Natural capital and sustainable development: The story so far

Falco Richardson
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Content

1. Introduction ................................................................................................................................... 1
   1.1 Background ................................................................................................................................ 1
   1.2 A framework to begin with ........................................................................................................... 3
   1.3 Thesis idea and purpose ............................................................................................................... 4
   1.4 Central concepts and definitions ................................................................................................. 6
   1.5 Thesis outline .............................................................................................................................. 8

2. Method ........................................................................................................................................... 10
   2.1 General approach ......................................................................................................................... 10
   2.2 The literature review .................................................................................................................... 10

3. The foundations of natural capital ................................................................................................. 13
   3.1 About capital in economics ......................................................................................................... 13
   3.2 The development of environmental concern in economics ......................................................... 15
   3.3 Economics gets ecological .......................................................................................................... 18
   3.4 The arrival of natural capital ....................................................................................................... 20
   3.5 Natural capital definitions .......................................................................................................... 21
   3.6 Economics for sustainable development ..................................................................................... 23

4. Weak versus strong sustainability ................................................................................................. 27
   4.1 About weak sustainability ........................................................................................................... 27
   4.2 About strong sustainability .......................................................................................................... 30
   4.3 Critical natural capital and ecological economics ....................................................................... 32
   4.4 Debating weak versus strong sustainability ............................................................................... 32

5. A critical perspective on natural capital ......................................................................................... 37
   5.1 Political-ecology ......................................................................................................................... 37
   5.2 Critiquing the concept of natural capital .................................................................................... 38
   5.3 Problems with viewing nature as capital .................................................................................... 39
   5.4 Further critique levelled at natural capital .................................................................................. 41

6. Conclusion ................................................................................................................................... 45

7. Acknowledgements ........................................................................................................................ 50

8. References ..................................................................................................................................... 51

List of abbreviations and acronyms

NC    Natural Capital
MC    Manufactured Capital
CNC   Critical Natural Capital
SD    Sustainable Development
ISEE  International Society for Ecological Economics
WS    Weak Sustainability
SS    Strong Sustainability
PE    Political Ecology
UNEP  United Nations Environment Programme
NCC   Natural Capital Committee
TEEB  The Economics of Ecosystems and Biodiversity

List of figures

Figure 1: Kinds of questions a literature review can address (p. 9)
Figure 2: How concern for the environment in economics developed (p. 17)
Figure 3: The integration of economics and ecology (p. 18)
Figure 4: The capital approach to sustainable development (p. 23)
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Abstract: Natural capital is a way of conceptualizing the linkages between economics and the environment. The concepts foundations can be traced back to the environmental movement of the 1970s and the works of influential economists at that time. Natural capital has come to have an elevated position in environmental conservation approaches in the United Kingdom. The UK government's advisory body, the Natural Capital Committee, is the first of its kind in the world to be established. The concept of natural capital points to those aspects of the environment that directly or indirectly are of value to people. Such aspects include the functions and services of ecosystems, species, and habitats, as well as atmospheric protection and clean air and rivers. Natural capital is also a central concept in the capital approach to sustainable development and the ecological economics field. However, natural capital has not been accepted into environmental conservation approaches in the UK without criticism. Considering natural capital's history then, and its current popularity in environmental conservation, this thesis is interested in addressing the key question: what is natural capital? To be able to account for natural capital's origins, definitions, development, and issues and debates about it, the method used for this thesis is wholly comprised of a literature-review. Throughout the review, reference is made to key scholarly works where natural capital is defined, developed, and used as a central concept. With regard to literature about natural capital, much of it is comes from scholars strongly associated with ecological economics. In addition, natural capital is analysed from three different perspectives. The first perspective is conceptual-historical, the second is a sustainable-development perspective, and the third a political-ecology perspective. From a conceptual-historical perspective, natural capital can be understood as a concept which has developed out of a body of thought of environmentally-aware economists who argue that economics must better take account of ecological systems and their complexity. From a sustainable development perspective, natural capital is a central concept underpinning a capital-based approach to sustainable development. Natural capital also features centrally in debates about how to give an operational meaning to 'sustainability' based around the traditional economic concept of capital. The key debate in this regard concerns weak versus strong sustainability. From a political-ecology perspective, the natural capital approach to environmental conservation is, in ideological terms, of a neo-liberal nature. Natural capital and economic valuation in environmental conservation arguably facilitate the 'monetization' and 'economization' of the environment. Natural capital is opposed for ideological and ethical reasons. Another view would present natural capital as a key part of the economists pragmatic attempts to improve the way economies are managed through better linking economics and the environment. By conveying the economic value of the environment we may be able to put it in a better standing in the priority policy-lists and economic-development agendas of governments and international development agencies. In the United Kingdom there continues to be an ongoing debate about natural capital's place in environmental conservation. This thesis is intended to be a contribution to that debate.

Keywords: economics; economic value; environmental conservation; natural capital; sustainable development; political-ecology.

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Summary: Natural capital is a term which is currently enjoying popularity and usage in the United Kingdom's environmental policy and conservation. Natural capital is an economic term and was developed as way of speaking about the environment that points to the benefits and services nature provides for us which contribute to our happiness and well-being. For example, pollination by bees provides us with food products which we consume. Economists concerned with the state of the environment suggest that it needs to be protected in the long-term, in order for our economies to survive, but more importantly, to secure the well-being of future generations. However, measuring our the state of our environmental, such as the amount of ancient woodlands, to see whether they are healthy or diminishing, is no easy task. Part of the reason why a natural capital approach is advocated in pursuit of protecting the environment, is to demonstrate to politicians that protecting the most important parts of the environment is a very good idea in the long-term. Sometimes, this requires presenting the preferences people have for the environment, such as wanting a nearby forest to remain because it helps reduce flooding, as a money-value. Money is an easy common denominator that most people are familiar with, and economists have come up with some clever ways of deriving peoples preferences for some change in the environment, e.g. cleaner air surrounding their house. A natural capital approach to conservation therefore involves at some point having to put a value on the environment. This remains a controversial practice for some despite the fact we already price and trade natures produce already, such as market sales of timber. The movement to a natural capital world raises some important questions such as: should our environments be valued like other goods and services are? How can this be done? And, what is the best way of going about it? Naturally, asking such questions raises concerns about natural capital and whether it is the right or appropriate approach in pursuing safeguarding the environment. Recently, as the natural capital approach has gained in popularity, much criticism has been directed at economists who advocate economically valuing the environment. In this thesis, a number of different perspectives from which natural capital can be looked at are presented here for the reader. The perspectives include: 1. a historical perspective about the origins of natural capital and definitions of it; 2. an economic perspective concerning how natural capital figures into economic debates about what is the best way we can protect the environment for future generations, and, 3. a critical perspective because natural capital is criticised for asking people to put a money-price on nature.

Keywords: economics; money-value; environmental protection; natural resources; human well-being; criticism.

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1. Introduction

1.1 Background

‘Natural capital’ can be considered as being one of the buzzwords of ‘sustainable development’ at the beginning of the 21st century. Natural capital is defined by Dieter Helm (2015:2), an economist who chairs the United Kingdom's Natural Capital Committee, as the “elements of nature; they directly or indirectly produce value to people, and can be broken down into ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions”. Natural capital is also a central concept in an approach to sustainable development coming from economics, the so-called 'capital approach' to sustainable development.

Pearce and Barbier (2000:7), two leading environmental economists, assert that a capital approach to sustainable development “is important because it places the environment in the same political dialogue as economic activity generally”. The authors further argue that because an 'economic value' is not placed on ‘natural assets’ such as rainforest, these ‘assets’ lose out to other kinds of economic development e.g. when rainforest is converted to agriculture for livestock-grazing. The authors argument proceeds to pointing to the 'economic costs' that occur by degrading and destroying nature, and that such costs aren't accounted for because losses of natural assets, e.g. the decision made to convert rainforest land to agriculture, don't come at a 'real-world price'. That is to say, the benefits of preserving the rainforest intact for example are forgone due to their loss. However, this loss does not have an actual 'value' attached to it because the benefits of preserving rainforest, e.g. absorbing carbon-dioxide, do not have a recognised 'exchange-value'. Nobody pays for these benefits as we do other everyday-services or for measures to protect the environment. Essentially, the world can be seen to have been freeriding on nature's services.

One way rainforest could have its 'economic value' 'demonstrated and 'captured' then, could be to establish markets for the services it provides to the global economy as a 'sink' for carbon-dioxide emissions. Such a market would be based around the world's populations demanding the service of the Amazon rainforest as a carbon-sink, and in turn, paying the owner's or stewards of the rainforest to keep on supplying this service by preserving the rainforest intact. 'Market-instruments' such as this, e.g. paying landowners to keep on providing services provided by the environment, have come to be known as 'payments-for-environmental-services'. They are one of many methods currently popular in environmental conservation policy which utilize economic valuation techniques to be able to estimate the kinds of prices that people might pay to maintain the services nature provides.

We can imagine a scenario where damaging nature's services doesn’t come at an economic cost because no one is paying to preserve those services at a certain level of output i.e. unimpaired. In addition, no compensation is being offered by the party causing the damage to the people who prefer that any such damage does not occur because they are directly effected in some negative way. In economics, a 'cost' (as opposed to a benefit) that is suffered by a third party (consumers for example) as a result of the actions of the first party (a producer for example), is known as a 'negative externality'. By Pearce and Barbier’s (2000) logic, if no economic value is placed on the rainforest for it's environmental services, then surely the land will be used for other more productive and profitable purposes that current market prices dictate. For example, the economic benefits coming from the conservation of rainforests have in the past had no market price, though they still had a non-market value, and therefore were not deemed to be important to maintain or exploit, unlike the economic and financial gain made from converting forest land for cattle grazing as is still the case (see e.g. UNEP, 2014). If natural assets are recognised for their benefiting of the
economy, and are assigned proper economic values and prices like other regular commodities such as food, Pearce and Barbier (2000) claim that it is only then that environmental conservation can stand a chance to compete with economic-development. Economists endeavours to demonstrate the benefits that come with conserving the environment, are summed up by Pearce (1992), who argued that the failure of markets to account for the environment should be corrected.

There have been several high-profile studies where natural capital is a key part of those studies conceptual frameworks. ‘The Economics of Ecosystems and Biodiversity’ better known as the TEEB (2010) report, and a report by the UK’s Natural Capital Committee ‘The State of Natural Capital: Protecting and Improving Natural Capital for Prosperity and Wellbeing’ (2015) are both focused on protecting and better accounting for natural capital. According to Helm (2015), natural capital is useful because humanities failings to preserve and protect much of its environment can be turned around by thinking about environmental problems in terms of natural capital. A natural capital approach according to Helm, presents what benefits, if recognised, the natural world has that can be better utilised to contribute to economic output. Helm’s (2015) argument is about 'sustaining' economic growth in an ‘efficient’ and ‘sustainable’ way by protecting and ‘enhancing’ natural capital in order to achieve ‘sustainable growth’. It is not Helm though who first framed environment-economy relations in this way, and not he who first argued for the natural capital approach. 'Our Common Future' (WCED, 1987) can be considered as being the catalyst in popularizing the notion of ‘sustainable growth', and natural capital dates back to the 1970s and the early 'ecological economists'. Although environmental conservation concerns existed before the natural capital concept, natural capital likely emerged out of the much debated and perceived trade-off between protecting the environment and economic growth.

In terms of scientific disciplines, natural capital has its beginnings with scholars who are most strongly associated with the foundations of ecological economics. The use of natural capital in today's forums fundamentally has to do with sustaining economic growth and attempts to 'green' the global economy (see UNEP, 2011). Pearce (1992) spoke of the green economy as constituting an economy that provided for non-declining human welfare over time synonymous with the sustainable use of natural resources.

It is possible to say that the rhetorical and scientific power of natural capital has increased a significant amount in recent years. The United Nations Environment Programme’s (UNEP) ‘Green-economy initiative’ (see UNEP, 2011) is stated by it's director Achim Steiner as being among UNEP’s key endeavours in progress towards sustainable development. Not only is the whole first section of the report about investing in different elements of natural capital e.g. agriculture, fisheries, water, and forests, the report references one of the first and most influential economic studies to argue for a capital approach to sustainable development, the book ‘Blueprint for a Green Economy’ by Pearce et al. (1989).

Whether just a novel conservation concept or a widely established conservation agenda to bring about a 'green-economy' and 'operationalize' sustainable development, natural capital is arguably now a widely used and accepted way of conceptualizing the environment. It is intended to represent the complex ecological functions and services that emanate from the environment which we utilize through our economic activities and ultimately benefit from in terms of our well-being. Natural capital underpins an approach to environmental conservation that the government of the United Kingdom is taking seriously with support from the largest conservation charities, e.g. Royal Society for the Protection of Birds and the Wildlife Trusts. However, a capital approach to conservation and even the use of the concept natural capital, as in seeing ‘nature’ as capital, is for some controversial. Scholars and journalists alike are vehement critics of the natural capital
concept and conservation approach promoted through it. George Monbiot for example, a popular journalist who writes on environmental issues for the Guardian newspaper in the UK, considers the idea of natural capital and the approach that goes with it as being a “neoliberal road to ruin” (Monbiot, 2014).

As has been done with other currently popular concepts in environmental conservation such as ‘ecosystem services’ (see Kull et al., 2015), some scholars (e.g. Spash, 2015) are critical of the way the natural capital concept reflects and reinforces particular market-based models of society and underlying ideologies, primarily that of neo-liberalism. In spite of the view of even those who advocate a capital approach to sustainable development that “…unfettered free markets tend to be the enemy of the environment and hence the enemy of green economies” (Pearce, 1992:4), natural capital could be viewed as being part of an agenda that seeks to mainstream the transformation of nature into commodities. Advocates and those championing natural capital disagree however with the critics. Helm (2015b) for example, argues that some of the critique levelled at the natural capital approach is misguided and, at its worst, sentences the environment to only more degradation.

1.2 A framework to begin with

When speaking about the natural world, there are a number of terms individuals usually use to do so. Similarly, concerning the impacts that human economic activity is having on the natural world, typical terms used to refer to that thing which ecologically conscious people wish to safeguard are 'the environment', 'nature' or the 'biosphere'. Any alterations that mankind makes to the environment can be considered as being positive and improvements on the current state of the environment. Such alterations and improvements may be a part of a countries environmental management strategy. In addition, infrastructure and industries can significantly alter and impact on the environment but at the same time contribute to our well-being and economic success through their produces goods which we consume. Just as the environment can be spoken about in terms of its health or cleanliness, or the destruction of nature in the context of economic externalities which result in biodiversity loss, the environment can also be spoken about in terms of its inherent functions and processes.

Science is constructed on conceptual foundations. Indeed, scientific concepts are commonplace in much of the science we learn about. Take, for example, the key concept of 'the environment' in environmental science. It would be difficult to discuss the discipline without referring to the environment or one of several alternative terms, e.g. biosphere. It is easy to take for granted the presence of concepts in science and how they enable to us to easily refer to complex worldly phenomena. Additionally, concepts are a central part of scientific inquiry because they aid us in being able to understand something in terms of something else and convey ideas in a way that is useful, appealing, and simplified. For example, from the point of view of an 'ecological' economist, it is useful to use and have a grasp of the the concept of 'biodiversity', which, according to Barbier et al. (1994:xii), “is generally used to describe the variability among living organisms and the ecological complexes of which they are apart”. For ecological economists who are fundamentally concerned with pursuing sustainable development, the term biodiversity is useful in the sense that it would be better if the variability in the living world was not being reduced as a result of human economic activity, because if it were (which it is globally), “ecological systems and functions would break down, with detrimental consequences for all life including humans” (Barbier et al., 1994:xii). By using the term 'biodiversity loss' we conceptualize the decreasing variability of organisms to be found living in the environment, species extinction being probably the most important and irreversible indication of biodiversity loss.
One particular conceptualization of the environment and its constituent elements e.g. ecosystems, habitats, and species, is the main focus of analysis in this thesis. It is the conceptualization of the environment as a producer, service provider and as having multiple values. The conceptualization of the environment to which I refer is perhaps most manifested in the use of the concept natural capital. In recent times (last several years), I would argue that the concept of natural capital has seen somewhat of a breakthrough in environmental conservation. It has come to have an elevated position because of its wide appeal to many actors and because it is a more tangible way of referring to the environment. Natural capital’s popularity today can likely be accredited to the influential environmental-economic publication *Blueprint for a Green Economy* (Pearce et al., 1989). Natural capital saw its first use in the work of an influential British economist writing in the 1970s.

