Conceptualising Ecological Sustainability: Issues, Values and Challenges

By

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Declaration

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Abstract

"The twin concepts of sustainability and sustainable development" (Hattingh 2001: 1) have been in international circulation (Hattingh 2001) for thirty years, and yet debate persists about both their meaning and implementation. Essentially, sustainability and its implementation in sustainable development are aimed at curbing our exploitation of the natural environment while endeavouring to share natural provisions more equally among the worlds' people. It is a conundrum, since sustainability and sustainable development seem to pull in different directions: how, in the context of a growing human population and hence rising demand, are we to reduce our extractions from the natural environment in order to conserve it, while simultaneously maintaining human wellbeing, requiring even greater extractions? Over time a few efforts have been made to conceptualise sustainable solutions, each proposing a different way forward. However, the world remains highly unequal and environmentally degraded. This suggests that, our attempts at sustainability/sustainable development maintain the status quo of a minimalist interpretation where we remain stuck in behaviours unsuited to a changed context. It is evident that sustainability has become a crucial consideration if we wish to safeguard our survival, and the survival of all other species. This said, meaningful action cannot be taken unless the full extent of social, ecological and economic issues is considered, and if the current perspectives on sustainability/sustainable development are critically assessed in terms of their suitability for intervening in our sustainability challenges. In this thesis, the cause of this situation "is explored from an ethical perspective" (Hattingh 2001: 1), and a few "proposals are made on a philosophical level" to "respond to the contested nature of these concepts", focusing in particular on what kind of an understanding of sustainability/sustainable development we need. Emphasis is directed toward internal "tensions" that shape different interpretations of sustainability, associated with different "ethical positions" (1) that can be taken with regards to questions that address (a) What is so valuable that we ought to sustain it? (b) Why is it so valuable that we ought to sustain it? (c) How should we go about sustaining it? (d) What are the criteria that denote when a state of sustainability has been achieved? Having briefly outlined where tensions are to be found, it becomes possible to show how models of ecologically sustainability can be differently understood. Specifically, the 'Brundtland Report' and the 'Caring for the Earth Report' are analysed as two influential policy documents subscribing to a strong and moderate anthropocentric stance to sustainability respectively. These reports are critically compared and contrasted with a more ecocentric approach, which characterises the field of deep ecology.

The emergent ecosystems services paradigm is also critically evaluated in order to ascertain whether it is sufficient for operationalising the premises of ecocentrism (the position that is supported in this thesis as appropriate for affecting sustainable change). Lastly, alternatives to the ecosystem services paradigm, aimed at overcoming its identified weaknesses, are also briefly considered to pave the way towards more sustainable interventions.

Abstrak

Alhoewel die nou verbonde idees van Volhoubaarheid en Volhoubare ontwikkeling al vir die afgelope dertig jaar internasionale erkenning ontvang het, word daar steeds debat gevoer oor beide die betekenis en implementering van hierdie terme. Volhoubare ontwikkeling en die implementering daarvan, is daarop gemik om die uitbuiting van ons natuurlike omgewing te bekamp, en terselfdetyd te verseker dat natuurlike hulpbronne meer eweredig verdeel word. Hier kom ’n teenstrydigheid voor, met ander woorde, hoe kan ons binne die konteks van ’n groeiende beVolking, en geVolglik, ’n stygende aanvraag, ontrekkings uit die natuurlike omgewing verminder sodat dit bewaar kan word, terwyl ons terselfdetyd menslike welsyn probeer handhaaf? Met die verloop van tyd is daar al ’n paar pogings aangewend om met Volhoubare oplossings vorendag te kom, elk met ’n verskillende rigting vir die pad vorentoe. Die wêreld bly egter steeds baie ongelyk en die omgewing word steeds stelselmatig vernietig. Dit dui daarop dat ons pogings vir Volhoubaarheid / Volhoubare ontwikkeling bloot die status quo handhaaf van ’n minimalitiese interpretasie, waarin ons vasgevang bly in gedragspatrone wat nie aanpas by die veranderende konteks nie. Dit is duidelik dat Volhoubaarheid ’n belangrike oorweging geword het as ons ons oorlewing en die oorlewing van alle ander spesies wil beskerm. Nietemin, kan betekenisVolle aksie nie geneem word tensy die Volle omvang van sosiale, ekologiese en ekonomiese kwessies oorweeg word nie, asook om die huidige perspektiewe op Volhoubaarheid/ Volhoubare ontwikkeling krities te evalueer in terme van hul geskiktheid om te kan ingryp by ons Volhoubaarheidsuitdagings. In hierdie tesis word die oorsaak van hierdie situasie vanuit 'n “etiese perspektief ondersoek” (Hattingh 2001: 1) en 'n paar "voorstelle word op filosofiese vlak gemaak", om te reageer op die betwiste aard van hierdie konsepte, veral oor watter soort begrip van Volhoubaarheid / Volhoubare ontwikkeling vir ons betekenisVol is. Klem word gelê op interne "spanning" wat lei tot verskillende interpretasies van Volhoubaarheid, spesifiek die wat geassosieer word met verskillende "etiese posisies" (1) wat geneem kan word met betrekking tot vrae wat aanspraak maak (a) Wat is so waardeVol dat ons dit behoort om dit te onderhou? (b) Waarom is dit so waardeVol dat ons dit onderhou moet word? (c) Hoe moet dit onderhou word? (d) Wat is die kriteria wat aandui wanneer 'n toestand van Volhoubaarheid bereik is? Nadat daar kortliks uiteengesit is waar die spanning gevind word, word dit moontlik om te bewys dat modelle van ekologiese Volhoubaarheid anders verstaan kan word.

Die 'Brundtland Report' en die 'Caring for the Earth Report' word spesifiek ontleed word as twee invloedryke beleidsdokumente wat onderskeidelik, 'n sterk en matige antroposentriese houding teenoor Volhoubaarheid beklemtoon. Hierdie verslae word krities vergelyk en in teenstelling geplaas met 'n meer ekosentriese benadering, wat die veld van diep ekologie kenmerk. Die opkomende paradigma vir die ekosisteemdiens word ook krities geëvalueer om vas te stel of dit Voldoende is om die perseël van ekosentrisme te operasionaliseer (die posisie wat in hierdie tesis ondersteun word, as toepaslik om Volhoubare verandering te bewerkstellig). Ten slotte word alternatiewe roetes vir die paradigma van die ekosisteemdiens, wat daarop gemik is om sy geïdentifiseerde swakhede te oorkom, kortliks oorweeg, om die pad na Volhoubare intervensies oop te maak.

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Table of Contents

Motivation for this study

It has been almost 60 years since Rachel Carson published her eye-opening work *'Silent Spring*' (1962), which revealed the detrimental consequences that the use of pesticide has on birdlife; and 45 years since Arne Naess first communicated his thoughts on deep ecology with the publication of '*The Shallow and the Deep, Long-Range Ecology Movements: A Summary*' (1973). Both of these are examples of publications that highlighted a pressing need to preserve the natural world, giving rise to the idea of sustainability. Around 30 years ago, the concept of sustainable development was added to this discourse, introducing a dimension of social equity to the need for environmental conservation.

However, despite the emergence of these "twin concepts of sustainability and sustainable development" (Hattingh 2001: 1), the world remains a highly unequal (Swilling and Annecke 2012), environmentally degraded place (MEA 2005; Constanza *et al.* 2017), where the loss of ecosystem health (MEA 2005) that supports not only life, but all our economic and social activities, continues apace. Add to this the confluence of "ecosystem degradation, global warming; oil peak; inequality; urban poverty food insecurity" (Swilling and Annecke 2012:28), and the seemingly limitless quantity of raw materials we continue to extract from our natural environment, and we arrive at what Morin (1999) term a 'polycrisis[1]', all of which combine to make our world unsustainable (Swilling and Annecke 2012; Hattingh 2014)

Consequently, in basic terms, the quest for sustainability and its implementation in the form of sustainable development, is aimed at "curbing our exploitation" (Hattingh 2001: 4) of the natural environment while, at the same time, endeavouring to more equally share what our natural environment provides among all peoples of the world.

[1] A polycrisis denotes a complex situation in which there is not a single problem, but multiple, interconnected and converging problems which influence, react to and can reinforce each other. See Morin (1999).

It is a conundrum, since sustainability and sustainable development seem to pull in different directions: how, in the context of a growing human population and hence rising demand, are we to reduce our extractions from the natural environment in order to conserve it, while simultaneously raising and maintaining levels of human wellbeing, especially the poor, and the wellbeing of all other species?

Over time a few efforts have been made to envision, or conceptualise, sustainable solutions to this conundrum. However, each proposes a different way forward, retarding implementation of sustainable solutions. In effect, it seems that what our attempts at sustainability/sustainable development have achieved until now is to leave things unchanged), by adopting a "minimalist" (Hattingh 2001: 9) model of sustainability. A "minimalist" (9) model adheres to an instrumental view of the natural world, in terms of which the natural world is to be used to serve human ends with little regard for the health of the natural world. The mode that has been dominant until now equates "sustainability with survival" (Hattingh 2001: 10). It has done little to change the current unsustainable situation of skewed resource distribution between rich and poor, and heavily extractive, polluting and wasteful economic structures.

This model thus leaves existing socio-economic structures unchanged (Hattingh 2001), which perpetuate the problems of environmental degradation and social inequality. Furthermore, this paradigm perceives the natural world to be without value other than its utility to humankind, in terms of the extraction at the least cost to produce goods at a profit, or to provide critical services essential to human survival and wellbeing. In this way, it adopts a very narrow view of what constitutes value. In this context, value is assumed to be either instrumental or financial.

Leaving unsustainable socio-economic structures unchanged, and failing to allocate value to the natural world, suggests that a minimalist model of sustainability/sustainable development is of little service to humankind in the long run, and of even less service to the natural environment. It might also go some way to explaining why, 30 years after we became aware of a need for sustainability/sustainable development, we are still stuck in behaviours unsuited to a changed context. The question arises as to *how* do we truly engage with the ecological and social realities facing us, to the extent that we are able to move beyond a minimal understanding? Which interpretation of sustainability/sustainably development do we need?

Hattingh argues that our current reality necessitates a move toward a more "radical" (2001: 7) understanding of sustainability/sustainable development, in which humankind faces the question of "what it means, in concrete terms, on a personal, institutional, national and international level, to live within the limits of supporting ecosystems, to work towards a fair distribution of resources in the world, today and in the future" (2001: 20). Additionally, answers to this question would also have to determine "what weight we should give to environmental protection, the integrity of nature and quality of life in our thinking about social, political and economic development" (20).

With this in mind, confusion as to what sustainability/sustainable development mean in practical terms seems to be an obstacle holding humankind back from transitioning to more sustainable ways of life. However, I would like to also claim that "*values"* (Hattingh 2001: 7) play a vital role in this state of affairs, particularly when deciding what importance should be given to environmental protection and the integrity of nature. I would argue that underlying fundamental change is a widening of our perception of the value of the natural environment beyond the instrumental and the financial.

When debating the meaning of sustainability/sustainable development mean, a primary question has to with what it is we are trying to sustain? Is it human life, or life in general, which includes non-human life? Tension arises from the goal of human survival negatively influencing the integrity of nature. For example, the use of the natural provisions required to sustain and elevate the quality of human life can impose negative consequences on the protection, and health, of ecosystems. The converse is also true, where the maintenance of the integrity of nature, under current socio-economic structures, generates opportunity costs for human survival and quality of life (Hattingh 2001).

These tensions can be visualised to exist between different poles in approaches toward sustainability/sustainable development. At one pole is a minimalist (or weak) perspective, in which sustainability/sustainable development is equated with basic human survival. Such a position falls short of addressing "the goals of quality of life" (Hattingh 2001: 9) and consequently neglects the needs of current as well as future generations, and the conservation of the "integrity of nature" (2001: 10).

Such opposing conceptions can be found along an imaginary "continuum of possible options between the two polar extremes" (Jacobs 1999: 25-31), and can be identified on a range of weak to strong, or anthropocentric to ecocentric (Hattingh 2001). Each position is representative of how each approach proposes to resolve the internal tensions discussed. This often places anthropocentrists and ecocentrists in the debate about the meaning of sustainability in a position of confrontation with one another (Jacobs 1999). These poles can be imagined to exist at either end of a spectrum, or scale. At one end is a minimalist or weak interpretation of sustainability.

A stronger, more ecocentric interpretation of sustainability/sustainable development that emphasises sustaining all life, and the quality of life, lies at the other pole. To do so requires the protection of whole ecosystems and suggests the allocation of intrinsic value to the natural world. Such an interpretation is fundamental to an ecological understanding of sustainability, as Hattingh (2001) points out. Without the healthy functioning ecosystemic nature, there can be no survival, or wellbeing, of humankind (and other forms of life) left to speak of.

Our environment is profoundly valuable to us, as without it we could not survive on a primary biological level, and subsequently neither on social or economic levels. For these reasons it has value. This is an instrumental interpretation, where the environment is valued in terms of what it can do to meet human wants and needs. The idea of intrinsic value, however, proposes that the non-human life forms that make up our biotic community, mammals or ecosystemic communities for example, possess inherent value that is not conferred on them by humankind. Intrinsic value arises from the proposal made by environmental ethics that 'value' (Rolston 2006: 50), outside of the instrumental considerations, exists in nature. Biology is at the basis of the question of intrinsic value as: "Biological conservation is innate, as every organism conserves and values its life" (Rolston 2006: 51).

This desire *to conserve and value their own lives* suggests the presence of intrinsic value. Ecosystems are systems that support vital speciation and life support of all their component members (Rolston 2006). Ecosystems produce and maintain vital biodiversity. These processes, Rolston proposes, are what is valuable. While the outcomes of these processes can be valued instrumentally, such as the provision of fresh water, Rolston proposes that on another level, it is the very "productivity of these ecosystems bringing into existence these phenomena" (2006: 60), expressed as biodiversity (which includes humankind), that can be valued intrinsically. For a more detailed explanation, please see Holmes Rolston III 'Intrinsic Values on Earth: nature and nations' (2006) and 'Value in Nature and the Nature of Value' (1993).

Problem statement and study aims

Given the above findings, it is evident that sustainability/sustainable development have become a crucial consideration if we wish to safeguard our survival and the survival of all other species. That said, meaningful action cannot be taken unless the full extent of social, ecological and economic issues is considered and the current perspectives on sustainability/sustainable development are critically assessed in terms of their suitability for intervening in our current sustainability challenges.

A standard Concise Oxford Dictionary reference to the verb 'sustain' explains that it is "to keep something going over time, continuously" (Concise Oxford English Dictionary 2011: 1452). However, the concept of sustainability/sustainable development evidently also contains "qualitative elements" (Hattingh 2001: 8) that involve "answers to value questions that cannot be deduced from a quantitative concept of sustainability/sustainable development alone" (Achterberg 1994a: 36 in Hattingh 2001: 8). This is because the core ideas of sustainability and sustainable development challenge us to make certain choices. These choices are based on assumptions of where value lies (Achterberg 1994; Hatting 2001). "It is important to highlight these questions, as well as divergent answers to them" (Hattingh 2001: 8), as they reveal that there are "moral dimensions" (2001: 8) to the concepts of sustainability and sustainable development.

According to Achterberg (1994), there are four vital questions we should ask of any conceptualisation of sustainability in this regard. These questions are:

1. What is so valuable that we ought to sustain it?
2. Why is it so valuable?
3. How should we go about sustaining it?
4. What are the subsequent criteria that would then denote when a state of sustainability/sustainable development has been reached?

(Achterberg 1994a: 36 cited: 36 cited in Hattingh 2001).

Hence, our values require "ethical choices" (Hattingh 2001: 14), and are vitally important to informing conceptions of sustainability/sustainable development. In light of the above, this thesis will critically explore the meaning of the concepts of sustainability/sustainable development housed in current paradigms put forward to deal with social, ecological and economic sustainability, through the lens of the values though which they are interpreted.

Specifically, the 'Brundtland Report' and 'Caring for the earth' are analysed as two influential policy documents subscribing to a strong and moderate anthropocentric stance to sustainability respectively. These reports are critically compared and contrasted with a more ecocentric approach, which characterises the field of deep ecology. The emergent ecosystem services paradigm is also critically evaluated to ascertain whether it is sufficient for operationalising the premises of ecocentrism (the position that is supported in this thesis as appropriate for affecting sustainable change).

Lastly, as our current models of sustainability/sustainable development seem to fall short of desired goals, alternatives to these paradigms, aimed at overcoming their identified weaknesses, are also briefly considered, to pave the way towards more suitable interventions. These offer some suggestions as to what kind of conceptualisation of sustainability/sustainable development we need.

Given that human behaviour is responsible for bringing about the unsustainable state we find ourselves in, the suggestion is made that human behaviour in general needs to change, in order to adapt to a densely populated world bound by natural limits.

Since our behaviour is informed and shaped by our values, this would require a shift in what we value away from an instrumental view of nature, toward values that are much less harmful to the natural environment and more socially just.

Healthy ecosystems provide all that is necessary to sustain life on earth. The fundamental premise of an ecological interpretation of sustainability is that without ecological health, the continuance of all life on earth will incrementally be jeopardised. Hence not harming nature should be a fundamental value of ours.

Social justice highlights the disparities between rich and poor (social inequity), where the former consume too much, ever drawing more from natural systems already at the limit of their capacity. Meanwhile, the latter consume too little and exist in a state of poverty. Social justice therefore highlights the need to reduce poverty by ensuring a more equal distribution of wealth and opportunities in a society, whereby each member receives a fair share. Conserving the healthy functioning of the natural world is linked to social justice, as climate change and ecosystem degradation exacerbate poverty. For example, the drought, floods, sea level rise, extreme temperatures, inadequate fresh water and loss of arable land associated with climate change will affect the poor disproportionately.

