their interactions with their abiotic environment and among themselves. It is worth noticing, however, that the nature's other non-living components, such as fossil reserves and minerals, aren't within IPBES Platform focus (IPBES, 2019). In the context of natural science the nature is considered to include e.g., all the biodiversity dimensions, species, populations, genotypes, the biosphere, ecosystems, ecosystem functioning, biomes, communities, as well as biocultural diversity, and the Earth's life supporting system with all the associated evolutionary, ecological, and biogeochemical processes (IPBES, 2019). When considering nature from the purely anthropocentric viewpoint, nature can also be defined through the services that is provides for humans. The Common international Classification of Ecosystem Services (CICES) is based on The Millennium Ecosystem Assessment's (MA) work (Dasgupta, 2021). In that assessment, the ecosystem services are categorized into four: provisioning services, regulating services, supporting services (nowadays called also maintenance services), and cultural services (MA, 2005). Provisioning services include things like fresh water, food, wood fuel, and genetic resources; i.e. the products that we get from the nature including the needed material and energy (MA, 2005; Dasgupta, 2021). Regulating and maintenance services, on the other hand, include things like primary production, nutrient cycling, climate and air quality, pollination of plants, as well as waste processing, and detoxification; i.e. services that maintain and regulate ecosystem processes (MA, 2005; Dasgupta 2021). The last category, cultural services, include all the non-material benefits that humans obtain from the nature (Dasgupta, 2021). These are things like hobby and recreation opportunity as well as opportunities for nature tourism. IPBES's Global assessment

report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019) introduced another concept for Ecosystem Services called Nature's Contribution to People (NCP). Although there are some differences, the concept divides more or less previously described ecosystem services a bit differently into three categories called nature's material-, non-material-, and regulating contributions (IPBES's, 2019). In previous IPBES's reports NCP was called Nature's Benefits to People (NBP), but as the platform recognized that, although majority of the nature's contributions to people are beneficial, there are also some negative contributions, and therefore the terminology was changed to more descriptive (IPBES, 2019). Despite this name change, the platform also recognizes that nature's contributions aren't inherently positive or negative, were as they largely depend on cultural, social, temporal, or spatial context. Because of this, the platform adds that the definitions of both the category and benefit are done case-by-case through cultural classes and that recognition of the trade-offs between different parties is important in decision and policy making. This contradiction can been seen, for example, in wolf-discussion (Yle, 2021). On the one hand, wolves are seen as part of nature's natural diversity, and for some they also represents our ability to conserve nature in general, but on the other hand, wolves have also been felt to be detrimental, for example, to hunters, farmers and berry pickers due to the loss they might cause for the property and through the fear that their presence causes.

Given that biodiversity can be understood as the diversity of life (Dasgupta, 2021), the IPBES's Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services focus's delimitation to the living part of nature is understandable. However, given that IPBES's platform also recognizes the importance of living organism's interactions with their abiotic environment, one could also argue that condition of abiotic environment matters, and therefore it cannot be ignored when talking about biodiversity, and even less when about natural capital. Dasgupta (2021) expands the biodiversity concept to the idea of biosphere. He argues that because the biosphere is understood as the part of the earth where the living organisms of nature are located, and because living organisms in turn use nature's abiotic parts, the economics of biodiversity is ultimately about economics of the biosphere. Further, Dasgupta (2021) continues to argue that as the living systems can be characterized by their ability to regenerate, the sustainability of the human-nature interaction is fundamentally about the regeneration and functioning of the biosphere as a whole, not just with it's living part.

In this paper the nature is defined through to it's functionality, i.e. nature includes all the biotic and abiotic aspects, and all the necessary processes that are needed for the resilient, functional, and regenerating biosphere. However, as the impacts for the biosphere are in most of the cases too broad a concept, the thesis uses smaller units – ecosystems. Ecosystems are regenerative and self-organizing functional-units that combine biological communities and abiotic environment regulating flows such as nutrients and energy (Dasgupta, 2021). It is important to notice that boundaries of different ecosystems do not acknowledge human-made boundaries – no state boundaries nor ownership rights. In addition, it also should be remembered that the ecosystems do not function in a vacuum but that there is an interaction between different ecosystems, they overlap, and are commonly nested with the processes that operate in different time scales (United Nations et al., 2021). Due to the emphasis on functionality, the paper also starts to take steps outside of anthropocentric viewpoint and considers weather the

impacts are positive or negative through to their impact to the functionality of biosphere or that particular ecosystem. For example, in the case of previously mentioned wolfs, this would meant weather the presence of the wolfs in particular ecosystem would be considered as a negative or positive influence would depend on weather their presence benefits or harms the functioning and regeneration of that particular ecosystem.

4.1.2. Nature's assets and natural capital

Gross domestic product (GDP) is used to measure nation's economic well-being (MA, 2005), but also development, and even progress (Chomsky & Waterstone, 2021). Specifically it tells us how much financial income (or output) a nation creates in a certain time period – usually within a year (World Bank, 2021). But GDP is criticized for showing improvement even in cases where the growth has been achieved at the expense of nature's decline (MA, 2005; Dasgupta, 2021; World Bank, 2021). This can happen, for example, when a nation unsustainably cuts down its forest to sell the wood or overfishes it's lakes to sell the fish. The selling of the wood and fish would increase the GDP (as G means gross output of the final services and goods) as the depreciation of the asset (in this case natural capital) is not included in a calculation (Dasgupta, 2021). Dasgupta (2021) goes even further and argues that the "economic growth" that the world economy routinely praises has decades been based on the declining natural capital. Therefore, it is no wonder that when nations are facing threats like climate change and biodiversity loss, the critic for GDP as a measurement for economic performance has increased and the demand for better asset valuation and inclusion has risen even across the economic field (Thompson, 2016; World Bank, 2021; Dasgupta, 2021); for even World Bank (2021) states that economic growth will eat away it's own base if increase in GDP comes at the expense of wealth per capita.

One way to look at the natural capital is to consider that biodiversity and ecosystems form the natural capital, and that the flow of ecosystem services are the "interest" that we receive from it (Costanza & Daly, 1992). What is noticeable in the development of capital context is that it could be argued to indicate that in order for the asset to be included into the capital it needs to have value for a someone (humans), and it needs to be monetarily measurable. The value for humans-point of view has been criticized for ignoring nature's intrinsic value (see e.g. Batavia & Nelson, 2017). Intrinsic value would, for example, mean that the previously mentioned wolf would be valuable regardless of its instrumental value, positive value regardless its maybe negative contribution to humans, simply because it exist. But there is also another problem which Dasgupta (2021) mentions and that is that many of the nature's properties are silent, invisible, and/or mobile. This means that their contributions to humans (direct and especially indirect) are not easily perceived, and their worth is only noticed in their absence. This silence and invisibility is especially characteristic of nature's regulating and maintenance services, which has led to a situation where historical economic growth has taken place through provisioning and cultural services by reducing the ability of the biosphere to produce regulating and maintenance services (Dasgupta, 2021). There are some who think that nature should be conserved simply because of it's intrinsic value (Batavia & Nelson, 2017), which could indicate that monetary valuation is not necessarily a requirement in order to value nature. However, for example, Costanze et al. (1998) remark that as the total value of the ecosystem

services is not captured, it has lead to the situation where nature's services have less weight in decision-making than they should have in terms of their true value. The notion makes sense, when all the other benefits are monetarily expressed, the item without it is easily downplayed when it's benefits are much harder to explain: *We should self this 1 million investment which would bring jobs to 100 people and increase our GDP by 30 million because nature's ability to provide regulating and maintenance services would decease by 4 %.*

Valuating capital, monetarily at least, has four aspects that are problematic especially concerning natural capital. The first one is that not all natural assets are, or even can be, valued monetarily (Radermacher et al., 2014); for how do you put a price to something like climate or photosynthesis, or know exactly how many worms are left globally? In a sense, for example the life-supporting services that the nature provides are infinite because without them life would come to a halt (Costanze et al., 1998). These parts of the natural capital that are critical and cannot be substituted with any another form of capital, are for example freshwater sources, fertile soils, and climate regulation (Ekins et al., 2003; Radermacher et al., 2014).

The second is the problem of point of view. This issue was previously passed with wolf discussion and whether their presence would be considered as positive or negative – would the point of view be individual or ecosystem functionality? If the value was positive, wolf would be considered to be an asset where as in negative value case it would represent liability or cost. Putting it another way, ecosystem services are anthropocentric way at looking at nature's value, but critical ecosystem services have intrinsic value beyond any individual human point of view. The second problem also includes the time-aspect. This issue could be argued to be a core of the current discussion of sustainability, and whether our production and consumption is sustainable. Perhaps the most known definition of sustainability is the one in Our Common Future-report (United Nations, 1987, p. 54) : "... meets the needs of the present without compromising the ability of future generations to meet their own needs". The sentence has a strong time aspect in it: "generations", "present", and "future" (Jouzi et al., 2021). What kind of capital – how much and consisting of what kind of assets – do we have today, what do they need in the future, and using how the current capital can we achieve tomorrows requirements? However, the report also recognizes that the definition of sustainable development also sets limits: "At a minimum, sustainable development must not endanger the natural systems that support life on Earth..." (United Nations, 1987, p. 55). This too would indicate that a capital including a certain group of assets must not be compromised at any given development option.

The third problem links to this same issue which is that as the nature can be consider to be a living system, each of its part has value beyond their intrinsic value because their existence contributes to other parts functioning as well (Dasgupta, 2021). If we consider, for example, mushrooms they first appear to be part of the nature's provisioning services. However, they also have a vital task as being part of regulating and supporting services in, for example, in nutrient recycling and soil remediation (Saastamoinen, 2014; Carrera, 2010). How then to put a value to something like forest's mushrooms? Is it a value of their commercial value, or something beyond that? If beyond that, where is the boundary of what is included in scope and in time?