For about 30 years, the natural capital concept has emerged and featured, sometimes centrally, in scientific literature and discussions about sustainable development. It has been used and developed as a way of conceptualizing environment-economy interactions and interdependencies. Mostly recently, different perspectives on natural capital have been put forward by scholars of varying backgrounds. On the one hand, natural capital can be considered a central paradigmatic concept within ecological economics. On the other hand, some scholars argue that natural capital is a reductionist way of viewing and approaching the environment. Critical scholars argue that the 'nature as capital' view and approach to environmental conservation is somehow connected with a 'commodifying dynamic' that is inherent to capitalist economies. Scholars critical of natural capital are also critical of capitalism on the basis that it is, in their view, intrinsically not 'set-up' to bring about 'sustainable developments', especially of the environmental kind. Other scholars and actors acknowledge the usefulness of natural capital as a means to communicate and demonstrate what the environment does for the economy and how much is at stake in terms of human well-being if we continue to degrade it. For example, natural capital, in part, comprises the natural resources it yields of which humanity makes extensive use. It is also comprised of the life-support functions that make human existence possible such as the ozone layer which protects life from deadly UVB radiation. Again, in terms of negatives, natural capital can be viewed as being a case of 'economism' (Norgaard, 2015). It reduces humans relationship with their environment to market logic, and does little to reconfigure our relationship with the 'more-than-human-world'. A relationship reconfiguration that some see as necessary in order for humanity to be able to be environmentally sustainable.

1.3 Thesis idea and purpose

The aim of this thesis is to address one key question: what is natural capital? Natural capital is a central concept in ecological economics, and the capital approach to sustainable development. There are also divergent views about natural capital. Because natural capital features in a number of debates and discussions about sustainable development and environmental conservation, it will be looked at from three different perspectives in this thesis. This is done in order to facilitate addressing the question of what natural capital is. Reviewing the origins and development of natural capital requires a different perspective than reviewing the current issues and debates be had about natural capital. This is arguably for the simple fact that the kind of critique that is being levelled at natural capital today did not exist at the time when natural capital was a concept limited to discussions in ecological economics. The thesis's purpose is to illuminate how the concept of natural capital has come about and the different ways scholars have thought about and made use of it. In other words, the purpose is to understand both the history of natural capital and its use in environmental sustainability approaches, as well as why it is has both advocates and critics.
Concerning structure, the thesis consists of six parts including this introduction (section 1), a method section (section 2), and a conclusion (section 6). Sections 3 to 5 illuminate different aspects and discussions about the concept of natural capital, and it is intended that there be somewhat of a chronological thread in the thesis. Section 3 begins with a review of the origins and development of the natural capital concept, in addition to how it has been defined. Section 4 is about how natural capital is treated in the economics literature on sustainable development, with focus on the weak versus strong sustainability debate. Section 5 presents a critical perspective on natural capital, focusing on some of the current issues and debates about natural capital. Rather than having a concluding discussion as is the usual format of many scientific articles, the topics of each section will be discussed within their respective sections. Thus, each of the three main analytical sections (sections 3-5) comprising the thesis is about something different. On the whole however, each focuses on the concept of natural capital and its place in the context of sustainable development. Together, the three main sections cover the origins, definitions, and development of natural capital, as well as central debates and issues that are had around it.

When approaching key literature for my thesis, I had in mind certain questions and issues that I have identified as being central to any current discussion to be had about natural capital. Firstly, I wanted to understand from where the idea of natural capital emerged. Secondly, I am interested in the possible connections between the concept and the political-economic goal or process that is sustainable development. Thirdly, I wanted to find out when and in what knowledge context the concept of natural capital was introduced. In addition, I have found interesting and important to understand the introduction of the concept of natural capital into attempts to 'operationalize' sustainable development. Fourthly, I have also chosen to focus solely on natural capital because I want to understand what it can contribute to discussions about what a sustainable economy might look like. Hence, in this thesis I have sought for a balanced discussion of natural capital from three perspectives that I are presented through sections 3-5.

Par of the purpose of this thesis is to present the reader with perspectives on natural capital so as to provide them with a view of the concept that is more complete than would be a view of just a critic. Thus, the included perspectives refer to the works of those mostly operating from one academic discipline, for example, economics, even though the field is very broad in terms of the beliefs and methods used by its practitioners. In writing this these I have presumed that there are others for which the concept of natural capital and current debate around it has sparked an interest. Each perspective presented in this thesis is not intended to be an exhaustive review of all the work that has been done by scholars about those particular aspects of natural capital that are covered in each section. It is rather the case that each perspective represents a review of one aspect of natural capital which I have deemed it important to understand to be able to get a 'fuller' picture of the concept, it's meaning and role.

Lastly, my thesis seeks to further understanding of natural capital and it's place in discussions and decision-making about sustainable development. In this thesis I am summarizing the 'story-so-far' of natural capital according to my understanding of it and through my own interpretation of different scholars works. The thesis is intended to be a constructive part of ongoing debates being had about natural capital. At the same time I recognise that natural capital has a 'history', and has been developed and influenced by a great many thinkers over several decades. I hope that I have been able to represent the pedigree of some of those scholars works in my review of natural capital.
1.4 Central concepts and definitions

Some key concepts should be defined, as used within this thesis. The first key concept is, evidently, natural capital (Helm, 2015:2). It is not my intention to analyse how natural capital has been used in resource economics models or wealth-accounting measures, but rather what are the underlying ideas connected to the concept of natural capital especially in the context of sustainable development. Additionally, I aim at understanding natural capital and it's use in the context of it's disciplinary and knowledge foundations. As I understand it, my own attempts here are towards presenting a kind of 'conceptual history' of natural capital including its development, what meaning it has been given, and it's application in economic approaches to sustainability. This will allow for an understanding of the different definitions and contributions different individuals and scientific communities have given to the concept of natural capital. I believe that natural capital is intended to represent those elements of the environment that are of particular importance to human economic activities, service them, and of which a certain 'amount' must by necessity be held constant so that human life can continue to flourish.

Sustainable development is a globally-known concept (Matson et al., 2016). It might be considered both conceptually and empirically, with definitions and explanations of it varying quite extensively from advocates to critics. It could be claimed that in its original conception, sustainable development can be understood as being a political-economic process or goal seeking to establish ways of sustaining economic growth into the future. Economic growth in this regard likely qualifies as both the 'quantitative expansion' of economic activity as well as 'qualitative improvements'. At the same time, importantly, 'environmental sustainability' is to factor into this this economic growth so as to reduce economic activity's impact upon natural capital. The idea of 'decoupling' economic growth from it's traditional dependence on the natural resource base is predominantly what recent calls for 'greening' growth are about.

Sustainability is a ubiquitous term (Matson et al., 2016). It also may be considered both conceptually and empirically, as it has to do with those things in life that we consider as worth 'sustaining' for the sake of human well-being. For many, I would argue, general use of the term sustainability usually pertains to something that reduces an activities environmental impact. For example, by polluting a water source less as a result of cleaning up the production process, a pulp-and-paper mill can in turn have less of an impact on the ecosystems it makes use of. Sustainability, when used on it's own in the present work, for the most part refers to environmental sustainability. However, sustainability also can pertain to things of a political, social or economic nature as well. For example, an institutional arrangement that is thought of as being 'more democratic' could be considered as being 'more sustainable'.

An economic paradigm is a 'worldview', a broader framework encompassing a particular economic theory (Pearce & Turner, 1990:4). Theories are not isolated creations, theory evolves alongside the existing social order. “The ways in which scientific research asks its questions of the human and natural worlds it seeks to explain will at times be influenced by social, cultural and political factors” (Pearce & Turner, 1990:6). At a fundamental level, economics has to do with allocating scarce resources among competing ends. However, there are several competing or coexisting (depending on your view) paradigms within economics, such as the neoclassical paradigm, the institutional paradigm, and the Marxist paradigm.
Economic value: There exist different interpretations of the term 'value', but economic value concerns the money-value of something (e.g. an object), which is derived or expressed via individual consumer preferences (Pearce & Turner, 1990). Economic value is measured by seeing how much someone is willing to pay for that thing which economists are trying to ascribe economic value to. In environmental economics, this is one method of 'economic valuation'. Pearce (1998:14) states that “...in affording economic values to environmental assets, functions and processes the economist is taking what are often, but far from always, non-market phenomena and stimulating willingness to pay for those phenomena”.

Economic growth occurs when a rise in peoples per-capita incomes permits them access to an overall better material standard of living (Hess, 2013). It also has the tendency to result in a reduction of absolute poverty (Hess, 2013). Costanza et al. (2015) assert that in current economic models, economic growth, in the conventional sense, concerns the growth of the market economy. The primary measure used to assess rates of growth is gross domestic product or GDP for short. Costanza et al. (2015) claim that it is assumed that having more economic growth, in the conventional sense, is ultimately the solution to all problems concerning economic-development. For a number of scholars concerned with sustainable development, economic growth, or at least more of it, has come to be seen as undesirable considering the biospheres (including humanity) current predicament, e.g. climate change, biodiversity loss etc. More economic growth can be seen as being undesirable, at least in the most developed countries, because it equates with growth in material consumption. On the one hand, more economic growth will result in raised material standards of living in developing countries. This I believe to be a good thing and something to be pursued. On the other hand however, Costanza et al. (2015:283) argue “growth in material consumption is ultimately unsustainable because of fundamental planetary boundaries (Rockström et al., 2009), and, further, that such growth is or eventually becomes counterproductive (uneconomic) in that it has negative effects on wellbeing and on social and natural capital (Costanza et al. 2014b, cited in Costanza et al., 2015:283)”. I share the view of Costanza et al. (2015) that economic growth, at least in terms of the quantitative expansion of global economic activity, will at some point have to be reigned in in order to not irreversibly impair the planet's life-supporting natural capital.

Ecosystem-services are described by the Millennium Ecosystem Assessment (MEA, 2005) as “the benefits that people obtain from ecosystems”. The MEA's classification scheme of ecosystem-services makes a distinction between: supporting services (e.g. nutrient cycling), regulating services (e.g. climate and flood regulation), provisioning services (e.g. fresh water), and cultural services (e.g. aesthetic and recreational aspects of nature). Fisher et al. (2009) view ecosystem-services as the connection between ecosystems and stuff that humans benefit from, not the benefits solely. According to Turner et al. (2015:19-20), ecosystem-services “include ecosystem organisation or structure (the ecosystem classes) as well as ecosystem processes and functions (the way in which the ecosystem operates). The processes and functions become services only if there are humans that (directly or indirectly) benefit from them. In other words, ecosystem services are the ecological phenomena, and the good (benefit) is the realisation of the direct impact on human welfare. The key feature of this definition is the separation of ecosystem processes and functions into intermediate and final services, with the latter yielding welfare benefits”.

7
Neo-liberalism “is everywhere, but at the same time, nowhere. It is held to be the dominant and pervasive economic policy agenda of our times, a powerful and expansive political agenda of class domination and exploitation, the manifestation of ‘capital resurgent’, an overarching dystopian zeitgeist of late-capitalist excess” (Venugopal, 2015:165). It has been declared by Anderson (2000:17) as being “the most successful ideology in world history”. Chang (2003:47) suggests neo-liberalism as being “born out of an unholy alliance between neoclassical economics and the Austrian-Libertarian tradition”. Ferguson (2010:170) claims neo-liberalism refers to “in perhaps the strictest sense... a macroeconomic doctrine”. Like with the term 'sustainability', neo-liberalism has many different meanings for many different people. This makes its use problematic. Venugopal (2015:166) argues that neo-liberalism, as a result of “growing conceptual ambiguity” with the term, “is now widely acknowledged in the literature as a controversial, incoherent and crises-ridden term, even by many of its most influential deployers”. In any case, neo-liberalism is often used as a concept through which to explain, challenge and critique particular political-economic phenomenon. In the fifth section of the thesis which takes a critical perspective on natural capital, neo-liberalism is used to mean, inter alia, “a depoliticized and technocratic fetishization of the market” (Venugopal, 2015:166). I use neo-liberalism in a way that I believe others make use of the term when criticizing the idea of natural capital and parts of the natural capital conservation approach, i.e. economic valuation. However, I share Venugopal's (2015:183) view that neo-liberalism “serves as a rhetorical tool and moral device for critical social scientists outside of economics to conceive of academic economics and a range of economic phenomena that are otherwise beyond their cognitive horizons and which they cannot otherwise grasp or evaluate”.

1.5 Thesis outline

The thesis consists of six sections; this introduction is section 1. Section 2 is a section of method. Section 3 takes a conceptual-historical perspective on natural capital. It reviews the history of natural capital, putting it within its proper disciplinary and knowledge foundations. The focus in this chapter is mainly to do with which academic fields and individuals came up with, defined and developed the concept of natural capital. This section also discusses in one part economic thinking in relation to sustainable development. Section 3 also covers some of the discussions that have been had concerning the 'limits to growth' thesis and the development of the adoption of the environment in neoclassical economic analyses.

Section 4 looks at natural capital in relation to two distinct sustainability paradigms, 'weak' and 'strong' sustainability. Section 4 seeks to illuminate how economists have taken different positions on how natural capital should be treated concerning the pursuit of sustainable development. Section 4 also includes discussion on how some economists have made natural capital a central concept in their attempts to ' operationalize' sustainable development.

Section 5 is quite different in nature to section 3 and 4. Section 5 looks at the concept of natural capital from a critical perspective, and how scholars have challenged and critiqued it. There are not only accepters and advocates of natural capital in the context of environmental sustainability. Natural capital has also attracted a number of critics and opponents. It is intended that more of the voice of the author will come through in the critical section 5, to the extent that I add my own thoughts to the discussion in this section. Additionally, a particular 'approach', that of 'political ecology', has been adopted in this section. It is my view that adopting a political ecology approach in section 5 as a lens through which to critique natural capital and its use in environmental conservation is enriched by doing so. Political ecology is a particularly relevant approach in terms of exploring conservation concepts and approaches and issues surrounding their use.
Section 6, the thesis's conclusion, gives some concluding remarks about natural capital and the perspectives that have been presented on it. The aim of this thesis is to answer the question: what is natural capital? The thesis's aim was inspired by and, in turn, came to fruition, when considering the present day debate about the value and perceived negatives of natural capital. Natural capital has come to be an accepted way of conceptualizing economic-environment linkages in UK environmental policy and conservation approaches. Not only that, it is a central concept in ecological economics and underpins the capital approach to sustainable development. To facilitate the thesis's aim, three perspectives have been chosen through which to review different aspects of natural capital. Firstly, a conceptual-historical perspective in section 3, secondly, a sustainable development perspective in section 4, and thirdly, a political ecology perspective in section 5.
2. Method

In the section that follows, the method of the thesis's research is presented. The chief purpose of this section is to expound the research design and process underlying the thesis. Firstly, the broad approach that has been taken is presented. Then, the choice of a qualitative approach is justified, specifically a literature review. Lastly how literature was identified and how the literature review is structured are explained.

2.1 General approach

Oliver (2012:59) asserts that “the writing of a literature review is ultimately a creative activity into which the writer has an enormous input. There are many decisions to take, concerning which it is simply not possible to make precise judgements about in advance”. Therefore, in this section I will account for the decisions and choices I have made concerning my literature review. This thesis is a literature-based study. It has been wholly conducted and written by compiling and referring to a number of literary works, academic articles, and reports about natural capital or related topics. I believe that this has been more than adequate to fulfil the purpose of providing different perspectives on natural capital in order to review key aspects about it. The benefit of doing an all literature-based study is that I have been able to make use of, and refer directly to, the work of key theorists on natural capital. The literature identified and cited in my review is largely from the transdisciplinary field of ecological economics. It is a field or movement rather than a discipline, and many scholars from different disciplinary backgrounds contribute to the field. For the most part, the Uppsala University online library search has been used to find journal articles relevant to the topics discussed in the thesis. I have also used books by authors I was already familiar with and made use of their bibliographies to identify literature my thesis could make use of. Literature has been included based on my subjective view of the influence and reputations of the authors. Literature has also been selected and used based on how it has helped me better understand natural capital.