Since the poor lack the financial means to satisfy their immediate needs, they will suffer first and suffer the most, a situation that is ethically intolerable. Conflict over dwindling resources is also a cause of mass migration, violence and war. Additionally, it is difficult to protect the environment without social justice. Those who live in the rural areas of developing countries tend to be marginalised, confined to farming less fertile agricultural land with a lack of infrastructure and access to markets. Households in such situations tend to be caught in a cycle of increasing poverty and worsening ecological degradation. To eradicate rural poverty therefore, and prevent environmental degradation by rich and poor alike, requires a high degree of social justice, this is why it is a core value of sustainability.

This suggests that a sustainable framework would require structural changes within society and radical changes in our economies, “to achieve an enduring solution to our environmental problems, or at least to create a situation in which they can be controlled” (Achterberg 1994b in Hattingh 2001: 4). What follows is a clarification of the concepts with which we approach the conundrum: What do sustainability and sustainable development mean?

Chapter structure

The discussion takes place over three chapters. As a starting point, chapter one begins by briefly tracing the history of the emergence of the concepts of sustainability and sustainable development, which stem from the 1970s. This gives a necessary background to the discussion that follows in which each of the three aspects of sustainability, namely environmental, economic and social aspects, are described separately and in detail, including the seven related predicaments pointed out by Swilling and Annecke (2012). The discussion illustrates the complex relationships that exist between these three dimensions of sustainability, showing how they mutually relate to, influence but also in some instances contest, one another.

Building on this background of the problems that make our modes of living unsustainable, the second chapter undertakes a values analysis, based on Achterberg's (1994) four questions, of three prominent conceptualisations of sustainability and sustainable development. The most prominent among these is perhaps the definition of sustainability/sustainable development that emerged from 'Our common future' (World Commission on Environment and Development 1987), also known as the Brundtland Report, but there are also others, such as 'Caring for the earth' (IUCN, UNEP, WWF 1991) and the theory of deep ecology.

In each of the three conceptualisations, the focus will be on different interpretations that have been given to these four value assumptions; the conceptions of sustainability/sustainable development that have come about as a result; and how they detract, or add to, the conversation on sustainability/sustainable development. While these three conceptualisations are not exhaustive of all interpretations on the subject, they usefully illustrate a spectrum of interpretations of sustainability/sustainable development, ranging from weak to strong sustainability, or, viewed another way, from an anthropocentric to an ecocentric interpretation.

What emerges from the analysis is that, whereas each conception differs, there are also areas where they could positively learn from one another. However, they all seem to fall short in some way. This leaves us without an interpretation of sustainability/sustainable development that shows respect for the natural environment, while also ensuring the wellbeing of all humankind, and one that is practically implementable.

In this regard, and as a next step, an ecosystem services paradigm has emerged as a powerful new concept that attempts to integrate sustainability criteria that recognise a relationship between human social systems and ecological systems.

Chapter three focuses on the ecosystem services paradigm, again exploring it by means of Achterberg's values analysis. What becomes apparent is that it both expresses essential support for the principle of respect for life in general, and suggests the management of ecosystems within biological thresholds. However, it does not specify what ecosystems should be managed for, leaving this open to interpretation and to potential environmental exploitation. This ambiguity, coupled with our current inability to pinpoint exactly where ecosystem thresholds lie, proves to be this paradigm's weakness. This leaves us with the question: what kind of conceptualisation do we need?

In conclusion, I would like to put forward a few practical proposals how ecological sustainability and sustainable development could be implemented.

Chapter One

1. Introduction

Chapter One introduces the concept of sustainability, and shows how a call for sustainability arose in response to environmental degradation brought on by human economic activities. Later, it grew to acquire an equally important social aspect, based on humankind's total dependence on the natural environment. Consequently, the concept of sustainability comprises three primary aspects: environmental, economic and social (Goodland and Daly 1996). However, a fixed and universal understanding of sustainability remains elusive since each aspect of sustainability opens it up to a variety of contextual and often conflicting meanings, rich with a "matrix of values" (Rolston 2017: 38).

Hattingh (2001) argues that the controversy that lies at the crux of the definition is the relationship between humankind and nature and the value nature has in that relationship. For example, for those for whom the natural environment is most important, the emphasis will be placed on its preservation. This, by contrast, conflicts with those who emphasise sustainable economic growth, fuelled by the extraction and use of raw materials found in the natural environment, while those who favour a social emphasis will prioritise the sustenance of the environment as a basis to serve human wellbeing. Those who argue for sustainable economic growth hold the continual increase in the production of goods and services to be sold at profit to be the most valuable. Economic growth refers to a continuous cycle where goods are sold that generate profit for a business, which gives companies financial capital to invest in hiring more employees and growing these companies. This creates more jobs, which raises income and gives people the power to purchase more goods and services, thus generating more economic growth.

In an attempt to arrive at a general understanding, the World Commission on Environment and Development (WCED) released a report entitled 'Our Common Future' (1987), also known as the Brundtland Report, after then chairman, Gro Harlem Brundtland. The report describes sustainable development as "development that meets the needs of present generations without compromising the ability of future generations to meet their needs" (1987: 43).

Although not without criticism (Swilling and Annecke 2012; Hattingh 2001), this definition has emerged to become what is arguably the most prominent (Jacob 1994) definition of sustainable development (Hattingh 2001; Porritt 2006; Bartelmus 1994; Gallopin 2003), and provides a base to work from.

With this in mind, this chapter opens with a concise account of how a quest for sustainability and sustainable development arose. It then goes on to discuss each aspect of sustainability – environmental, economic and social – separately and in detail, showing how they came about, what they aim to achieve and how they influence each other. In particular, the discussion notes seven related predicaments as highlighted by Swilling and Annecke: "ecosystem degradation and biodiversity loss, global warming, oil peak, inequality, urban poverty, food insecurity and material flows" (2012: 27-28), that when combined, converge to make the world we live in unsustainable. Collectively, they are what motivate a quest for sustainability.

Based on a realisation that we are an integral part of, and dependant on, the natural world, the chapter concludes by suggesting that this underly a shift from a sense of separation and domination of nature, toward one of integration, respect and conservation. Consequently, although humankind must impose on the natural world to ensure our wellbeing, the question a call for sustainability poses is one of limit – where should the imposition stop? Ecological science tells us that biological limits exist and need to be observed in order to conserve the health of the natural world.

Such a shift would thus find expression in behavioural change necessary to observe such limits. The need for adherence to biological limits is reinforced by the additional proposal that non-human life possess intrinsic value (that is, value independent of their utility to humankind). This necessitates its preservation, as far as possible, through strict adherence to such limits. However, to do so requires a curbing of human exploitation of the natural world, necessitating a restructuring of the current organisation of our economies and societies.

2. How the concepts of sustainability and sustainable development came about

Briefly, "two distinct historical contexts" (Hattingh 2001: 4-5) led to the emergence of, firstly, ideas about sustainability, later followed by ideas regarding the development of a sustainable path forward, or sustainable development (Hattingh 2001).

The former has to do with biophysical limits that exist in nature and that cannot be exceeded without causing systemic ecological change. The latter has to do with ideas about distributive justice and development (2001).

At times the two contexts can be complementary: human society, its economy and its developmental paths are dependent on healthy, functioning ecosystems to sustain them, but they can also be in conflict. This applies to a situation where the biological limits of ecosystems are not adhered to, creating a condition where what the natural world provides us with is consumed at such a rate (and so unfairly) so as to degrade ecosystems. This leaves little for future generations. It also unfairly distributes natural provisions among current generations. The conflicting needs of reducing our extractions from ecosystems to prevent degradation and ensure the provision of natural benefits for future generations, while raising the wellbeing of the poor, requiring even greater levels of extraction, leads to tension in understanding and implementing, sustainability and sustainable development (Hattingh 2001).

The first context, an awareness of biological limits being exceeded, "arose in the 1970s" (Hattingh 2001: 5). It emerged as a result of the realisation among developed (industrialised) "Western nations that industrialisation and patterns of production and consumption associated with it seriously jeopardised the continued existence of a safe, healthy, clean and diverse environment" (2001: 5), and were not sustainable. Sustainability, in this regard, came about as a means to introduce an environmentalist perspective into economics (Dresner 2002).

Influential publications that brought this realisation about include Rachel Carson's '*Silent Spring*' published in 1962, which warned against the overuse of pesticides in agriculture (pesticides are poisonous, unintended exposure to them cannot be completely contained, and where exposure to them occurs, the results can have toxic, or lethal, repercussions for human and non-human health). In 1968, biologist Garrett Hardin published an article on '*The tragedy of the commons*' pointing out that freedom in the commons, that is, open access resources with no regulation on their use, leads to ruin for all.

The commons refer to a shared resource that no one owns or is exclusively entitled to. For example, the earth can be thought of as a global commons, with shared global resources that no single person or nations owns, and that are shared by and necessary to the wellbeing of all. The tragedy of an unregulated use of the commons is incurred when independent individual users act in their own self-interest to gain personal benefit, but which harms others who are denied the common benefits.

This is contrary to the common good of everyone. Rolston (2006). In 1972 the Club of Rome published the Meadows Report" (Meadows, Meadows, Randers and Behrens 1972) with the self-explanatory title of *Limits to Growth*" (Hattingh 2014: 225).

Focusing on "world population, resource use, food production and industrialization" (Robinson 1992: 22), 'Limits to Growth' predicted that current economic growth trends point toward a world that is "fast running out of the resources" (Jacob 1994: 482) required for economic growth, and would eventually run out. Optimistically, it also suggested that these trends could be halted, or turned around, in preference of a world that is enduringly ecologically and economically sustainable. In the same year, the United Nations responded by establishing the United Nations Environment Programme (UNEP) which followed with a publication of its own, the 'World Conservation Strategy' (IUCN, UNEP and WWF 1981).

To confront these various problems, the proposed way forward seemed to lie in introducing structural adjustments to the economy and in human lifestyles, where consumption and wastage would be reduced to reach "a state of equilibrium in which material growth is halted" (Hattingh 2001: 5), while services that create a higher quality of life such as education, health care and cultural and recreational activities, would be augmented (Hattingh 2001). The steady state economy proposed by Herman Daly (1973) is an example of this.

These economic and lifestyle adjustments encompassed the understanding that what is provided by the natural environment, which from an economic perspective translates into environmental 'resources', should be managed, and that this should be done so as to ensure that what the natural environment provides us with, namely environmental 'benefits' (Constanza *et al.* 1997) could be maintained and extracted from those natural sources over time.

An example of an economic and lifestyle adjustment would be the introduction of extreme efficiency of water use, and the recycling and purification of all water used in domestic and industrial contexts. New environmental awareness took on the broad term of "sustainability" (Hattingh 2014: 236) in the 1980s. Its basic idea was to decrease the human impact on the natural environment while still managing to secure the multiple ways in which it provides for humankind.

Concurrently, in response to the degradation of the natural environment, the United Nations convened a series of conferences about the environment and development, the first of which was held in Stockholm in 1972 while the most recent one, the 2005 World Summit, was held in New York. "A number of reports have emanated from these conferences" (Hattingh 2001: 5), of which the most significant are the 'World Conservation Strategy' (1981), 'Our Common Future' (1987) and 'Caring for the earth: a strategy for sustainable living' (1991).

These conferences also gave poorer, less developed countries a chance to voice their frustration with what was seen as a Western preoccupation with the natural environment and what the" essential environmental policy toward it should entail" (Hattingh 2001: 5), while neglecting the greater impact that environmental decline holds for the poor, as well as the real inability of these countries to engage in poverty-eradicating developmental paths (Hattingh 2001; Swilling and Annecke 2012).

From this arose ideas of development encompassing fair and "equal access to the natural resources of the world" (Hattingh 2001: 5) (equity) for all those currently living (intra-generational justice) and future generations yet unborn (inter-generational justice), as fundamental to sustainability and sustainable development. It is an important distinction: the first context called for limits to the extractive and exploitative attitude toward the natural world, the second called for "development, (in particular for the poor) within the physical limits of the ecological systems of the earth sustaining it" (2001: 5). This distinction recognised an emerging social aspect to sustainability/sustainable development.

It is within this latter context of the need for greater equity to alleviate poverty, that the Brundtland Report (WCED 1987) devised its definition of sustainable development, which states that "sustainable development is development that meets the needs of present generations without compromising the ability of future generations to meet their needs" (1987: 43).

It recognises both the environment and equity as factors in sustainable development, but while maintaining a substantively anthropocentric approach. The Brundtland Report retains an anthropocentric approach by nominating human life as the highest value that ought to be sustained, while ignoring all other forms of life. It thus views the needs of humankind to be paramount and nature is considered a resource, only of instrumental value. See section 4.1. The Brundtland Report: What is so valuable that we ought to sustain it? for a more detailed explanation.

Moreover, it acknowledges the "inter-generational" (Hattingh 2001: 7) equity of sustainability and sustainable development, showing that it applies to the lives and rights of current as well as future generations. Consequently, we also came to speak of sustainable development, which is seen as development that promotes that improves the "*quality of life*" (Hattingh 2001: 8) of current generations but while expressly observing finite ecological and resource boundaries, so that future generations may enjoy the same quality of life.

Humankind and the societies into which it organises itself are dependent on the environment, and are part of a greater ecosystem that, on a biological level, sustains all life (Meadows *et al.* 1972; Lovelock and Margulis 1974, 1979; Capra 1996; Constanza *et al.* 1997; Porritt 2006; Swilling and Annecke 2012). Given this humankind's dependence on what the natural environment provides for survival, Hattingh, argues that environmental benefits are therefore a form of social benefit and without the healthy functioning of the natural environment, there will be no societies to speak of and fight for. So, from a social point of view, the two are inextricable. Society (and in that we include the economy) is dependent, and predicated, on the existence of a healthy, functioning natural environment.

The idea of sustainability thus began as an environmental movement concerned with the question of the limits to human-induced environmental impact (Elkington 1998; Hattingh 2001). This was augmented to include social aspects, based on the recognition of a dependant relationship between humankind and the natural environment (Hattingh 2001). Thus, sustainability/sustainable development has three primary aspects: economic, social and environmental (Goodland and Daly 1996) and is broadly discussed in these terms. Although these three aspects of sustainability are linked (1996), each is also a field in its own right and can be discussed separately. Each however, has sustenance of something as its end goal (Hattingh 2001).

Broadly, sustainability refers to "the capacity for continuance into the long-term future" (Porritt 2006: 21). However, beyond this sustainability/sustainable development is a contested, ambiguous and controversial concept, and as such is open to a variety of contextual, and often conflicting, meanings (Dresner 2002; Wackernagel and Rees 1996; Gallopin 2003; Hattingh 2001).

For example, the Oxford Dictionary describes the noun, sustainability, as 'conserving an ecological balance by avoiding depletion of natural resources' (*Concise Oxford English Dictionary* 2011: 1452). Sustainability, at least in this sense, means to endure, on an ecological basis. It implies the indefinite perpetuation of natural resources, and is an ecological definition.

By contrast, an economic definition, according to current neo-liberal economic theory, would require constant economic growth to be sustained, based on a throughput of resources extracted from the environment, which interferes with the natural ecological balance (Porritt 2006). There is also a social definition which addresses the questions of what constitutes a decent human life, and what constitutes social and environmental justice. Sustainability means meeting those physical and emotional requirements (Dresner 2002).

However, that something is a "contestable" (Hattingh and Attfield 2002: 69) concept (open to interpretation), "does not mean that it has no meaning at all" (Dresner 2002: 3). A view, supported by Meadows *et al.* (1972), is that while there is vagueness and disagreement as to what sustainability means, the concept "will become clearer as people learn a new environmental language" (Dresner 2002: 3). Meadows and colleagues propose that because we have never before had to deal with a congested world and environmental limits, we consequently don't have the vocabulary for it (Dresner 2002).

It is also relevant to distinguish between sustainability and sustainable development. The "two concepts" (Porritt 2006: 21) are often used "interchangeably" (2006: 21). However, Porritt maintains that they are distinct, and sustainable development (however development is to be defined) is to be understood as the "process by which we move towards sustainability" (21), or implemented.

The traditional neo-liberal economic view conceives of sustainability as being about economic growth and industrialisation (Porritt 2006; Hartwick and Peet 2003), while others consider it to be more about the "non-material improvement of life" (Dresner 2002: 63). Here an additional question arises: Whose life? Does it apply exclusively to human beings (an anthropocentric perspective) or to life on the planet (an ecocentric perspective) (Hattingh 2001)?

Definitions of sustainability are further confounded by each of its three aspects being subject to interpretation and bereft of a single, universal meaning. Blewitt (2008) notes that a primary obstacle to developing a universally accepted framework designed to address the ecological, economic and social aspects of sustainability, is the "lack of consensus among experts in *each discipline* as to how ecological, economic and social systems relate to one another" (2008: 28).

In addition, sustainability is not an "ideologically neutral" (Hattingh 2001: 10) concept, and, depending on where value is placed, there are a number of ideological approaches, or interpretations (2001: 11), to the understanding of the concepts of sustainability and sustainable development. Each is informed by different values and constitutes a unique approach (Lélé 1991; Hattingh 2001; Gallopin 2003; Blewitt 2008), contributing to what Blewitt calls a "global dialogue" (2008: 27) and showing that the definition of the concepts is far from closed.

In this regard, Blewitt, drawing on the work of Blake Rattner (2004), suggests that the most suitable approach to concepts of sustainability and sustainable development is "a dialogue of values" (Blewitt 2008: 27). This is explained as follows: "different individuals, communities, pressure groups, institutions and governments are likely to view sustainability and sustainable development from different perspectives" (2008: 27). The question of values is important, as what is considered valuable will, inevitably, be sustained (Hattingh 2001). Consequently, sustainability (and sustainable development) has been variously defined by different parties to justify divergent intentions and outcomes. Buried within these assumptions are values that determine what is important and should be prioritised.