The final problem with natural capital is that it's value is not constant – neither spatially nor timely (Hamilton & Hartwick, 2014). The value of a lake which consist of clean water is different in an area with plenty of water than it is in the area of water

scarcity (Addicott & Fenichel, 2019), and it's value is different today than it probably has tomorrow, especially if clean water resources decline and demand increases. But above all, like all capital's, also natural capital's value can decline if they are miss- or overused. Declining of the natural capital happens when it no longer has an ability to provide the same range, quality, or quantity of ecosystem services on a regular basis as before (United Nations et. al., 2014). There is, however, a difference between decline in natural capital, and decline in produced capital. Dasgupta (2021) identifies three differences in depreciation in ecosystems as capital goods than depreciation in produced goods: 1) at best, it takes a long time to recover the ecosystem, however, depreciation is usually irreversible, 2) replication of depreciated ecosystem is not possible and 3) a collapse of an ecosystem can be abruptly without many prior warning signs. Problems in determining the value also create uncertainty about set value's correctness. The problems of setting the value are summarized in table 3.

Table 3: Problems with setting a value to natural capital

Problem		**Example**
Determination of monetary value	Assets with infinite value	Clean freshwater, fertile soil
	Assets which quantitative and qualitative value is uncertain	Ground water, gas in the ground (Radermacher et al., 2014)
Point of view	Anthropocentric, intrinsic, functionality	Wolf: Anthropocentric: asset or liability Intrinsic: asset Functionality: asset or liability
	Time	Present, future (how far into the future?)
Synergies	Asset is valuable to other assets of the ecosystem, delimitation of the boundary of influence	Mushrooms
Value is not constant	Temporal and spatial difference	Clean freshwater
	Differences in value decrease compared to produced capital	Ecosystems: 1) value recovery takes a long time or does not happen at all 2) replication is not possible 3) collapse can happen abruptly without many prior warning signs

Despite the difficulty of assigning value to nature, some indicative values have been calculated for it. In 1998 Costanze et al. (1998) publish an article where the authors argued that although they consider it to trivial to calculate nature's total value, which they consider to be infinite, they nevertheless consider it to be important to know what it would cost to produce ecosystem services artificially. For example, New York City avoided $ 2 billion investment to new water treatment plants, and $ 300 million yearly running costs by investing $ 1.5 billion on a land in the Catskill Mountains and restoring it's habitat (Chichilnisky & Heal, 1998; Campbell et al., 2021). Despite

several limitations, Constanze et al. (1998) came up with the amount of US $ 33 trillion (in 1995 US$) for total value. The authors continue that one way to look at this value, which is 1.8 times the prevailing global Gross National Product (GNP), is to consider that we ought to be able to increase the prevailing global GNP by at least US $ 33 trillion in order to even try to in partly cover the services already included in GNP and partly also those that are not. In 2002, Boumans et al. (2002) used A global unified metamodel of the biosphere (GUMBO) and arrived initially to the estimation that global ecosystem services' value was around $ 180 trillion, which was 4.5 times the value of Gross World Product (GWP) during that same time. In 2014, Costanze et al. published an update article, and estimated that the value of total ecosystem services in 2011 was $ 125 trillion/yr (assuming changes in biome areas and update in unit values), and US $ 145 trillion /yr (assuming only update in unit values) (US $ 2007). What is the most noticeable estimation in this article was that the authors estimated that the global land use changes between 1997 and 2011 had resulted decline in ecosystem services worth of $ 4.3 – $ 20.2 trillion each year. There are some who have criticized these estimates, and argued that the natural capital's total value cannot exceed total GDP. Costanze et al. (2014) have responded to this criticism saying that the argument is based on the assumption that the values are based on willingness-to-pay -values and therefore the critics consider that total value cannot then exceed the total ability-to-pay (i.e. GDP). The authors continue that in order for the assumption to be true it would require that all the human benefits are not only marketed but also captured in GDP, and that is not simply true as many of the ecosystem services are free and outside of market systems.

4.2. The bottom line

4.2.1. Impact Inequality and planetary boundaries

Costanza and Daly (1992) noted in their paper that because the flow of the ecosystem services require that the whole system functions as a unified system, the diversity and structure of the ecosystem is an important element of the natural capital. There are considered to be three levels of biological diversity: genetic diversity, species diversity and ecosystem diversity. Genetic diversity includes variation within and between populations, and is important for adaptation (Campbell et al., 2021). Species diversity includes the number of species in an ecosystem as well as across a biosphere, and ecosystem diversity the variety of ecosystems on Earth (Campbell et al., 2021). Keyes et al. (2021), for example, found out that species that play supporting roles through interactions in ecosystem services are critical to the robustness of both the services as well as the food webs. As a result, the authors revealed indirect risks to ecosystem services that are caused by secondary species losses. The landscape's physical feature, structure, influences heavily on biodiversity (Campbell et al., 2021). The landscape that features small fragments would seem to support smaller number of species (Campbell et al., 2021) and, for example, Haddad et al. (2015) found out that fragmentation of the forest decreases biodiversity by 13 to 75 % causing undermining in central ecosystem functions by altering nutrient cycle and reducing biomass. Synergies, interactions, between different components of the ecosystem are essential to recycle, for example, nutrients and material (Mori et. al., 2013). Bennett et al. (2009) also note that

understanding relationships – trade-offs and synergies – between different ecosystem services is essential to better ecosystem management. If the flow of ecosystem services is considered to be an interest of natural capital, then the level of functionality is arguable an indication of the diversity and structural well-being of nature. In the Millennium Ecosystem Assessment (MA, 2005) they had estimated that approximately 60% of the ecosystem services that were evaluated were being degraded or used unsustainable. That number included 70% of the regulation and cultural services. IPBES's (2019) report estimated that 14 out of 18 nature's contribution categories have declined, most of these regulating and non-material contributions.

Functionality is an important aspect of the Impact Inequality -formula, which serves as a basis for Dasgupta Review (2021). The Impact Inequality -formula was presented in this form in Barrett et al., (2020) and it represent the balance between human population's use of biosphere's goods and services (demand) and biosphere's ability to supply them (supply) per unit of time (see figure 9). When our demand surpasses biosphere's regeneration rate, biosphere is being depreciated (Dasgupta, 2021), and the value of natural capital decreases.

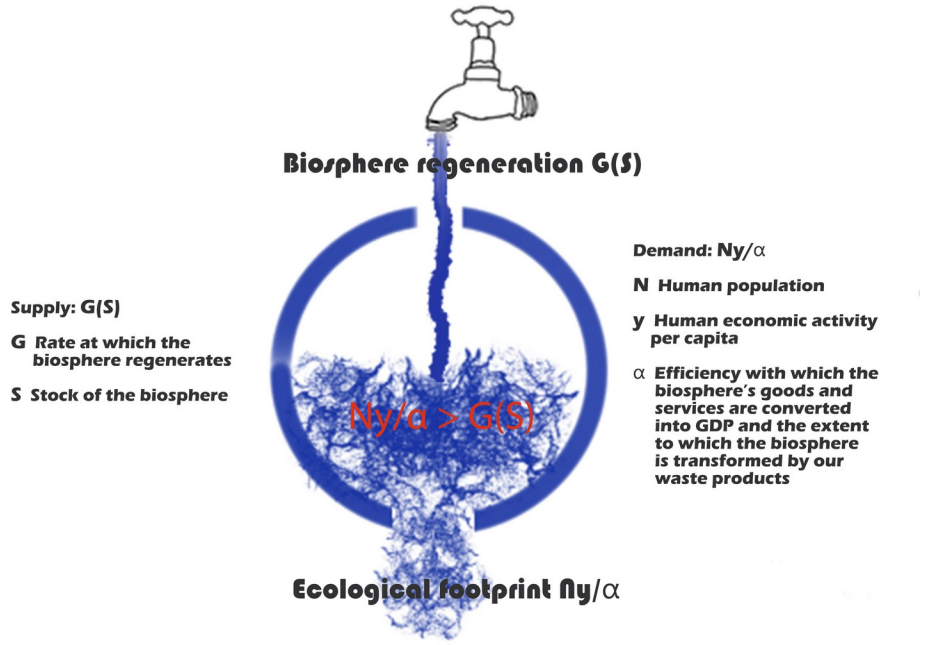

Figure 9: The Impact Inequality (adapted from Dasgupta, 2021, page 118, described in Barrett et al., 2020

A rough estimate from 2019 was that the ratio was 1,75, meaning that we used biosphere's goods and services 75% faster than what they were generated (Wackernagel & Beyers, 2019). When our demand is larger than nature's regeneration rate, we are decreasing the natural capital stock (Wackernagel et al., 2002). For example, Smil (2011) estimated that during the last two millennium the biosphere's phytomass stock has reduced by 45 percent, and 17 percent during the twentieth century since the 1900s, because of human actions. In practice this means that we are diminishing the very same capital that generates us ecosystem services as an interest. Advocates of strong

sustainability are of an opinion that at a minimum natural capital stock should not decrease (Costanza & Daly, 1992; Barrett et al.; 2020, Dasgupta, 2021) Also from the viewpoint of weak sustainability thinking, it can be considered that from the point of view of individual capital its use is not sustainable when the capital stock decreases (Ekins et al., 2003). When the capital decreases, the interest decreases – unless we can raise the "interest rate".