2.2 The literature review

Hart (1998:14) has stated that there are several kinds of questions that a literature review can address (see Fig. 1 below). Three particularly relevant to this thesis are: 1. “what are the key sources?”; 2. “what are the origins and definitions of a topic?”; and 3. “what are the major issues and debates about the topic?”. In the case of my thesis, question 1 is “what are the key sources regarding natural capital?” This question is addressed through the choice of a literature review as the method. I have emphasized leading studies in my review by adopting somewhat of a historical perspective. What this means is that I have grouped the literature into the periods of time when they were written (in terms of decades). For example, the first discussion section of the thesis (section 3) refers to a number of classic 'environmental' studies such as Schumacher (1973) and Meadows et al. (1972). Also in this section, more recent key studies such as Costanza and Daly (1992), & Pearce and Turner (1990), are referred to due to their importance in developing and popularizing the concept of natural capital. In the fifth section of the thesis, which looks at natural capital critically, reference is made to some of the most up-to-date treatments of natural capital, e.g. Barbier (2014), Sullivan (2014), and Helm (2015). Grouping the literature in this way justifies the discussion of older studies where natural capital is little mentioned if at all, but are studies that are foundational to the concept, and at the same time making use of recent scholarly treatments of natural capital.
The second question my thesis addresses is “what are the origins and definitions of natural capital?” In section 3 of the thesis, natural capital is looked at from a conceptual-historical perspective. Natural capital is a scientific concept. It is essentially an economic concept but included in its definition are ecological concepts too. In exploring the literature about sustainable development, especially within ecological economics, natural capital is a commonly used concept if not central to the field. To account the origins and definitions of natural capital in my thesis, I have chosen to cite literature that I consider to be seminal about natural capital. Scholars whose works on natural capital I consider to be seminal include David Pearce, Herman Daly, Robert Costanza, and Dieter Helm. Personally speaking, I have been mostly influenced by the writings of David Pearce, a scholar whose works are well-known, influential and reputable in the field of ecological economics. I have looked to the references in Pearce's work to aid me in identifying key literature about the origins and definitions of natural capital, as well as about the 'weak' versus 'strong' sustainability debate (see section 4). It ought to be stated that, to some extent, the literature I have referred to in my review, i.e. literature I have chosen to include and what I have not, reflects my own subjective position about natural capital.

In sections 4 and 5 of my thesis, I analyse and discuss natural capital from two different perspectives. In section 4, natural capital is looked at in the context of the debate about 'weak' versus 'strong' sustainability. In section 5, a critical perspective is presented, where a political ecology approach is taken in particular. It is in these two respective sections of the thesis that I address the third question of my review, “what are the major issues and debates about natural capital?” Regarding perspectives in literature reviews, Oliver (2012:13) indicates that “it is important to acknowledge that individual writers may approach the subject from different perspectives”. It is important because “the perspective of a writer or researcher can have a significant effect upon the way in which they approach a research question, the way in which they write about it, and the type of concepts which they use in analyzing it” (Oliver, 2012:13). Concerning my choice of particular perspectives, I regard them as being the most suitable to facilitate addressing the three questions my literature review asks about natural capital.
Additionally, the three particular perspectives were chosen based on them being familiar to me and the most interesting.

About the subject of a literature review, and the questions it addresses concerning that subject, Oliver (2012:15) suggests that “...a thematic sequence of the development of ideas should reveal far more about the particular subject, and indeed the underlying development of concepts and knowledge within that area”. My literature review's 'thematic sequence' is evident from the different topics that are treated in the respective sections. Whilst the main thesis question addressed is “what is natural capital?”, the three main analytical sections of the thesis that comprise the literature review, each address the three key sub-questions that I have set to facilitate addressing the thesis's main question. Section 3 of the review titled “the foundations of natural capital” addresses sub-question 1 “what are the origins and definitions of natural capital?”. Section 4 titled “weak versus strong sustainability” and section 5 “a critical perspective on natural capital” both address sub-question 3 “what are the major issues and debates about natural capital?”. Although each main section of the review, 3, 4, and 5, gives a different perspective on natural capital and covers different topics, each of these sections addresses sub-question 1 “what are the key sources?”. They do this by identifying the key sources concerning the specific topics that they each separately cover.
3. The foundations of natural capital

In the introduction it was suggested that natural capital has gained recognition as a way to speak about and conceptualize economy-environment interdependencies. In this section titled 'the foundations of natural capital', I will review where the concept of natural capital has come from, including its disciplinary and knowledge foundations. In particular, it will be seen that the fields of environmental and ecological economics are largely responsible for the development of natural capital. But with some input from ecology. Furthermore, questions such as: to what in our natural environment does natural capital refer to, just elements of it or all of it? are considered. Also to be considered in this section is the approach of treating the natural environment and its resources as capital by economists concerning sustainable development, and what criteria needs to be met for a sustainable economy according to some key theorists. In addition, in this section, I will raise points of my own emphasis concerning the material presented here. For example, where I have deemed it necessary I will add my own voice to that of the views and definitions of natural capital by others. I will also raise points that will be considered further and in more depth in subsequent sections.

3.1 About capital in economics

During the seventeen and eighteen hundreds, European economists living in the era known as the classical in terms of economics, identified three factors of production or resources which made-up the goods and services that result from economic activities. The three factors are land, labour, and capital, the third (capital) defined by Adam Smith (1776) as being an input that is not used-up in in the making of a product. A typical example is machinery or factories. Land as a factor of production, including all natural resource endowments, was treated as distinct from capital because it was seen as being a gift from nature, available aplenty (Farley, 2012). There are two points that I would like to make here. The first concerns land being one of the three classical factors of production. It has long been recognised that although man can cultivate 'land capital', as we do with agriculture, the ability to do this ultimately rests on the production of soil and its various qualities by ecosystems. For some, the fact that nature does this matters no amount with regard to the economy. For others, however, in a somewhat more spiritual sense, happenings in nature such as the development of fertile soil are rather seen as a rare gift.

Early economists recognised the free supply of functions and services from nature which give economies the basis from which they can function and grow. However, as will be explored in subsequent sections, ideas of how we value the environment and how this affects how we treat it and what we choose to use it for have become rather controversial. On the one hand, many economists concerned with conservation see placing 'economic values' on the environment a progressive step in the direction of better conserving and protecting the environment (e.g. Helm, 2015). Others, however, challenge economic valuation on several grounds (see for example, Spash & Aslaksen, 2015). What is more, it can probably be stated that there are others still who see the environment as an impediment to economic growth. The second point I wish to make is, that in terms of economics in relation to sustainable development, it could be claimed, as some notable theorists (Costanza et al., 1997) have done, that it is precisely because nature's bounty is limited today (not the case only a century or two ago), that there are resounding calls by some for 'greening' our economies. Daly (2007) claims that we have moved from a sparsely used world in terms of economic activity to a full one, with an overabundance of capital but with little environment left. Therefore, as Daly (2007) sees it, humanity needs to find an optimal scale for global economic activity. Daly is pessimistic about the ability of global environment's to support further economic growth during the course of the 21st century if they are subject to further degradation.
In the early part of the 20th century, the capital concept was redefined to refer to “any asset that produces a stream of income over time” (Fisher, 1906; in Farley, 2012). Similarly, George Stigler, a Nobel prize winning economist, defined capital as anything other than human beings which yields valuable services over an appreciable time. Stigler's definition of capital clumps together land as one previously distinct factor of production with another, capital. Capital would from then on be seen to encompass all natural resources, as well as the conventional forms of it, i.e. man-made goods (Clark & Munroe, 1994). As a result of this redefining of capital, Farley (2012) claims economics generally went on to ignore natural resources as a factor of production, to the point where another Nobel economist at the time suggested that “the world can, in effect, get along without natural resources” (Solow, 1974:11). This ignoring of natural resources by the so-called mainstream of economists can be understood as being the departure point for some economists from the economics mainstream in order to facilitate the creation of a new economic paradigm that would be able to tackle complex economy-environment interdependencies and issues relating to sustainable development (see Spash, 2013). On the one hand, some concerned with environment-economy and sustainable development issues such as Pearce and Turner (1990) view the mainstream neoclassical economic approach as adequate to be able to relieve and counter the current economic systems pressure on the biosphere and its ecosystems. On the other hand, scholars such as Spash (1999), and Söderbaum (1992), are particularly critical of neoclassical environmental economics. Both scholars consider the currently dominant neoclassical paradigm as one that is limiting and inadequate in terms of being able to solve the current ecological crises.

It is worth stating in the interest of the reader that there are in fact many coexisting (or competing could be another way of seeing it) paradigms in economics, and it is possible to take from each the good and the bad. It is arguable that each paradigm has something it can contribute to the analysis of environment-economy interactions and to solving sustainability issues. Rather than having competing economic paradigms then, perhaps paradigm coexistence would result in an 'enhanced sustainability economics' that may be more than up to the task of moving economies towards sustainability. With regard to sustainability and sustainable developing, ecological economics has arguably been the most important addition to the world of economics. I state this because a large part of the motivation for ecological economics, new paradigm or not, was to depart from conventional economics and move to a new economics where sustainability concerns are paramount.

Victor (1991:192) has succinctly stated that “there is no single theory of capital to which all economists subscribe”. If Adam Smith can be said to have given us the classical definition of capital, from times when economics was known solely as political-economy, some other definitions of capital such as Stigler's, are neoclassical definitions. How different schools of economics theorize on capital, particularly natural resources, has important implications for sustainable development. The different positions economists taken on capital, i.e. what they believe about capital, affects their beliefs about what the necessary criteria is that needs to be met for to have economic sustainability. For example, Victor (1991) claims that part of Herfindahl's and Kneese's (1974) neoclassical definition of capital, that every manageable source of services is capital, emphasises what natural resources have in common with manufactured capital (machinery). It also, Victor (1991:194) states, “implies a high degree of substitution not only between different types of manufactured capital goods, but also between these capital goods and resources.” This happens to be important in the context of sustainable development because “the easier it is to substitute manufactured capital for depleting resources or a degraded environment, the less concern there need be about the capacity of the environment to sustain development” (Victor, 1991:194). Two competing economic sustainability paradigms, 'weak' and 'strong' sustainability, which are
connected to the differences in belief economists have about substitution possibilities between the forms of capital is one of the focuses of section 4.

3.2 The development of environmental concern in economics

“The discipline and practice of economics, once famously deemed the dismal science by Thomas Carlyle, is not generally thought of as being friendly to planet-earth. Some might claim that economic progress is destructive because it negatively affects the environment, and appears to make the quality of the environment a dispensable item in the pursuit of raising humans living standards. However, the image of economics as the science that legitimises this process is outmoded and false.” (Pearce, 1998:34)

The above quote by David Pearce, an influential British ecological-economist, is intended to 'set the scene' for the rest of this section. To make one thing immediately clear, I also subscribe to Pearce's view that any statement making out that the discipline of economics is in some way dangerous to the prospects of achieving sustainable development is misguided and unhelpful. Economics and how economies are managed has to be at centre of environmental sustainability efforts. What is more reasonable to claim is that it is not the discipline of economics itself, but certain paradigms within economics that could have implications for environment-economy interactions and whether economies in the end will actually move in a sustainable direction. For example, some charge neoclassical economics as playing bedfellow to capitalism and neo-liberalism. However, such a matter as taste in economic paradigm ultimately depends on individual views and ideological position.

Generally speaking, economists have factored the environment and natural resources into their analysis since the 1950s, and pursued environmental issues from the 1960s onward. Still, it is possible to say that the interest of economists in environmental issues can be traced back to the classical economists, in particular Francois Quesnay and the physiocrats (Victor, 1991). “The physiocrats believed that land was the only truly productive agent or factor of production since only land produces more wealth than was consumed in its creation. The physiocrats are remembered most of all for their conception of the economy as an integrated whole that is tied inextricably to the productivity of nature” (Victor, 1991:192). Furthermore, during the time of classical political-economy, figures such as Adam Smith, Thomas Malthus, and David Ricardo, were concerned with limits to economic growth but from a different perspective to the modern theories underlying the call for sustainable development. A key common concern for these classical economists, in this regard, was the effect of increases in human population on economic growth (Spash, 1999). Another classical political-economist, John Stuart Mill, recognised the prospect that non-renewable resources (e.g. fossil fuels such as coal) could act as constraints on economic growth independent of population pressures, therefore being one of the first economists to engage with issues concerning limits to economic growth imposed by nature (Spash, 1999). In addition, Costanza et al. (1997) claim that Mill was one of the first economists to raise concerns about, in his view, the need to conserve natural resources. For the classical economists, it was the environment that ultimately set the limits to the expansion of economic activity (Common & Stagl, 2005).

Anyone who points to issues of population in sustainable development debates is often charged with being a 'neo-Malthusian'. 'Malthusians' are those who can be considered as being pessimistic about humanity's environmental predicament, claiming that positive human population growth coupled with economic-growth generally increases humanity's ecological footprint. The prospect of
economic or ecological collapse typically factors into Malthusian forecasts. Nonetheless, the Malthusian perspective is influential concerning natural resources in a sustainable development context. According to Pearce and Turner (1990:288), “from the Malthusian perspective, it is the absolute physical limit to non-renewable resources which is important and which is predicted to become binding in the near/medium term future”. A related neo-Malthusian position stresses the significance of ecological limits to resource exploitation (Pearce & Turner, 1990). Ideas of 'limits to growth' and 'ecological limits' to economic activity have been particular influential in ecological economics. The term 'limits to growth' was spawned from an influential report by a group of MIT computer-modellers (Meadows et al., 1972) whose study “implied that environmental protection policies and the promotion of economic growth objectives were incompatible (i.e. that long-run economic growth objectives were not feasible)” (Pearce & Turner, 1990:15). Malthusian perspectives continue to influence debates and prominent economists concerned with sustainable development, particularly in the line of thinking that calls for steady-state or de-growth economies. The leading figure in this respect is American economist Herman Daly, a key theorist in ecological economics. Daly states that:

“...the limits to growth, in today's usage, refers to the limits of the ecosystem to absorb wastes and replenish raw materials in order to sustain the economy (the two populations of dissipative structures). The economy is a subsystem of the larger ecosystem, and the latter is finite, non-growing, and materially closed. Although the ecosystem is open with respect to solar energy, that solar flow too is non-growing. Therefore in a biophysical sense there are clearly limits to growth of the subsystem.” (Daly, 2007:9-10)

I want to save any more discussion of economic growth for the next section (section 4) which will go into more depth about relations between natural capital and economic activity. What can be said for now is that there are competing perspectives and paradigms at the level of economics for sustainable development. Since the 1970s, though perhaps as far back as the early 19th century, economists have raised concerns about the trade-offs between environmental protection and economic-growth, and about whether it is necessary to curtail growth oriented economic activity to achieve sustainability. Paul Ekins (2012) for example, discusses the issue of whether environmentally sustainable growth is a feasible and desirable objective and, if so, how it might be brought about. Another view concerning sustainable growth sees the very idea of it as paradoxical (a like view exists regarding sustainable development). The idea that growth in the overall human economic activity of the planet can go on forever is, to some, an absurd notion. Indeed, considering the trends the world is currently seeing concerning ecosystem degradation and a exacerbating climate crisis, there is a rapidly spawning literature questioning the feasibleness of continued economic growth in the “overdeveloped” parts of the globe (Buch-Hansen, 2014). Yet, the term 'growth' in the context of economics can mean different things. For example, it could refer to increases in economic activity such as growth in gross-national product, or qualitative improvements in the economy, such as technological advancement and dispersal of more environmentally-benign technologies. Further still however, the idea that capitalism can be expected to deliver such “qualitative development” and become ecologically sustainable is challenged (see for example Blauwhof, 2012) on the basis that inherent within capitalism is a drive for economic growth. Built-in to capitalist economic systems are dynamics such as the accumulation of capital to fuel production. Therefore from an ecological-Marxist perspective, capitalism is unable to avoid exploitation and degradation of natural resources and ecosystems. Additionally, much of the emphasis on better protecting and making 'wise-usage' of the environment at the level of decision-making for sustainable development is in large part linked with ideas about how we can proceed with economic activity that is ‘more sustainable’.
Broadly speaking, environmental economics literature in the first part of the 20th century can be viewed as developing concerns about issues of conservation related to agriculture and forestry. Resource economists tasked themselves with finding a level of natural resource use that is more sustainable, rather than their outright protection. All the same, Spash (1999), claims such environmental subject matter was no longer the concern of key figures in economic philosophy but was already relegated to interest economists in sub-disciplines, and economists interest concerning the environment's capacity to provide the resources needed to uphold economic activity waned substantially. In the interim, mainstream economics developed theories implicit in which was the assumption that economies could function independently of either natural resource constraints or the environment's assimilative capacity and so further subjected environmental issues to the periphery of economic study (Spash, 1999). This is, I would argue, an unfortunate part of the history of economic thinking if true. Because of developments in economic thought and practice during the 20th century, still too little attention is paid by most economists about issues of natural capital depletion and impairment. Is this because such issues are deemed not of central concern for the functioning of economies or of interest theoretically? Whatever the case may be, some economists who predominantly make use of neoclassical methods, David Pearce for example, undoubtedly express an environmental concern, and have done much to factor the environment into economic considerations. Soon to be discussed in the current section is perhaps the most promising development of ecological concern in economics. These 'ecological' economists “have accepted the argument that sustainability requires the conservation of certain biophysical entities and processes: these “resources” may have immeasurable economic value, yet are often not even recognized as inputs to the economy, they maintain life-support functions of the ecosphere, the risks associated with their depletion are unacceptable, and there are no technological substitutes” (Rees & Wackernagel, 1994:366).