The Brundtland Report, in an attempt to approximate clarity and universality, gives us a starting point in its suggested definition of sustainability/sustainable development. It implies that sustainability/sustainable development are necessary to meet human needs diminishing environmental problems.

We have also seen that sustainability/sustainable development consist of three aspects, and that all three need to be equally considered. A word on the choice of vocabulary: where the natural environment is conceptualised in terms of a 'resource' it takes up an economic framing. The danger of this framing, which also extends to the notion of 'natural capital', another term that appears frequently in discussions about sustainability/sustainable development, is that it evolved in a context that does not consider the larger natural systems of which all beings but, not only humans, are a part, and which are essential to the survival and wellbeing of all.

Consequently, while economic terms are useful as communication devices that are well understood at levels of policy and commerce, their use risks perpetuation of the perception that the natural environment, and all non-human forms of life within it, are separate from humankind and have little value beyond their utility. This subsequently condones their exploitation. These issues of conceptualisation and language are important, and are addressed in greater detail in Chapter Three. To better illustrate this point, their use will be retained here and in Chapter Two.

3. Environmental aspects of sustainability

The word 'environment' is used here in its scientific sense. It refers to the totality of the biosphere, which is the sum of all ecosystems: atmosphere, oceans, climate and soil, which together operate as a feedback system whose purpose it is to maintain an ideal environment that makes life on this planet possible (Lovelock and Margulis 1974, 1979; Hawken *et al.* 1999). The components of this system incorporate a complex of all living species, atmospheric (climatic) and geological elements and their mutual interaction. See Johnson *et al.* (1997) and Landy (1979) for a more detailed explanation.

3.1 Natural capital

When natural provisions we receive from the environment are formally spoken of, they are not often referred to as gifts from Gaia, but more commonly as "natural capital" (Constanza *et al.* 2007). Natural capital refers "the sum total of the ecological systems that support life, different from human-made capital in that natural capital cannot be produced by human activity" (Hawken, Lovins and Lovins 1999: 151).

The earth's natural capital, being part of a system, is more than a catalogue of the resources it offers humankind. It comprises all the biotic and abiotic components of the earth, oceans and atmosphere, and the relationships between them, the maintenance of whose integrity is vital for their ability to self-regulate and to continue producing.

Natural capital is thus an all-encompassing term, and is commonly utilised in discussions regarding environmental sustainability, and sustainability in general. The term 'capital' borrows conceptually and linguistically from economics, capital being traditionally thought of as "accumulated wealth in the form of monetary investments, factories and equipment" (Hawken *et al.* 1999: 4), that delivers a form of income or dividend. In this context 'natural capital' becomes an analogy for "any stock of natural assets that yields a flow of valuable goods and services into the future" (Wackernagel and Rees 1996: 35). It also includes the less visible natural resources, such as the waste sinks needed to digest the by-products of industrial activity and which support economic activity.

Natural capital is not the only stock from which humankind draws a sustainable flow of services for its benefit, and in which we need to continually re-invest to sustain that flow over time. There are another four types of capital (or stocks), in addition to natural capital. They are:

1. *Human capital* (Porritt 2006:113), in the form of labour, intelligence, culture and organisation.
2. *Social capital*, which takes the form of structures, institutions, networks and relationships which enable individuals to maintain and develop their human capital in partnership with others (2006: 113). It includes families, businesses, trade unions, political, health and educational systems.
3. *Manufactured capital* (113*)*: which includes infrastructure, machines, tools and factories.
4. *Financial capital* (113) consisting of cash, investment and monetary instruments.

(Porritt 1996: 113. Also see Hawken *et al.* 1999).

It is this flow of 'benefits' (Constanza *et al.* 1997) to people that is valued and that "makes the capital stock an asset" (Porritt 2006: 112). Together they are important in realising that "valuing different capital types will be critical if we are to achieve sustainable development" (2006: 160). Since all five are interdependent, deterioration in one results in a deterioration in the rest.

The Five Capitals framework represents, in economic terms, the systemic link between the natural environment and our social world, alerting us to the need for an integrated approach. Since natural capital is the basis that sustains life itself, it is intrinsically valuable not only to us, but to all life. Natural capital is the foundation that underpins and maintains the remaining four capitals.

The interaction of human, social and financial capital is valuable, as together they create and sustain human wellbeing. Manufactured capital, while not valuable in itself, is necessary to facilitate the production process that creates financial capital, and in this way becomes valuable (Porritt 2006). Hence, the integration and valuing of all five capitals is able to achieve sustainable development.

Natural capital "falls into several categories: resources, some of which are renewable (timber, grain, fish, and water), while others are not (fossil fuels); sinks that absorb, neutralise or recycle waste; and environmental services, such as climate regulation. Natural capital is not only of production, but of life itself" (Porritt 2006: 113).

Stocks of natural capital could, for example, be a "forest, fish or an aquifer" (Wackernagel and Rees 1996: 35). The forest, fish or water represents a capital stock from which humankind can draw a "natural income" (1996: 35). For example, the forest supplies humankind with clean, oxygenated air, a habitat for diverse species of plants (some of which are medicinal, others nutritious) and animals, all of which maintain an ecosystem balance, but also provide food. A forest also regulates flood control and soil erosion.

These functions can be seen as services, termed 'ecosystem services' (Constanza *et al.* 1997). Critically, the "flow of services from ecosystems requires that they function as intact systems" (Wackernagel and Rees 1996: 35), an idea explored in detail in chapter three. Since the structure and diversity of the system (contained in the concept of biodiversity) is necessary to keep it intact, it means that biodiversity is also an important component of natural capital.

Consequently, different biological ecosystems provide humankind with benefits, termed ecosystem services. The principal focus of the Millennium Ecosystem Assessment Report (MEA) (2005) is on these services. From ecosystems humankind derives:

- Provisioning services: food (crops, livestock, fisheries, aquaculture, wild foods); fibre (cotton, timber, hemp, silk, wood for fuel); genetic resources; biochemicals, natural medicines, pharmaceuticals; and water.
- Regulating services: air of a breathable quality; climate regulation; water purification; erosion control; pollination and disease regulation.
- Cultural services: Spiritual and religious values; beauty; recreation and ecotourism.
- Supporting services: nutrient cycling, soil formation; and primary production.

(MEA 2005: 13).

Some of these services, such as climate regulation and the provision of food, are termed 'critical' services (Wackernagel and Rees 1996) as the survival of humankind is dependent on them, and as yet there are no known substitutes for these services (1996). What this shows is that humankind is still "fundamentally dependent on the constant and reliable flow of ecosystem services to secure our wellbeing" (Porritt 2006: 6).

Human wellbeing is a recurrent theme in discussions about sustainability/sustainable development and concerns the improvement of human lives. Essential to that is basic survival (ensured by the healthy functioning of ecosystems and their services), but it also goes beyond that by saying that what matters is also the quality of life (Porritt 2006; Hattingh 2001). Hence, the various factors that comprise wellbeing are relevant. The MEA (2005) defines these as:

- Security (personal safety, secure resource access and security from disasters).
- Basic materials for a good life (adequate livelihoods, sufficient nutritious food, shelter, access to goods).
- Health (strength, feeling well and having access to clean air and water).
- Good social relations (social cohesion, mutual respect and ability to help others).

(Porritt 2006: 8)

All of these should be available through freedom of choice and action, so that individuals can achieve what they value doing and being (MEA 2005 in Porritt 2006). However, authors such as Constanza and colleagues (1997), Gardner (2006), Hattingh (2001) and Swilling and Annecke (2012) draw attention to a protracted divorce from an awareness of these ecosystems, how they operate and our dependence on them.

Human actions, in ignorance or in defiance of our inseparable dependency on ecosystems, are causing negative changes to terrestrial, oceanic and atmospheric systems. These changes are taking place as a result of excessive extraction and use of what ecosystems naturally provide us with, that exceed rates at which ecosystems can regenerate, largely due to economic activity but also due to the scale of the human population and consumer demand (Hattingh 2001). Consequently, ecosystems and the services they supply go into decline and, if not checked, will eventually collapse.

Humankind is also dumping high levels of waste back into these ecosystems in quantities and at rates beyond their absorptive and assimilative capacities (Wackernagel and Rees 1996). Since viewing sustainability in the form of capital stock that can be drawn from implies that these capitals be drawn from no more quickly and to no extent greater than they can be replenished (1996), this has led to a situation where, at present, consumption exceeds income.

The conclusion of MEA (2005) is that while changes made to ecosystems by human extraction and use have resulted in gains in human material wellbeing and economic growth, the ecosystems concerned are "being degraded or used unsustainably". (Porritt 2006: 7). For example, regulation of global climate and natural hazards has been destabilised (Porritt 2006). Biodiversity loss, ecosystem degradation and global warming have been cited by Swilling and Annecke (2012) as constituting the greatest environmental threats to life on this planet and are what a call for sustainability/sustainable development seeks to address.

3.2 Biodiversity loss

"Biodiversity refers to the range of ecosystems, species and genes in existence" (Bartelmus 1994: 19). Biodiversity is the foundation of ecosystem services. It is important because each species, be it plant, animal, fish or microbe, has a role to play and a loss of one or a number of their kind means that they can no longer play that role, compromising the health of the entire system. The Millennium Ecosystem Assessment (MEA) (2005) and Rockström *et al.* (2009) demonstrate that where a critical threshold in an ecosystem is transgressed, systemic stability is affected and the system shifts abruptly to a different state. At the point the damage or loss is irreparable as far as ecosystems and biodiversity are concerned.

Given our dependency on ecosystem services, the irreversibility of these changes will have significant consequences for our wellbeing (Porritt 2006). The '*Living Planet Repor*t' indicates the state of the world's ecosystems "continues to show a decline" (Living Planet Report 2016: 2). For example, it shows that in the period from 1970–2005 "vertebrate species populations declined by nearly 30 percent" (2016: 3); marine species dropped by an average of 14 percent and freshwater species by 35 percent (Living Planet Report 2016: 8).)

Biodiversity loss and ecosystem degradation are brought about by the conversion of land to agriculture and urban development, clearing forests, climate change, pollution, and the introduction of alien species, which together are encroaching on the habitat and health of diverse species and the ecosystems (UNEP Global Environmental Outlook 2005). Thus, at the beginning of the 21st century we see that the world's ecosystems are rated to be in serious decline (Hawken *et al.* 1999). The interaction between species is critical to the continuation and functioning of ecosystems (UNEP Global Environmental Outlook 2005). This decline, unless halted, will continue and gather momentum as the world's population and consumption patterns increase.

Where ecosystem decline, as a result of "habitat change, pollution and climate change" (MEA 2005: 27) for example, continues, the ability of ecosystems to provide benefits to human and non-human life is reduced. This directly affects human wellbeing (MEA 2005), the poor foremost (MEA 2005) but also the lives and wellbeing of the many member species of which ecosystems are comprised. Should decline not be halted, we face the ultimate risk of transgressing critical biological thresholds, in which the ecosystem abruptly shifts to a new state, the effects of which are yet unknown.

3.3 Global warming and climate change

Global warming is a phenomenon in which a dense layer of carbon dioxide (CO_2) and other gases, mostly released by the combustion of hydrocarbons (derived from fossil fuels) have become concentrated in the global atmosphere, with the net consequence of allowing the sun's heat to penetrate but not escape. This is exacerbated by deforestation (trees absorb CO_2) and other human-induced activities, such as land use.

As a result, the earth's atmosphere is slowly warming and global climatic temperatures are rising. If not checked, in a cascade effect, it will trigger destructive climatic changes (Hawken *et al.* 1999; Rockström *et al.* 2009; Steffen *et al.* 2018).

The warming surface of the earth changes every aspect of its climate. It raises the temperature of the oceans, causing currents to shift and change. This affects wind patterns and rainfall in various parts of the globe (Lovelock and Margulis 1974, 1979; Rockström *et al.* 2009; Steffen *et al.* 2018). Warm oceans also release more CO_2 (which is important as the oceans contain just as much carbon as the atmosphere does), and polar ice caps melt, and the oceans are no longer able to support certain species of marine life that require cooler temperatures. Combined, this results in a rise in sea levels, the extinction of species of fish and the flooding of coastal cities (Hawken *et al.* 1999).

Warming effects will also change global ecology, which will affect global food production and economic systems. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2007) stated that the solution is not to be found in changes to climate policy, but in the re-structuring of global and national economies.

The current structure of the world's economies follows a model of high-carbon constant material growth, requiring ever increasing rates of natural resource extraction (Swilling and Annecke 2012). However, it is undermined by the fact that continuous growth is impossible in a context where natural resources - biosystemic, ecosystemic and mineral - have finite limits (Rockström *et al.* 2009). Current levels of resource extraction, pollution and carbon emissions are environmentally, socially and economically unsustainable as they are a direct cause of ecosystem degradation (MEA 2005) and climate change. These are detrimental to the wellbeing and eventual survival of all life forms, including humankind.

With this in mind, a quest for sustainability suggests the restructuring of global economies towards solutions that offer continued economic prosperity, while reducing environmental impact harm-levels. Such solutions remain elusive however, iterating the fundamental conundrum that the concept of sustainability addresses: how in a world of increasing human population and hence need for what our natural environment provides us with, are we to reduce our use of these benefits, while ensuring the wellbeing of all populations of the world?

Climate change is expected to have a "devastating effects on human livelihoods through flooding, storms, changing rainfall patterns, changing disease habits and habitats, and sea level rise" (McLaren 2003: 20).

This points to a situation where global emissions of greenhouse gas emissions need to be halted within in the next few decades to stabilise the climate and limit an increase in mean temperature to no more than 1.5ºC (IPCC 2018). This is to prevent a situation where "further warming could activate important tipping elements . . . raising the temperature further to activate other tipping elements in a domino-like cascade that could take the Earth System to even higher temperatures" (Steffen *at al.* 2018: 3).

A tipping point refers to context where a threshold in a complex system has been reached, and a little further induced change tips that system over the threshold into an unstable state. At this point, "the system follows an essentially irreversible pathway driven by intrinsic biophysical feedbacks" (3). Due to such feedback mechanisms, global warming "could activate important tipping elements: . . . raising the temperature further to activate other tipping elements in a domino-like cascade that could take the Earth System to even higher temperatures" (3) and it this is why the effects of climate change would not be reversible.

The effects of increased temperature change are "likely to be uncontrollable and dangerous to many" (Steffen *et al.* 2018: 5), "pose severe risks to health, economies, and political stability" (5), and ultimately the "habitability of the planet for humans" (5) and other life forms. A hotter climate profoundly alters the earth's climate and biosphere (2018), a state that could last for tens of thousands of years (2018). For example, changes in the hydroclimate affects rainfall and water cycles, and agricultural systems in particular would change (2018). A decrease in agricultural production leads to increased prices exacerbates the existing divide between rich and poor and could lead to famine. Associated extremes of hot and dry or cool and wet could trigger mass migrations and resettlement brought on by severe drought or flooding (2018). Warmer temperatures will result in the melting of polar ice caps and glaciers (2018), all of which will cause sea levels to rise, flooding the perimeter of coastal cities. A great number of the world's largest, most densely populated cities are located on the coast, for example New York, Los Angeles, London, Rio de Janeiro, Mombasa, Lagos, Sydney, Mumbai, Jakarta and Tokyo.

3.4 Conclusion

Environmental sustainability introduces the idea that sustainability, however defined, begins with the relationship between humankind and our environment and the value the environment has in that relationship. This is because the health and resilience of ecosystems is fundamental to the production of activities on which human survival, wellbeing and economies depend. Environmental sustainability is thus needed by humans (Goodland and Daly 1996). However, while ecosystems can tolerate a certain amount of stress, there are ecological limits to growth in the consumption of resources and the assimilation of wastes (Constanza *et al.* 1997; Rattner 2004; Blewitt 2008). If sustainable development is to be authentic, it therefore needs to house climate change solutions, the preservation of biodiversity and ecosystem health (Swilling and Annecke 2012).

4. Economic aspects of sustainability

In an economic context, the need for sustainability has come about due to the fact that, historically speaking, little consideration has been afforded the natural environment, except as a repository of free natural resources, subsequently overexploited, and a dumping ground for waste, in quantities that exceed natural assimilation capacities (Wackernagel and Rees 1996). This has led to a situation where economic trends are erosive of natural capital. As a consequence, natural capital is neither accounted for (except in terms of its extraction cost) nor physically measured and the results incorporated into economic analysis (Wackernagel and Rees 1996; Constanza *et al.* 1997; Porritt 2006). Thus structured, the economy does not consider the value of ecological services and the irreversible extraction of raw natural provisions that sustain it (Wackernagel and Rees 1996).

4.1 Capitalism

The dominant contemporary economic model is shareholder capitalism (Porritt 2006). It subscribes to a neo-classical theory of economics in which 'self-regulating markets' (Hartwick and Peet 2003: 188) (where goods are bought and sold) generate competition and trade to sustain constant economic growth.

Economic growth refers to a self-perpetuating cycle where goods and services are produced to be sold at profit, thus generating financial capital, which can then be invested in company growth and the hiring of more employees. This creates jobs and generates the income for people to purchase more goods and services. In it, all members of society are supposed to benefit from increased welfare.

Within this economic vision, the assumption has been made that somehow the social good derived from economic prosperity will spread itself through society, but widespread poverty persists, (Porritt 2006; Swilling and Annecke 2012), resulting in social inequalities. The core concept of capitalism is the generation and maintenance of capital (Porritt 2006), coupled with the perceived primacy of shareholder returns. Any organisation will use all five types of capital to deliver its products or services (2006). To recall, these are natural capital, human capital, social capital, manufactured capital and financial capital (Porritt 2006: 113).