The supply of the biosphere depends biosphere's regenerative rate G, which in turn depends on biosphere's stock S (Barrett et al., 2020). The G function can be influenced with policies (Barrett et al., 2020) like investments to biotechnology. Dasgupta (2021) mentions "ecosystem engineering" and genetically modified crops as an example of these, but also notes that using them does not come without risks and other complications. Gene-flow is one of the complications that might cause appearance of new and severe weeds as well as increasing the extinction of their wild taxon (Ellstrand, 2001). Strohman (2001) also has raised concerns that the short – term benefits might outweigh the need to know the long – term effects, and that the sought benefit might outweigh the need to know the overall effects in decision making. When the supply side of nature is considered it must be taken into account that natural systems strive for a state of stability. The amount of interference that a stable regime tolerates before it shifts to another stable state is called ecosystem resilience, and the point where this regime shift occurs is called a tipping point (Dasgupta, 2021). Tipping points are points where a small perturbation in a system triggers a large reaction, producing abrupt, and sometimes irreversible system-wide changes (Lenton, 2013). The conception of tipping points comes largely from the bifurcations-theory, and recently focus has been on the "saddle-node" bifurcation where steady forcing leads to abrupt transition to another attractor (Lenton 2013). Bifurcation-type tipping points can be either reversible or irreversible, and they have early warning signals (Lenton, 2013). However, Lenton (2013) notes that there are also two other type of tipping points that might not show early warning signals – noise-induced tipping points and rate-dependent tipping points. Noise-induced tipping, which is caused by internal perturbation, is not expected to show early signals, where as rate-dependent tipping – where a critical rate of forcing causes a tipping – early signal's are under research (Lenton, 2013). Environmental tipping points, which can arise from geophysical, biogeomorphological, biogeochemical, biogeophysical, or species-interaction processes, are ubiquitous and occurring in many systems across spatial and temporal scales (Lenton, 2013).

A tipping point could be considered to be the point where the method of determining the interest changes: some of the interest amounts might decrease and others increase, eventually leading a new set of assets with new interest rates. Where a tipping point actually occurs is not known. However, Rockstrom et al. (2009) introduced a concept called planetary boundaries that illustrates the cumulative effects we have had on nature, and as a consequence, the amount of risk that ecosystems are approaching tipping points where even large planetary changes may occur. Whiteman et al. (2013) have argued that the concept of planetary boundaries challenge corporate sustainability scholars to not only to reconsiders ecological and systemic foundations of sustainability, but also to integrate natural sciences more closely to their work. The state of the boundaries were updated by Steffen et al. In 2015, and 2022 Persson et al. argued a boundary for novel entities, which was still left as a question mark in Steffen et al's paper (see figure 10).

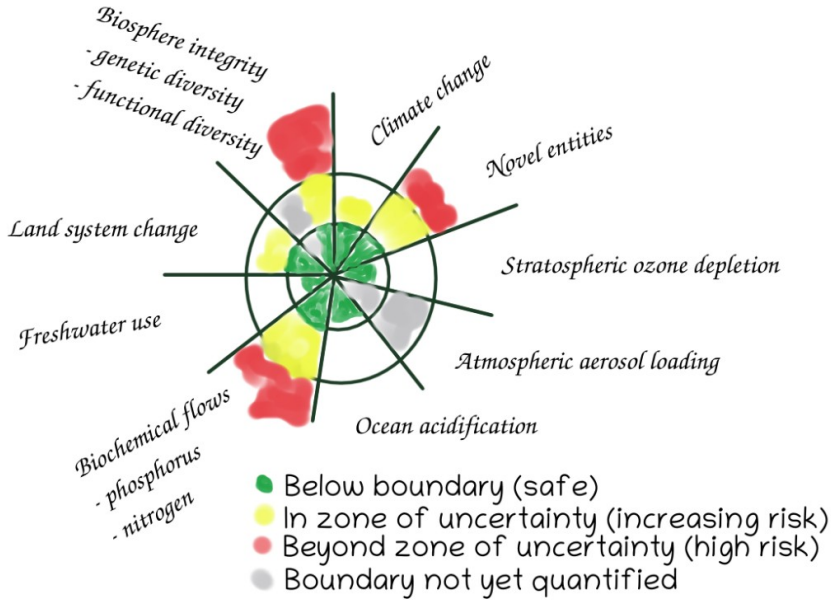

Figure 10: Current status of the control variables for the planetary boundaries (Adapted from Steffen et al., 2015, page 736 and Persson et al., 2022, page a

From the seven planetary boundaries (PB) two are considered to form a core of the PBs because of their central role in Earth systems – climate change and biosphere integrity (Steffen et al., 2015). The paper notes that "The climate system is a manifestation of the amount, distribution, and net balance of energy at Earth's surface; the biosphere regulates material and energy flows in the ES and increases its resilience to abrupt and gradual change" (Steffen et al., 2015, page 736). Steffen et al.'s (2015) message is that four of the seven ES features/processes are outside of proposed safe zone: land-system change, biochemical flows, climate change, and biosphere integrity. However, they still left three areas with question marks: biosphere integrity's functional diversity, novel entities, and atmospheric aerosol loading, areas which boundaries are not yet quantified according to the paper. For one of these question mark areas a proposed status was introduced in 2022. Persson et al. (2022) argue that for novel entities, like chemicals, safe operating space is exceeded when annual manufacturing and use exceeds global monitoring and evaluation capacity. According to the authors valuation this threshold has been exceeded. In 2019, Lenton et al. published a comment where the authors argue that the evidence from the tipping points alone indicate that we have a planetary emergency already. The authors define the emergency (E) as risk (R) multiplied by urgency (U): $E = R*U = p*D*t/T$ (p indicates insurers as probability, D damage, t reaction time to an alert, T intervention time left to avoid a bad outcome). The situation is urgent when the risk and the urgency are both high, and if the intervention time left is smaller than the reaction time, control has already been lost (Lenton et al., 2019). According to the authors the time left for intervention is reducing towards zero, whereas reaction time is 30 years at best.

It is also noteworthy that biodiversity has a task beyond of biomass and functional factor: the variety and amount of biodiversity plays a similar role in natural capital than diversity does in financial portfolios – reduces fluctuation and uncertainty

in yield (Dasgupta, 2021). The smaller and narrower the distribution of the portfolio, the greater the risk of annual return fluctuations, and at worst, a collapse in the value of the whole capital. Wackernagel et al. (2002) describe biodiversity as a "buffer" for ecosystems, meaning that it supplies resiliency and other stability factors. Although the equation does not say what is the sustainable amount of natural capital (Dasgupta, 2021), if we take into the consideration that Costanza and Daly (1992) have argued that further declining of the natural capital stock would cause us huge risks, and that we are already using far more of the "interest" than what the current capital can produce (Wackernagel & Beyers, 2019), the current natural capital stock can be argued to be at it's minimum or even at negative amount. In addition, Dasgupta (2021, abr.) argues that according to MA (2005) and IPBES (2019) the G function has decreased around 1,2% annually[5]. Taken as a whole, if the demand side's efficiency (α) cannot be increased substantially (and even then, there is a limit of how low the natural capital stock can be before it's functionality breaks down), the supply side can be argued to be bounded in a way where the stock amount and the regeneration rate must be maintained at least at the current level in order for the impacts to natural capital to be sustainable.

The demands that we make for the biosphere come from two sources: 1) we use nature's goods and services for production and consumption and 2) biosphere is used as a sink to our waste (Barrett et al., 2020; Dasgupta, 2021). In a longer form of ecological footprint (I), demand, calculation, our duplex demand appears more clearly.

$$I = (Ny/\alpha_X + Ny/\alpha_Z) \equiv Ny/\alpha$$

Source: Ecological footprint (Dasgupta, 2021, page 116)

Ecological footprint calculation consist of human population (N), human economic activity per capita (y), numerical measure for how efficiently biosphere's goods and services are being converted into global GDP (α_X), and from numerical measure for the extent of which our waste products are treated before there are discharged (α_z) (Barrett et al., 2020). Together, technological solutions and institutional changes are a way to change efficiency of which we convert nature's goods and services into final products (Dasgupta, 2021). Some of these changes that Dasgupta (2021) and Barrett et al. (2020) proposes are investments to carbon capture and storage technologies, investments to nonfossil fuel energies, establishment of protected ares, introduction of pollution taxes, and removal of harmful subsidies. One single big factor that affects α's efficiency in α_X as well as in α_z is circular economy. If and when the circular economy works, it not only reduces our need for biosphere's goods and services, but also reduces our impact to biosphere as sink of waste. Dasgupta (2021, abr.) has estimated that α has increased 3,5% annually between 1992 and 2014. The author, however, continues that if we wanted to stabilize the equation (i.e. demand and supply to be even) by 2030, we would need to increase efficiency (α) by 10% annually[6], which is a huge increase to historical

5 The calculations assumes that G function is proportional to S (Dasgupta, 2021, abr.)

6

rate. However, the efficiency of the α cannot grow indefinitely for the simple reason that even if the material is obtained through a circular economy, it is still originally a waste that must be converted into a raw material for a new product. This process causes environmental impacts. Dasgupta (2021) argues that raising efficiency of both the α_χ as well as α_z are just buying us time for we cannot grow global output (y) indefinitely without exceeding the limit of ecological carrying capacity, after which human economy would cease to function.