During the latter part of the 20th century, Kneese and Herfindahl, two economists working on environmental issues, “concentrated on two main types of services for the economy performed by the environment: as the source of natural resources and the sink for waste products (or 'residuals'). Later, Kneese and other economists recognised the role of the environment in providing 'amenity' services and general life support” (Victor, 1991). According to Pearce (2002), the beginnings of studies concerning environment-economy interactions are related to the notion of there being limits to economic activity imposed by the planet's ecological systems (e.g., the absorption capacity of the environment to absorb toxic pollutants). The environmental movement of the 1960s focused on what it thought of as the seemingly wasteful lifestyles of people living in the modern-industrialised economies, prompting a logic that said if these lifestyles put the planet in peril, then the lifestyles must change. Over time, the unsustainable lifestyle issue became synonymous with the pursuit of economic growth, and the zero GDP growth or steady-state economy (see Daly, 2007) movement came to life (Pearce, 2002). Likewise, Farley (2012), claims that during the 1970s, due to growing evidence of the limitations on natural resources and environmental problems worsened by accelerating economic growth, many economists called for explicitly recognizing 'natural capital' as a distinct and essential factor of production.

Finally, the more formal spreading of an evident environmental concern within economic circles in Europe was greeted as an opportunity to put across the message to politicians and fellow economists that the economy and environment interact with each other in ways that are of central importance to understanding the interdependencies that exist between human-economies and the natural world (Spash, 1999).
3.3 Economics gets ecological

“The closed earth of the future requires economic principles which are somewhat different from those of the open earth of the past. For the sake of picturesqueness, I am tempted to call the open economy the "cowboy economy," the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behaviour, which is characteristic of open societies. The closed economy of the future might similarly be called the "spaceman" economy, in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy.” (Boulding, 1966)

The above quote by Quaker economist Kenneth Boulding was presented as 'The Economics of the Coming Spaceship Earth’ on the 8th of March 1966 at the sixth 'Resources For The Future' forum on 'Environmental Quality in a Growing Economy'. According to Scott (2009), the above Boulding's paper arguably signs the dawn of modern ecological economics. This is important due to the fact that prior to Boulding's influence, mainstream economists were lacklustre in their thinking about how the economy impacts upon the environment (as well as how the environment effects the economy). Moreover, Boulding's article was lucid in it's communication of the fundamental aspect that is the environment to economies, and also made explicit the claim that economists could no longer ignore the environment in their analyses (Scott, 2009). In the rest of this section I will discuss ecological economics, a field of economics which has at its core a concern for issues of sustainable development. In the early days of the field, ecological economics has been described by one key theorist as “the science and management of sustainability” (see Costanza, 1991).

Ecological economics is a relatively new field of study and can be said to have many different roots (Røpke, 2004). Yet, a tradition of thought which can be considered as ecological economics can be traced back at least to the middle of the 20th century (Martinez-Alier, 1990). Most would likely agree that the ecological economics of the present has its foundation in the concerns of the 1960s and early 1970s for limits to economic growth and the study of the flow of energy and materials in the economy founded upon the work of Nicholas Georgescu-Roegen (1971). In addition, although Kenneth Boulding did not describe himself as an ecological economist, he also contributed to its foundations (Victor, 2015). Boulding differentiated between open and closed systems in relation to matter, energy, and information, and explained that economies are subsystems of the environment. He also recognized that human activities had gone from having what was more common at the time environmental impacts on a local level, to impacts which were global in nature. “Boulding famously summed up his analysis by comparing what he termed a “cowboy” economy, which is designed to maximize throughput (for which gross domestic product (GDP) is a rough measure), with a “spaceman” economy in which stocks are maintained with minimum throughput” (Victor, 2015:94).

In terms of the aims and scope of ecological economics, the first edition of the journal published in 1989, described ecological economics as being “concerned with extending and integrating the study and management of 'nature’s household' (ecology) and 'mankind’s household' (economics)”. This evolution in economic thought is pictured below (Fig. 1) where taking account of economy-environment interdependencies forms the core of the science for sustainability that is ecological
ecological economics is about the interactions between economic and ecological systems. This integration was and still is deemed necessary. Conceptual and professional isolation (within academia and institutions) were thought to have led to economic and environmental policies being mutually destructive rather than reinforcing in the long term.

Fig. 1. How the discipline of economics has evolved in terms of taking into account the environment through the 20th century. Figure from Spash (1999:431).

Common and Stagl (2005) state that the scholars who set up the International Society for Ecological Economics (ISEE) were largely motivated by the judgement that the way the world economy was operating was by-in-large unsustainable. That is to say, that there are features of current economic activities that may possibly undermine the capacity of the joint economy-environment system to continue to ensure human well-being and economic survival (Common & Stagl, 2005). At a foundational level, ecological economics begins from the point that economic activity takes place within the environment, and unlike the mainstream of economic thinking, centres around the study of economy-environment interdependencies.

In Pearce and Barbier's (2000) view, perhaps the most important contribution of the literature comprising ecological economics has been to draw on the work, mainly of ecologists, to direct attention towards the important implications of ecological functioning and resilience to human welfare (see Fig. 2 below) Adger and Hodbod (2014:100) assert “in an ecological sense, resilience relates to the functioning of the system, rather than the stability of the component populations’. Moreover, “resilience is the key to sustainability in the wider sense” and “resilience is an important criterion for the sustainability of development and resource use, since all human welfare is ultimately dependent on the biosphere and its sometimes surprising nature” (Adger & Hodbod, 2014:100). By ecological functioning, ecologists tend to mean those base processes of ecosystems, such as nutrient cycling, biological productivity, hydrology, and sedimentation, as well as the overall capacity of ecosystems to sustain life (Pearce & Barbier, 2000). Ecologists consider the extent of life-support functions to be the key attribute that defines an ecosystem, as well as the source of the numerous fundamental ecological resources and services that are essential to human welfare (Pearce & Barbier, 2000). Whereas economists may be inclined to focus only on those ecological resources and services furnished by ecosystems that appear to lend directly to current
and future welfare, ecologists point out that such resources are an inherent part of a much wider assemblage of life-support functions that characterise ecosystems (Pearce & Barbier, 2000).

Ecological economics is understood as being something different to environmental economics (usually neoclassical is added in front). However, scholars of varying disciplinary backgrounds have defined ecological economics differently in line with their own views. For example, Spash (1999), claims that ecological economics is an important leaving behind of environmental economics because it tries to incorporate and synthesize many different disciplinary perspectives. Which is unlike environmental economics which for the most part makes use of neoclassical economic theory and methods to analyse and recommend policy options for dealing with environmental issues. Additionally, Prugh et al. (1999), view ecological economics as being a big camp that attempts to provide space for numerous positions and views. One-way-or-another, most who align themselves with ecological economics would likely agree with Söderbaum (2013:1019), who suggests “ecological economics can be tentatively described as economics for sustainable development”, and “ecological economists are concerned about many environmental and social trends that are unsustainable” (Söderbaum, 2015:421).

Fig. 2. Ecological economics, to a large extent, has drawn on knowledge and insights from the scientific fields of economics and ecology. It has done this in order to develop an approach to sustainability issues that better takes account of environment-economy interdependencies (Common & Stagl, 2005).

3.4 The arrival of natural capital

In his book 'Small Is Beautiful' (1973), economist E.F. Schumacher appears to be the first to have used the term 'natural capital' to refer to the capital that is provided by nature and not by man. “Schumacher argued that there are irreplaceable natural capital stocks which make up the larger part of all capital, and also identified two types of natural capital. The first was fossil fuels, and the second was the ability of natural systems to regenerate themselves” (Farley, 2012:264). Another early interpretation of the natural environment as capital or natural capital also appeared in the early 1970s. Freeman et al. (1973:20) proposed that the environment should be thought of as a “capital good” for the array of “services” that it renders:
“We view the environment as an asset or a kind of nonreproducible capital good that produces a stream of various services for man. Services are tangible (such as flows of water or minerals), or functional (such as the removal, dispersion, storage, and degradation of wastes or residuals), or intangible (such as a scenic view).”

The conceptualization of the environment as capital and service provider by Freeman et al. (1973), in my view, signs the beginnings of the concept of ‘ecosystem-services’ which are a key part of the natural capital concept. Also on the foundations of natural capital, Åkerman (2005) and Gough (2005), both believe is was David Pearce who introduced the concept. However, it appears that the authors do this referring to the appearance and popularisation of the concept in sustainable development literature during the later 1980s and early 1990s. Bell (2005), also cites Pearce as having introduced natural capital as a way of interpreting sustainable development. In his own words, Pearce (1988:599) claims the common environmental theme in discussions of sustainable development suggests that “sustainability requires at least a constant stock of natural capital, construed as the set of all environmental assets”. Moreover, the fact that David Pearce was engaged in the ecological economics movement since the inception of the ISEE’s journal (Ecological Economics) in 1989 illuminates Burkett’s (2006) view that ecological economists have been at the vanguard in developing the conceptual underpinnings of natural capital and popularizing it’s usage. Folke et al. (2003), also point to the concept of natural capital having been developed by the groundbreaking work of ecological economists, though they offer Robert Costanza's and Herman Daly's work (see Costanza & Daly, 1992) as an example. Furthermore, Burkett (2006) claims some key ecological economists have wanted to position natural capital as a 'core paradigmatic concept' in their field. For example, in August 1992 the ISEE held a conference in Stockholm which in particular emphasized the concept of natural capital and its 'maintenance' and 'enhancement'. The volume generated by this conference, Investing in Natural Capital: The Ecological Economics Approach to Sustainability (see Jansson et al., 1994), also emphasized the need to conserve natural capital and arguably made recognisable natural capital as a central concept in ecological economics from then on in. Folke et al. (2003) suggest that natural capital is in fact a central concept in ecological economics.

3.5 Natural capital definitions

In Pearce's (1988:599) view the environment can be thought of as a “stock of natural assets” delivering “economic “functions. Pearce (1988:599) states that these assets act as:

1. “a supply of natural resource inputs to the economic production process-soil quality, forest and other biomass, water, genetic diversity, and so on;
2. a means of assimilating waste products and residuals from the economic process-oceans and rivers as waste-receiving media, and so on;
3. a source of direct human welfare through aesthetic and spiritual appreciation of nature; and
4. a set of life support systems-biogeochemical cycles and general ecosystem functioning.”

Because capital is defined as a “stock that yields a flow of valuable goods and services into the future” (Costanza & Daly, 1992:38), the economic functions of natural assets that Pearce (see above Pearce, 1988:599) points to can also be thought of as flows of environmental goods and services emanating from the stocks of the environment i.e. natural capital. “For example, a stock or
population of trees or fish provides a flow or annual yield of new trees or fish, a flow that can be sustainable year after year” (Costanza & Daly, 1992:38). In addition, “this sustainable flow can be considered as a natural income from the stock of natural capital, because it is these flows from stocks of natural resources that are utilised in economic activity” (Costanza & Daly, 1992:38).

The next thing to be considered about natural capital is whether it encompasses all the different stocks and flows and resources recognizable in the environment. Costanza and Daly (1992:38) “differentiate two broad types of natural capital:

1. renewable or active natural capital which is active and self-maintaining using solar energy. Ecosystems are renewable natural capital because they can be harvested to yield ecosystem goods (such as wood) but they also yield a flow of ecosystem services when left in place (such as erosion control and recreation);
2. nonrenewable or inactive natural capital which is more passive. Fossil fuel and mineral deposits are the best examples as they generally yield no services until extracted.”

Additionally, Costanza et al. (1997:105) make a distinction between two additional categories of natural capital: “marketed” from “nonmarketed” natural capital. According to the authors:

“There is a large subcategory of marketed natural capital that is intermediate between natural and human-made, which we might refer to as “cultivated natural capital”. This consists of such things as plantation forests, herds of livestock, agricultural crops, fish bred in ponds, and so on. Cultivated natural capital supplies the raw material input complementary to human-made capital, but does not provide the wide range of natural ecological services characteristic of natural capital proper (e.g., eucalyptus plantations supply timber to the sawmill, and may even reduce erosion, but do not provide a wildlife habitat or conserve biodiversity).”

In considering then the many elements and functions of the environment that are represented by natural capital, what is key to note about natural capital is that it is supposed to represent just anything 'natural', e.g. typical examples of natural resources like fish and lumber. Natural capital, rather, is “multifunctional and includes the flow of life support services itself and, as such, biological diversity and evolution are caught up within the definitions” (Barter, 2015:367). The multidimensional nature of 'environmental capital' is summarized by Ekins (1992:149-150), who attributed four key functions to it: 1. materials provisioned for production; 2. the capacity to absorb wastes; 3. life-supporting functions such as regulating the climate and the production of oxygen; and, 4. providing recreational and sensory stimulus and pleasure for humans, such as that we get from smelling a pine-forest, bird-watching or bathing in a lake.

What is also important to note concerning the natural capitals functions, e.g. those ascribed to it by Ekins (1992:149-150), is that the functions do not occur in the environment on their own to put it one way. Integral to the existence of natural capitals functions are interdependencies between those functions. Hence, how natural capitals functions are organized and interact is central to understanding the concept (Barter, 2015). Additionally, while the functions that can be attributed to natural capital represent some of its key aspects, Costanza and Daly (1992) suggest that it is important to consider that the flow of services emanating from natural capital requires the functioning of whole systems, e.g. ecosystems, and the biosphere as a whole.
More recent definitions of natural capital, e.g. Dieter Helm's (2015:2), are essentially akin to the past defining examples given thus far. Helm defines natural capital as “the elements of nature, that directly or indirectly produce value to people, and can be broken down into ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions”. What has also emerged out of ecological economics concerning natural capital, is the concept of 'critical natural capital' (CNC). According to Brand (2009), critical natural capital emerged as a “trade-off” between two different positions taken by economists concerning how capital can be treated in order to achieve economic sustainability. These two “competing paradigms” (Neumayer, 2013), 'weak' and 'strong' sustainability, will be reviewed in detail in section 4. For now, critical natural capital can be understood as representing the natural capitals significant and irreplaceable environmental functions. In terms of sustainable development, critical natural capital also points to those elements and functions of the environment that ought to be maintained under any circumstances (Brand, 2009).

Lastly, regarding definitions of natural capital, “the concept of natural capital is an extension of the traditional economic notion of capital, which is generally defined as the manufactured (human-made) means of production, i.e., machinery, tools, equipment, buildings and so on. What natural capital and manufactured capital have in common is that they both conform to the working definition of capital as a stock (collection, aggregate) of something that produces a flow (a periodic yield) of valuable goods and services”(Prugh et al., 1999:49). Additionally, “as with other assets in the economy, we can choose to use up or delete natural capital today, or alternatively, we can choose to save or even expand these economic assets for future use” (Pearce & Barbier, 2000:22).

3.6 Economics for sustainable development

One of the most important sustainable development publications in the latter part of the 20th century, the report 'Our Common Future' (WCED, 1987), was the catalyst for launching the sustainable development agenda into institutional and public consciousness globally. According to Atkinson et al. (2014:1, my italics) “the Brundtland report viewed sustainable development as serving many different (and possibly competing) goals: economic development, a better environment and a particular concern for human well-being both now and in the future”. Whereas in the late 1980s sustainable development was for many identical to reconciling economic-growth with environmental sustainability in order to conceive sustainable growth, others regarded the very notion of sustainable growth as an oxymoron (van den Bergh, 2014).

Sustainable development is a tricky term in the sense that a myriad of definitions of it have been proposed. Yet, it has not been easy to find one definition that satisfies all disciples of all disciplines (Hamilton & Naikal, 2014). Moreover, the problem in part has to do with with the uncertainty that surrounds what exactly the object of sustainability is, rather than the idea itself (Hamilton & Naikal, 2014). For example, some still see sustainable development as being essentially about pursuing environmental sustainability. Indeed, sustainable development has its roots in ideas about protecting the planet's ecosystems against the destructive elements of modern-industrialised civilization (Blewitt, 2015). Arguably, economists have done much to provide answers to the question of what it is that ought to be sustained regarding sustainable development. Such economists have provided answers by coming up with imaginative approaches that address the issue of how economies might be realigned to better coexist with 'ecological realities'. As previously pointed out in section 3.3, issues relating to sustainable development occupy a key position in the field of ecological economics, as well as considering of ecological realities. Van der Bergh (2014), for example, claims that ecological economics expresses the view that the economy
is a subsystem of the biosphere that limits physical growth of the economy (van den Bergh, 2014).