Thus, natural capital is "required to maintain a functioning biosphere, supply resources to the economy and dispose of its wastes. Human capital provides the knowledge and skills that create manufactured capital and operate it effectively. Social capital creates the institutions that provide the stable context and conditions within and through which economic activity takes place, and financial capital provides the lubricant to keep the whole system operating" (Porritt 2006: 114). However, these flows, although interconnected, are conditional on natural capital.

If we accept that these five forms of capital are the "essential ingredients of modern industrial productivity" (Porritt 2006: 114), and the most "widely accepted definition of economic sustainability is the "*maintenance of capital*", or, "keeping capital intact" (Goodland and Daly 1996: 1003), then it follows that economic sustainability implies the maintenance of all five forms of capital. This is an augmentation of traditional economic thinking, which understands capital to be limited to either manufactured or financial capital (1996). Hence, not only does sustainability require an expansion of our idea of capital, but in so doing it also implies an expansion of our conception of what is valuable, augmenting it to include ecological services (natural capital), human health and education (human capital), trust, relationships and human rights (social capital) (Porritt 2006).

However, economics is still structured to value things in monetary terms, so natural capital – intangible, intergenerational and commonly accessed (air, water, oceans) – and social capital, equally intangible, are problematic as neither has yet been subject to any monetary evaluation (Goodland and Daly 1996). The blindness to the ecological value of natural resources (except their extraction cost) and living systems is a deficiency in economies the world over. Ecological value is the benefit or benefits an organism, ecosystem, product or practice can offer the natural environment. It shows capitalism to be financially profitable but ultimately unsustainable (Wackernagel and Rees 1996), as it "does not conform to its own accounting principles" (Hawken *et al.* 1999: 5), by liquidating its (natural) capital, and giving it the status of income (1999).

In this way, environmental costs and benefits have managed to escape integration into economic indicators of economic performance, most especially the such as Gross Domestic Product (GDP), thus managing to bypass mainstream decision-making (Bartelmus 1994; Constanza *et al.* 1997).

The failure to account for natural capital and the income derived from it, nor to physically measure it and have the results incorporated into economic analysis, gives rise to the problem of economic externalities. The idea of externalities refers to a process whereby ecological damage, such as a decline in the productive capacity of ecosystems, but also social costs, such as pollution, are not accounted for in the final sale price an item (Theis and Tomkin 2012). In other words, they are externalised. For example, the damage done to ecosystems by powerful extractive technologies is seldom given a monetary value (Constanza *et al.* 1997; Hawken *et al.*1999). Extracted materials, such as minerals and oil, thus only appear cheap, because the consequences of their extraction – denuded rainforest or toxic mining tailing spilling into groundwater – are not taken into account. This erodes ecological value and consequently imposes social and economic costs in the future, such as the cost of cleaning up pollution or the loss of vital natural benefits, such as the oxygen production of trees.

Treating ecosystem services and goods provided by the environment as an externality is useful for generating short-term profits, yet economic growth that systematically depletes these services eventually leads to a decline in the quality of life, both human and non-human (Elkington 1998; Hattingh 2001; Porritt 2006; Swilling and Annecke 2012).

The environmental crisis, a response to which is a call for sustainability, stems from the nature of economic production and consumption (goods and services supposed to meet our needs and improve wellbeing) that is "depleting our natural capital so that its ability to support the projected levels of the human population" (Porritt 2006: 123) is diminished.

An idea central to the quest for sustainability/sustainable development that current decisions should create a fairer spread of wellbeing for everyone (i.e. equity) and that this should not impair the ability, or prospects, of future generations to enjoy the same (Hattingh 2001), as expressed in 'Our Common Future'. The direct implication of this idea is that our economic systems should be arranged in such a way that we are able to live off the dividends of our resources, and not the capital (Goodland and Daly 1996). However, in persisting with an economic structure that is erosive of its natural capital foundation, we are living off the capital itself, and not the dividends. The prospect of future generations to receive an equal share of natural provisions, is jeopardised. This makes the current structure of the economy environmentally unjust.

An additional consequence of a failure to recognise ecological thresholds and to allocate adequate value to natural capital, is the false sense it fosters that natural capital is limitless (Hawken *et al.* 1999; Porritt 2006). It is a mindset that began with the industrial revolution and has persisted ever since. In it, corporations are believed to exist in order to maximise returns to shareholders within an approach that is shaped by the following set of beliefs:

- Economic progress can best occur in a free market system of production.
- "Competitive advantage is gained" (Hawken *et al.* 1999:6) through "more efficient plants" (1999: 6) that manufacture "more products for sale" to "expanding markets" (6)
- Growth in total output maximises human wellbeing
- Any resource shortages that do occur will elicit the development of substitutes.
- Concerns for a healthy environment are important but must be balanced against the requirements of economic growth.
- Free enterprise and market forces will allocate people and resource to their highest and best uses.

(Hawken *et al.* 1999)

This is the primary economic ideology adopted by the industrial revolution (Hawken *et al.* 1999: 6), which began about 250 years ago (Theis and Tomkin 2012). It was premised on an extractive, instrumental view of nature in which nature is only good, or has value, in so far as it is useful for acquiring something else considered to be of greater value, a manufactured good, or money (Porritt 2006). The industrial revolution was made possible by the invention of machines (Hawken *et al.* 1999) that supplanted human labour and facilitated enormous productivity. Machines enabled the manufacture of goods in far greater Volumes, in less time and with considerably less cost than manpower.

Standards of living benefited as a consequence, as did wages and the demand for additional products. At the same time, these factors generated a demand for "transportation, housing, education, clothing, and other goods, creating the foundation of modern commerce" (Hawken *et al.*1999: 7). This model has become the conventional view of value creation (1999), in which value creation assumes a linear and one-directional sequence of extraction, production, distribution, use and eventual disposal as waste (Wackernagel and Rees 1996).

The dominance of reductionist thinking in science, which attempts to arrive at understanding via analytical dissection of something into its basic component parts (Swilling and Annecke 2012), has at the same time further contributed to this narrow view (Lovelock 2007; Swilling and Annecke 2012). As such it is incapable of capturing the relationships (especially when they are non-linear) and emergent phenomena that characterise the systemic behaviour of the natural world.

4.2 Material flows

"In order to function, the global economy depends on a flow of materials that are extracted from the Earth, processed . . . to meet human needs, and then disbursed as wastes" (Swilling and Annecke 2012: 43). Materials extracted in the most significant amounts are "biomass, fossil fuels, ores, industrial minerals and construction materials" (2012: 43). In order for economic activity to continue, it becomes destructive of the natural environment, as flows of resources are used to support human societies, but generate waste and pollution at each stage of the production process. The flow operates in three stages:

- Natural materials are extracted from the earth and are purposed in industrial terms as raw materials or energy (which produces pollutants and waste).

- These raw material and energy flows are then transformed into products that can be sold and used (which produces more pollutants and waste).
- The resulting products are then distributed (which creates additional pollution), consumed, and at the end of their productive purpose, discarded. Ultimately, all of these stages produce waste, which becomes pollution unless it is recycled or reused.

(Wackernagel and Rees 1996; Hartwick and Peet 2003; Blewitt 2008).

"These material flows, which make economic growth possible are also referred to as the 'metabolic rate' of the global economy, are measured in tonnes per capita or per unit of GDP" (Swilling and Annecke 2012: 44). Material Flow Analysis (MFA) makes it possible to quantify total amounts extracted and used. What MFA shows is that "Population growth and rising income levels have been the primary drivers of rising resource use" (2012: 44-45) but, as we are coming to realise, within a context of finite limits. It follows that in order to sustain any economic activity, we need to know what these limits are and work within them.

Our planet is not growing, and extraction and waste are steadily eroding stocks of natural capital. At the same time, the human population is growing, and from this nexus of depletion, waste and population growth a pattern of scarcity of natural resources is emerging (Swilling and Annecke 2012). The outcome of increasing scarcity is an expansion of the scope and severity of existing poverty and conflict over scarce resources, "such as the Rwanda Genocide and ongoing Sundanese conflicts" (Swilling and Annecke 2012: 159), the basis for modern resource wars and many failed states (2012). This scarcity implies that, in order to consider current and future prosperity (as articulated in the Brundtland Report), "society must make its use of *resources* vastly more productive" (Hawken *et al.* 1999: 8).

4.3 Peak oil

The increasing scarcity and inevitable finitude of reserves of oil is one of the most damning indicators of a lack of economic sustainability (Kendall 2008; Swilling and Annecke 2012). This is because the global economy is premised on the availability of oil, and that this supply be both abundant and cheap. Oil, however, is a finite resource with no known energy-equivalent kilojoule for kilojoule, substitute (Kendall 2008).

This makes the global economy inherently unsustainable. Peak oil is the point at which global oil production is maximised, after which the total global oil supply will gradually decline. Quite when this key date will be reached is a matter of controversy (Porritt 2006), calculations depending on the size of recoverable reserves, the efficiency of extraction techniques, demand for oil and the influence of price (2006).

There are other forms of hydrocarbon energy such as gas, shale and tar sands, but their extraction is energy intensive and, in addition, inflicts substantial environmental damage (Porritt, 2006; Kendall 2008). Oil scarcity will lead to conflict over reserves and an increasingly expensive and ecologically destructive search for hydrocarbon energy sources (Swilling and Annecke 2012).

4.4 The question of economic growth and the environment

The false sense that natural capital is limitless is nowhere more apparent than in a global economic order that supports the idea of constant economic growth (Hartwick and Peet 2003). However, sustainability science paints a different picture in which this vision of growth breaks down in the face of collapsing ecosystem services, global warming, increasing scarcity of raw materials and finite reserves of oil (Hawken *et al.* 1999; Swilling and Annecke 2012).

This illustrates a situation where economic growth, on one hand, is in conflict with environmental restoration and health, on the other. What this grand-scale industrial economic trend (Swilling and Annecke 2012) fails to appreciate, and incorporate into its planning, is that nature is important to the economy, expressed by our reliance on ecosystem services (2012). The neo-liberal capitalist model fails to consider that all economic activity is embedded in the environment: where the environment is understood as the full spectrum of ecosystem services that create and sustain life (Hawken 2009). In its role as the major instrument of production in our society, business has, (and must) intrude, into ecosystems (Shaw and Barry 2001). Thus, economic sustainability is, in part, a debate about where to draw boundaries to this intrusion, as articulated by the United Nations Millennium Ecosystem Assessment (2005).

Consequently, there is a need to integrate environmental conservation into the structures of the world economy to ensure that we live within biological limits. This leads to the perception that a 'trade-off', "defined as an exchange of one thing in return for another: especially relinquishment of one benefit or advantage for another regarded as more desirable" (Angus-Leppan, Benn and Young 2010: 231), is inevitable: in order to have economic growth, environmental health must be sacrificed, and vice versa.

However, a sustainable economy proposes an alternative that reconciles both: to foster a productive, flourishing economy but to structure it in such a way that natural resources are restored, through re-envisioning modes of extraction and use (Benyus 1997; Hawken *et al.* 1999; Braungart and McDonough 2002; UNEP 2011). The question is how this should be done. It describes a situation where, to maintain trade and production while avoiding ecological breakdown, pollution and waste need to be drastically reduced, if not eliminated entirely (Benyus 1997; Hawken *et al.* 1999; Porritt 2006). Where to place these limits is critical and revisits the question of sustainability being about the value humankind perceives in the environment and our relationship with it.

There is a belief that an ecological breakdown can be averted by technological innovation (Porritt 2006). This means radically reducing negative environmental and social impacts of production (termed eco-efficiency) in all sectors, while up-scaling improvements in resource efficiency (termed eco-innovation) (Porritt 2006; Elkington 2012). While this is a definite first step, Rogers and colleagues (2005) make the point that, given the scale of the human population and its projected continued growth, eco-efficiencies alone cannot meet demands for resource consumption.

Approaches more radical than eco-efficiency can be found in concepts of circular economies. Such economies are 'circular' because they envision closed loops in which resources are re-captured and re-used, or can be safely returned to the soil to biodegrade. In other words, everything becomes a resource for something else, as in nature (Benyus 1997). Circular economies also envision a high degree of technological and ecological information being available, leading to innovation which results in products that can be continuously re-used, or recycled for use in some other form. The basic idea is to reduce to an absolute minimum, or eliminate entirely, the extraction of natural materials.

Some examples of such thinking are biomimicry (Benyus 1997), which looks to the natural to provide solutions to human problems, such as buildings designed to self-regulate their internal temperature and which can absorb CO_2; or cradle-to-cradle production (Braungart and McDonough 2002) wherein the waste of a given process becomes the fodder of another. Both recognise that humankind "is embedded absolutely in the heart of the natural world" (Porritt 1996: 163), and could echo these systems in devising economic approaches that do not produce pollutants or waste.

The human "population has doubled in the past 40 years and increased by 2 billion people in the last 25 years, reaching 6 billion in 2000" (MEA 2005: 114). In that time, "Global economic activity increased nearly sevenfold" (2005: 114). The idea that we can sustain the kind of growth that we have has since the 1950s is not plausible, given our knowledge of ecosystem decline and global warming. Knowing that finite ecological limits exist, "any serious analysis of the potential compatibility of sustainability, on one hand, and capitalism, on the other, must address the question of economic growth" (Porritt 2006: 45).

Due to these finite limits, the global economy cannot permanently and exponentially grow as this is impossible (Porritt 2006). This is because the economy "is a subsystem of human society, which is itself, in the second instance, a subsystem of the totality of life on earth (the biosphere). *And no system can expand beyond the capacity of the total system of which it is a part*" (2006: 46). The scale of the economic subsystem is thus constrained by the scale of the ecosystem.

To address the issue, it is necessary to target unrestrained economic growth, as well as the possibility of transitioning the current capitalist economic system into a form that repairs the social and environmental consequences of economic behaviour (Hawken *et al.* 1999; Porritt 2006; Swilling and Annecke 2012). Because so much environmental degradation is the result of economic activity, to be effective, the fulfilment of sustainability indicators would gradually overturn current economic methods of production and patterns of consumption (Hattingh 2001), which would require the restructuring of the entire economy.

4.5 Conclusion

Since the 1950s, "environmental quality and social justice were increasingly traded-off against growing prosperity and consumption" (Porritt 2006: 198). Where once environmental damage could be considered an inevitable price to pay for economic progress, reasons to accept this is as an unavoidable trade-off have become less justifiable. In addition, the existence of biophysical limits also undermines the assumption of constant economic growth, while human population levels rise, which imply that there will be even fewer resources left for even more people.

The need to adhere to biophysical limits suggests that correct valuation of natural resources, drastically reduced consumption of these resources and utmost efficiency in the treatment of finite resources, would be central aspects of economic sustainability. The new position endorsed by sustainability is to have a flourishing economy *and* a safe, clean and healthy environment. The economic aspects of sustainability thus propose the transformation of contemporary capitalism into a more environmentally benign form, and leads to the question of whether capitalism is able to restructure itself in order to be sustainable (Blewitt 2008).

5. Social aspects of sustainability

The social aspect of sustainability pertains to the meeting of human needs fairly and efficiently, hence issues of human wellbeing and equity are central to it (WCED 1987; Hattingh 2001; Porritt 2006; Swilling and Annecke 2012). Like the economic aspects of sustainability, these are conditional upon ecological sustainability, as it is nature that provides humans with the services essential to basic survival, but also human wellbeing (Hattingh 2001; Porritt 2006), and, to be sustainable, these should be more equally shared among all peoples of the world. The sharing of these services more equally is necessary to raise the wellbeing of the poor, and alleviate their suffering which is ethically intolerable. Aspects of equity and wellbeing are thus interdependent, being premised on every individual alive today (as well as generations yet to be born) receiving a fair share of social and environmental resources.

5.1 Inequity and poverty

The idea of sustainability being about equity arose from the fact that many people live in poverty, where they lack the basic stuff of life: adequate food, shelter, health care and schooling. In very broad terms, substantial inequity in terms of shares of environmental and social resources exists in the world (Wackernagel and Rees 1996; Väyrynen 2005).

From a sustainability perspective, inequity induces poverty (Swilling and Annecke 2012), especially in situations of unequal consumption of finite natural resources and ecosystem services. These are brought about by a few consuming more than their fair share, leaving less for everyone else (2012). Moreover, the persistence of widespread poverty undermines the neo-classical economic position that somehow the social good derived from economic prosperity will spread itself through society (Porritt 2006; Swilling and Annecke 2012).

By far the greatest share of environmental resource consumption is concentrated in the First World. Research conducted by Smith and Jalal (2000 cited in Rogers *et al.* 2005: 67) shows that "developed countries consume 64 % of the meat, almost half the cereals, over 80 % of the metals, over 86 % of chemicals, and 92 % of cars available in the world" (Rogers *et al.* 2005: 67), leaving little over for anyone else.

We clearly live in a very unequal world that contrasts great wealth with poverty. "Inequality is a measure of how various assets are distributed within a given system of units: as a rule, the greater the share of the rich, the smaller the share of the poor" (Väyrynen 2005: 10). It is brought about by excessive consumption (manifest in forms of material wealth but also in the use of ecosystem services) by a few, on the one hand, while on the other, there are those who consume too little and who endure a state of hunger, squalor and disease as a result (Wackernagel and Rees 1996).

From a sustainability perspective, when it comes to consumption of resources, poverty is linked to inequality in the form of unequal access to resources, with the poor receiving a disproportionately small share (Hattingh 2001; Porritt 2006; Swilling and Annecke 2012), but poverty is not the same as inequality. A helpful description perhaps, because it gives insight into the actual lives of the poor, is to view poverty in a qualitative sense, where people are poor because of the quality of their lives.