If we accept the idea that supply half of the equation is bounded, and should not be reduced, and that supply and demand must be balanced in the long run, one comes to the conclusion that the footprint of demand cannot exceed a certain point. In addition, it must be remembered that the demand function's factors interact (Dasgupta, 2021). For example, switching to green energy in order to reduce the "waste load" on nature is likely to increase also the amount of raw materials required from nature, such as rare earth metals, and the negative environmental impacts of their acquisition. We must also take into account that number of human population is expected to grow over 9,1 billion by 2040, and over 10.1 billion by 2060 (United Nations, 2019), which would, in bounded economy, mean that ecological footprint per person needs to reduce in proportion. This can happen either by reducing consumption per person, and/or reducing ecological footprint per consumed item. Consumers have also been encouraged to reduce both – their consumption as well as switching to products with smaller "footprints". What is sometimes forgotten, however, is that the consumer's ability to influence the footprint of a product or service is non-existent after a certain point, and that once the raw material has been acquired and the product produced, its ecological footprint has already emerged from both the production's footprint and the footprint of future waste, regardless whether it is consumed or not. The consumer can choose from the variety of products that are presented to her (or not to buy at all), how it is delivered to her, how long she will (or tries to) use it, and whether she will recycle it of not. The corporation chooses the rest: from where the raw-materials are acquired and what they are, how they are processed, where, how globally, and what kind of supply-chain their have, the distribution channels, how long the product is designed to last, is it reparable, and for how long, is it recyclable, is it sold to places where recycling is not possible, does the corporation invest to the development of sustainable products, is marketing used to create need, etc. If we return to Diamond's (2005) question of what are the core values that we need to evaluate in order to resolve our environmental problems, one emerges from the above: Can anything, with any production volume, and by any means of production be produced? Considering Dasgupta's (2021) review's core messages of bounded economy which is embedded in nature, and taking into account the consequences of our historical economic growth, the answer could be argued to be that there are limits to how much we can produce and with what kind of environmental consequences. From the point of view of corporations, the bounded economy by natural capital with the boundary conditions previously presented, could be argued to mean that in order for the corporations to be sustainable their activities must not at least reduce the generated ecosystem services by reducing the amount of natural capital stock or regeneration rate. Nor should they increase the risk of reducing future generation of "interest" by reducing the capital portfolio, or increase the cumulative risk of a regime shift. If we accept the assumption that the human population is rising and that we need a

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Calculation assumes that current I=G – rate is 1,7 , Ny continues to grow 3,4% annually and G continues to decline 1,2% annually (Dasgupta, 2021, abr.)

certain minimum level of consumption for a good life, and that we cannot raise efficiency or the interest rate generated by nature indefinitely, then, in theory, after a certain number of people, all available resources might be spent on minimum requirements for good life. At the latest, we are also then faced with the fact that ethically we cannot produce everything. Restricting usage, production, or usage of raw-materials would not be a new phenomenon, for it has been done, for example, during the war-times (Utrio et al., 2010). However, where as wartime is exceptional and also often temporary, overcoming the problems of natural loss requires permanent, or at least long-term changes. What could this then mean for the corporations? For example, the decision of the European Union Judgement of the Court's on C-461/13 and the decision of the Finnish Court KHO 2019:166 may give some indications on what corporations might be facing. In both cases the target status of water bodies was considered binding, which for example in KHO's case led to the annulment of large investment. How then, can the company legitimize it's existence and operations?

The legitimization could be argued to rise from three ways in bounded economy (table 4): 1) the product or service is vital, in which case the ecological footprint exceeding sustainability could be compensated by society for social reasons, or 2) the company is able to verify that its ecological footprint does not exceed the carrying capacity of nature, or 3) in cooperation with another actor corporation is able to achieve sustainability.

Table 4: The legitimacy of a company's operations may rise in three ways

1) Product or service is vital	Ecological footprint exceeding sustainability compensated by society
2) Product or service is sustainable	No reduction on natural capital's stock
	No reduction on natural capital's portfolio extent
	No reduction to nature's regeneration rate
	No increase to cumulative risk of regime shift
3) In cooperation with another actor sustainability is achieved	Cooperation with two or more actors produce an end result in which their overall operations as a whole is sustainable

The third option would not include schemes like payment for ecosystem services (PES) per se. PES schemes in general can be described to be voluntary agreements between ecosystem service "users" and "producers", which are thus obliged under the agreement to better and more sustainable management of natural resources (Thompson, 2021), and therefore it would fall under the "normal" reduction of one's environmental footprint. The third option would be, for example, a case where the company x's waste product can substitute corporation y's raw-material acquisition, and thus reducing company y's ecological footprint so much so that both companies, taken together, would operate within the limits of sustainability.

Is this then the end of all non-vital products and service, as all production causes some kind of ecological footprint? Not necessarily, for we must remember that natural capital generates "interest" which we can use without stepping outside of sustainable operations. But what it does indicate is that corporations would need to consider what

they produce, how much, where, and how they impact nature both more comprehensively, and over a much longer period of time. Barrett et al. (2020) note, that when the United Nations' Sustainable Development Goals (SDGs) were set in 2015, the assumption was that they are attainable. However, if one looks at the background documents, they do not consider whether the targets can be sustainable if world GDP grows at the same time (Barrett et al., 2020). Therefore Barrett et al. (2020) wanted to identify minimum conditions, i.e. demand equals supply, of global economy's relationship with biosphere before SDG's themselves can even begin to be sustainable themselves. Wackernagel et al. (2002) argue the same thing: sustainability requires that we are living within the biosphere's regeneration capacity. If the equation really creates a minimum requirements for sustainability, then they must be realized before other sustainability requirements are met, and then the potential for growth is also determined within its limits. But it should be remembered that where as growth has, or at lest should have, limits, development does not have a limit, and it does not necessary also need growth (Chomsky & Waterstone, 2021).

The corporation's legitimacy's number 2 (Product or service is sustainable) can be argued to contain the information that we are seeking from the reports in order to evaluate corporation's sustainability. Therefore, the BIBs should also contain information which answers to the question of whether natural capital has changed due to corporation's operations by increasing or decreasing natural capital stock, expanding or narrowing natural capital portfolio, increasing or reducing natural capital regeneration rate, and increasing or decreasing the risk of regime shift (table 5)?

Table 5: What it is that we are monitoring / to which questions BIBs should answer?

Has the corporation's operations changed the natural capital due to:	
Natural Capital stock	Increasing / decreasing?
Natural Capital portfolio	Expanding / narrowing?
Natural Capital regeneration rate (interest rate)	Increasing / reducing?
Possibility of regime shift	Decreasing / increasing?

4.2.2. Sustainability principles

Impact inequality formula can be argued to emphasize certain basic principles of sustainability (summarized in table 6). The first one rises from the demand equation, which considers both the α_x as well as α_z. The "cradle to grave"-approach, where the product's or service's whole life cycle chain from raw-material acquisition through production and usage to waste handling is considered (Sala et al., 2012), represents this kind of thinking. However, there is a problem with the approach in addition to the fact that they are expensive to calculate. For example, in the net-zero promises given to solve climate change, preventing the double counting of scope 3[7] emissions has been problematic (Sadhukhan, 2022). From the corporation's point of view it might also be impossible to predict what the end use is like, or where the product ends up in the globalized economy. However, it can be considered that legislatively and politically this principle has already been regarded. In global economy, the transportation is one of the significant components, and emissions from transportation is something that EU has also paid attention to in the European Green Deal (COM(2019)640), where the target for reducing transportation emission is 90% by 2050 include among other things to favor rail and waterways in freight transport. This poses challenges for material-intensive sectors in terms of raw material sourcing, transport routes, and the location of production facilities. Another item that The European Green Deal emphasizes is a faster transition to a circular economy. The Communication notes that resource acquisition and processing of materials, food, and fuel cause more than 90% of biodiversity loss and water stress, and almost half of the greenhouse gas emissions (COM(2019)640). Circular economy could resolve some of these issues, but in order for the materials be recyclable, the products need to be designed so that recycling is economically and technically possible, and that there is a functioning infrastructure to enable economically sustainable recycling.

Another sustainability principle would rise from the demand side also – the holistic approach, which would mean that not only are the trade-offs be taken into account, but also that supporting function's impacts need to be taken into account. Diaz et al. (2020) argue that there are three critical points to consider if nature's decline is to be stabilized or reversed: multiple goals are needed, they need to be defined and developed holistically, and highest level of ambition in setting to goals and implementing them is needed. The authors argue that one of the reasons to multiple goals is the "Goodhart's law", which states that the measure ceases to be a good measure for system once it becomes a policy goal itself (Newton, 2011). This is because due to human behavior, the goal itself becomes important and it ceases to represent what it was originally set to measure. Holistic measuring would mean that e.g. if ecological impact would be measured and reported by per product item, then the ecological impacts from functions like support offices would need to be allocated accordingly, however, in such a way that the effect of total production volume is not lost.

The third principle could be argued to be the ecosystem approach which rises from the supply side and which, perhaps, would be the biggest change in how the corporation approaches sustainability. For example, a forest company could need to be

7 In GHG emissions, scope 3 includes emissions that arise due to the company's operations, but whose source is not under the company's ownership or control, like transportation and usage.

considered to inform impacts to whole ecosystem, not just to peace of land it changes, and it also could be requested to take into account the impacts to regulating and maintenance services as well as the provisioning services. However, the approach raises a contradiction, especially for global corporations: how to handle situations where corporation's ecological impact would seem to be neutral in biosphere-level, but are unequal in ecosystem-level? This dilemma may be encountered e.g. in transitioning to green energy (EEB, 2021), where global emission might reduce, but local negative environmental impacts increase. If we consider that Costanza and Daly (1992) stated that the structure of the ecosystem is also important, one might therefore also ask that wouldn't this also mean that the structure of the biosphere is also important? Also Richardson et al. (2017) have commented that tipping points for biodiversity lie in individual ecosystems. This could mean that causing "imbalance" between ecosystems is not possible widely nor in long-term. Another contradiction comes from the nature's mobility (Dasgupta, 2021), which means that nature itself can transfer impacts to affect other ecosystems too. For example, Allen et al. (2019) found out that microplastics can travel up to 95 km in atmosphere, which raises a question of how wide is the boundary that needs to be considered. The third contradiction comes from the fact that ecosystems are not defined by property rights. How then should corporations deal with impacts to capital values that affect properties that they do not own but which are affected by their actions and vice verse.