Chapter two of *Our Common Future* features the most well-known definition of sustainable development. It defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987:43). Going off of the work of *Our Common Future*, the issue was distinctly put by Pearce et al. (1989), who argued that sustainable well-being is realizable if future generations inherit a wealth stock of no less value than the stock inherited by the previous generation. Wealth, or capital assets, becomes the object of the sustainable development paradigm in the view of many economists (Hamilton & Naikal, 2014). A definition of wealth is given by Hamilton and Baikal (2014). It is the stock of assets that consist of, for example, the wealth of a nation or the planet itself. Importantly, it also consists of those assets which have been supplied at no cost by the environment. In addition, Pearce and Barbier (2000:22) have claimed in reference to *Our Common Future*’s definition of sustainable development that:

“...economists are generally comfortable with this broad interpretation of sustainability as it is easily translatable into economic terms: an increase in well-being today should not have as its consequences a reduction in well-being tomorrow. That is, future generations should be entitled to at least the same level of economic opportunities - and thus at least the same level of economic well-being – as is currently available to present generations. Consequently, economic development today must ensure that future generations are left no worse off than present generations.”

Another key aspect of *Our Common Future* is that it also “tried to make the case that environmental protection is an essential element of economic development because the environment is an essential “factor of production” and source of important welfare services to people” (Ayres, 2008:285). This is an important point concerning natural capital which is the focus of this thesis. In the next section (4), I will point out that not all economists share the view that natural capital is an essential component of economic activity. The debate here concerns whether or not the environment and it's functions i.e. natural capital, can be replaced or substituted for man-made capital that could provide the same goods and services, environmental functions and life-support systems as does natural capital. As illustrated below (Fig. 3), economists concerned with natural capital have taken different positions concerning whether or not the environment has a special or unique role to play in pursuit of sustainable development. The 'weak' versus 'strong' sustainability debate is reviewing in detail in section 4.

*Our Common Future* concluded that there needed to be “a new era of economic-growth that is forceful and at the same time socially and environmentally acceptable” (WCED, 1987:xii). This is how the definition of the sustainable development principle came to exist, which imagined the continued pursuit of economic growth and social progress, less the environmental damage which had historically come along with this pursuit (Common & Stagl, 2005). In sections 4 and 5, reviewed are debates about whether continued economic growth can be had that conforms to the requirements of sustainable development. The idea that humanity can continue to pursue economic-development through growth as a means to sustainable development is contested (e.g. see Daly, 2007). However, such economic-growth trajectories also have implications for natural capital, considering it is a central concept in much of the discussion about sustainable or green economic-growth. In addition, much of the interest in sustainable development has been formed out of the concern that present economic development could be leading to rapid accumulation of manufactured and human capital, though at the expense of inordinate depletion and degradation of
natural capital (Pearce & Barbier, 2000). The leading concern has been that, by consuming the earth's stock of natural assets irreversibly, today's current development pathway will have detrimental implications for the well-being of future generations (Pearce & Barbier, 2000). This view then leads us to consider if current economic development is essentially unsustainable (Pearce & Barbier, 2000). Even so, despite the general consensus by most economists of some environmental persuasion that economic development around the world is leading to the irreversible depletion of natural capital, there is far-flung disagreement as to whether this needfully imply that such development is inherently unsustainable (Pearce & Barbier, 2000).

Another aspect of sustainable development that can be considered from an economics perspective, is that from an economics point of view, the critical issue of debate is not whether natural capital is being irreversibly depleted, but whether future generations can be somehow compensated for the current loss of natural capital. If that is possible, how much compensation is required for future generations to be appeased for their loss is important to consider (Mäler, 1995). However, this is only one perspective on the issue of loss of natural capital in the context of sustainable development. For some, perhaps those operating from a ecological economics position, it may well be irreversible loss of natural capital that gives larger cause for concern than compensating for it's loss. Different perspectives on this issue will be reviewed in subsequent sections of the thesis.
To summarize, economics as the science of resource allocation occupies a central position concerning natural capital in the context of sustainable development. The capital approach to sustainable development, developed and popularized in influential works such as that by Pearce et al. (1989), is now highly regarded, having proved critical in working out core theoretical ideas about what sustainability means in practice and how it might be attained (Atkinson et al., 2014). Through the capital approach, sustaining development becomes an operation of sustaining wealth and, successively, maintaining and enhancing assets or capital (Atkinson et al., 2014). Sustainability is a necessary status for sustainable development, which at the global level, wants to not just sustain the joint economy-environment system's capacity, but expand it at least from the arguably impaired state that it is in currently (Common & Stagl, 2005). Sustainable development as presently understood concerns growth in what the global economy delivers i.e. development, but development that does not damage the environment beyond renewal and repair (Common & Stagl, 2005). For some, the notion of sustainable development includes green or sustainable economic growth trajectories based on resource efficiency, 'green' technologies, better utilizing the planet's remaining natural capital without undermining it.

The purpose of this current section has been to entrench natural capital in it's disciplinary and knowledge foundations by providing a conceptual history of it. From a conceptual-historical perspective, it has been reviewed where thinking of the environment in terms of capital has come from, whilst 'shedding some light on' what the reasons have been for doing so. Sustainable development and some of the foundational formulae by economists on how to approach it have also been reviewed to emphasize the contribution and influence economic thought has had on shaping notions of sustainable development. Hence, the knowledge and preliminary discussion found within this section is also intended to serve as the contextual background for the topics that feature in the next two main sections of the review (sec. 4 & 5).
4. Weak versus strong sustainability

This section is about the different 'positions' economists have defined that have to do with natural capital (NC) in context of sustainability. In this section, I review in detail two key sustainability paradigms that have arisen out of the debate about the perceived trade-offs between environment sustainability and economic growth. The first to be considered is the so-called 'weak' sustainability (WS) paradigm. Its foundations lie with neoclassical school of economic thought. The second sustainability paradigm treated is known as 'strong' sustainability (SS). 'Strong' sustainability has its roots with scholars now strongly associated with the field of ecological economics. Both WS and SS are sustainability paradigms of an 'economic nature'. They are specifically have to do with the capital based approach to sustainable development (SD). It is the view of Atkinson et al. (2014:2) that “the capital based approach has proved to be critical in working out core theoretical notions about what sustainability means and how it might be achieved”. Putting economies on a path towards SD is about “a process of sustaining wealth” and “maintaining and enhancing assets or capital” (Atkinson et al., 2014:2). The key focus in this section of the this is about economists debating if NC should be given special treatment in terms of SD, and if sustainability actually requires NC be maintained. From the1990s onwards the WS versus SS debate has held a focus on the substitutability of NC (Ang & Van Passel, 2012). Additionally, “economists who think about NC as an irreplaceable resource and those who believe that it is like any other input into an economy have very different ideas about how society should treat the natural world” (Farley, 2012:264). Hence, economists vary in their beliefs about NC and these differences in belief, whether kept as just that, or put into practice, arguably have consequences for the direction SD takes. WS and SS can be considered to represent two opposing means in economists quest to give a practicable dimension to sustainability (Cabeza-Gutés, 1996).

4.1 About weak sustainability

The paradigm of WS was in effect founded in the 1970s (though so such SD terminology existed at that time). WS can be viewed as an attempt at extending neoclassical economic-growth theory to account for non-renewable natural resources as a factor of production (Dietz & Neumayer, 2007). The key assumption underlying WS is that substitution between NC and manufactured capital (MC) is possible. This assumption likely arose out of the beliefs of prominent neoclassical economists in the 1970s and 1980s such as Nobel laureate Robert Solow, who, in the words of Herman Daly, seriously suggested that, thanks to substitution, “the world can, in effect, get along without natural resources” (Daly, 1994:27). Another view influential in neoclassical thought during this period comes from Herman Kahn and Julian Simon. This view, “that there can be smooth exponential growth where resources are never scarce because human ingenuity always invents substitutes, assumes that humans have an infinite capacity to innovate and that nature changes gradually-fast enough to be detected yet slow enough to be managed” (Holling, 1994:61).

If a WS sustainability paradigm is assumed, progress towards SD will mainly concern management of the economies overall stock of capital assets, since all forms of capital are assumed to have substitution possibilities. Pearce (1999:98) states this as being the “operative constraint” of WS. Therefore, “although natural capital is a form of wealth whose services contribute to well-being it has no 'special role' as such” if WS is assumed in practice. WS advocates argue that MC can substitute for NC as long as the value of both types of capital combined does not decrease. In this case economic sustainability is being achieved. According to Farley (2012:265), in the WS model, “clear cutting the Amazon could be viewed as sustainable as long as future generations were left with an equal value of roads and buildings”. Notwithstanding David Pearce having been identified as a key developer of the WS paradigm (his advocacy is not implied here), he claims that:
“In the WS world there is nothing special about the environment as such. However, this does not permit overly rapid depletion of non-renewable resources or imply that environmental degradation does not matter. In the latter case these actions involve a loss in future well-being unless accompanied by adequate compensation in the form of investments in alternative forms of wealth.” (Pearce, 1998:100)

What are also key in the WS paradigm, are notions of intergenerational equity, whereby it is deemed just and fair that future generations should inherit the same opportunities and capacities that previous generations have enjoyed. Considering the WS paradigm is a core idea in the capital approach to SD, these opportunities and capacities stem from the overall set of capital assets that an economy makes use of at any given time. At any given time, an economies capital assets enable people to advance socio-economically, technologically, and also allow them to enjoy levels of consumption through which their needs and wants are met. To some extent, if we assume we are living in a WS world, “the critical issue of debate is not whether natural capital is being irreversibly depleted, but what are the costs of these losses and whether society today can compensate future generations for the current loss of natural capital” (Barbier, 2014:157).

At this juncture, for the sake of clarity, an important distinction concerning WS should be made between those earlier neoclassical economists such as Solow, Kahn, and Simon who laid the WS foundations, and economists such as Pearce who is strongly identified with environmental economics and advocating for WS (rightly or wrongly). Farley and Daly (2006) state that neoclassical economists (e.g. Solow) have tended to ignore the importance of NC. They assume there is no absolute resource scarcity due to their theory that as any resource becomes scarce, its price increases, providing incentives to create substitutes. Neoclassical economists (unlike ecological economists) have also tended to be particularly optimistic about the role which technology can play in freeing us from dependence on natural resources. Ang and Van Passel (2012) claim that in a WS world it is believed a certain level of technological progress will be sufficient to advanced levels of human well-being despite damage to NC. For the least part, what can be discerned from their words, is that David Pearce and his long time colleague Kerry Turner certainly acknowledged more the importance of NC in pursuing SD. They (Pearce, 1988, Pearce & Turner, 1990) argued that to have SD requires keeping a constant stock of NC. Furthermore, Pearce and Turner (1990) and Pearce and Barbier (2000) in their formulations of WS, regarded substitution of man-made capital for NC as acceptable as long as a resource stock e.g. a fishery, is not depleted below a critical minimum.

Because of their recognition of the significance of NC in terms of the part it plays in sustaining an economy, prominent environmental economists (thought not exclusively) such as Pearce and Turner (1990) state that certain ‘management rules’ are necessary if the important functions of NC are to be maintained over substantial periods of time. Their (Pearce and Turner, 1990) ‘management rules’ for NC in no particular order are:

1. “Always use renewable resources in such a way that the harvest rate (rate of use) is not greater than the natural regeneration rate.” (p. 44)  
2. “Always keep waste flows to the environment at or below the assimilative capacity of the environment.” (p. 44)  
3. “Exhaustible resources cannot be held constant in physical terms unless we use none of them.” (p. 44)
4. “To ensure that as exhaustible resources are depleted, their reduced stock is compensated for by increases in renewable resources.” (p. 45)

5. “To allow for the fact that a given standard of living can be secured from a reducing stock of resources.” (p. 45)

6. “Stock of renewable resources should not decline over time.” (p. 45)

7. “The life-support and waste assimilation functions of NC are not substitutable.” (p. 47)

The last notion (number 7) is perhaps the most interesting then with respect to the departure of environmental economists such as Pearce from the more loose and optimistic treatment of capital by earlier neoclassical economists. It can already be shown that even within the WS camp there are different interpretations of and additions to the rules. What is clear in my view is that particular environmental economists have been sensible enough to adopt ecological concerns into their analysis. For example, concerning environmental considerations in economics, Pearce (1998:115) claimed that what is increasingly apparent is that “the really scare resources are not materials and energy, but the receiving capacities of our environments”. In addition, the pioneering work of Pearce and Turner (1990) on the WS paradigm remains influential as can be seen from Helm's (2015:162;142) recent treatment of NC. Helm's sustainability aim is to “maintain the aggregate of natural capital”, offsetting damage to “renewable natural assets” where possible, yet recognising that this may not be possible because of the nature of renewable NC.

It is arguable that what also underpins the WS paradigm is the philosophy of 'trade-offs' and concept of 'economic cost' or 'opportunity cost'. The trade-off philosophy and mentioned concepts are central to the neoclassical economic paradigm. In Pearce's (1998:20) view, the concept of opportunity cost “refers to the thing that is sacrificed when undertaking a course of action. Any cost is a foregone benefit since the resources that make up cost could have been used elsewhere”. What is an important part of the thought underpinning the WS paradigm, is the idea that there is a possibility that even if NC consumption occurs in one place, the benefits of the gained welfare due to an increase in the MC stock through NCs consumption outweighs the benefits or costs of keeping some particular element or amount of NC intact or unperturbed. Moreover, Ekins (2014:59) claims “an assumption of WS underlies the standard economic approach to decision making that involves trade-offs between goods and services produced by different forms of capital, and indeed between the forms of capital themselves”.

Environmental economics clearly made a shift during the late 1980s and early 1990s from earlier less 'ecologically-aware' thought towards taking seriously and integrating ecological-constraints into their analysis. Even so, it is unlikely that any self-proclaimed ecological economists would welcome the rational of certain environmental economists. Pearce and Turner (1990:48), for example, maintain that there are “...two reasons why the idea of maintaining the natural capital stock need not, after all, be essential to a sustainable economy: technological change which improves the efficiency of resource use, and the substitution of more productive man-made capital for natural capital”. However, the authors also display some of the same caution and perhaps, at a stretch, pessimism which characterizes advocacy of the SS paradigm. It is mostly in the ecological economics camp where SS has its strongest advocates. What can be said for now is that, whatever merits and flaws both the WS and SS paradigms have, in the end, it is as Pearce and Turner (1990:50-51) claim that:
“One of the problems of reaching very definite conclusions about the role which natural environments play in supporting and sustaining economic systems is that we face considerable uncertainty about that role... If we could be sure of the benefits of substituting man-made capital for natural capital then the trade-off between them would not be a serious one... the presence of uncertainty and irreversibility together should make us more circumspect about giving up natural capital.”

Interestingly, it could be argued that, at least since industrial times, industrial-economies have been slowly but surely substituting NC for MC. Daly (2007) claims just this, that humanity has moved to a full-world in terms of the abundance of MC available in highly-developed countries. This has happened at the cost of NC though, which is now limited in its availability compared to what used to be the case pre-industrial times. So, with regard to Pearce and Turner's claim in the above quote, if our economic systems are sustained by continuing the production and consumption of goods and services, natural capital's role has been to fuel that continuation. Natural capital has been used up in order to meet the needs of a growing world population. However, the key questions to be asked are if the levels of natural capital that we have now in the world can go on supporting and sustaining economic systems? What if the world's natural capital is degraded 'beyond repair' in the process? And, how can we begin to understand better whether giving up our natural capital for more manufactured capital is really a good idea in the long-run in terms of securing future generations well-being? These are some of the kinds of questions that have come out of the debate about whether WS or SS is the more suitable sustainability paradigm in making progress towards SD.

4.2 About strong sustainability

Neumayer (2013:1;23), a key contributor to the WS versus SS debate, considers WS as being the “substitutability paradigm” (p. 1) and the “resource optimism” paradigm (p. 23). SS on the other hand, can be considered the “non-substitutability” paradigm in Neumayer's (2013:23) view. The SS paradigm has its roots clearly in the thought of those economists who took much influence from the 'limits to growth' hypothesis. Herman Daly, published his 'Steady-State Economics' first in 1977, which may mark the foundation of SS thinking according to Neumayer (2013). Additionally, on the possible foundations of the SS paradigm, David Pearce and his colleagues have given arguments for the possibility that sustainability requires stronger rules (Neumayer, 2013). Furthermore, Neumayer (2013) argues that due to the numerous contributions that have been made in formulating the SS paradigm, this renders its definition slightly more challenging than defining WS.