Indicators of poverty cite that people are poor because "of increasingly unequal access to the world's primary natural resources" (Swilling and Annecke 2012: 40), these being fresh water, and sufficient nutritious food. Their housing is inadequate, they have little or no access to social resources such as decent health care, education and employment opportunities (Porritt 2006). These circumstances result in human suffering, which is ethically unsupportable, and are also what basic socio-economic development seeks to address (Swilling and Annecke 2012).

Sustainability therefore encompasses the need to address vast inequalities in the state of human lives. On an ecological level it is about sustaining life, but persistent issues of inequity show us that it is also about sustaining the quality of that life (Wackernagel and Rees 1996; Hattingh 2001). Thus, strategies for more sustainable systems include social justice, most notably greater equity. Such strategies are expressed in terms of concepts of wellbeing (Jalal and Boyd 2005; Porritt 2006; Swilling and Annecke 2012), which encompass peace, health, social capital, human capital, human rights, labour rights, environmental justice and social responsibility (Jalal and Boyd 2005).

5.2 Environmental degradation and urban poverty

Environmental degradation is both a cause and a symptom of urban poverty, and it threatens global food security (Swilling and Annecke 2012). Poverty induces environmental damage through the unsustainable exploitation of the immediate environment, resulting in its eventual destruction in the form of cutting down trees, overgrazing or exhausting soils in order to survive (WCED 1987). This has consequent "effects on food and energy, marginal conditions in human settlements, environmentally conditioned diseases and natural disasters" (Bartelmus 1994: 12). The poor, in particular those in developing countries, are also severely impacted by environmental problems in the form of water shortages or lack of access to potable water (Blewitt 2008). This shows that within the capitalist system, the "harmful effects of this degradation are borne disproportionately by the poor" (Porritt 2006: 7:).

5.3 Environmental justice

Environmental justice recognises that in the dependent relationship between humankind and the environment, the poor receive a disproportionately small share of environmental resources, while also suffering the most from the effects of environmental degradation (Hattingh 2001).

The need thus arose for the concept of sustainability to encompass a fairer distribution of environmental resources among all peoples of the world, encapsulated by the term "environmental justice" (McLaren 2003: 22). It also applies to an alleviation of environmental damage in the form of polluted air, contaminated water, inadequate food supplies, heavy traffic and poorly ventilated buildings – all of which affect human health (a topic intrinsic to human capital and the idea of wellbeing) (Porritt 1996).

Environmental justice is directly conducive toward quality of life, and equity and wellbeing are mutually reinforcing. It calls for cuts in resource use, fairer distribution among the world's inhabitants, and that the costs are not borne disproportionately by any group (McLaren 2003).

5.4 Food insecurity

Agricultural economies, found predominantly in developing countries, depend on a range of quality natural provisions being available for sustained use for agriculture, forestry, fishing and ranching (Bartelmus 1994). Hence the degradation of soil, water and forests is highlighted as an environmental problem of these countries. These problems become social when they lead to an "inability of local systems to provide sufficient food for rapidly growing populations" (Bartelmus 1994: 23), causing hunger and malnutrition. Agriculture in its commonly manifest industrial, mono-cropped and chemically enhanced form, is responsible for substantial ecological degradation. As soils and the ecosystems that support them break down, so they are unable to support the growth of food crops. In some areas, this is exacerbated by changes in rainfall and temperatures brought about by global warming.

Globally, consistent and high levels of food production are needed to feed expanding populations, but in a context where production is destabilised by a combination of inhospitable weather, declining soil fertility, bio-fuel crops and an increased demand for meat (which encroaches on plant crops for grazing land and water). The future this conjures up is one where food production is insecure, resource scarcity manifests in increasing food prices, and malnutrition (mostly within developing countries) spreads among those unable to afford to feed themselves.

5.5 Urban poverty

An inability to live off the land contributes to the migration of significant populations to areas perceived to be more secure. The poor, in an effort to escape desperate circumstances, will migrate to cities in the hope of finding work, but because they are unable to afford decent housing, live in slums that lack basic sanitation and plumbing (Swilling and Annecke 2012). Unless they find work, bearing in mind they have little to offer beyond their labour due to a lack of education and therefore skills, their suffering will continue.

This points to a trend toward increasingly urbanised societies in most countries (Satterthwaite 2003; Bartelmus 1994; Swilling and Annecke 2012). For the first time in history, the majority of the world's population are "a majority urban species" (Swilling and Annecke 2012: 40).

Humankind is now a predominantly urban species whose future will be lived out in urban areas (Swilling and Annecke 2012), where they are "flocking in millions to slums" (2012: 41). Hence, increasing urbanisation has seen growing numbers of people living in urban poverty, in squatter settlements whose living conditions are characterised by "overcrowded housing, inadequate provisions of safe water supplies, sanitation, drainage and garbage collection" (Satterthwaite 2003: 74), which pose a risk to personal safety and health.

Many of these shanties are poorly constructed and additionally vulnerable to extreme weather, being built on marginal lands regarded as unsuitable for housing by others, such as flood plains, beside rivers or slopes (2003). Given the magnitude of the problem and the "vulnerability" (Bartelmus 1994: 25), of slum dwellers, the conditions of human settlements are very high on the agenda of social aspects of sustainability, since this is an area where the effects of poverty on the quality of the environment and living conditions are dramatic.

5.6 Population growth

At the same time, the world's population is growing and is expected to rise to 11 billion people by the end of the century (Andreev, Vladimira and Boongaarts 2013). A growing global population exacerbates scarcities. The dual outcome is an expansion of the scope and severity of existing poverty and conflict over scarce resources (Swilling and Annecke 2012).

Population control is another significant factor in sustainable development (Rogers *et al.* 2005; Porritt 2006). The sheer pressure of human numbers on the earth's finite ecosystems, resulting from the current size and projected growth of the human population, is one of the primary originators of the earth's ecological problems.

As the global population expands, so the competition for land and water intensifies, but also for commodities like oil and minerals, pointing to a situation where they could instigate conflict, as in Southern Sudan (Swilling and Annecke 2012). The greater the population, the greater the need for living space, so arable areas available for food production, forestry and habitat for diverse species are forced to cede space to housing. The demand for food and energy becomes greater, as does the demand for consumer goods. When combined these threaten biodiversity, the health of populations of oceanic fish, supplies of fresh water, arable land and virgin forest (Rogers *et al.* 2005. Also see Swilling and Annecke 2012).

5.7 Wellbeing

Human wellbeing refers to improving people's lives (MEA 2005). The concept tends to look at issues of quality of life for all members of a community, and should not to be confused with the standard of living (Anand and Sen 1996), which focuses on material consumption. As already mentioned, it is comprised of numerous factors, such as "personal safety; basic materials for a good life; health; good social relations" (Porritt 2006: 8).

Hence, wellbeing includes access to decent health care, housing, education, employment opportunities, recreation and good social relationships, all which are intrinsic aspects of social and human capital. A lack of access to these factors induces a state of poverty[2].

[2] Poverty is understood here to refer to the living conditions experienced by people who are poor, and less to the narrow economic definition offered by The World Bank of those living under $1.90 per day. Living in poverty applies to people who are unable, or powerless, to meet basic needs for food, clean drinking water, shelter, clothing, basic sanitation and medical care. Consequently, they experience hunger, disease, cold, vulnerability and destitution. A lack of education and skills, which impair opportunity and the earning of income, exacerbate poverty.

For this reason, overall wellbeing is what development strives to accomplish (Porritt 2006). Access to education and skills (the development of human capital) is a means of escaping poverty, and highlights the question of empowerment and emphasises the idea of equity in which all people within a society enjoy schooling and medical care.

5.8 Human capital

Education and healthcare are within the domain of human capital. Human capital refers to "the physical, intellectual, emotional and spiritual capacities that each person brings to a working, loving or playing relationships" (Porritt 2006: 138). It is developed by sustaining human health, which implies having access to competent and affordable health care. It also means diminishing the use of environmental resources in such a way that they are damaging to human health.

In addition, human capital refers to the education and skills that a person has. These are necessary to find or create employment to generate income, but they are also a means of personal fulfilment. "Our emotional abilities include our skills in empathy, conflict management, relationship-building and organisational awareness" (Porritt 2006: 142), are what allow us to function effectively in society (Porritt 2006) and are linked to the maintenance of social capital – social capital and human capital are "mutually reinforcing" (2006: 151). Spirituality, a final aspect of human capital, is understood to address questions of meaning and purpose in life and with it, values (2006).

5.9 Social capital

Social capital is a concept that is applied widely when discussing the social aspects of sustainability (Daly 1996; Harris *et al.* 2001; Porritt 2005). Social capital makes tangible the things we are familiar with in our personal and working lives: networks, relationships of trust, and shared initiatives. It is also part of what we talk about when we use the term 'community' (Porritt 2006). Values, and what is valued, can also be considered part of social capital (2006), as a value is something that is shared and that allows people to cooperate, and work toward a shared goal. Social capital can be put to negative or positive use. In a positive form it fosters support, cooperation and trust. When negative, it is expressed in things like ethnocentrism, corruption and sexism.

Porritt (2006) argues that building social capital is vitally important to sustainable development, since social capital facilitates efficient functioning of job markets (social networks help us find and retain work); facilitates the desire for and acquisition of education (which strengthens job opportunities and income); contributes to lower levels of crime and may improve the effectiveness of governance (participation in legitimate democratic governance is a critical part of sustainable development) (Porritt 2006). Democracy, participation and empowerment, because they are about political rights, are dimensions of social sustainability. Democracy, and the participation it facilitates, is socially empowering, and is a dimension of social sustainability.

5.10 Wellbeing, development and economic growth

Social sustainability is thus about enhancing the wellbeing of mankind. The concept of wellbeing is important when it comes to interpretations of what constitutes human progress and consequently, development. Porritt (2006) argues that the notion of economic growth, which up to now has been synonymous with income and progress (2006), is disconnected from wellbeing. In this view clean water, productive soils and access to functioning health care and educational systems are a more relevant interpretation of sustainable development than the single indicator of economic growth.

Daly (1996) points out that economic growth is about quantitative expansion (derived from material consumption), whereas development, if it is to be sustainable, is about qualitative growth. And what the environmental factors of sustainability show us, is that while qualitative growth can go on indefinitely for all nations, quantitative expansion in the form of material throughput growth (condensed in GDP) cannot (Goodland and Daly 1996). Qualitative economic growth, unlike quantitative economic growth that focuses on the material expansion of the economy, is not a purely economic process. It is multidimensional and applies to growth in social ‘capital’, ecological conservation and personal spiritual development, all of which can go on indefinitely.

Sustainability maintains that any growth that depletes the natural provisions on which it depends cannot, in the long run, improve the quality of human life (or any life), but in fact will diminish it.

This suggests that notions of GDP and economic growth are limited facilitators of wellbeing. The inadequacy of GDP stems, partially, from its failure to acknowledge natural capital. It is not a reflection of the total consumption that has taken place: that is, consumption that includes ecosystem resources and services that provide the material inputs and flows of energy into the economic production process (Porritt 2006).

Sustainability is linked to the idea that economic organisation should be judged not according to economic growth, but to the extent to which it promotes human wellbeing. This is because economic growth concentrates on augmenting income; which is not evenly distributed in a society, limiting the choices of those living in poverty. Instead, wealth tends to be concentrated in the hands of those with power and those who have either the education and/or skills to access well-paying jobs, with little trickle-down of that wealth to those who possess neither power nor skills, creating distinctly unequal societies (Bartelmus 1994; Porritt 2006).

The concept of developing societies that are sustainable focuses not on the quantity of economic growth (measured in GDP), but on the quality and distribution of that growth (Harris *et al.* 2001). In this paradigm, economic growth is not the goal of development. Rather, it provides the means to improve lives or, put differently, enhance the wellbeing of the majority. Sustainability in this context means the preservation of the "capacity to produce human wellbeing" (2001: 32).

5.11 Conclusion

The social aspects of sustainability prioritise human wellbeing, especially of the poor. It cannot be measured in terms of GDP which, because it focuses on economic growth and consumption alone, is too limited an indicator to express tangible day-to-day experiences of increased food, real income, education, health care and supplies of potable water. The creation of wellbeing requires the meeting of basic needs related to the alleviation of inequality and poverty alleviation (Rogers *et al.* 2005), and augmentation of human and social capital, which impacts economic aspects of sustainable development since it requires investment in human capital in the form of "education, health and nutrition of individuals" (Goodland and Daly 1996: 1003).

6. Summary: what makes the world so unsustainable?

The science of sustainability paints a picture in which the current version of the capitalist economy breaks down as a result of collapsing ecosystem services, make it unsustainable: "eco-system degradation; global warming; peak oil; inequality, global warming, increasing scarcity of raw materials and finite reserves of oil vast inequalities in human development.

In this regard, the research of Swilling and Annecke highlighted seven consistent threats that the world currently faces – not global warming only – and which, if left unchecked ty; urban poverty; food insecurity; and material flows" (2012: 27-28). The majority of the world's population now live in cities where substantial numbers of people reside in slum conditions that negatively affect their wellbeing.

Together these show a world that is "highly unequal, urbanised" (Swilling and Annecke 2012: 28) and "dependent on rapidly degrading eco-system services, with looming threats triggered by climate change, high oil prices and food insecurities" (2012: 28). These are the challenges which collectively motivate a quest for sustainability. Thus, the concept of sustainability should explore "the relationship between economic development, environmental quality and social equity" (Rogers *et al.* 2005: 42).

7. Conclusion

The environmental, economic and social aspects of sustainability reviewed in this chapter show that there are limits to the extraction and use of natural provisions. These limits apply to the ability of the natural world to absorb and neutralise the effects of human activities, as much as to finite natural resources and the biological thresholds within which ecosystems are exploited for human use. Trends also show a great disparity in the use of these resources, in which the poor receive a lesser share and endure suffering as a result. Scarcity of resources and inequity in their distribution also undermine belief that economic growth can be pursued limitlessly and for the betterment of all.

Sustainability, in this light, addresses what needs to be done to keep our environment, economies and societies healthy and flourishing, while also suggesting that human behavioural change might be a necessary first step.

The foundation of this change would be our realisation of the relationship we share with the natural world, and in which the natural world is properly valued not only as an economic asset, but as an end in its own right. The result would be a transformation of current economic structures, addressing persistent poverty and adhering to absolute environmental limits. Now that we have an idea of what makes the world we live in so unsustainable, and which has brought about the recognition of the need for more sustainable modes of living, we are equipped to turn our thoughts to some proposed solutions in the form of models of sustainability/sustainable development. Given that sustainability/sustainable development are contested concepts that lack conceptual clarity, the following chapter is concerned with analysing different approaches to the concept of sustainability/sustainable development.

This presupposes that without a clear understanding of what it is we are trying to sustain, we cannot go about formulating a response to it. The chapter analyses three prominent conceptions of sustainability/sustainable development that represent a spectrum of values, showing each conception and what it values contributes to, or takes away from, the discourse on sustainability. These conceptualisations are the Brundtland Report; 'Caring for the earth'; and deep ecology.

Chapter Two

1. Introduction

In the 1980s, three prominent and influential conceptualisations of sustainability and sustainable development emerged. In the policy domain, the Brundtland Report (WCED 1987) is perhaps the most well-known. It adheres to a conventional economic understanding of sustainability that prioritises the interests of humankind, making it anthropocentric in orientation.

Still in the policy domain, it was followed by 'Caring for the earth' (IUCN, UNEP, WWF 1991), a report that moderates the Brundtland Report's anthropocentric stance in pointing out that humankind has a duty to care for the natural environment, and that this should form part of the definition of sustainability and sustainable development. A more radical and alternative response to both is found in the ecocentric theory of deep ecology (Naess 1973; Devall and Sessions 1985), which allocates intrinsic value to the natural world, placing it on a par with human interests.

The basic idea of sustainability, which provides the starting point for each conceptualisation, is to make use of what the natural environment provides humankind with, while protecting it in order to ensure continued provision. Some interference with nature is therefore necessary, but it is the degree of that interference which is contested in various frameworks.

Since what nature can provide has finite limits, the problem that conceptualisations of sustainability face is that the goal of human survival can sometimes clash with considerations that pertain to quality of life (is it merely survival that is the goal, or is the wellbeing and quality of life also important?) and interference with nature (how much of nature is required to ensure human survival, and how much more to ensure wellbeing?) (Hattingh 2001). Underlying answers to these questions are assumptions about humankind and our relationship to the natural environment, which in turn are supported, and justified, by ideas of what is valuable enough that we should sustain it (Hattingh 2001; Gallopin 2003).

Thus, competing objectives between the three aspects of sustainability i.e. environmental protection, economic and socio-cultural development and intra and inter-generational equity (Hattingh and Attfield 2002) – for limited natural provisions suggests that practical implementation in terms of sustainable development leads not to integration, but to the management of trade-offs. Consequently, we are faced with multiple questions of what development that is sustainable sets out to achieve when addressing questions regarding the following:

- Whose needs are at issue?
- What those needs are.
- Our needs as opposed to wants, and who gets to decide.
- How many generations into the future are we talking about, and;
- Whether their needs will be the same as current generations (Hattingh 2001).

This leads to a situation where, until we properly understand what is at stake, a viable response to sustainability is futile.

With this in mind, and in an attempt to achieve clarity on the matter, this chapter analyses the three aforementioned understandings of sustainability/sustainable development from the perspective of an ecological conceptualisation of sustainability/sustainable development. As Hattingh (2001) points out, since humankind (and all other life forms) depends on the natural environment for survival and wellbeing, and that without the healthy functioning of the natural environment there will be no form of social or economic sustainability left to fight for, the health of the natural environment should form the foundation of understanding of sustainability/sustainable development. It is why an ecological perspective should be prioritised.

The analysis shows how each definition has acquired a different interpretation according to its perception of the relationship between humankind and the natural environment, the value nature has in that relationship, and what this implies for a conceptualisation of sustainability that is ecologically sustainable.