The fourth principle concerns irreplaceable assets which are invaluable in the functioning of the ecosystem. Assets which value can be argued to be infinite would need to be monitored separately, and more carefully, and a discussion should be made on weather the reduction on their value even temporarily is acceptable. The last item is not a principle per se, where as it reminds us that the worst case scenario is where product or service is produced without it having a market (i.e. it is not consumed). What are our needs then is an ethical discussion, which is beyond this paper. However, there has been some critic for Dasgupta review that can be linked this this question. For example, Martins (2021) raises a question of "citizen investor's" subjective preferences.

Table 6: Principles of sustainability through The Impact Inequality-approach

Principle	Indicator
"cradle to grave"-approach	Sustainable (full) cost
Holistic approach	Trade-offs need to be included
	The impacts of support functions must also be allocated
Ecosystem-approach	Impacts informed at ecosystem/biosphere level
	Impacts include also impacts to regulating and maintenance services
Monitoring irreplaceable assets	Value should not reduce
Production for need	

Instead of the "usual" footprint calculation, the footprint of an individual product is not relevant in itself in BIBs, only the permanent impact left by the overall production. This means that instead of calculating footprints, we are monitoring whether the value of the

ecosystems changes during the fiscal year. This means that, for example, problems with possible double calculation becomes relevant only if corporation's operations have decreased the value of natural capital. Also holistic-approach can be considered to be automatically included. The most problematic aspect, however, rises after the final product is sold. Unless the product is fully recyclable and/or "environmental neutral", it is virtually impossible to know which ecosystems are affected during the usage and disposal.

4.2.3. Valuation

Ecosystem services valuation has two dimensions: 1) a biophysical assessment of the supply and 2) socioeconomic assessment for per unit value (Schägner et al., 2013). Schägner et al. (2013) divided the methodologies used to mapping ecosystem service's supply into five categories: one-dimensional proxies (like LCLU), non-validated models (like causal combinations of explanatory variables based on researcher's assumptions), validated models (like using primary or secondary data in order to calibrate the model parameters by using manual model optimization), representative data of the study area, and implicit modeling. Implicit modeling is an approach which uses value functions that relate variations in the context, characteristics of ecosystem, and population of the beneficiaries to the variation in the unit ecosystem service values (Schägner, 2013), and as such could be considered to represent closest of what impact equation represents but which, according to the Schägner et al. (2013), was relatively rarely used. Excessive generalization might give us general information, but might not be valid for specific site (Schägner et al. 2013). Addicott and Fenichel (2019), for example, argue that location of the asset matters, and that aggregated values of the natural capital must reflect these assets' possible costly and weak arbitrage opportunities. Therefore, the authors recommend that for at least for the most important assets the valuation must start from the local level and aggregate upwards. Thus, their views also seem to coincide when it comes to examining the impacts in individual ecosystem level. What this could indicate for the corporations is that the importance of site specific valuation increases, which increases not only administrative work and financial costs, but also demand for relevant know-how.

When starting to determine the value of an asset, it is important to consider the value base on which it is based. When natural capital is discussed, one can come across a term accounting (or shadow) price. Dasgupta review (2021) defines accounting prices as assets' true values to the society. What this actually means is not very well defined in the review (Spash & Hache, 2021). However, review's abridge version gives some indication: "...reflect an accommodation between economic futures that are both socially desirable and socio-ecologically possible, which means they reflect social scarcity values of capital goods" (Dasgupta, 2021, abr., page 24). In a sense, the approach seems to be solely anthropocentric which is a contradiction to the main message of impact inequality-formula. The valuating methods and how the information is used, are one of the criticized aspects of the review. For example, Spash and Hache (2011) argue that review represents neoliberal capitalism and conservative values, where financial assets form the world, and where nature with bad yield is liquidated, and future generations are discounted. Munda (2004, p. 913) has also previously criticized that usage of shadow prices "implies the acceptance of the implicit

assumption that different forms of capital are always substitutable". Regardless of the critic, for example, Martins (2021) notes that Dascupta's anthropocentric approach seems to be strategic, although not without downsides. The anthropocentric value-approach is based on the idea of how much nature provides utility (or well-being) for humans, which in turn is inherent part of the cost-benefit analysis (Kareiva et al., 2011). In the ecosystem service's marginal cost and benefit function, the changes in quantity or quality in services has value insofar as they change either the human activities' benefits, or their costs (Constanza et al., 1998). For example, in land conservation this would mean that the optimum level of conservation is when adding one more unit produces less value in ecosystem benefits than what it would cost in lost in other development opportunities (Spash, 2015). The cost-benefit analysis is often associated with willingness-to-pay, which should be understood in a broad sense, and these methodologies were mentioned in the Dasgupta's review also. However, there are few downfalls in these methods. The first one is that often the different set of values (regardless of individual's knowledge of ecology, attitude towards future generations etc) would have same weight (Kareiva et al., 2011). This means that, for example, present generation's short-term utility might be given much more higher emphasis than future generation's long-term utility, and that the some of the "less noteworthy" assets aren't considered valuable because their value is not understood. The second is that economists usually regard lexicographic preferences as anomalies and therefore exclude them from results (Spash, 2015). Although it is desirable to cleanse the value base from the so called protest values, the practice appears in a questionable light when calculating natural capital, especially when defining values for ecosystem functioning, as well as for those assets that are irreplaceable and can be considered infinite in value. In this light, it is worth considering whether KHO 2019:166[8] case can also be seen in a light of lexicographic preferences and what it means for the corporations in the future in regard of cost-benefit analysis if the environmental regulations tighten? From corporation's perspective the question of who has the mandate to define the value also becomes relevant. Is it only for the experts, as can be argued due to needed level of know-how, or can the corporation set them themselves? If it is a latter, is some form of auditing needed to verify the correctness of the values? Addicott and Fenichel's (2019) argument would nevertheless indicate that "database" or "average" values are not applicable.

It is also argued that absolute values aren't important (Dasgupta, 2021, abr.; Costanze et al., 1998; United Nations et. al., 2021), where as for what purposes they are used is significant. In Dasgupta review, accounting prices are used for impact inequality -formula which, as discussed previously, compares ecological footprint to nature's regenerative rate. The accounting price could then be considered to reflect the price that we pay as a society for not leaving the ecosystem intact.

> According to preliminary calculations, on average, a single great whale captures 33 tons of CO_2, binding it for centuries. In

8 KHO 2019:166: KHO revoked the valid for the time being -environmental permit granted to Finnpulp Oy on the grounds that it could not be sufficiently convinced that the operation at *this investment site* and with *the production amount* indicated in the permit application during its *entire life cycle* would not cause significant pollution as prohibited by the Environmental Protection Act to the wastewater discharge basin taking into account the development of the ecological state of the water body and when the law is interpreted in the manner required by the obligations under Union law and the precautionary principle.

> addition, whales seem to have also increasing effect on phytoplankton production. These are the same phytoplanktons that not only contribute to at least 50 % of atmospheric oxygen, but do that by capturing around 37 billion metric tons of CO_2. Compared to tree's annual 48 pounds of CO_2, the difference is significant. If the whale population would be allowed to increase and the amount of phytoplanktons would also increase as a result, at the minimum even 1% increase in phytoplankton production would capture additional hundreds of millions of tons of CO_2 per year. That is equivalent of 2 billion mature trees. If we take into account the CO_2 amount that a single great whale captures in it's lifetime by using carbon dioxide market prices, and financial discounting techniques, and adding other economic values (like ecotourism and whale's positive impact to fisheries), the conservative value of a single great whale is more than 2 million dollars on average. (Chami et al., 2019)

Let's make an assumption that a corporation wants to harvest a whale, but aims to do that in net-neutral way. The impacts that the corporation needs to offset consist of impacts caused by harvesting (impacts from ships fuel, possible lost nets, noise etc), production (understood widely), transportation, possible packaging recycling, and impacts from not leaving the whale alive. If we look at the caused impacts to CO_2 emissions and their capture alone, the company could, in a broad sense of sustainability, to offset them by for example planting enough trees to compensate the impact. However, sustainability framework from the impact equity-formula can be argued to indicate that this would not be sustainable, because not only is the offset done in different ecosystem, but also because they do not correct the impact to the regeneration of phytoplanktons, nor the negative impact to the fishing industry. In addition, whaling might have a negative impact to the eco-tourism. The impacts from the whale itself could be argued to be null if the whale itself could be considered to be "interest" from the whole whale population i.e. stock. If this was the case, two ethical questions arise: 1) who has a right to harvest these "interest whales", and 2) what is the sustainable level of whale population? The first one arises when more whales are wanted to be harvested than what is generated as interest: who's harvest is then no longer sustainable? The second one raises not only a scientific question, but also an ethical one of what is considered to be sustainable level? For example, assuming that the current population balance is adequate then the interest could be harvested. But if it is assumed that the level of the population is below the desired level then one may ask whether each individual caught is in fact unsustainable, even if the total population remains the same in the long run[9] - i.e. we are actually harvesting stock? Even with harvesting interest whales one must nevertheless remember that sustainable harvesting must target individuals who do not change, for example, the whale population's regeneration rate according to impact equity formula.