Ecological economists are thought of as being the main proponents of the SS paradigm. This is the case because of their beliefs about how the environment and economies interact with one another. Ecological economists argue that the relationship between the economy and the environment should be made central to economic analyses in order to reorientate economic activity to be sustainable. Folke et al. (1994:4), for example, believe “viewing the economic subsystem in its proper perspective relative to the entire system is crucial for achieving a sustainable relationship with the environment, and assuring our own species continued survival on the planet”. Unlike if we were to live in a WS world, where capital is substitutable, in a SS world the key assumption concerning capital is that NC and MC are complementary to one another. Both NC and MC, in turn, must be maintained intact because the productivity of one, e.g. MC, is dependent on the availability of the other, i.e. NC (Daly, 1994). The difference between the two paradigms concerning assumptions about substitutability is detailed by Figge (2005:186) who suggests:
“From the point of view of weak sustainability fish stocks and fishing boats are substitutes. If this were true diminishing fish stocks could be substituted by an increase in fishing boats. Obviously the value of fishing boats relies on the existence of fish stocks. Fishing boats and fish stocks are therefore complementary. For a sustainable development both natural and human-made capital must therefore be preserved. This is the point of view taken up by strong sustainability. Strong sustainability presupposes that different forms of capital are complements.” (italics in original)

Although Daly (1994) believes that putting into practice the rules of the WS paradigm would be an improvement on how capital is currently treated in current economic practice, writing in the same volume, Folke et al. (1994:3) consider the “...belief that there is infinite substitutability between human-made and natural capital... to be a dangerous one, given the huge uncertainty”. Ecological economists such as Daly have critiqued neoclassical economists because many of them have assumed 'smooth' substitution possibilities exist between MC and NC (see e.g. Daly, 1997). In addition, Folke et al. (1994:6), clear proponents and advocates of the SS paradigm, claim regarding capital substitution that:

“From the perspective of ecological economics, it is not possible to have perfect and unlimited substitution between natural and human-made capital. Human-made capital cannot be created and sustained without energy and natural resources. Hence, there will always be a minimum or critical amount of natural capital needed to sustain any individual of the human species, and there will always be a minimum amount of natural capital needed to produce anything in the human economy. Production of goods and services cannot be decoupled from its biophysical reality. It is not possible to fully substitute human-made capital for natural capital, since the former is in itself made out of the latter.”

Folke and his colleagues views may be seen as being fairly realistic about substitution possibilities between NC and MC. The pessimism that is said to characterize ecological economics regarding substitution and decoupling possibilities is not unfounded. However, it remains to be seen whether future technological breakthroughs will enable us to recreate the life-support functions of NC such as nutrient cycling and climate stabilization. About this matter, it is Ayres (2007) view that at least for the foreseeable future, humanity is dependent on some type of agriculture based on sunlight, topsoil and rainfall. Currently, it is simply not possible for us to substitute for all of the functions and services provided by NC with MC. Thus, those supporting the SS paradigm do so because they argue that NC is essentially non-substitutable (Dietz & Neumayer, 2007). An important point in considering the SS paradigm, is that like ecological economics, it has grown out of a countermovement to the neoclassical-influenced WS paradigm (Ang & Van Passel, 2012). If NC has become the limiting factor in terms of possibilities for continued economic growth, in a world 'chock-full' of man-made capital as Daly (1994) claims, SS paradigm supporters argue certain components of NC should be conserved in addition to maintaining the overall capital stock. Unlike the WS paradigm, the SS paradigm affords special protection to environmental assets (Pearce et al., 1990). The pursuit of environmental sustainability is fundamental to the SS paradigm, which requires the important environmental functions of NC to be protected and maintained. The NC that performs such functions and services, is called 'critical natural capital' in ecological economics (Ekins, 2014).
4.3 Critical natural capital and ecological economics

Within the ecological economics literature, one of the first ways NC has been 'disassembled' is by making a distinction between CNC and non-critical NC (Cabeza-Gutés, 1996). The CNC concept points to those basic life-support functions of NC that are all but surely infeasible to substitute (Barbier et al., 1994). The focus of the SS paradigm then, is, most importantly, the protection of CNC. In other words, sustainability requires the global environmental and ecological systems that supply humanity with the elementary functions of food, water, breathable air and a stable climate (Dietz & Neumayer, 2007) be protected and maintained. Additionally, the concept of CNC emphasizes that, by necessity, humanity must maintain the global environmental and ecological systems above certain thresholds of degradation (e.g. from pollution). The purpose in doing so, would be to safeguard the capacity of NC to provide the services which are critical for the continuation of our species (Brand, 2009).

It should be stressed that, like the WS paradigm, there are slightly different interpretations of the SS paradigm present in the literature also (Neumayer, 2013). One the one hand, we have an interpretation of SS which allows for substitution within the NC stock so as to keep constant the aggregate value of the total NC stock. On the other hand, there is what can perhaps be tentatively labelled a 'stronger' interpretation of SS, which distinctly ruling that substitutability within the NC stock must be constrained (Neumayer, 2013). The first interpretation, according to Neumayer (2013:26), "calls for preserving NC itself in value terms". Although in this interpretation of SS the environment does not have to be preserved as is, it does require that non-renewable resource depletion is compensated by investment of the rents in renewable energy sources (Neumayer, 2013). The second and stronger interpretation of SS points to need to preserve the physical stock of NC, in particular CNC, or those elements of NC that SS supporters regard as non-substitutable (Neumayer, 2013). Nor does the second interpretation, unlike the first, allow for substitution between CNC (even if it were possible). However, like in the first interpretation the second also does not imply that the environment should remain as it is (Neumayer, 2013). In Neumayer's (2013) view, the possibility of preserving our present environment intact and as it is, is an insurmountable task. However, in an SS world, the critical functions of the environment such as its waste-assimilative capacity should be kept intact. Additionally, even if the flows from some NC functions and services are exhausted, then the regenerative capacity of that NC must not be overstepped, so that its environmental functions remain unimpaired (Neumayer, 2013).

4.4 Debating weak versus strong sustainability

So far in this section, the orientation of economists of different persuasions, e.g. neoclassical, environmental, ecological, have been illuminated concerning two sustainability paradigms that have arisen out economists attempts to give meaning to SD. The capital approach to SD is, arguably, fundamentally a consideration of how to improve and sustain human well-being into the future. A capital approach to SD aims to accomplishes this through 'caretaking' and maintaining the economies capital assets. The capital approach to SD frames the issue in terms of human well-being because the capacity to provide this utility is conceptually embodied in the forms of capital. Under the early influence of strictly 'neoclassically' inclined economists, the WS paradigms key concern was ensuring that an economy's wealth does not decline over time. Therefore, measuring and maintaining the aggregate capital stock would lead to sustainability, thought not necessarily SD. An early (1970s) influential economist in this regard is Partha Dasgupta, who claims that whether or not SD is possible depends upon “...demographic behaviour, consumption patterns, and production and substitution possibilities among the myriad forms of capital assets” (2001:142). Considerable in some respects as being opposed to WS, proponents of the SS paradigm argue that
NC maybe substituted to some extent with MC. However, to a large extent, critical elements of NC, i.e. CNC, are non-substitutable. Under a stronger interpretation of the SS paradigm recognising CNC and protecting it are key in making progress towards SD. What is also fundamental to any notions of sustainability according to ecological economists, is the recognition that it is not possible for man's inventiveness to create MC without assistance from NC (Daly, 1990). In terms of sustainability then, the natural environment is the ultimate constraint on human economic activity and any possibilities for its expansion. Hence, most of the adherence to the SS paradigm is to be found with scholars aligning themselves with ecological economics.

Under both paradigms, WS and SS, a minimum safe condition for economic sustainability is to maintain the total capital stock at or above the current level. In a more 'neoclassically' influenced WS world, MC can fully substitute for NC through technological progress. In a world where we have 'ecologically-adjusted' WS, there will always be a minimum amount of NC needed to sustain human life and to produce needed consumptive goods and services. A strong sustainability indicator would involve identifying and measuring NC to see if stocks of critical natural assets are declining (Pearce, 1998). Any positive depreciation in the NC stock, in turn, would indicate the non-sustainability of the economy (Pearce, 1998). In both a WS and SS world, a minimum safe condition for economic sustainability is to maintain the total capital stock at or above the current level. However, in order for either WS or SS to be operable in terms of assessing the sustainability of the economy, NC has to be measured as well as other capital assets (Pearce, 1998). O'Connor (2000), believes that in general, there is no one wholly satisfactory indicator for the total quantity or stock of NC. Attempts at defining aggregate measures of the NC stock thus far are listed below:

1. “the physical quantity of natural resource stocks;” (O'Connor, 2000:5)
2. “the total economic value of the natural resource stocks, which would permit physically declining levels of a stock if accompanied by a rising unit value (price);” (O'Connor, 2000:5)
3. “the unit value of the resource/service (as measured by a price or shadow price);” (O'Connor, 2000:5)
4. “the total value of the resource/service obtained through time from the stock.” (O'Connor, 2000:5)

An issue that Pearce (1998:94) has identified with attempts at NC measurement is that it may not be possible to “capture all the economic functions of ecological systems”. The second issue with NC measurement is about figuring out exactly what maintaining the NC stock constant actually means in practice. Pearce and Turner (1990:53) provide us with several key interpretations:

1. “We could say that the capital stock is constant if its physical quantity does not change. But we have no way of adding up the different physical quantities (tonnes of coal, cubic metres of wood, litres of water, etc.) The standard economic approach would be to value each type of resource in money terms and compute the overall aggregate money value. If this could be done, in the same way as we make estimates of the 'national wealth' – i.e. the stock of man-made capital – then we could rephrase the Kn [NC] requirement in terms of a constant real value of the stock of natural assets.”
2. “We could think in terms of the unit value of the services of Kn. That is, we could look at the prices of natural resources and aim to keep these constant in real terms. If we are satisfied prices reflect absolute scarcity – constant real prices will imply a constant natural capital stock in this modified sense. One obvious problem here is that many resources do not have observable prices. We would need to find implicit or 'shadow' prices in some way.”

3. “We could think of a constant value of the resource flows from the natural capital stock. This is different from constant prices because we would allow quantity to decline but the price to rise, keeping value constant.”

Placing money values on NC in order to be able to account for it is for some a controversial practice. However, the 'economic valuation' of natural capital and ecosystem-services is an approach that has become standard within environmental economics and has its advocates among ecological economists. Concerning notions of economic sustainability, economic valuation of NC is seen by different economists as either a necessary measure to be able to comprehend whether natural assets are being damaged and degraded, or as undesirable for several reasons which will be be looked at in the next section (5). What can be stated is that in the case of both the WS and SS paradigms, the two have in common assumptions by scholars that measuring NC in monetary terms is necessary. Although there are some dissenting ecological economists such as Spash (Spash & Aslaksen, 2015) who views economic valuation of NC as problematic in its application, and Söderbaum (2015:422), who considers NC valuation as representing a kind of “monetary reductionism”, some of the fields most influential scholars have stated “in order to account for natural capital it must be priced” (Prugh et al., 1999:88). This statement by Prugh and colleagues is interesting to consider alongside Ekins (2014:69) view that the WS paradigm “...permits the monetization of CNC, the environmental functions it produces, and environmental impacts” and that the SS paradigm does not, but requires “...that different forms of natural capital and their functions are separately identified, and sustainability standards derived to reflect whether the functions are being maintained”. Whilst supporters of the SS paradigm usually stress the value of NC in general, some in particular put more emphasis on the need to discuss the value of NC in physical rather than monetary terms (Özkaynak et al., 2004). The physical rather than monetary distinction under SS has to do with whether a 'weaker' or 'stronger' variant of the SS paradigm is preferred.

The debate about whether there can be substitutability between natural and other forms of capital ultimately defines the difference between the WS and SS paradigms. But which of the two paradigms is more argued for in the SD literature? And for what reasons? For many ecological economists such as Herman Daly, the SS paradigm is essentially the relevant paradigm in any discussion about SD (Daly, 1994). However, Daly also believes that a WS world would be an improvement over current world practices of managing and protecting NC (Daly, 1994). Dietz and Neumayer (2007:619) suggest there are four reasons why the SS paradigm may be the preferable over the WS paradigm: 1. “risk and uncertainty”; 2. “irreversibility”; 3. “risk aversion”; and, 4. ethical concerns about consumption of non-substitutable NC. Turner and Pearce (1992) also argue in favour of the adopting the SS paradigm in pursuit of SD. The authors view the SS paradigm a way of integrating economic efficiency, intergenerational equity, and the precautionary principle
(because of the existence of CNC). Turner and Pearce (1992:10) argue how the principle of maintaining capital constant delivers two “incidental effects”: 1. “It protects the environments of the poorest communities in the world who depend directly on those environments for fuel, water and food”; and, 2. “it protects the environments of sentient nonhumans and nonsentient things”. In the literature on SD, both the WS and SS paradigms are often presented as being opposed to each other (e.g. Neumayer, 2013). However, like Daly (1994), even Neumayer (2013:25) claims that:

“Proponents of SS are not against achieving WS. Rather, they would regard achieving WS as an important first, but insufficient, step in the right direction. In a sense, SS encompasses WS, but adding further requirements. In this perspective, WS is better than traditional neoclassical economics, but it is still a far cry away from what is needed for SD.”

The above quote by Neumayer is interesting considering some of the infighting that goes on between scholars in the ecological economics field. On the one hand, scholars (rightly or wrongly) strongly associated with environmental economics, such as David Pearce and Dieter Helm, are thought of as championing the WS paradigm presumably because it aligns better with their neoclassical adherence. At the same time, some ecological economics use this perceived advocacy of WS by environmental economists to attack them on grounds that the substitution allowances of the WS paradigm world are dangerous and deluded. This is in spite of the different interpretations of both the WS and SS paradigms. On a final note, Pearce and Barbier (2000) argue that no matter which paradigm is favoured in the context of SD, there is still commonality to be found between the two paradigms. Clearly for some scholars such as Pearce, Daly, and Neumayer, recognising this common ground is to be viewed as an important stepping stone in making progress towards SD.

In this section, two sustainability paradigms, WS and SS, have been reviewed to illuminate economists attempts to make SD operational. The debate about WS versus SS has been looked at through the views and beliefs of a number of economists fundamentally concerned with issues about SD. The first paradigm, WS, has its foundation in neoclassical economic thought, with its utilitarian welfare concerns and notions of intergenerational equity. In a WS world, the forms of capital are believed to be substitutable. This, in turn, enables capital stocks to be maintained for generations to come for the purpose of providing them with the same or an improved level of well-being and socio-economic opportunities. An 'ecologically adjusted' WS world can be said to take better account of the representative concerns of ecological economics. Such concerns include the recognition that there exist critical elements of NC for which there are currently no substitutes. Hence, the total NC stock must be maintained to ensure the sustainability of economic activity. However, even in an 'ecologically adjusted' WS world, substitutions between MC and NC are permissible in addition to substitutions within the NC stock, e.g. a wetland here for a wetland there. A technological optimism and penchant for the continued pursuit of economic-growth can be said to characterize and distinguish the WS paradigm from its strong competitor, SS.

The SS paradigm has its roots with the work of scholars strongly associated with ecological economics. In essence, advocates of the SS paradigm believe it to be the more ecologically relevant paradigm for SD because it emphasises that the point that continued production of consumptive goods and service relies fundamentally on the continued functioning and service-provision of NC. Therefore, in an SS world, NC is clearly the limiting factor in considering substitution possibilities concerning capital. Contrary to the WS paradigm, the SS paradigm views the forms of capital as complementary to one another in terms of producing human well-being. Furthermore, SS advocates, namely ecological economists, have furthered the concept of NC by suggesting the concept of critical natural capital. CNC points to those critical elements of NC that make-up the
very basis of the environment. For example, its capacity to support and provide for all forms of life on the planet. In an SS world, neoclassical optimism about the substitutability of capital and technological progress providing substitutes for NC is contested and viewed with scepticism. Also, in an SS world, it would be necessary to 'constraint' economic growth in order to conserve CNC. From an SS perspective, what is fundamental to any approach to SD is ensuring the protection and maintenance of NC. In terms of capital substitution, unlimited replacements even within the NC stock, e.g. forest for forest, are viewed in a 'stronger' interpretation off SS as not possible.

What can be taken from this section by the reader about the weak versus strong sustainability debate is that in spite of economists attempts to make operational SD, there are divergent views on what constitutes the best 'sustainability path' towards SD. I would argue that underlying both of the two paradigms, WS and SS, are different notions about economy-society-environment interactions. On the one hand, one can be optimistic about the kinds of technologies and resources that will be invented and discovered in the future that will may enable substitution between NC and MC. Any such substitution may lead to progress in 'decoupling' economic growth from the environment. Such 'decoupling' may even 'let-up' some of the pressure current economic activity places on natural capital. On the other hand, less optimism may follow from observing the kinds of unsustainable trends that humanity is currently witnessing (see e.g. Rockström et al., 2009). Because of humanity's dependency on natural capital and ecological systems, I would argue that some form of SS is what is truly needed to make progress towards SD. In the next section, NC will be looked at from the perspective of scholars who voice concerns about thinking of the environment as capital. It is in particular ideas about better utilizing NC in order to secure 'green' economic-growth and the environment as service-provider that have found criticism amongst scholars.
5. A critical perspective on natural capital

In this section, NC will be analysed through the work of scholars who have presented us with critical perspectives and views on NC. For some scholars, thinking about the environment as capital incites certain kinds of values and ideologies that are antithetical their interpretation of SD. A critical perspective is taken on NC in this section making use of a political-ecology approach to aid in the analysis and critique of NC. It is arguable that using NC as a core concept in approaching SD represents adherence to a particular political-economy. Underpinning this political-economy is belief in the resilience of capitalism, the efficacy and fairness of markets, and that economic growth is king. Moreover, political-economies that accept and advocate natural capital can be considered as being aligned with neo-liberalism. Part of the motivation behind this particular section of thesis is to allow room for some my own thoughts regarding critique that has been levelled at the NC concept and its use in environmental conservation approaches. Additionally, the critical perspective on natural capital presented here should be viewed as being opposed to SD approaches that accept thinking about the environment as capital.