2. Methodology

As already mentioned in Chapter One, a standard dictionary reference of sustainability refers to keeping something going over time or continuously (*Concise Oxford English Dictionary* 2011: 1452).

However, it is evident that sustainability and sustainable development entail much more than this limited "quantitative notion" (Hattingh 2001: 8). This is because they also entail "*qualitative* elements" (2001: 8) that require "answers to value questions that cannot be deduced from a quantitative concept of sustainability/sustainable development alone" (Achterberg 1994a: 36 cited in Hattingh 2001: 8).

As a result, this proposal arises from the observation that the central question differentiating understandings of sustainability concerns that which is to be sustained, and that this is determined by perceptions of value (Hattingh 2001; Dresner 2002). Additionally, answers to these questions "throw light on the ethical dimensions of the concept of sustainability/sustainable development" (Hattingh 2001: 8), as well as on how different conceptions of sustainability/sustainable development can be arrived at. The most important of these questions are (Achterberg 1994a: 36 in Hattingh 2001: 8):

1. What is so valuable that it should be sustained?
2. With a view to whom or what is the sustainability of this valuable something to be pursued?
3. How is sustainability pursued?
4. What are the criteria for sustainability? Such criteria are necessary so that the question whether and when we have reached a state of sustainability can be answered.

To find our way through the confusion and progress to an understanding of what sustainability/sustainable development could mean, and taking the question of value as our guiding theme, this chapter undertakes a values analysis of each of the three conceptions of sustainability, seeking answers to these four questions. More specifically, and as mentioned above, a pivotal point of contention in interpretations of sustainability concerns differing perspectives on the relationship between humankind and the natural environment and the value that the natural environment has in this relationship.

Each analysis is framed by the above four questions. This is followed by a summary of the criteria that would prescribe when a state of sustainability/sustainable development has been reached, and by a discussion of the contributions and limitations each approach brings to the discourse on sustainability/sustainable development.

Part of the point of sustainable development is to curtail the unlimited exploitation of nature by governments and industry alike, and not to accelerate it (Norton 1999), so it is important that conceptual clarity be obtained on what is understood by 'use' of nature, in practical terms so that coherent goals for sustainability can be discussed (Hattingh 2001). This is most cogently addressed in different ideas regarding weak and strong sustainability. These address the question of whether, and to what degree, the natural environment can be traded-off against human economic and social wellbeing without violating sustainability.

In a weak interpretation of sustainability, the needs of humankind take precedence over nature, making it anthropocentric in orientation. The understanding of sustainability offered in the Brundtland Report is an example of this. In it, the natural environment is viewed as a resource to be used and extracted from for the benefit of human social and economic activities. Moreover, it encompasses the idea of substitution, or "substitutability" (Porritt: 2006: 128), in which natural capital can be substituted "with other forms of capital (2006: 129), just as long as it "creates equivalent value" (129) assuming this is possible. Such a "minimalist" (Hattingh 2001: 10) interpretation of sustainability, fails to respect critical natural processes and limits and, while it advocates a gradual reduction of harm over time, does not fundamentally alter economic structures.

A more moderate position is advocated in the document 'Caring for the earth' (IUCN, UNEP and WWF 1991). It introduces the idea that the natural environment (ecosystems and all living beings in them) possesses intrinsic value, but that this should only be respected to the degree required to safeguard human wellbeing. Additionally, it recognises that there are limits to what can be achieved with human technology and it does not support the idea that human innovation or accumulation of financial wealth are worthy substitutes for natural resources and services.

A stronger, more ecocentric interpretation of sustainability stands for the protection, conservation and enhancement of ecosystems. According to this interpretation, the natural environment possesses intrinsic value that makes the protection of entire ecosystems paramount. It is foundational to the theory of deep ecology espoused by Naess (1973) and Sessions (1995), among others. Deep ecology insists that humankind learns to live on the services generated by existing ecosystems, while leaving the integral ecosystems in place.

The importance each allocates to the value of nature can be thought of in terms of degree, ranging from weak sustainability which allocates a low degree of value, to strong sustainability, where a far higher degree of value is allocated. As already mentioned, to reflect these shifts in emphasis, it is useful to visualise these perspectives not as distinct and mutually exclusive categories, but as existing on a continuum (Jacob 1994), or spectrum. This is a visualisation device that has the advantage of still being able to capture the complexity of these theories: how they relate to one another, borrow from or build upon each other, areas where they intersect, and areas where they clearly differ – all of which would otherwise be lost if a compartmentalised approach were to be used.

Additionally, it avoids the danger, inherent in a compartmentalised approach, of augmenting exclusion by thinking in terms of the logic of "binary opposites" (Rolston 2017: 15), which tend to separate and negate, while leading to rigid positions and thereby losing critical mutually enriching information. In this way, visualising weak and strong sustainability as part of a continuum helps us evaluate individual perspectives in terms of their description of the central problem sustainability faces: how to extract less from the earth while ensuring the wellbeing of all its peoples. What emerges in the subsequent analyses is that differing perspectives have "core and specialised meanings" (Hattingh and Attfield 2002: 68). that may "overlap" (2002: 68), but also have "specialised interpretations that may not overlap, or could even be incompatible" (69).

For example, the strength of the Brundtland version of sustainable development is that it provides insights into the kinds of problems likely to be faced when trying to operationalise an ecological worldview (Jacob 1994), but it fails to impose limits that would reduce current rates of extraction of natural resources; it also ignores the amount of waste returned to natural systems so as not to impair their functioning.

The strong point of a more ecocentric position, such as deep ecology, seems to be that it lays a philosophical foundation for an ecological worldview. However, it fails to suggest an operationalisable policy for sustainable development, and consequently seems to lack practical application (Jacob 1994).

In this regard, the three conceptualisations analysed in terms of their descriptions of and solutions to environmental problems, appear incomplete, and while traditions of weak and strong sustainability appear to pull in opposite directions, the scope for mutual enrichment is substantive and each can learn from the others. With this in mind, the chapter concludes with a discussion of the kind of conceptions of sustainability that we need. It suggests that an alternative, stronger and more ecocentric understanding of sustainability than that of the Brundtland Report, is necessary. Such a conception would acknowledge the intrinsic value of the natural world and an appreciation of the value of ecosystems.

On a practical level, it would require that development should adhere to the protection of ecosystems (Constanza *et al.* 1997, 2017; MEA 2005) by observing strict biological limits; and that this protection should go beyond the maintenance of critical ecosystems necessary for human survival by valuing nature, and the ecosystems in it, as something more than a resource for human use (Hattingh 2001; Gallopin 2003; Swilling and Annecke 2012). In terms of implementation, this would necessitate the structural transformation of current patterns of production and consumption to something more benign – environmentally and socially (Hattingh 2001).

3. Overview of the values frameworks: the Brundtland Report, 'Caring for the earth' and deep ecology

Within the conceptual framework of the Brundtland Report and neo-classical economic theory (which informs current business practice) a substantively anthropocentric approach is adopted. Additionally, in recognising the state of technological advancement as the only limitation to the meeting of human needs, it also implies that natural resources can be substituted with manufactured capital and financial capital.

Since it is questionable whether human technology can really take the place of, or compensate for, natural assets, such as the aesthetic quality of wilderness, or substitute critical natural processes, such as the hydrological cycle, I suggested that an approach to sustainability/sustainable development is needed in which the "intrinsic value of nature" (Hattingh 2001: 6) is acknowledged.

4. The Brundtland Report

4.1 What is so valuable that we ought to sustain it?

The Brundtland Report's version of sustainable development has exerted the most influence on the global discourse with regard to sustainability and human development (Jacob 1994) and is emphasised (to the exclusion of others) in policy formulation. Bearing accelerated ecological decline in mind, the Brundtland Report acknowledges that the future of humanity is threatened when it states that "some consume more of the earth's resources at a rate that would leave little for future generations. Others, many more in number, consume far too little and live with the prospects of hunger, squalor, disease and early death" (WCED 1987: 27).

This leaves us with the knowledge that human needs must be met to ensure (a) life, in the form of survival; (b) the quality of that life, including the imperative that environmental resources be shared equally between every individual on earth to prevent the suffering that arises from poverty; and, (c) that these imperatives apply as much to current generations (intra-generational equity) as it does to future generations (inter-generational equity) (Hattingh 2001).

The Brundtland Report thus typifies human life as being so valuable that it ought to be sustained to the cost of other life, making it distinctly anthropocentric in orientation (Hattingh 2001; Sneddon, Howarth and Norgaard 2006). It also stipulates that the quality of human life, beyond the level of mere survival, is an important sustainability goal. Anthropocentrism views the needs of human life as more important than the needs of any other form of life (Shaw and Barry 2001; Hattingh 2001). In it, nature is viewed as a resource, where its value is assessed in terms of its usefulness to humankind (Hattingh 2001). In this case, nature is subservient to the achievement of human social and economic goals (2001).

As a result, the Brundtland Report articulates the purpose of the preservation of nature as a basis for human social activities (including economic activities), now and into the future (Hattingh 2001). In addition to the preservation of ecosystems as a basis for the economy, the Brundtland Report acknowledges the need to improve the quality of life of all people of the world, but particularly that of the poor, within the limits of these ecosystems now and in the future.

This prescribes fair and equal access to the natural resources of the world as preconditions of sustainability and sustainable development (Hattingh 2001). It is within this context that the Brundtland Report devised its well-known definition of sustainable development: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987: 27).

4.2 Why is human life so important that we ought to sustain it?

There is a plurality of debates about what is so important about human life that is should occupy this position. Briefly, they relate a point of view in which humankind alone, among all expressions of life, is perceived to be sentient and cognisant enough to possess intrinsic value and to count morally. In so doing it is a position that denies any other life forms moral consideration, a position that remains controversial, unresolved and open to debate. For example, there are multiple forms of non-human life in the air, on the ground and in the water that fall into the category of possessing a brain, skin, some form of self-identification, and ability to "defend itself against injury or death" (Rolston 2017: 166), just as humans do. Elephants, horses, ducks, gorillas, sparrows, whales and dolphins, for example, also have young which they birth, nurture and raise. These things show that they do care, and have interests about which to care (2017). On what basis should they not count as worthy of having intrinsic value?

An additional point to consider is that nature, and all non-human life that form part of it, when compared to humankind, is deprived of language or weaponry, and therefore cannot enunciate or defend its preservation, as humankind can. However, this does not mean that non-human life is less valuable than human life. Thus, while the question of the supreme importance about human life is a fascinating and important one, it requires further elaboration that falls outside the scope of this research.

4.3 How ought we to go about implementing sustainability/sustainable development?

The Brundtland Report regards a situation as being sustainable if it ensures that the same amount of capital will be available to the next generation as well as our current generation (Hattingh 2001; Goodland and Daly 2006). In so doing, it refers to two things: the total stock of capital and that this capital be made available to humans. Capital, in this context, refers "not only" to "natural capital" (Hattingh 2001: 13), but also to "financial capital and human capital" According to this position, nature – seen as natural capital – can be substituted for human, financial or manufactured capital.

In this way the Brundtland Report subscribes to a weak version of sustainability (Hattingh 2001) that adopts the view that society is sustainable as long as the total stock of capital does not decline in value, which implies that one form of capital, such as manufactured capital, can be exchanged with another, for example, company stock (financial capital) or a day spent loading crates at the dock (human labour), where each provides an equivalent substitute for the other. In this case, manufactured or financial capital would provide an equivalent substitute for natural capital.

However, this position is undermined by the fact that there are some ecosystem services, termed critical, such as the regulation of the climate, the provision of oxygen, or the maintenance of the temperatures of the oceans, that human-made capital (in the form of machines, gadgets or processes) simply cannot perform. They have no functional equivalent and therefore no substitute exists (Wackernagel and Rees 1996). Consequently, human, financial or manufactured capital cannot always substitute for natural capital.

4.4 What are the criteria for sustainability according to the Brundtland Report?

In the Brundtland Report's interpretation of sustainability, a trade-off has been made in which economic goals are favoured above environmental conservation, both in the immediate and long term.

As a result, the criteria indicating a state of sustainability according to the Brundtland Report are (Hattingh 2001):

- Human life, and wellbeing, is so valuable that its existence should be prolonged indefinitely. In this paradigm, humankind is separate from nature and is the only species to be allocated intrinsic value.

- Nature is perceived to be valuable to the extent that it benefits humankind.
- It should therefore be preserved as a resource to support human economic and social activity, where it is expressed as a natural capital to be extracted from.
- As such, human interests predominate at the expense of a rich and biologically diverse nature.
- The only limit acknowledged is that of technological innovation. Consequently, ecological services can be replaced and substituted for as much as technology allows. In this way, a situation can be regarded as being sustainable if it ensures that the same amount of total capital is available to the next generation as to the current generation.

4.5 Critical assessment of the Brundtland Report to sustainability

Implicit in an anthropocentric approach is the instrumental assumption that the preservation of nature is valuable solely due to its profound usefulness to humankind. It adheres to a point of view that empowers human perceptions of dominance over nature (Naess 1973; Luke 2002; Rolston 2017) in which much of nature is viewed as inanimate, objectified and commoditised. This view thus condones the use of nature to serve as a basis for social activities now and into the future (Hattingh 2001). It is a position that iterates the fundamental tension between the economy, on the one hand, and the preservation of nature on the other. A trade-off treats this tension between sustainability "goals as being in conflict and requires that a choice be made between them" (Van der Byl and Slawinski 2015: 54). not as an "integrative" (2015: 55) position.

Given an anthropocentric focus on human economic goals, ecological goals are compromised when presented as a choice (Van der Byl and Slawinski 2015. Also see Elkington 1998). The result is that, within the Brundtland Report, ecological sustainability goals remain secondary. What the Brundtland Report essentially implies is that "no limits are put on the nature or scale of human activities by the environment itself" (Hattingh 2001: 13). However, this position is undermined by a failure to recognise finite biological physical boundaries that exist in nature and that cannot be exceeded (Gallopin 2013. Also see Constanza *et al.* 1997). In so doing, it ignores that stocks of certain resources, like oil and water, are finite; and that if ecological regenerative capacities are exceeded, then stocks of replenishable resources like soil fertility and fisheries, automatically enter an irrevocable decline (Constanza *et al.* 1997).

It further assumes that the value of natural resources can be substituted with human, manufactured and financial capital, "regardless of the impact that it may have on the health and integrity" (Hattingh 2001: 14) of ecosystems necessary to support these human activities, but also on the quality of human life and, ultimately, all biological forms of life.

On a practical level, this affords the critical and regenerative capacities of ecosystems little protection, both at present and in the long term (Hattingh 2001; Goodland and Daly 2006). Substitution interprets sustainability as an end "state in which the total stock of capital in the world is maintained" (Hattingh 2001: 8-9). This translates to the legitimate destruction of nature if "we can compensate" for that (2001: 9) "by achieving important human goals, such as raising the general level of welfare" (9) for all peoples of the world, or "increasing the total value of the economy by generating growth in our stocks of financial capital" (9).

Since its implementation does not stipulate that adjustments be made to current economic and social structures, it maintains current patterns of resource distribution that exclude the poor and favours development that does not consider the needs of future generations (2001). Outcomes, for the poor at least, would equate sustainability with basic survival (2001). The net outcome is that ideas of substitution and maintenance of current economic structures that only superficially recognise ecological services, some of which are "critical functions" (Porritt 2006: 129), undertaken by ecosystems and the risk – economic, biological and social – of their irreversible loss, effectively undermines the Brundtland Report's goals of intra-generational and inter-generational equity (Hattingh 2001), as well as human wellbeing.

Its weakness is that it lacks ecological relevance, and continues to undermine the very resources necessary to maintain human economic and social wellbeing into the future (Hattingh 2001; Constanza *et al.* 1997, 2017). Hence, an anthropocentric position can be criticised for its repeated trade-off of ecological value for socio-economic gain. In terms of the relationship between humankind and the natural environment, it falsely separates us from our natural environment (Naess 1973; Luke 2001) and neglects the biological relationship we share with it, and upon which we are ultimately dependent for our survival. We also depend on it for the satisfaction of material needs.

Since the preservation of critical natural processes negate increases in financial, human and manufactured capital as equivalent substitutes that can "compensate for the loss of nature" (Hattingh 2001: 6), an alternative approach to sustainability and sustainable development proposes the explicit acknowledgement of the "intrinsic value of nature, that is, the value it has independent of its use value to humans" (2001: 6).

It suggests that a more "robust form of sustainability, in terms of which nature is valued for its own sake, and as far as possible saved from being made totally subservient to human needs" (Hattingh 2001: 9) would result from the pursuit of a process in which natural assets are restored and "kept intact" (9). In this way, "the regenerative and creative systems in nature" (9), not acknowledged by an anthropocentric point of view, "are preserved in order to continue functioning indefinitely" (9). Such an approach can be found in '*Caring for the earth. A strategy for sustainable living*' (IUCN, UNEP and WWF 1991) (Hattingh 2001).

5. 'Caring for the earth: a strategy for sustainable living'

This report refines the purpose and ideals of sustainable development into a "strategy for *sustainable living*. Mention is also made of a strategy for a *sustainable* economy" (Hattingh 2001: 6), the aim of which is to "help improve quality of human life as far as it is possible within the boundaries of the carrying capacity of the ecosystems on which it is dependent" (IUCN, UNEP and WWF 1991: 3).

"Elaborating on the vision articulated for sustainable development in the *World conservation strategy*" (Hattingh 2001: 6), 'Caring for the earth' lays out nine principles "that should form an ethical platform (or basis of values) of sustainable living" (2001: 6). These are:

- Respect and care for the community of life (this is an ethical principle that defines a duty of care for other people and all forms of life, now and in the future);
- Improving quality of life;
- Conserving the vitality and diversity of the earth;
- Minimizing the exhaustion of non-renewable resources;
- Keeping within the carrying capacity of the earth;
- Changing personal attitudes and practices, in accordance with an ethics for sustainable living;
- Enabling communities to care for their own environments;

- Forming a national framework for the integration of development and "conservation"; (Hattingh 2001: 6), and
- Forming a world alliance to implement sustainability on a global scale.