Why then to use accounting prices, wouldn't the offsetting using the CO_2 emissions-amounts be enough? The problem is that, for example, water usage in a

9 In Finland, Luke is assessing what is the smallest viable population size for wolves. Preliminary results suggest that the current population does not meet that requirement (Valtonen et. al., 2021)

water-rich operating environment causes different impacts than usage in water-poor operating environment, so comparing just liters wouldn't give the right picture. Off-setting water footprint with using accounting prices should, at least in theory, mean that it is more expensive to do that from usage in water-poor environment, and therefore the bigger environmental impact would be seen in the market-prices also. Another problem is that CO_2- and water-impacts are not the only impacts that production can cause and comparing, for example, water footprint and emissions which would be needed when comparing for example sustainability of two different products, production methods, or even two different companies, is problematic without having a uniform measuring system. There are few drawbacks in using accounting prices. Munda (2004) argues that from technical point of view the shadow prices primary implement efficiency. This means, according to author, that because the shadow price rises as the asset becomes scarce, the value of the "stock" stays the same or even rises even thought the physical quantity has reduced. Another problem arises from the practice of converting future costs and benefits into a present value using discount factor. Gardnier (2010), for example, states that when the discount factor is a positive, after several decades all the cost disappear except the most disastrous ones, which will became minimal. Although calculating the overall sustainability of operations using accounting prices isn't without downfalls, it nevertheless enables a computational scale that can also be compared to the traditional economic benefits of a product or service. In addition, it enables comparability between companies and industries, which is particularly important in a resource-poor economy.

What kind of value should the BIBs then use? Based on the discussion before, one could argue that it should reflect at least the asset's values as a stock, it's regeneration ability, and it's resiliency (table 7). Together, these would form the assets full sustainability value, and the impact that company's operations causes to that value would be the full sustainability cost.

Table 7: The criteria for which the asset's value should reflect

Asset's value as a stock	For providing ecosystem - provisioning services - regulating services - maintenance services
Asset's regeneration ability	"Interest rate"
Asset's resiliency	- Asset's biodiversity - Asset's position in planetary boundaries

4.3. Balance sheet

4.3.1. Assets

The company's natural capital balance sheet could be approached from two perspectives: the first one is the traditional balance sheet formula which contains both the assets as well as the liabilities, and the second is the notion of showing just receivables and liabilities. Both approaches have both advantages and disadvantages. The most problematic aspect arises from the contradiction of property rights and ecosystem principle. If the company would include the value of, for example, the forest in it's balance sheet, it would normally do that using purchase price (Leppiniemi & Kykkänen, 2019). Dasgupta Review's core idea, however, seems to argue that the natural capital's balance sheet should be valued according to assets' true values i.e. using accounting values. The problem is that the "group of assets" for which the company has a property right, probably is not the same as the one defined by the ecosystem. Even if the company could define what is it's "share" of the ecosystem value based on to the company's property right share, the discrepancy rises when the assets are used in a way that decreases it's value. Based on the sustainability principles defined earlier, the decrease of the whole ecosystem's value would need to be taken into account, not just the decrease in the group of assets defined by the property rights. However, the whole decrease could not be shown in the revaluation of the assets, in stead the difference between the decrease in property rights assets and caused decrease in ecosystem level would need to be shown separately. The problem with property rights could be bypassed if BIBs would include only receivables and liabilities. In this case, the change in the value of the natural capital caused by the company's operations could be compared to, for example, to the development of the national natural capital. However, this could lead to the situation where it would be more difficult, for example, to define the corporations efficiency if one did not know the natural capital that the corporation had in use. It would also hinder monitoring the preservation of the ecosystem's value from structural perspective if the changes in values could not be compared to the original asset values. The practice would also go against balance sheet ideology where non-current assets that generate income more than one fiscal year must be capitalized in the balance sheet (Leppiniemi & Kykkänen, 2019; KPL 5:5). Therefore, it would be arguable that BIBs should follow more traditional balance sheet model where assets are included.

The difference between traditional balance sheet and BIBs would be that asset's income generating capacity would be defined according to asset's ability to generate ecosystem services, and not according to it's ability to generate income to the corporation. Another difference would be that the asset would need to be capitalized to the balance sheet according to it's sustainable full value, and not according to it's purchase price. At a first glance, the practice would go against KPL 5:2 and 4:5 where non-current assets are activated according to the acquisition price as a default. However, one way to look at the BIBs would be that it measures the asset's value to the biosphere functioning, and as such it's acquisition price would be the value that would have to be paid if services provide by that particular ecosystem would have to be produced artificially. The situation can also be compared to KPL 5:17 where a revaluation is

possible under certain conditions in items belonging to non-current assets, when their market value is permanently and significantly higher than their underappreciated acquisition cost is on the balance sheet. It is noticeable that revaluation of the assets upwards is also recorded in tied-up equity (Leppiniemi & Kykkänen, 2019) from which it cannot be distributed for example as a dividend according to the Companies Act (OYL 624/2006) 8:1 and 13:5. As a simplified example, and assuming the corporation would own the great whale and the great whale would be alive, the corporation would include it into the assets as follows: per great whale a natural capital 2 million.

4.3.2. Liabilities

Normally, expenses capitalized in balance sheet are recorded as expenses to the profit and loss in the form of depreciation, the amount of which is based on the assumed period of income generation (Leppiniemi & Kykkänen, 2019; KPL 5:5). The difference with natural capital is that ecosystems are in a way a perpetual motion machine whose value does not, or at least should not, decrease in at least in no such time that the depreciation rate would produce a significant change in the balance sheet values. But depreciation in ecosystems could happen as Dasgupta (2021) describes, but it is not linear as for example KPL 5:5 assumes. How then to define when the ecosystem's value has changed? The question is fundamentally linked to the answers sought from BIBs, and therefore one can also argue that the theories (i.e. impact inequality-formula and planetary boundaries) define the moment when the change in asset's value happens. Depreciation in asset's value happens when the natural capital stock has decreased, natural capital portfolio has narrowed, natural capital regeneration rate has reduced, or possibility of regime shift has increased (table 8), and as such asset cannot produce ecosystem services in the quantity and/or quality as before, or the risk of that happening has increased.

Table 8: Depreciation in natural capital asset value can happen in four ways

Indicator	Trend	Example
Natural Capital stock	Decreased	Decrease in lake's fish population
Natural Capital portfolio	Narrowed	Decrease if meadow's butterfly variety
Natural Capital regeneration rate (interest rate)	Reduced	Yearly amount of blueberries has permanently decreased
Possibility of regime shift	Increased	The lake's cumulative phosphorus load has increased

Because it has been previously defined that the value of natural capital should not decrease, it is arguable that instead of transferring the depreciated amount of an asset as expenses to profit and loss, as would be done in traditional balance sheet (KPL 5:11),

corporation is actually creating a debt. According to KPL 4:6 corporation has to book debt when the expenses have been realized on an accrual basis, but from which there has not been payment maid. This debt can be considered to have been created for society based on how the company's operations have reduced or weakened the local and overall formation of ecosystem services. In here, the BIBs would differ from traditional balance sheet as KPL 5:11 mandates to transfer capitalized purchase price to burden the profit and loss in a form of depreciation in no longer than 10 years. The created debt needs to be "paid" ,for example, by conservation methods in order to restore asset's value, and as such the reduction in value is not permanent, in which case it would have to be taken to burden the profit and loss according to KPL 5:11. In theory, the greater the decrease in natural capital value, the greater the cost of conservation would be. As the conservation actually costs money, the expenses would need to be transferred to the prices of goods and services, thus bringing their prices more towards their actual costs. Dept thinking brings leeway to the corporations as it allows temporary decrease in natural capital. As a result, the corporation can be considered to operate in sustainable manner, despite the large and significantly impacting investment on natural capital, as long as the debt is eventually paid off. If paying is not possible, corporation's operations can not be considered to be sustainable, when sustainability is defined as previously mentioned.

The decrease in ecosystem's natural capital value would need to be divided into two: decrease in value concerning assets defined by property rights, and decrease caused to ecosystem values outside of property rights. This situation might occur, for example, in situations where meadow is transformed into monoculture farmland thus causing a decrease in number of pollinators, which in turn affects the production volumes of the neighboring orchard. The situation is no different than, for example, building owned by multiple corporations: if one owner causes a decrease in asset's value by mismanagement, it affects also other owners' asset's value. Even though the asset would be later restored, the damage might have caused expenses to other owners, from which the causer might be liable of. If we would only concentrate to restoration of asset's value within our property right, it might lead to a situation were, although our asset value has been restored, other "owners" have lost substantial amount of "interest" and the value of their asset has even decreased permanently because of, for example, changes in the stock. The question of how, and overall could, this distinction be done is outside of this paper's scope. However, the distinction of these two is important at least in the theoretical setting in order to grasp the idea of natural capital value setting in ecosystem and biosphere level.

Debt could also be created solely outside of property rights when, for example, the subcontractor's operations are not sustainable. This, however, raises a problem of double counting, which is outside of this paper. Perhaps the most common impact to natural capital outside of corporation's property right is a situation where impacts are caused to biosphere (like CO_2 -emissions), or to common goods (like water or whale). This debt, although might be the hardest to define and calculate, needs to be included in the BIBs as a debt similarly as a debt caused to asset within property right.

Since the reduction in value would primarily be treated as a debt and not as a permanent reduction in value, the depreciation would not change the assets value. This also enables the long-term gradual erosion and the overall effect of the corporation's operations over time to become more visible, when original asset value and debt associated with it can be compared. In traditional accounting, the other side of the

depreciation would be taken to profit and loss, from which at the end of the accounting period it would affect the profit for the year and thereby reduce equity. Therefore, in BIBs debt could be considered to directly reduce equity as well.