5.1 Political-ecology

Political-ecology (PE) is an interdisciplinary field and ought not to be considered as a theory, but rather a 'theoretical approach'. In an early and influential publication in the field, *Land Degradation and Society*, Blaikie and Brookfield (1987:17) define PE as an approach that “combines the concerns of ecology with a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself”. According to Robbins (2012:13) in his *Political Ecology: A Critical Introduction*, “political ecology is a critical research field whose numerous practitioners all query the relationship between economics, politics, and nature but come from varying backgrounds and training”. Furthermore, “the term political ecology is a generous one that embraces a range of definitions... the many definitions together suggest that political ecology represents an explicit alternative to 'apolitical' ecology” (Robbins, 2012:14). It is Robbins (2012:14) view that PE “commonly presents its accounts as alternatives to other perspectives”. However, “political ecology is not 'more political' than other ecologies and approaches to the environment. Rather it is simply more explicit in its normative goals and more outspoken about the assumptions from which its research is conducted” (Robbins, 2012:19).

Research in PE “tends to reveal winners and losers, hidden cost, and the differential power that produces social and environmental outcomes. As a result, political ecological research proceeds from central questions, such as who benefits from wildlife conservation efforts and who loses?” (Robbins, 2012:19). PE “is a field that stresses not only that ecological systems are political, but also that our very ideas about them are further delimited and directed through political and economic process” (Robbins, 2012:20). Notions of justice and injustice that are examined in cases of political ecological research “can be extended to the environment itself, insofar as ecosystems or species may lose or suffer for the benefit of other actors” (Robbins, 2012:88). Moreover, “as critique political ecology seeks to expose flaws in dominant approaches to the environment favoured by corporate, state, and international authorities, working to demonstrate the undesirable impacts of policies and market conditions...” (Robbins, 2012:99).

In addition, Kull et al. (2015) state that “political ecology is a research approach or posture that addresses nature-society phenomena – whether concrete local cases of environmental change or abstract global concepts like ecosystem services using historically and geographically contextual approaches”. Furthermore, “political ecology guides researchers to pay attention not only to the
ecology or science of the topic at hand, but also to the agency of ideas and the actions of social, economic, and discursive power across scales”. The PE approach “pays particular attention to who wins, who loses, and what the impacts are for different parts of society and different components of the environment” (Kull et al., 2015). PE has also “been defined as a more specific analysis of Marxist debates about materialism, justice, and nature in capitalist societies, with the view to achieving a fairer distribution of rights and resources” (Forsyth, 2005). Lipietz (2000:70) claims “political ecology, like the Marxist-inspired workers’ movement, is based on a critique – and thus an analysis, a theorized understanding – of the “order of existing things.” More specifically, Marx and the greens focus on a very precise sector of the real world: the humanity-nature relationship, and, even more precisely, relations among people that pertain to nature (or what Marxists call the “productive forces”).”

PE has also to a large degree operated as a critique of neo-liberalism. In his Principles of Political Ecology, Atkinson (1991) motivates PE as that which seeks to set up a socio-economic system which incorporates a sustainable relationship between man and nature. Additionally, PE begins from a recognition of the environmentalists' warnings that Western culture is on a trajectory that will potentially end in catastrophe (Atkinson, 1991). If methodology is the principles and practices that underlie research in a discipline or research area, then the principles of PE “arise out of the sense of bewilderment of our own age, as steeping stones intended to assist in a reformulation and reconstruction not only of our social world but of relations between the social and natural worlds” (Atkinson, 1991:2-3). Furthermore, Atkinson (1991:5) claims it is a requirement or aim of PE to deliver transformed cultural practice with respect to nature, in addition to “…seeking out concepts and ideas which will provide the basis for a social process that will establish a benign relationship with the rest of nature” (Atkinson, 1991:10).

5.2 Critiquing the concept of natural capital

SD is being pursued presumably with the ultimate goal in mind of stemming the decline of nature in order to be able to continue to pursue economic growth. However, there are different ways of going about sustainability, be it through measures to abate toxic pollutants or managing ecosystems to conserve a particular species. Different actors with a variety of views and approaches to the natural world are involved in the debate about what is the best way to move towards SD. These different actors come with different ideologies and values, and different motivations for wanting to pursue sustainability and protect the environment. Any decision taken concerning SD cannot be in every respect objective and devoid of the influence of an actors personal values and ideological orientation; no decision is value-neutral. It is claimable that the way particular actors choose to relate to and conceptualize the environment says much about an actor. The choice of these variables may vary greatly between people, groups, and institutions around the world. The 'more-than-human world', i.e. non-humans, such as plants and animals, are also ‘components’ of ‘the environment’. They are involved in and usually impacted on by the decisions humans make about how to relate to and manage the environment. Ecosystems for example, are a socially-constructed idea. An ecosystem is a scientific concept. Like natural capital, talking about the environment in terms of its ecosystems is a way to refer to a natural phenomenon. Such scientific concepts can aid in understanding the ‘things’ that surround us humans out there in the environment. The pursuit of SD is not something which can be independent from morality and can be as much about benefits and costs to human-society as it can be about benefits and costs to other species inhabiting the same environment as we humans. What interests does nature have if any? And how can we best represent them and cater for them?

One approach to SD that has come to prominence in recent decades, and is enjoying particularly
strong attention from conservation organisations and the government in the United Kingdom is the 'natural capital approach'. As is evident from the name, this particular approach to conservation and SD features the idea of the environment as capital centrally. Economists and actors who support the natural capital approach do so because they believe that if the economic value of nature is recognised and demonstrated (ultimately by placing monetary values on people's preference for having more or less nature), nature can be better conserved and utilized to contribute to economic output. Dieter Helm, chair of the UK's NCC, and key supporter of the natural capital approach, believes the continued pursuit of economic growth to be a paramount concern if human well-being is to be secured for the future. In addition, Helm views the natural capital approach as the only approach that will allow us to secure human well-being whilst at the same time safeguarding humanity's critical natural assets. A large part of the motivation for the natural capital approach is to create economic growth that is 'sustainable'. The natural capital approach also happen to be at the heart of UNEP's (2011a, 2011b, 2011c) 'green-economy' initiative. The idea of a 'green-economy', at least concerning UNEP's interpretation, is receiving strong critique from particular political-economists such as Wanner (2015:36), who argues:

“More radical alternatives to human-nature relations and for creating a sustainable green society are subsumed and normalised through the 'passive revolution' of green economy and green growth. Green economy is the promise of a green capitalism without questioning the underlying dynamics and power relations and causes of unsustainability of this system... On the contrary, the green economy/growth discourse further intensifies the privatisation and marketisation of the fictitious commodity of 'nature', and perpetuates the myth of limitless growth... The shift to green or sustainable societies requires more radical transformative changes which the discourse of green economy/growth is designed to prevent.”

From a critical perspective, some key questions concerning NC might be: 1. what is lost in terms of differing views and perspectives if natural capital comes to dominate approaches to environmental conservation in the context of SD? 2. What does and doesn’t the concept of NC allow for in terms of different actors conceptualisations of the environment? 3. What kind of relationship with nature is constructed by nature being thought of as NC instead of 'just' 'nature' or 'the environment'? And, 4. does the concept of NC sufficiently conceptualize economy-environment interactions? From a critical perspective, questions need to be asked about why the NC concept is becoming dominate in environmental conservation approaches, and why it is being received uncritically by leading conservation charities and the global development institutions? (see e.g. Green Alliance, 2016; UNEP, 2011, 2014). Any legitimate critical perspective on NC ought to arguably view the consensus that has been formed around NC with scepticism. What evidence is there to back up the claims of natural capitals advocates such as Helm, that it is the surest way of protecting the environment for future generations? It may be the case that the natural capital approach is not all it appears to be, i.e. an approach championing environmental conservation. In this regard, Soderbaum's (2015:423) words seem pertinent: “we should never forgot that values, ideology, and indeed, personality, are involved in our advocacy of specific ideas and approaches”.

5.3 Problems with viewing nature as capital

So what is lost through natural capital becoming dominant in environmental conservation approaches and the language of SD? Well, If sustainability is a normative notion concerned with the way how humans should act towards nature as Baumgärtner and Quaas (2010) claim, then naming and viewing nature as capital may not sit comfortably with some people. It may be that the
idea of nature as capital is an alien notion for some, one that cannot come to comprehend. It also may be that thinking of the environment as capital, as producer and service provider is something antithetical with a persons values or ideology. For example, what if NC is something that is not compatible with a persons way of relating to nature? In terms of an individuals unique set of values, sense of spirituality, and ethical position, an inherently economic concept such as natural capital might be rejected by some on the basis that it is too anthropocentric. That is to say, the concept of natural capital perhaps further portrays nature as a resource, rather than pointing to its instrumental value. Further critique levelled at NC has to do with it being aligned with the current economic system, namely capitalism. Perhaps to stem the decline of nature what is actually needed is for humanity to shift to a different political-economic reality, whatever that may be. Those opposed to capitalism and markets also will likely oppose NC on the basis that it is supports a neo-liberal conservation agenda. The existing neo-liberal conservation agenda is described as being “inherent to broader capitalist processes, and as a particular set of governmentalities that seeks to extend and police profitable commodification processes based on artificial and arbitrary separations of human society from biodiverse-rich (non-human) natures” (Büscher et al., 2012). The natural capital approach then be viewed as being a central part of the neo-liberal conservation agenda. Furthermore, it is claimable that the concept of NC reflects a certain way of thinking about nature. MacDonald and Corson (2012) view the prominence that NC has gained in approaches to environmental conservation as a moment in virtual reality. The popularity of concepts such as NC and ecosystem-services in conservation currently are part of a process of abstraction which is moving our imagined ideas of nature further away from their ecological reality. MacDonald and Corson (2012:181) suggest that “increasingly modes of conforming reality with the image of 'natural capital' circulate in popular culture and the daily economy of life... the realization of this vision has entailed the privatization of new rights to nature, the creation of new commodities, and the establishment if new markets for their exchange” (2012:160-161).

From a critical perspective, the widespread move in conservation approaches to conceptualizing nature ‘capital’ can be considered as being an overly-anthropocentric approach to conserving nature. This anthropocentric positioning, which can be viewed as underpinning economic concepts such as NC, is gaining in popularity in approaches to SD and environmental conservation. It involves viewing and valuing nature purely as something there to primarily meet humans need for natural resources. Coffey (2016:219) fleshes out the critique being levelled at NC for it being overly-anthropocentric:

“...using economic metaphors ensures the environment is considered in narrow anthropocentric (human centred) and economistic terms, with markets and market forces positioned as the best way of promoting environmental (as well as other) objectives. The use of economic metaphors represents a neoliberalisation of environmental policy. It marginalises transformative agendas, and a promotes a view of environmental issues that limits their seriousness and constrains what should be done to address: the environment is only viewed as important to the extent that the natural capital of ecosystems provides goods and services which are viewed as having economic value to humans.”

In contrast to NC an an overly-anthropocentric position with regards to environmental conservation, others take a 'biocentric' positioning which entails valuing nature for its own sake. In particular, because it exists independently of humans experience and interaction with it. Environmental ethical concerns have not been neglected by economists however. On the one hand, notions of the environment as having value might be rejected on philosophical grounds. On the
other hand, others may accept the notion that the environment has economic value, but at the same time reject the notion that nature's value can be represented as a money value. Economic valuation is often wrongly understood as being the practice of 'putting a price on nature'.

From a non-critical perspective, I wonder if the critique directed at NC may stem from individuals personal feelings of being at odds with the NC view of nature. I also wonder if the critique that has been levelled at NC might have more to do with individuals personal feelings of contempt and disillusionment for the neoclassical economists and their currently dominant paradigm. Some individuals prefer to identify with economists who claim that what is really needed for SD is a fundamental rethinking of our economic philosophy and restructuring of our economic system. This, however, is not what the NC approach offers. Also, to a large extent, the economists who are advocating the NC approach do so in the hope that nature can be better conserved under the prevailing economic system. In this sense, 'mainstreaming' the NC approach can be considered as bringing about a revolution in how we conduct our economic activity. From a critical perspective, however, NC can be view as part of economists attempts at 'economizing' nature. For example, neoclassical environmental economists believe part of the reason why nature is subject to large-scale degradation is because it has not been properly incorporated into the workings of the prevailing economic system. Neoclassical environmental economists argue that this situation can be corrected if nature is made subject to the workings of the market as are other commodities. The beliefs of neoclassical environmental economists have been heavily criticised however. Ecological economists such as Söderbaum (2015) and Spash (2015) have sought to distance themselves from the part of the ecological economics movement that maintains neoclassical principles and methods are of value. Scholars like Spash and Söderbaum also challenge neoclassical economics on grounds that it is overly concerned with the efficiency principle, and is too positive towards economic growth and economic valuation methods.

5.4 Further critique levelled at natural capital

From a critical perspective, it could be claimed that the acceptance of the NC concept into conservation approaches illuminates how at ease some actors are with viewing nature as a service-provider. How things are conceptualised especially the environment arguably will affect how they will be viewed and consequently treated. Global development institutions such as the United Nations (specifically its UNEP arm), academics including economists and conservation biologists, and many conservation charities are advocating for the widespread adoption of the NC approach. From a critical perspective this maybe important in relation to democracy. Advocacy of the NC approach includes the voices of a number of powerful and influential actors. It is arguably being accepted and received uncritically into society. Have electorates been consulted about this matter though and asked what they think about NC? Or does it only matter concerning environmental sustainability that NC is backed by the 'experts'? Such concerns may only arouse concern for those who consider it important to stress the role of democracy in decision-making however. On the one hand, the NC approach is being backed by a number of powerful and influential actors. One the other hand, 'mainstreaming' the NC approach into conservation occurs at the exclusion of other values and motivations that exist for wanting to protect the environment. Dieter Helm (2015) argues that in recognising nature's economic value, and demonstrating it to decision-makers, nature can stand a better chance of being safeguarded. The NC approach fundamentally emphasizes nature's economic value as being the reason why it should be protected and conserved. However, the NC approach arguably does this at the expense of other approaches that emphasize different values that could motivate conserving nature. Hopkins (2016:19), who also takes a critical perspective on NC, suggests:
“A major problem is, of course, that appealing to alternative, collective values that have been steadily washed away – specifically, those of a collective ecological responsibility – is a formidable task. Communicating environmental issues in a nonabstract way is particularly difficult: but money is a more abstract measure than, for example, tonnes of CO₂, and it gains an illusion of reality simply by being an abstractions that everyone understands. This can make financial methods the most tempting choice for those wishing to encourage proenvironmental actions.”

Although NC was coined and developed by economists, it is also supposed to appeal to politicians and the business community in order to advantage nature conservation in political debate. One further criticism of NC could be it is something which distances people from those very things that it is being used to protect. Pearce (1992) argued for the ‘capital approach’ to the environment because he would have liked to see nature placed in a better position on the bargaining table concerning economic-development versus environment trade-offs. He did this in part because he did not expect the majority of decision-makers, as well as consumers, to wake up the next morning having internalized the ‘green’ values that would make them budding conservationists overnight. In his own words, Pearce (1992) claimed “like it or not, real wealth versus the environment is how many politicians still characterize the issue.” Other ecological-economists however would likely challenge Pearce on his view that markets need to be created for biodiversity in order for it to be better protected. Some might view the idea of markets for biodiversity as absurd or immoral, in spite of the fact that markets for biodiversity already exist, illegal or otherwise. Norgaard (2015:6) for example, argues “the invasion of the field of ecology by market-based reasoning is especially problematic, as its object of enquiry—the environment—is often harmed, rather than helped, by markets.” Indeed, from a critical perspective, the NC approach is, in general, an approach championing markets-instruments for biodiversity such 'habitat banking' and 'biodiversity offsets'.