(Hattingh 2001: 6)

'Caring for the earth' extends moral consideration to all life on the basis that it "recognises that nature has to be cared for in its own right, and not just as a means for satisfying human needs" (Caring for the earth 1991: 13) on the basis that humankind is "a part of nature" (14) and "the community of life" (14). It goes on to say that: "Every life form warrants respect independently of its worth to people" (14), commensurate with the concept of intrinsic respect. However, apart from recognising that humankind is a part of nature, it does not offer any additional reasons as to why this should be the case. In the case of 'Caring for the earth', care is understood as a responsibility to treat "all creatures decently and protect them from cruelty, avoidable suffering and unnecessary killing" (14). However, the value it allocates to nature still seems to be largely instrumental, as "responsibility for . . . impacts on nature" (14) is to ensure the continuance of nature's productivity and that human "uses of renewable resources are sustainable" (14), for the benefit of current and future generations.

These principles are acknowledged to show "respect for life in general" (Hattingh 2001: 6) while "emphasizing the importance of nature and ecosystems" (2001: 6). Hence, what 'Caring for the earth' makes us aware of is that while both intra-generational and inter-generation justice have anthropocentric objectives, there is a concurrent ecocentric concern that points out that equity cannot be achieved without preserving biodiversity and ecosystems. This adds a moral consideration that addresses "environmental protection and respect for life" (7) (an approach most strongly expressed in the theory of deep ecology). The idea is derived from the fact that the way in which human activities significantly and negatively impact natural systems (that sustain our lives) requires that we assume an environmental ethic in which an attitude of respect for nature in its own right, beyond its resource value.

The central difference between 'Caring for the earth' and the Brundtland Report, therefore is that the latter introduces "essential support for the principle of respect for life in general", and emphasises the importance preserving ecosystems though adherence to biological limits (IUCN, UNEP and WWF 1991).

As such, it represents an attempt at defining sustainability/sustainable development that is at once more equitable and integrative of the ecological dimensions of sustainability and the human economic and social dimensions. While it still prioritises the interests of humankind (Hattingh 2001), making it anthropocentric in orientation, its introduction of ecological value, the duty of care and the imposition of limits, absent from the Brundtland Report, moderates this position (2001).

In a context that recognises the imposition of limits, we can "discern the assumption that *structural adjustments* will be required in order to achieve sustainability or sustainable development" (Hattingh 2001: 7) and that, within industrialised societies, "the fundamental pattern of production and consumption and the values informing and perpetuating it, should be radically changed" (2001: 7).

5.1 What is so valuable that we ought to sustain it?

'Caring for the earth' understands sustainable development as an improvement "in the quality of human life" (IUCN, UNEP and WWF 1991). However, its first principle, "Building a sustainable society" (1991: 8), mentions that this should be done in conjunction with conservation of the "vitality and diversity of the Earth" (8) in order to maintain the "variety and productivity of nature" (8). Hence, it is human life, and the quality of that life, in union with the productivity inherent to the earth's biodiversity, that are so valuable that they ought to be sustained.

5.2 Why are human and other life forms so important that we ought to sustain them?

Housed within the strategy for building a sustainable society is the principle of "Respect and care for the community of life" (IUCN, UNEP and WWF 1991: 9), prescribing an ethic of "duty of care" (1991: 9), for humankind and all forms of life. 'Caring for the earth' mentions that "the species and systems of nature deserve respect regardless of their usefulness to humanity" (14). This suggests that the allocation of intrinsic value to nature, and not just humankind, is important, and hence nature is deserving of being sustained and cared for in its own right. Furthermore, 'Caring for the earth' recognises that all life on earth is part of a complex and "interdependent system" (9), providing a reason, in addition to ethics, for the protection of other species and their habitats.

Since humankind depends on ecosystem services for its basic survival, quality of life and economic prosperity, the maintenance of a rich and diverse nature is essential for human life to flourish. This requires "use of other species" (IUCN, UNEP and WWF 1991: 9), who provide a "resource base" (1991: 8), but in order to affect the duty of care, this should not be done "cruelly or wastefully" (9). Hence nature ought to be conserved, that is carefully used (or managed) as a resource to avoid depletion.

Thus, sustaining ecosystems through protection and restoration is important only to the degree required to deliver the services essential to human wellbeing (Hattingh 2001). As such, the interests of humankind remain paramount, which still retains an anthropocentric approach, albeit in a moderated form where ecosystems may still be interfered with, but within biological limits. Hence, while 'Caring for the earth' advocates "respect and care for the community of life" (IUCN, UNEP and WWF 1991: 3), it still retains an instrumental approach in which nature is regarded as a resource for human use. Where it differs from the Brundtland Report is that limits are imposed on the extent of this use (1991).

On our imagined spectrum, this has the effect of moderating, or 'softening' (Hattingh 2001) an anthropocentric approach, by attempting a limited form of harmony between socio-economic structures and the natural environment, but human interests still dominate. Its inherent recognition of human dependence on nature is sometimes seen as a more 'enlightened' form of anthropocentrism (Wackernagel and Rees 1996; Norton 1984). Wackernagel and Rees suggest that, within our current anthropocentric value system, this form of "ecologically enlightened human self-interest" (1996: 38) may provide the highest motivation to maintain meaningful biodiversity, and an appreciation of nature.

5.3 How ought we to go about implementing sustainability/sustainable development?

'Caring for the earth' understands sustainable development as "improving the quality of human life while living within the carrying capacity of supporting ecosystems" (IUCN, UNEP, WWF 1991: 10). Carrying capacity, it defines as "the maximum impact that the planet or any particular ecosystem can sustain" (1991: 43). In this case a sustainable economy, one that maintains its "natural resource base" (IUCN, UNEP, WWF 1991: 10) and condones the "management of habitats" (1991: 38), especially those that are large and commercially more viable, would be the product of sustainable development.

'Caring for the earth' therefore advocates development that is both "conservation-based and people-centred" (27), striving to create a balance between the two. It highlights human population density as a problem and suggests both a reduction in the size of the human population and resource demand, to equate with the carrying capacity of the earth, alongside a variety of other sustainability indicators. These include living a life of "dignity and fulfilment" (9), and is a move away from the single anthropocentric indicator of economic growth, which it acknowledges cannot "go on indefinitely" (9).

These indicators show that development, in order to be sustainable, would have to acknowledge ecological limits, as well as physical and psychological factors relevant to human wellbeing (Hattingh 2001). Adherence to ecological limits would mean that we "must not take more from nature than it can replenish" (IUCN, UNEP and WWF 1991: 8) and thus stay within the earth's carrying capacity without dangerous deterioration. This is to be achieved through policies that reduce human population together with technologically enhanced "careful management" (IUCN, UNEP and WWF 1991: 10) of the natural world. The acknowledgement of finite limits implies that structural changes would have to be made to our social and economic lives in order to adhere to these limits.

In this way, a more 'enlightened' anthropocentrism moves away from economic sustainability as a sole value, and emphasises the value of social and environmental value as goals of sustainability. It envisages a world of human flourishing in conjunction with environmental conservation. However, the natural environment still ought to be preserved for the benefit of man (Hattingh 2001), which suggests that 'Caring for the earth' cannot authentically realise its aim that "all the species and systems of nature deserve respect regardless of their usefulness to humanity" (IUCN, UNEP and WWF 1991: 14), as introducing intrinsic respect would require that we refrain from interference with nature altogether.

5.4 What are the criteria for sustainability according to 'Caring for the earth'?

According to 'Caring for the earth' (IUCN, UNEP and WWF 1991), the criteria that would imply a state of sustainability would be:

- The wellbeing of humankind, beyond a level of mere survival, is primary.

- However, ecosystems and all other expressions of life are important, because they maintain "the productivity, resilience and variety of the biosphere" (1991: 27), and should be cared for.
- The resulting moral obligation to protect, or at least refrain from, interfering with the natural environment is respected to the extent allowed by the carrying capacities of the ecosystems on which human wellbeing is dependent.
- This is on the understanding that humankind depends on ecosystem services for basic survival, quality of life and economic prosperity. This means that the maintenance of a rich and diverse nature is a non-negotiable necessity from a human point of view (this is missing from the Brundtland Report).
- Limits to the functioning of ecological systems are recognised, and should be adhered to, but use is still permitted within those limits for the purposes of safeguarding human social and economic wellbeing.
- The acknowledgement of finite limits implies that some structural changes would have to be made to our social and economic lives in order to remain within these limits.
- Hence, sustainable development is seen as improving the quality of human life to the extent permitted by the carrying capacities of the ecosystems on which is it dependent.

5.5 Critical assessment of 'Caring for the earth' contribution to sustainability

Since the possession of intrinsic value generates a moral obligation to protect, or at least refrain from interfering with, the natural environment, a degree of tension and uncertainty is created within 'Caring for the earth' where use of, and damage to, nature conflicts with its protectionist stance. Consequently, a trade-off between prioritised economic growth and the natural environment is still maintained and economic interests are still likely to take precedence. In this regard, despite its aim to intrinsically value other species, 'Caring for the earth' is unable, or unwilling, to fulfil the strictures required by respect for intrinsic value, and does not manage to fully break away from perceptions of dominance over nature.

'Caring for the earth' prescribes alteration to existing economic structures in so far as this is necessary to preserve the ecosystems that humankind depends on. Alteration is necessary to ensure a more equitable distribution of what nature provides to all the peoples of the world, and greater environmental preservation.

However, enlightened anthropocentrism still retains an instrumental point of view toward ecosystems in which they are protected only to the extent necessary to ensure human wellbeing. Consequently, enlightened anthropocentrism has the effect of easing, but not eliminating, the waste, pollution and inefficiencies generated by humankind (Luke 2002).

As a result, this position is weakened by questions raised as to whether human scientific and technological development is capable of maintaining ecosystems to the degree required to serve the needs of *all* humans, not just those living in developed countries, and whether this approach will be sufficient to protect biodiversity, which it recognises to be essential, in the longterm.

6. Deep Ecology

Environmental philosopher Holmes Rolston III (1988) contests these anthropocentric points of view (Hattingh 2001). Instead, Rolston offers an alternative perspective when he speaks of a 'naturalistic ethic', in which nature has intrinsic value, irrespective of its usefulness to humankind.

This constitutes a more radical and ecocentric vision of sustainability which indicates that what we are trying to sustain is all forms of life (Leopold 1949), including the health of the planet itself (Naess 1973; Lovelock 1974, 1979; Sessions 1995; Hattingh 2001; Rolston 2017). The basic tenants of ecocentrism are to place humankind on an equal footing with nature in a relationship of mutual interdependence, which would dismantle any notion of separation of humankind from nature, or dominance of it (Young and Macy-Brown 1998: 45-46). This would require the protection of, and minimal interference with, nature and that humankind learns to identify with, and confer value on, non-human life (Sessions 1995: xxii). As such, ecocentrism, "has profound implications for our attitudes and actions" (Macy and Young-Brown 1998: 45), and strongly advocates values and choices that are less anthropocentric.

It is possibly best illustrated by the theory of deep ecology, a school of thinking about the need to preserve nature and which views the health and integrity of natural systems as a primary concern. At its core, deep ecology challenges a worldview in which humankind is dominant (Naess 1973), which tends to separate humankind from, and negate, nature, leading to a tendency to degrade and use nature (Rolston 2017).

Deep ecology has arisen out of an awareness that "increased population, pollution, resource depletion, nuclear radiation, pesticide and chemical poisoning, the deterioration of cities and the disappearance of wildlife and wilderness, decreased quality of life, and continued economic growth and development at current rates of scale, complexity and productivity – indicates a decline in the quality of our biological relationships" (Sessions 1981: 392). Hence, deep ecology foresees that a "foundational change in thinking is needed" (Luke 2002: 182), in which we see ourselves as part of nature, where its flourishing is necessary to our flourishing.

6.1 What is so valuable that we ought to sustain it?

An ecocentric point of view would regard as valuable that which is of an ecological and natural basis (Hattingh 2001). Its innovation is that it introduces the perspective of complexity, and immerses humankind in a deep and complex set of relationships with our natural environment, which comprises all other living organisms. These relationships, because they are about interconnection and interdependence, negate any separation between humankind and nature. In it, humankind is positioned not as dominant, but as an equal (Naess 1973). Consequently, it focuses on the protection of entire ecosystems, and all living organisms within them.

An ecocentric position, recognising that we are a part of nature (Naess 1973), further "acknowledges that interdependence and diversity contribute to the flourishing of all human and non-human lives on earth" (Capra cited in Sessions 1995: 214), and that this is part of what we are trying to sustain. Such complexity makes thinking in terms of systems logic inevitable, as "everything is ultimately connected" (Thomas Berry cited in Sessions (ed) 1995: 11).

6.2 Why are all life forms so valuable that we ought to sustain them?

A defining feature of deep ecology is that all living organisms, human and non-human, are considered to possess intrinsic value (Sessions 1995: 20). Consequently, deep ecology proposes that the notion of an automatic basic moral right to life and flourishing that humankind is entitled to, can equitably be extended to non-human life. This corresponds to the notion of 'biocentric equality' (Naess 1973), a deep ecological norm that houses "an awareness of the equal right (of all things) to live and blossom" (Devall and Sessions 1985: 68. Also see Naess 1973: 100; and Young and Macy-Brown 1998). It requires that we learn to affiliate with forms of life other than our own (Wilson 1994 cited in Porritt 2006: 302).

Also see Sessions 1995: xxii; and Young and Macy-Brown 1998) and places their interests on a par with our own (for a more detailed answer regarding the basis on which deep ecology extends intrinsic value to all life forms (see section 5. 'Caring for the earth').

As a result, deep ecology is all about preserving resources for each species, not just humans, and that this should be incorporated into a very long-term view, in which a concern for future generations is expressed. An ecocentric position further suggests that "the purpose of sustainability is not to ensure mere survival (a weak interpretation of sustainability), but should broaden its capacity to ensure quality of life for all living species" (Hattingh 2001). In this way the protection of entire ecosystems, which are 'home' to these diverse life forms, becomes paramount to an understanding of sustainability.

An ecocentric position adheres to a very strong interpretation of sustainability (Hattingh 2001), in which the world's total stock of natural resources should be kept intact so that "the regenerative and creative systems of nature are preserved in order to continue functioning indefinitely" (2001: 9). A pre-requisite would be the preservation of a rich state of biodiversity. In other words, what we are trying to sustain is life in general, and the very conditions that bring that life about and enable all forms of life to continue (Hattingh 2001).

6.3 How ought we go about implementing sustainability/sustainable development?

Strong sustainability is a position wholly supportive of the protection, conservation and enhancement of ecosystems in an integral state (Naess 1973). Ecosystem integrity, in this case, refers to an ecological system that retains (Norton 1992: 107 cited in Hattingh 2001: 14):

(a) the total diversity of the system, with its sum total of species and associations that have held sway, historically: and

(b) the autonomous processes (systematic organization) that maintain that diversity, including, especially, the multiple layers of complexity through time

Ecosystem integrity is not the same as, or conflated with, ecosystem health. Ecosystem integrity refers to the original ecosystem (Rolston 2017) from which human interference, or induced change, is absent.

The preservation of ecosystem integrity is oriented toward the preservation of unfettered nature (Rapport 2003). Ecosystem health, on the other hand, is more likely to be found in "ecosystems that have been modified by human activity" (Karr and Chu 1999).

Ecosystem health is a metaphor for the condition of an ecosystem. An ecosystem is healthy if, despite management intervention, it still possesses dynamic stability over time (Rolston 2017), and "the systemic capacity for self-repair when perturbed is present" (2017: 165). As such, it remains "resilient to stress" (Constanza, Norton, and Haskell 1992: 9 cited in Rolston 2017: 165). Furthermore, ecosystem health also refers to ecosystems that while they may be lacking some of the original species, may also include some that have been introduced by human cultures (Rolston 2017), they are still able to perform ecosystem functions.

Inherent in the preservation and protection of natural ecosystems in an integral state, is that "other species and natural systems should also be seriously considered, for their own sake" (Hattingh 2001: 10), irrespective of their usefulness to humans. What emerges from this position of strong sustainability is that the notion of natural limits be made explicit, the point being to protect the diverse and healthy functioning of ecosystems. Any use of ecosystems that ignores this cannot be presented as progress or economic growth (2001), since it is ultimately ecologically unsustainable (Wackernagel and Rees 1996).

Hence, an ecocentric position insists that humankind learns to live on the services generated by existing natural assets, while leaving the net capital stock in place (Hattingh 2001). This implies that what ecosystems and earth systems provide humankind with, can never find and like equivalent with financial, manufactured or human capital. Since it is a perspective that supports ecosystem integrity, it requires that we interfere minimally with ecosystems, managed by the imposition of strict limits, and adopt a worldview where waste and pollution are not merely eased, but eliminated entirely (Naess 1973). As such, deep ecology prescribes profound structural change to the global economy and to our lifestyles.

Furthermore, in social terms**,** a deep ecology approach to sustainable development implies fairness that the basic needs of all people, and other forms of life across the world, are met. This arises from the deep ecology principle that prescribes equal respect for the needs of human and non-human life alike. It is an egalitarian approach.

The challenge, however, is immense and lies at the crux of solutions to sustainability/sustainable development: how, if we are to use less resources and reduce our imposition on ecosystems to a minimum, we do ensure the wellbeing of all life within the context of a growing human population, which only imposes further on ecosystems?