4.3.3. Receivables

Asset's value can also increase. The rules of increase are strict in traditional balance sheet and unlike the depreciation of assets, increasing the value is voluntary (KPL 5:13, 5:17). Increasing the asset's value can be done if the increase is significant and permanent, and it must also be verified (Leppiniemi & Kykkänen, 2019). It is to be noted that increase in asset's value is booked to the restricted equity and therefore does not affect profit and loss nor can it be distributed as dividend (Leppiniemi & Kykkänen, 2019). The increase in the asset's value could be derived from the same theories as depreciation i.e. from impact inequality formula and planetary boundaries. In this case, it could be argued that natural capital's value has increased if natural capital's stock has increased, natural capital portfolio has widened, natural capital regeneration rate has increased, or possibility of regime shift has decreased, when other indicators have stayed at least the same or increased (table 9), thus resulting increase in ecosystem service's quantity, and/or quality, or the risk of fluctuation in them has decreased.

Table 9: Increase in natural capital asset value can happen in four ways

Indicator	Trend	Example
Natural Capital stock	Increased	Increase in lake's fish population
Natural Capital portfolio	Widened	Increase if meadow's butterfly variety
Natural Capital regeneration rate (interest rate)	Increased	Yearly amount of blueberries has permanently increased
Possibility of regime shift	Reduced	The lake's cumulative phosphorus load has decreased

Although the increased asset value does have a significance when calculating corporation's solvency, the bigger question for corporation is, could this increase be considered as a receivable in some cases in regards of BIBs? Receivables are a form of assets that consist of income which have been realized on an accrual *basis,* but from which payment has not been received (KPL 4:6). So, what could the receivables be used for? One way in which a corporation can be considered to have used receivables is offsetting. Biodiversity offsetting is a tool which aims to compensate the decrease in natural capital resulting from the corporation's operations. Offsetting, however, has raised concerns and objections. Karlsson and Edvardsson Björnberg (2021) identified, for example, 5 ethical objections for the offsetting in scientific literature: not enough is known in order to make adequate trades, one cannot compensate decrease with human interventions, nature's intrinsic value is being violated, and offsetting causes negative

justice implications, and hinders virtuous dispositions towards nature. Josefsson et al. (2021) also did not found out any evidence that biodiversity gains from offsets had actually compensated losses due to fact that the original deduction was not known. What is most troubling in Josefsson et al.'s (2021) findings was that most studies rarely included ecosystem services, and instead used only reference habitats as comparator, and singular taxa of biodiversity for evaluation. In terms of natural capital, however, an ethical problem also arises: can a corporation show receivables if the natural capital can be considered to have been too low in the beginning? If, for example, the European Commission's (COM(2020)380) premises that the natural capital should be increased was made mandatory, could the corporation then use receivables for offsetting, or even claim receivables in the first place?

When we take into account sustainability principles defined earlier, the receivables could be used for offsetting only in situations were offsetting was done within the same ecosystem. Similarly as where loan taken from financial institution X inherently cannot be paid to financial institution G. Using the receivables to offset debt caused in another ecosystem could only be used in situation where offsetting can be done in biosphere level without causing permanent discrepancy in ecosystem level. The receivables could be used on the other hand, for example, by "selling" its benefits to another corporation operating in the same ecosystem when it improves their sustainability gap. Because increased value in natural capital cannot be booked both in asset value and receivables, receivables could be considered to be reasonable only in situations when the corporation's own operations are sustainable by themselves, and that corporation does not want to consider them as permanent. In this case, corporation does not need an increase in value to cover the sustainability gap of its own operations, but can look for additional income when the increase is otherwise financially profitable.

Similar as liability, receivables would then affect equity and create a buffer for the decrease in equity. Ethically, however, we find ourselves in a situation where we have to decide how far the receivables can offset the decrease in equity. Since it has previously been established that the lack of sustainability cannot inherently be corrected in another ecosystem than where to gap has been created, in BIBs, receivables and liabilities could not be equalized in the same way as in traditional accounting, despite their monetary valuation.

4.3.4. Equity

Corporation's equity is the foundation to the corporation's solvency (Leppiniemi & Kykkänen, 2019). Assets, receivables, liabilities and equity (accumulation of transfer of accounts and mandatory reserves are ignored here) are tied together in the following manner:

$$\text{Assets} + \text{Receivables} = \text{Equity} + \text{Liabilities}$$

or putting in another way:

$$\text{Equity} = \text{Assets} + \text{Receivables} - \text{Liabilities}$$

One way to look at the equity in traditional balance sheet is to consider it to present the value that the owners (or shareholder) would get if all the assets would be liquidated, and all the liabilities would be paid off. What does the equity represent in BIBs; could the corporation's sustainability be defined by it? Directly equity cannot be considered to represent corporation's sustainability, at least in a sense that positive equity would indicate sustainability. That is because the equity stays positive as long as the assets' value is larger than liabilities, which would mean that corporation could "depreciate" the whole natural capital value, and still show positive sustainability. Negative equity would mean that corporation has caused natural capital depreciation outside of property rights more than their own asset's value in BIBs, or it has reduced the asset's value so much that the ecosystem can be considered to be contaminated.

However, it is worth thinking whether the equity ratio could be used to measure sustainability. If we consider that in BIBs assets are also tied-up equity, then it can be argued that corporation's operations can be considered to be sustainable when there are no liabilities, and therefor:

$$\text{Equity} = \text{Assets} \ \ (+ \text{ receivables?})$$

A corporation's financial risk is generally measured by capital structure, solvency. The more prevalent debt capital is in the company's financial structure, the worse it's solvency is, and the greater the financial risk associated with the company is estimated to be (Leppiniemi & Kykkänen, 2019).

The equity ratio is calculated as follows:

$$\text{Equity ratio (\%)} = \frac{\text{Equity}}{\text{Total capital}} \text{ X } 100\%$$

The sustainability ratio would then be:

$$\text{Sustainability ratio (\%)} = \frac{\text{BIBs Equity}}{\text{BIBs Total capital}} \text{ X } 100\%$$

100% sustainability rate would indicate that corporation's operations does not cause decrease in natural capital, or it has receivables at least with the same amount that it's liabilities are. Less than 100% would indicate a gap in sustainable operations. How much less than 100% sustainability ratio could still be considered acceptable largely depends on the company's operations, future prospects, and the reasons that have led to the gap. In traditional equity ratio calculation, even the high debt ratios could be considered to be acceptable if the risk associated with the company's operation is low, and the income development is good and stable (Leppiniemi & Kykkänen, 2019). On the other hand, if the company's income varies greatly from one fiscal year to the next,

or the income development is limited and the company also has loss-making fiscal years, high indebtedness is considered particularly worrying, and even low indebtedness can then be a risk threatening the company's continuity (Leppiniemi & Kykkänen, 2019). A similar consideration could also be applied to sustainability ratio. If the gap is due to resent large investment even large gap could be considered to be acceptable. On the other hand, if the negative gap is due to normal operations, or liabilities have been largely been offset with receivables or the gap does not show any indication of reducing, a gap is a risk. The risk that can be considered to be caused by the fact that the company's daily operations do not meet the defined sustainability criteria or they have had to be compensated in a way that does not meet the basic principles of sustainability defined here. A widening gap from one fiscal year to another without any large investments could be considered to indicate high risk. Sustainability ration, however, is problematic in one aspect. If the corporation owns sizable and valuable assets, ratio-calculation could fade even large decrease in one or two ecosystems. Therefore, ecosystem-level monitoring could be considered necessary at least in those ecosystems where debt has been built up.

5. DISCUSSION

5.1. Summary of results

Assets and natural capital are terminology that are used in balance sheet. They represent the positive part of the balance sheet that will generate profits and other benefits for the corporation in the future. But the balance sheet also has a negative side, the one that describes the debts and other commitments for which the company will also be responsible in the future. Diamond's (2005) question at the beginning about what would happen if companies were responsible for ensuring that assets' values do not deteriorate, raises the question of liabilities in a whole new light: when does the liability come to exist? In this case, we inevitably have to ask what it is that we are actually preserving, or like Norman and MacDonald (2004) put it, what is the bottom line? Also the bounded economy that Dasgupta (2021) describes indicates that there are limits, but limits to what and what are they? If the bottom line is to preserve the ecosystem services at the level that they currently are or above that, we also come to face the knowledge that we have to value ecosystems and biosphere as a functional system, regardless of the value of its individual parts to ourselves. All this requires information that may not be easily available or even measurable. Drawing boundaries can be difficult and technically the calculation may even become impossible. In addition, it raises some very difficult ethical questions like the ones from rights: what are my rights to use my own property and, on the other hand, what are the rights of others to the ecosystem services it produces? On the other hand, these are the questions that we need to tackle as a society one way or another if we want to avoid the looming crisis.

The BIBs described in the thesis starts to look at corporate sustainability from the ecosystem- and biosphere system perspective. It considers that they provide valuable ecosystem services, and that when corporation's operations either decrease the quantity or quality of those services, or increases the risk of negative fluctuation of those services in the future, the corporation is no longer considered to operate in sustainable manner. Measuring and managing corporate sustainability is done using traditional balance sheet model in order to bring sustainability issues in the same playing field as economic matters. For this reason also, the BIBs uses monetary valuation, however in a way, where the cost of trade-offs are more included. The interfaces between liabilities and receivables are driven from Barrett et al.'s (2020) impact inequality-formula and Rockstrom et al.'s (2009) idea of planetary boundaries, where a change in the components of the supply side of the formula, or the distance from the safe boundary changes results also formation of liability or receivable for the corporation. However, the principles driven from system-perspective also restrict the "payment" of liabilities, or usage of receivables that differs significantly from the traditional monetary form.

The outline of BIBs can be seen in table 10, and examples of BIBs transactions are described in appendix 1.