Even if the goal of the NC approach is to try stem the decline of the nature, it ought to be considered that if by pushing the NC concept in conservation, a situation might occur whereby humans become further alienated from nature. This could happen as NC becomes more accepted as a way of viewing nature. A scenario can be imagined whereby as people start to incorporate NC into their 'worldview', the environment and its constituent parts will begin to be viewed as solely existing to provide goods and services which are important for the economy and human well-being. This imagined scenario may come across as being somewhat far-fetched. However, as NC is being mainstreamed into conservation approaches and eventually becomes the accepted, perhaps even dominant way of viewing nature among decision-makers, can we really say what the long-term consequences of this might be? Spash (2000; 2008) has pointed out that NC and the economic value of nature it espouses is part of an economic philosophy that is presented as being value-neutral, knowledge-based and practical. However, there exist many values and motivations for wanting to protect and conserve the environment. Additionally, the 'wholesale' adoption of a concept like NC by powerful and influential actors might, in Sullivan's (2014:32) critical view, “…intensify the disembedding emphasis (of 'society' from 'land' and 'nature') lying at the heart of capitalist enterprise…the displacement of different socionature knowledge and value practices...”.

Abram (1996; in Spash & Aslaksen, 2015:250) claims “in pre-modern culture people view themselves as part of the wider community of Nature in active relationships with animals, plants, landscapes, mountains, rivers, wind and weather patterns, and it is only in recent centuries that humanity has come to think of nature as an inanimate object or, even more recently, as a human artefact”. NC is arguably a good example concerning Abram's claim. The NC approach is premised on a theory that regards nature as some rare and coveted artefact that needs to be rationed out in
order to secure the limitless expansion of global economic activity, i.e. exponential growth. What will result from moving towards a NC worlds is a situation where decisions about environment conservation will ultimately be made by experts and elites. The fate of rare habitats, endangered species, and badly degraded ecosystems will depend on whether or not they are economically valuable enough to be considered as worthy of conservation or not. In a NC world, much of the non-human nature that is deemed to be not so valuable by experts and politicians, or those actors with decision-making powers in a society, will be resigned to a fate of extinction. Furthermore, those who reject the trade-off, cost-benefit philosophy underpinning the NC approach, will be excluded from decision-making on the basis that the NC approach is the only truly 'scientific' approach. The 'mainstreaming' of NC into conservation policy by governments could be part of a phenomenon Forsyth (2005) claims happens when the related interests of political actors, who have allied with one another, may result in the espousal of scientific explanations or problem closures as means of 'concretizing' these interests. The kinds of interest such actors share could be, for example, those of a particular state which uses intricate strategies for control and legitimisation that may, in turn, be successful and co-produced through the phenomenon of “discourse coalitions” (Hajer, 1995:65). “Discourse coalitions” take place when different actors viewpoints and objectives overlap, and, as a result, strengthen the belief that these views are the sole way of viewing things. An alliance between a state, seeking to increase control over important land, and middle classes, who want more action to be taken on protecting wildernesses, may hence result in the perceived function of that land being classified as solely existing for the purpose of conservation, to the exclusion of certain social groups who may benefit from other uses of such land (Forsyth, 2005).

The purpose of this section has been to review and present some of the critique that has been levelled at the NC concept and approach. I have sought to illuminate, using a PE approach, that NC is not only something we can view as being a positive development in the way we do conservation. NC and its place in environmental conservation is something that ought to be critically examined, and deconstructed. Perhaps, eventually, NC is also something that will be resisted because of some of the problems that may arise from its use in environmental conservation in the long-term. To make use of a well-known Marxist term, the NC approach may be just the next intricate part of a process of alienation from nature that the capitalist system and current prevailing economic logic is forwarding. In this regard, NC is just another one of man's fantastical notions of nature, standing alongside previously influential notions of nature as a machine for example.

From a critical perspective, the NC approach serves the global neo-liberal agenda. The NC approach is really an neoliberal conservation agenda. Its 'mainstreaming' into conservation will only lead to further appropriation of natural resources into the hands of a small wealthy global elite. This process is occurring at the expense and exclusion of the majority of people and other species, therefore only deepening already existing global socio-economic and environmental inequities. This process is being championed through the NC approach. The NC approach is characterized by a deeply persuasive economic logic that tells people that we must first recognise nature as being something that is increasingly scarce and precious. Secondly, that experts with their elaborate tools and know-how are the only ones who can save nature by pricing it up and trading it off against other goods in the global marketplace. Thus far, none of the works by environmental economists I have read start with the question to their readers “what kind of nature conservation do we want?” They instead begin with, as Helm (2015) does, the notion that we cannot escape putting a price (money-value) on nature. A critical PE perspective on NC is informative in this regard. By critiquing NC from a critical PE perspective, questions that aren't being asked by most regarding the NC approach can be explored such as: who may be benefiting from NC being mainstream into conservation approaches? NC as a way of viewing nature and the economic approach to conservation being championed through it are currently popular in environmental conversation at
least in the United Kingdom. Developments around the NC concept and its place in approaches to SD and conservation deserve to be scrutinized for the sake of the possible improvements or detriments to well-being that it may have on current and future generations of humans as well as the innumerable other forms of life which we have the privilege of sharing the planet with.
6. Conclusion

There are many actions that can be taken which will benefit the environment where it is not necessary to have natural capital as something underpinning the approach. Environmental protection and nature conservation have been practised for many decades, and around the world we can find many examples of successful measures and endeavours resulting in the protection and restoration of certain environmental qualities (cleaner rivers), individual species, habitats, and degraded ecosystems. However, even with all of the past and present success stories concerning our environment, we are living against the backdrop of an unprecedented level of biodiversity loss, ecosystem service degradation, and unsustainable use of natural resources. Not only that, but with an global population exceeding seven billion and on its way to nine, the global demand for natural resources is going to grow to previously unknown levels. Not only will this likely place further pressure on the planet's previous ecosystems, it will also put their capability to provide services vital to our continued well-being in greater jeopardy.

All these developments taken into account, we can expect to see during the rest of 21st century the competition between nature and economic development continuing to play out on a vast scale. To some extent, what fertile land is left in the world yet to be exploited will be turned over to agriculture, and competition for coastal zones for urban development as well as for our oceans for fish will also grow to a greater or less extent. Much of this development of course is understandable and justified because it will occur with the purpose of meeting the needs of a speedily growing world population, and the many investments that will be made into infrastructure by governments and private businesses alike will make a return, social and financial. In many cases, nature is going to 'lose out'. It will disappear, diminish, be destroyed, but not all of it has to. In fact, at least as far as we know, we can't let this happen unless we do not mind things possibly turning really nasty by the end of the 21st century. We are going to have to do something then to stem nature's decline.

This is where natural capital comes into the picture for a number of environmental and ecological economists. Natural capital has a conceptual history going back several decades, to economists who were, at a fundamental level, concerned with the scale of impact human economic activity was having on the environment. During the 1970s, influential environmental treatise were written which proclaimed that human economic activity was heading in a direction that was unsustainable, that there were limits to growth, and that the scale of human economic activity needed to be reigned in. Unsurprisingly, around the same time, the term natural capital was coined to refer to the materials, resources, services and functions that nature provides to the economy, that man does not. So began the development of ecological economic thinking around the idea that there are elements of nature on which man not only depends but cannot do without. This is because no man-made substitutes exist for our environment's life-support systems. At the same time, a larger number of economists than had ever previously been the case, began to take more account of the environment in their analyses. From this, a sub-discipline of mainstream economics was formed which used the theory and methods of the neoclassical school to analyses environmental problems. Environmental economists focus their attention on environmental issues such as pollution emanating from factories to water and air, and resource economists in large work with calculating the optimal levels of exploitation of particular natural resources such as fish or oil.

It was not until the late 1980s and beginning of the 1990s, with the publication of Our Common Future and Blueprint for a Green-Economy, that the capital approach to sustainable development which natural capital is a central concept in, began to be seriously developed. Around the same time, the ecological economics movement was founded. Scholar mainly from the USA, UK, and Sweden, can be considered as being central in adding real substance to the concept of natural
capital and how it connects to sustainable development. Both ecologists and economists contributed to developing natural capital conceptually, in order to be able to adequately conceptualize the linkages and interdependencies existing between economies and the environment. Essentially, natural capital expands on the conventional economic notion of capital, which is broadly defined as the man-made means of production, such as machinery and tools. What is common between the forms of capital, including natural capital, is that they all can be considered as being a stock of 'something' that produces a flow (a cyclic yield) of valued goods and services. And, like with any other economic assets, we can decide to consume or delete natural capital today, or as an alternative, we can decide to save or even grow these economic assets to use in future instead.

As well as developing the concept of natural capital, ecological economists have also laid much of the groundwork concerning the concepts of sustainable development and environmental sustainability. Using the Brundtland definition of sustainable development as a starting point, the capital approach to sustainable development is an attempt to give an operational meaning to the concept of sustainable development. The capital approach assumes that sustainability requires maintaining capital at an suitable level, and also asks two fundamental questions connecting to making operational sustainable development. The first question is, can depletion of natural capital be compensated by accumulating one of the other forms of capital? And the second, if the answer is yes, how can we measure whether the amount of compensation being made is sufficient to guarantee sustainability? Attempts to answer these two questions has lead to sustainability being developed further on a conceptual level. In the economic approach to sustainable development, there are two ways in which sustainability is characterized. First, is the 'weak' sustainability paradigm, the foundations of which lie with neoclassical economic theory, and starts with normal assumptions in economics which in turn moulds the framework in which ecological and environmental concerns are evaluated. Second, is the 'strong' sustainability paradigm. 'Strong' sustainability gets more of its foundations from ecological science, and begins by assuming ecological imperatives which, in turn, provide the principles for the ensuing form of economic analysis.

'Weak' and 'strong' sustainability are fundamentally distinct from each other in terms of principles, but they too can be considered as being opposing paradigms. The key concern relating to both paradigms is what the conditions shall be for the capital stock. It is often thought to be the case that neoclassical environmental economists will favour 'weak' sustainability over 'strong' sustainability based upon the assumption under 'weak' sustainability that all forms of capital are assumed to be substitutable. 'Strong' sustainability on the other hand, appears to be more in-line with the preference of most ecological economists. Many ecological economists have tended towards favouring 'strong' sustainability, which, generally speaking, rules out substitutability between natural capital and other capital. A requirement under 'weak' sustainability is that the aggregate stock of all forms of capital is kept constant, while 'strong' sustainability requires that both the aggregate stock and that of natural capital be non-declining. The crux of the choice between the two sustainability paradigms is decided depending on the extent to which natural capital and man-made capital are believed to be substitutable.

'Weak' sustainability tends to be criticized for assuming substitution, and for giving no special role to natural capital in order for it's critical functions to be maintained intact. However, advocates of 'strong' sustainability tend to erroneously believe that 'weak' sustainability is 'anti-environmental', that it advocates the idea that natural capital is dispensable. In fact, both 'weak' and 'strong' sustainability require that the aggregate capital stock be maintained but the the latter also emphasizes the critical nature of natural capital. It is my own view that 'strong' sustainability
paradigm is therefore the more preferred paradigm concerning sustainable development. However, it is unrealistic and idealistic to believe that the only sustainable economy is one with a non-declining or ever increasing natural capital stock. The veritable issue happens to concern figuring out what is and what isn't substitutable, and why. Many economies are likely to already fail a 'weak' sustainability test, so getting economies on track in terms of them maintaining the aggregate capital stock is a good step in a sustainable direction. Satisfying the conditions necessary for sustainability under both the 'weak' and 'strong' paradigms requires that natural capital be measured as well as other capital stocks. Otherwise, how can we known whether stocks are declining or being maintained?

There has been a fair amount of real criticism levelled at the natural capital approach. A great proportion of this is directed at economic valuation as it is seen as a tool which 'prices' the environment. From a critical political-ecology perspective, a main issue with the natural capital approach to conservation has to do with it being uncritically received into approaches to nature conservation and the sustainable development agenda. To the critics, what the 'natural capital movement' really represents is a championing of neo-liberal conservation. It is an approach which is attempting to 'financialize' nature conservation mainly to benefit corporate and establishment actors, and the 'capitalists'. Under a 'natural capital regime', nature is to be further subsumed under man's dominion. The 'natural capital agenda' facilitates the move to creating and utilizing fantastical markets through which to transform nature to the status of commodity, where it can be marketed at its exchange values.

Ecological economists who are 'anti-growth', stress 'limits', and believe that the economy is a subsystem of nature, would likely challenge those who see natural capital as a way through which to pursue new opportunities for economic growth. There is perhaps a distinction to be made between on the one hand those who believe natural capital to be a concept that should be used to emphasize the 'strong' sustainability paradigm, largely the ecological economics camp, and on the other hand, mainly environmental economists who believe the environment is a part of the economy and can be properly integrated into it through natural capital. A number of scholars stress that ecological economics was initially a reaction against the neoclassical school because of its lack of ecological considerations. Therefore, ecological economists who stress the importance of pluralism in terms of economic paradigms, and are largely critical of the neoclassical paradigm (which has a large footing in the movement), might ask the question of whether working under the current economic paradigm is appropriate concerning our attempts to stem the decline of nature.

In a democratic society, there a many different actors with different views, and natural capital is just one of those many views about how environmental issues might be better dealt with. Natural capital is an attempt being made under the traditional capitalist paradigm, without any call for a fundamental rethinking of economic philosophy, approaches, or systemic issues that characterize it such as gross socio-economic inequities. In addition, there also exist different individuals and different cultures who both value different things and value things differently. How can moving to a 'natural capital world' where nature is 'monetized' and 'economized' be in any way accommodating of this fact? And, how does natural capital lead to a strengthening of public and open deliberation on environmental issues whilst at the same time making room for multiple actors voices and views?

Thus far, I have pointed to those who believe in natural capital more and to those who are sceptical and critical of it. That there exist such divergent views on natural capital will only likely see the debate over natural capital continue, particularly in the context of environmental conservation in the United Kingdom where the world's first natural capital committee has been established. It is my own view that much of the criticism directed at natural capital, in particular that bit which sees it as
putting a money-value on nature, is misguided. Natural capital developed as a concept through the
work of ecological economists trying to adequately conceptualize economy-environment
interactions. It may not be adequate in terms of being able to represent all the functions of
ecological systems, but no one concept is likely to ever fully succeed in this respect. However,
natural capital may serve under the current economic paradigm (which is likely to remain for the
foreseeable future), as a sure way of getting it to better account the huge dividends that stem from
nature's products and services. It may also serve as an ecological-economic concept that adequately
communicates to decision-makers and the business community that, for at least the rest of the 21st
century, a huge proportion of the world's population will rely directly on nature in pursuit of better
socio-economic opportunities.

The motivation for advocating natural capital and related concepts such as 'ecosystem-services' is
also liable to be interpreted by some actors as being purely about protecting the environment
because of the dominant part it plays in securing human well-being. Indeed, this is where some of
the criticism aimed at natural capital really appears to be misguided. Like many others, as an
advocate of natural capital, I want to stress that a key motivation for natural capital is also trying to
protect other species, their habitats, and ecosystems, for their own sakes. Neoclassical
environmental, ecological, or otherwise, economics has to have a substantial role in bringing about
environmental sustainability. Whilst some self-proclaimed champions of nature may have a hard
time stomaching the 'trade-off' philosophy of neoclassical economics, under many circumstances,
there is an inevitable trade-off between human well-being and conserving nature. This occurs
because what different actors and interest groups in society want, does not always coincide with
environmental sustainability, however much we wish it were the case. It is my own view then that
natural capital can aid us in making better informed decisions about the trade-off between people's
wants and desires and having more or less of nature, between sustainability and development.

Stating that the environment should be protected out right has likely run its course as a strategy for
conservation. The world has seen much economic-development in recent decades, and there lies
more promise in, advocating 'sustainable use' practices concerning environmental conservation than
proclaiming nature should be left alone. Sustainable use is one way of conveying that nature has
economic value, that maintaining natural capital a certain level of exploitation so as to not impair
its renewable capabilities, is in the long-term interests of all. There may be another fish species to
fish after one has disappeared, and we may be able to destroy a wetland there and create one here,
but 'socio-ecological systems' are much more complex than than, and beyond a certain threshold
they are unlikely to withstand such a 'smooth' approach to substitutability. Underpinning natural
capital is a powerful argument that says the environment must be demonstrated to have economic
value in order to compete with other developments such as agriculture or infrastructure projects.
Moreover, the environment's economic value has to be captured through the creation of institutions
that feed that economic value to those who make land-use decisions. However much we succeed in
'decoupling' the economy from the environment, inherent within the pursuit of sustainable
development are conflicts of interest arising from differing actor's differing needs, wants, and
priorities. Natural capital and sustainable growth are not 'silver-bullet' solutions that will see the
disappearance of conflicts of interest around development and conservation.

I view natural capital as a key part of ecological-economists pragmatic attempts to change and
improve the way economies are managed through better linking economics and the environment.
By conveying the economic value of the environment to decision-makers, we may be able to better
secure its protection from the economic-development agendas of governments and international
development agencies. I maintain a hopeful outlook for the 'natural capital approach' because of the
successful and progressive outcomes it may lead to in the context of environmental conservation. I
also hope that the ongoing debate about natural capital will continue, as this thesis is intended to be a contribution to that debate.
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