Table 10: Biosphere Impact Balance Sheet (BIBs)

Assets			**Equity and Liabilities**		
Assets			Equity		
Asset A			Natural capital		
Separately followed	xxx		Asset A	xxx	
Others	xxx	xxx	Asset B	xxx	xxx
Asset B			Previous fiscal years		
Separately followed	xxx		Increase / decrease asset A	xxx	
Others	xxx	xxx	Increase / decrease asset B	xxx	
Total assets		XXX	Debt outside of property right	xxx	xxx
			Fiscal year		
			Increase / decrease asset A	xxx	
			Increase / decrease asset B	xxx	
			Increase / decrease debt outside of property right	xxx	xxx
			Total equity		XXX
Receivables			Liabilities		
Asset B		xxx	Asset A		
			Reduction within ownership	xxx	
			Reduction outside owners.	xxx	xxx
			Debt outside of property rights		xxx
			Total liabilities		XXX
		XXX			**XXX**

For what purposes could information in the BIBs then be used? First of all, it could be used to determine the price of financing: the larger the sustainability gap, the higher the price for the borrowed money due to the higher risk. Or if the issue is viewed from the point of view of efficiency: the more efficiently the corporation has been able to convert natural capital into other capital forms, the smaller the risk of interference in the continuation of operations, which results cheaper financing. Secondly, it could be used as a guidance in sustainable investing, where sustainability-ratio could indicate the corporation’s share’s position in the sustainability portfolio. Thirdly, in a resource-scarce economy, for example, the price or pre-emption of raw materials could be differentiated based on the buyers' sustainability: the higher the sustainability-ratio, the lower the price or better the pre-emption would be. Thirdly, it could be used for societal guidance. In a traditional balance sheet negative equity obligates the company's board of

directors to immediately make a register notification of the loss of share capital (OYL 20:23) If, according to the balance sheet, the company's equity is less than half of the share capital, the board of directors must immediately convene a general meeting to decide on possible measures to improve the company's financial position (OYL 20:23). Similar control could be used according to BIBs, which would also help controlling national natural capital. For example, if the corporation's equity were to fall by 20% due to debt, or if the debt caused by the investment could not be compensated within the time specified at the beginning of the investment, the corporation could be obligated to report it to the appropriate authority. Similarity, if for example the equity is halved due to debt, or the debt resulting from the investment has not been reduced in the last two fiscal years, the corporation could be obliged to submit a plan to correct the situation. In extreme cases, BIBs could be used when considering the conditions for extending the business license, or when considering the amount of damages. Worth considerations is also a situation on when natural capital has been considered permanently to been reduced, could the corporation then be obligated to compensate the reduction to the society? Although this would not correct the production price of the past products or services, it would raise the price of the corporation's future products, thus correcting the cost imbalance between the corporations. In situation where the investment is considered to cause permanent or large decrease in natural capital already at the beginning of the investment, it is worth considering could the corporation be considered to be obligated to produce a deposit or guarantee amounting the decreased value in sustainable full cost-prices?

5.2. Comparison of results with previous studies

Contrary to ecological footprint assessments and life-cycle assessment (Wackernagel et al., 2002; Reap et al., 2008), BIBs considers weather corporation's operations have caused impact to natural capital’s value, and therefore also it’s ability to provide ecosystem services during the fiscal year and the “individual footprint” of particular product or service is not in it’s focus. Therefore, it includes the production amounts and trade-offs more clearly, but might also hinder individual customer’s ability to manage one owns footprint unless the production can be considered to be environmental-neutral, or the impacts are allocated accordingly. Latter, however, might be problematic and cause miss-information from product’s impacts if, for example, impacts originally were thought to be fully “payable”, but which would later to be found untrue. However, the biggest difference would be the shift of focus from calculating how “heavy” to footprint has been to measuring how permanent or how “far” the footprint has been from environment’s carrying capacity. This means that, for example, product with large water consumption produced in water rich area might not leave permanent footprint and thus would not cause an impact to BIBs, whereas the same product produced somewhere else might leave permanent footprint by, for example, reducing the stock of water, and therefore would also been seen in BIBs.

Another difference is that BIBs is “purely” environmental- and balance sheet-approach and therefore it does not have a profit and loss-aspect nor does it consider what something actually costs in market prices unlike for example Ogilvy (2015) seems to do. However, BIBs does sees similarly than Ogilvy (2015) that depreciation in assets is a liability, which should also have impact in equity.

5.3. Evaluation of research

The BIBs outlined in the paper seem to answer some of the questions raised in the beginning. It outlines the limits that the corporation's operations must not exceed. In other words, it creates a boundary line for when the corporation’s operations can no longer be considered to be sustainable. By using sustainable full values it also better highlights the well-being created by ecosystem services in a way that enables better comparability with the profit produced by the traditional economy. Above all, it can be considered to enable monitoring of how far from sustainability the corporation's operations are. At the same time, however, it also fades away some of the important aspects of the ecosystem services, like, for example, the “protection value” that the biodiversity provides against to the fluctuation of the yield, and information of exactly how the decrease has happened, due to condensing everything down to a numerical value. Numerical values themselves are problematic also due to the fact that they are set based on the chosen value base that is fundamentally affected by it’s authors point of view and own value base, and could be seen for example in boundary setting. Paying the debt might not be possible due to irreversibility, or it might be much harder than originally thought due to hysteresis. Also interaction of two complex systems, like the natural and social, might cause rebound effects that are not considered here (Lu et al., 2019). There is also the question of how to separate the value change caused by corporation’s activities from the ones caused by others (like overall effect from climate change), and how to process the “other” costs. One must not also forget that even if we attempted to stay withing a sustainable yield in our extraction, estimating that yield in most natural biological resource populations is difficult as the impacts from extraction, the natural processes of growth and death and relationships with other species are usually non-linear, variable and often not entirely understood in scientific terms (United Nations et. al., 2014). In addition, it raises complex ethical questions of how to allocate yield between different stakeholders. However, maybe this is exactly what for example emissions trading (Directive 2003/87/EC) is trying to do.

5.4. Future research topics

If BIBs were to be developed, one of the subjects of the research should be whether the basic idea of examining only the permanent footprint as described in the BIBs is more economical that for example life cycle-calculations. Also there should be made an assessment whether BIBs would ultimately be able to preserve the value of natural capital, or does the not counting the footprint "within sustainability" cause such a change in value creation that has not been taken into account here. The thesis also only describes the basic principles and interfaces of BIBs, and therefore more thorough study of individual components would be necessary in order to establish, for example, when the stock has been reduced in a way meant in BIBs and isn’t just a normal yearly fluctuation. Above all, a careful study should be made how to calculate and capture the overall ecosystem value.

Surprisingly however, even though the ethical aspect were exclude from the scope of the thesis, the ecosystem perspective-principle causes so strong clash with property rights-thinking that without ethical discussion of this issue in society level the development of BIBs might not be possible. A way to forward could be, for example, to consider weather property rights should be thought in the line of housing company, where for example AOYL (1599/2009) 4:3 indicates that share owner is obligated to maintain the condition of the flat so that for example the components of the building aren’t compromised.

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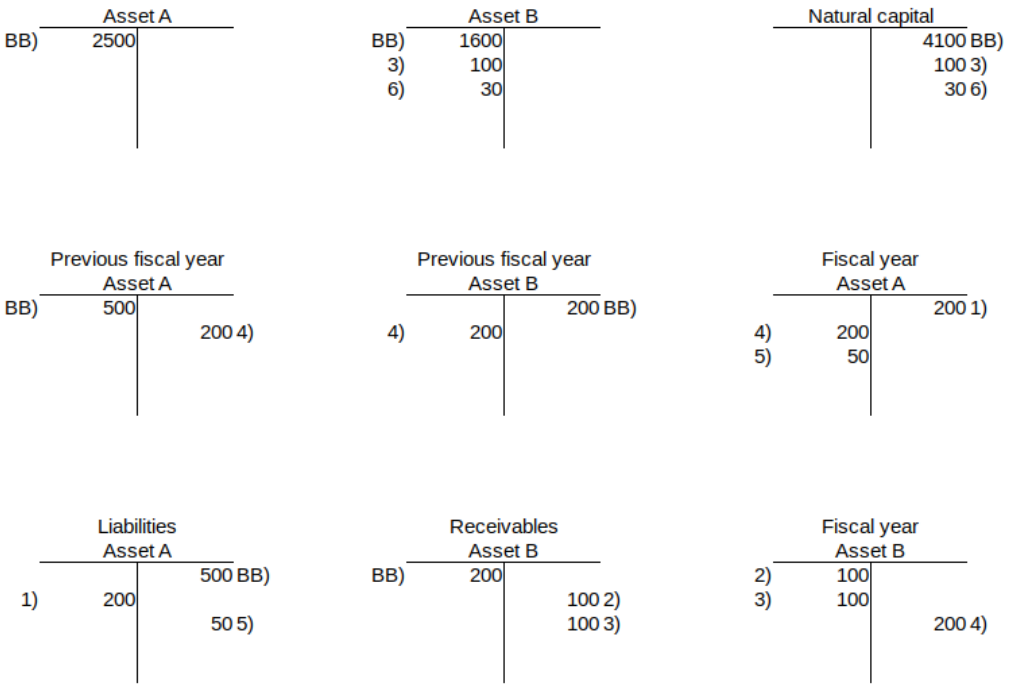
APPENDIX 1:

Examples from BIBs transactions



BB) Beginning balance
1) Reduction of liability in asset A amounting 200
2) Receivable in asset B "sold" to company X amounting 100
3) Receivable in asset B transferred to asset's value amounting 100
4) New fiscal year
5) Decrease in asset A value amounting 50
6) Increase in asset B value, not considered receivable amounting 30