In this regard, deep ecology takes the radical step of describing a situation in which "humanity must drastically downscale its industrial activities on earth, change its consumption lifestyles, stabilize and then reduce the size of the human population by humane means, and protect and restore wild ecosystems and the remaining wildlife on the planet" (Sessions 1995). To do this, it should combine "traditions of pre-capitalist, non-urban, pre-industrial primal peoples" (Luke 2002: 181). For example, Devall and Sessions (1985: 3) and Naess (1973) suggests that the creation of small communities in which ecological consciousness is cultivated simultaneously with the protection of ecosystems (Devall and Sessions 1995: 1985: 3).

The mode of living in small communities is to take from nature only what is vital to meet basic human needs. In this way nature is not managed, altered, polluted or over-extracted from, which contributes directly to the rehabilitation and flourishing of ecosystem health. Ecosystem health is what humans depend on for their own survival and flourishing, thus contributing directly to human wellbeing. Living in this manner allows humans to identify temporally and spatially with nature (as opposed to highly industrialised cities, with little green space and in which people are dislocated from food production and the natural habitats of non-human life). When living in small communities, human learning is more easily modelled on sustainable activities, where attitudes of restraint and mutual respect shape action.

Some historical examples of such thinking are Christian Franciscanism, Taoism, Buddhism and hunter-gatherer tribes (Luke 2002). Their re-interpretation in our contemporary age would amount to what Luke (2002) refers to as 'future primitivism'. A tenant of deep ecology is that we cannot live connectedly with all of life if we retain, or are blind to, the dominance of humankind (Macy and Young-Brown 1998). Yet this retention or blindness is deeply embedded in our culture and consciousness. Thus, deep ecology envisions the personal development of an ecological consciousness in which human beings come to see themselves as an equal part of nature, as a necessary catalyst to induce a paradigm shift away from destructive anthropocentric values (Naess 1973).

Having an ecological consciousness implies having a theory of value that recognises intrinsic value in nature (Rodman cited in Sessions 1995: 125. Also see Sessions 1995); recognises the importance of relationships and systems; ethics that include the duty of non-interference and where intervention is limited to the repair of environmental damage; forms of human cohabitation with nature that are knowledgeable and respectful; and restraint in the use of nature (Sessions 1995: 125-126).

It also means that human beings experience themselves as part of nature (Luke 2002), because the ability to confer value on non-human life stems from the ecological consciousness that nature and the self are one. This is substantiated by an awareness of complexity and the interconnectedness of all living things. If this connection with nature is made, then it is more likely that humankind will care for it since "The requisite care flows naturally if the self is widened and deepened so that protection of free nature is felt and conceived of as protection of our very selves" (Naess 1973). Or, put another way, humans are inclined to care for the things they love, or at least value.

6.4 What are the criteria for sustainability of a deep ecological approach?

An ecocentric interpretation of sustainability comprises the following criteria:

- All living organisms possess intrinsic value, independent of their utility (Leopold 1949; Naess 1973; Sessions 1995; Capra 1996; Hattingh 2001; Rolston 2017).
- Hence, it is all life, and not just human life, that we are trying to sustain (Sessions 1995; Hattingh 2001), as expressed in the term 'biocentric equality' (Naess 1973).
- To respect the intrinsic value of all organisms requires that resources for each species (not just humans) be preserved (Naess 1973; Sessions 1995; Hattingh 2001).
- Sustainability is thus about the protection of entire ecosystems in an integral state, to ensure that "the regenerative and creative systems of nature are preserved in order to continue functioning indefinitely" (Hattingh 2001: 9).
- A pre-requisite for this would be the preservation of a rich state of biodiversity (Hattingh 2001).
- Preservation of biodiversity requires that ecological limits needed to protect the diversity and healthy functioning of nature be made explicit (Hattingh 2001).
- Consequently, humankind will have to live on the services generated by existing natural assets, while leaving the net capital stock in place (Hattingh 2001).

- This asserts that manufactured, human and financial capital cannot supplant the critical services that ecosystems and earth systems provide us with.
- Waste and pollution would have to be eliminated entirely.
- This implies drastic change in the nature of the current economy, reducing both its scale and rate of productivity (Sessions 1981).
- Deep ecology requires a 'foundational change in thinking' (Luke 2002: 182) away from ideas of dominance to interdependence. This would bring about extensive changes to our lifestyles and to global economic structures.
- It takes up a view far into the future, in which the wellbeing of generations to come are taken care of by current generations using fewer resources, thus preserving them as much as possible.

6.5 Critical assessment of a deep ecology approach to sustainability

While deep ecology paints prospects of what might be, it fails to outline practical means for attaining this vision (Luke 2002). This is compounded by a context where, according to the Millennium Ecosystem Assessment (MEA 2005), humankind has already breached the limit (maximum rate) at which vital services can be extracted from the world's ecosystems. Since any human use of ecosystems alters these systems (MEA 2005), how can we meet the increasing needs of humankind without imposing on other life-forms present in those ecosystems, whose intrinsic value dictates an 'ethic of non-interference' (Sessions 1995: 125-126)?

In other words, tension arises when the goal of human survival clashes with considerations that pertain to quality of life and interference with nature (Hattingh 2001). This is because the use of resources required to maintain ecosystems in an integral state "generates opportunity costs that could undermine the goals of quality of life as well as human survival" (2001: 10). Additionally, this plays out over time since the resources required to equalise distribution between those currently alive may compromise the maintenance of a sufficient store for generations yet to come to enjoy the equivalent.

When it comes to finding a solution to these problems, deep ecology prescribes a humane reduction in the human population, although it does not describe how this could be achieved, and cultivating numerous small, self-sufficient ecologically conscious communities who live with minimal impact on surrounding ecosystems. However, this is complicated by the fact that the world's city dwellers are the fastest growing sector of the human population (UNEP, UNDP, WWF 1991). Currently, it is estimated that over 50% of the world's population live in cities, a number expected to rise to about 66% by 2050 (UN DESA Population Division 2014). On this basis, half of humanity is expected to live in cities by the end of this century (2014: 104). Megacities with a population of 10 million or more are also increasing in number (2014).

Deep ecology omits any mention of how to solve the problem of converting contemporary densely populated cities into the desired small, self-sufficient communities of a few hundred people, after having done away with industrial mechanisation upon which the functioning of such cities relies. Deep ecological precepts also call for a substantially reduced human population, but do not explain how this could be brought about.

Deep ecology is totalitarian in requiring and assuming that it should be possible to cultivate in every human being, ecologically aware values of "Taking care of a place, bringing an attitude of watchful attention to the environment, focusing on self in nature and finding maturity and joy in natural being" (Luke 2002: 184). These are values shared by lovers of the outdoors but are by no means universal, perhaps especially in the case of those born and raised in urban environments as mentioned above and who have little experience of wilderness.

In summary, it seems doubtful that anyone born in an industrial, globalised modern society would be able to consistently fulfil all the strictures of deep ecology, this suggests that it may not be possible to operationalised fully (Luke 2002). However, while it might be lacking in means for practical application, the thinking of deep ecology still holds valuable insights with regard to the relationship between humankind and our natural environment. It questions human civilization and identifies human population density and lack of awareness of the functioning of ecological systems as a problem. Moreover, it voices scepticism as regards the ability of technology to manage these natural systems successfully (Sessions 1981: 392).

Its value is to be found in the view its shapes of the connection between humankind and the natural environment. In this relationship, "ecocentrism and deep ecology enlarge the class of beings whose good ought to be taken into decision-making consideration" (Sessions 1995: 123), on the basis that all life possesses intrinsic value and from that, to draw appropriate limits to human conduct. What these ideas of ecocentrism show us is that it is life – and not just human life, but all biological life – and the quality of that life, that is important and part of what we are trying to sustain.

Sustainability thus requires the allocation of value, often previously ignored, to the ecological and social sources of our wellbeing (Hattingh 2001). Since "The pace of stock depletion and accelerating global changes suggests that remaining natural capital stocks are already inadequate to ensure long-term ecological sustainability" (Wackernagel and Rees 1996: 37) called for in the Brundtland Report, in practical terms, what deep ecology and ecocentrism recognise is that "limits are put on the nature and scale of human activities by the environment itself" (Hattingh 2001: 13). Hence, inherent to an understanding of sustainability/sustainable development is the need to recognise, in our decision-making, that finite biological and physical boundaries exist in nature that cannot be exceeded.

These circumstances would suggest that strong sustainability, in which humankind lives off the services generated by the natural world while leaving ecosystems intact, "to protect the diversity and health of our nature heritage" (Hattingh 2001: 9), is a necessary foundation to ecologically sustainable development (Wackernagel and Rees 1996; Hattingh 2001). Consequently, the notion of natural limits should be made explicit (Hattingh 2001).

Strong sustainability also sets the condition that each generation inherit "an adequate stock of essential biophysical assets that is not less than the stock of such assets inherited by the previous generation" (Wackernagel and Rees 1996: 38). Hence, it requires, too, that we work with extended time scales (Wackernagel and Rees 1996; Hattingh 2001; Elkington 2012).

The motivation for doing so would be as much to support the health of the natural environment as a means to ensure human wellbeing, as to respect the needs for all forms of non-human life, who equally depend on a healthy environment for their own wellbeing.

This shift in worldview away from the anthropocentric and short-term, goes hand in hand with a change in what is valued. This changes from an exclusive focus on human wellbeing to a recognition of the need for all life to experience wellbeing. It also represents a move away from reductionism to holism and integration.

This need for a reorientation of values derives an outdated worldview (and its associated concepts and values), which is inadequate for dealing with the problems of an overpopulated, globally interconnected world (Devall and Sessions 1995:19). Seen another way, it is a move away from an instrumental worldview to an ecologically interrelated, whole-systems view which appreciates the functional relationships that form a living whole.

In this regard, Devall and Sessions (1985) resolve that deep ecology embodies the values of being part of a larger community (which stresses interconnectivity and interdependence), and that this perspective encompasses empathy and a notion to save. Finally, deep ecology communicates that limits to human domination and a sense of dependence are imperative in which "Living as if nature mattered is a vitally important goal". (Luke 2002: 184)

7. Sustainability criteria alternative to the Brundtland Report

What a quest for sustainability points to is that ecosystems and biodiversity are critically important to human life (Constanza *et al.* 1997; Hattingh 2001; MEA 2005; Lovelock 2006; Rolston 2017). This occurs at the level of survival, but also beyond survival in terms of what is needed to live a happy and healthy life and maintain a flourishing economy (Hattingh 2001; Porritt 2006). It shows that human life, and the quality of that life, and the economy, need to be part of and are dependent upon ecosystems (Hattingh 2001). This is a point that ecocentric theories, such as deep ecology, bring to our attention.

Consequently, the answer to what is so valuable that its sustenance should be ensured in perpetuity is: life. Not just human life (an anthropocentric position) but the lives of all living things within ecosystems (an ecocentric position) (Hattingh 2001). Supportive evidence from the Millennium Ecosystem Assessment (MEA 2005) however, confirms a disregard for, or lack of awareness of, what ecosystems are and how they support life: "Over the past 50 years humans have changed eco-systems more rapidly than ever before in history to meet demands for food, fresh water, timber, fibre and fuel "(Swilling and Annecke 2012: 29); the "costs are the degradation of eco-systems" (2012: 29); and that this "will get worse over the next 50 years" (29). This is destructive to the point that it is threatening the viability of critical ecosystems and consequently, the circumstances necessary to sustain the wellbeing of humankind and other species, but also threatening its life-support general (Hattingh 2001).

The Brundtland Report's definition of sustainable development is reflective of this destructiveness, when it suggests that the environment's role is to act as a resource base for the economy and that the expansion of the economy is limitless, and consequently that natural capital is substitutable with human, manufactured and financial capital (as long as the total combined value of these capital stocks stays the same) (Hattingh 2001). Such an interpretation does not acknowledge the importance of ecosystems and the requisites for their flourishing (which includes the notion of biological limit), and is contested here.

The Brundtland Report's failure to acknowledge limits imposed by ecosystems on the nature and scale of human use of these systems for the sake of economic growth, is a denial of the fact that stocks of certain assets are finite, like coal and fresh water, while others are regenerative as long as critical thresholds are not exceeded, such as soil fertility (Hattingh 2001; Rolston 2017).

As entrenched as the perception may be, sustainable economic growth does not mean material growth (Devall and Sessions 1985). This is due to the fact that economic growth is "now confronting both *source limitations* (scarcity of natural resources) and *sink limitations* (saturation of the natural capacity for dilution and neutralisation of pollutants and wastes)" (Gallopin 2003: 25. Also see Wackernagel and Rees 1996).

This illustrates why current economic structures are unsustainable as, in the long run, they are biologically unsustainable. An additional problem with equating sustainable economic growth with material growth, as the Brundtland Report does, is that "all values are hereby reduced to a single (monetary) scale" (Hattingh 2001: 14), which makes the substitution of capitals possible, but which is blind to the "impacts it may have on the health and integrity" (2001: 14) of ecosystems. This leaves us in a position where we are challenged to develop sustainability criteria alternative to the Brundtland Report (2001). Such alternative criteria would have to recognise a relationship between human social systems (of which the economy is one) and ecological systems (Hattingh 2001).

To be sustainable, such a relationship would allow human life not only to continue and flourish indefinitely, but would ensure that human activities remain within biological boundaries prescribed by ecosystems so as not to affect their health (and integrity), as an ecosystem services approach sets out to do (Constanza *et al.* 1997). Consequently, any set of criteria alternative to the Brundtland Report would have to consider natural thresholds, which would foreclose any form of inter-substitution of resources, technology or human organisation (Hattingh 2001) and recognise equity as part of a definition of sustainable development.

In debates about the implementation of sustainability (sustainable development), the difference between weak and strong underscores the question of what value nature has, and consequently how much nature (and in what state), "needs to be conserved in order to achieve sustainability/sustainable development" (Hattingh 2001: 8). Since a weak interpretation of sustainability (embraced by the Brundtland Report) fails to address critical natural thresholds and thereby a more equal distribution of resources, what is supported here is a far stronger interpretation of sustainability. This would maintain the integrity of our natural resource base by respecting biological thresholds for current, as well as future, generations, resulting in the sustenance of quality lives for all forms of life as far as these boundaries permit.

We thus need to "develop alternative criteria for a state of sustainability/sustainable development to those developed in the Brundtland Report" (Hattingh 2001: 14) that will summon fundamental choices with regard to the value placed on nature and the meeting of critical thresholds to sustain that value (2001).

Sustainability values nature in its rich and diverse form because of the dependence of all life – not just human life – on the intricate functioning of intact ecosystems to ensure its continuation (Rolston 2017). Wellbeing happens when all life has access to the natural provisions, they need to meet not only basic needs, but are afforded the environment necessary to fulfil their potential. Since nature cannot support wellbeing in a diminished state, it follows that ecosystems must be protected and preserved to their fullest biological expression.

This necessitates the making of choices (which unavoidably denote forms of value) to conserve sufficient natural capital to ensure wellbeing for all forms of biological life alive today and into the future. A central criterion for this conception of sustainability is that natural capital be maintained over time (Constanza *et al.* 1997, 2017; Hattingh 2001; MEA 2005), for current as well as future generations, requiring that natural biological limits imposed by nature be articulated and adhered to.

The process by which this should be implemented, sustainable development, is understood to apply to positive changes in support of the structural transformation of the current economic system, to one that is able to integrate environmental conservation, necessary to wellbeing, with a flourishing economy (Hattingh 2001). This elimination of the causes of the problem, these being our intensely extractive economies and lifestyles, as well as consideration for the wellbeing of future generations. Imperatively, it requires the valuing of nature "If not as a then certain aspects of it, as something more than a mere resource for human use" (2001: 19). Consequently, sustainability is an argument for the preservation of all forms of life.

In this light, "the preservation of the environment –a biocentric viewpoint –is the "ethical precondition for sustainability" (Gallopin 2003: 15), congruent with a stronger interpretation of sustainability. Given finite biological limits, it would impose limits on the nature and the scale of economic extraction. This would call for structural changes to the economy, institutions and human lifestyles where resource extraction is reduced to a bare minimum, well below critical biological thresholds, if not eliminated entirely. This would result in vastly more efficient economies, lifestyles and the recycling of resources, characteristic of the steady state economy described by Herman Daly (1973).

It would further prescribe economies in which resources can be redistributed more fairly among all peoples of the world to ease the life of the poor, and future generations, while adhering to natural limits imposed by biological boundaries on the systems that supply these resources (Hattingh 2001).

8. Conclusion

The conception of a form of development that is sustainable as expressed in the Brundtland Report is highly anthropocentric, reflective of a current anthropocentric value system. It places the emphasis on human survival, and not wellbeing, and does not consider the wellbeing of other species. However, the continued provision of ecological services essential to humankind's survival and wellbeing does require their conservation, which necessarily means the "direct protection of whole ecosystems" (1996: 38).

Sustainability therefore entails the allocation of increased value, previously largely ignored, to the ecological and social sources of our wellbeing (Elkington 2008). Because of this, and in the knowledge that there are no substitutes for certain natural resources, the conservation of ecosystems becomes a precondition for sustainability, and whose health therefore cannot be undermined without a loss in social welfare and wellbeing.

Seen in this way, the central ideas that pertain to sustainability and sustainable development are radical in that they place humankind as dependent, and not dominant, and suggest structural changes to the economy. This would be to "achieve an enduring solution to environmental problems, or at least create a situation where they can be controlled" (Achterberg 1994b: 136 cited in Hattingh 2001: 4).

These changes evoke the idea of an economy that, instead of depleting nature, restores it. The criteria for sustainability offered here are also radical in their condition that ecosystem conservation and health enjoy parity, if not precedence over economic activities. What this shows is that when making decisions, it is important that our choices take natural thresholds (limits) into account and that our choices decline any confidence in technology to take the place of critical natural processes.

Since these ideas of sustainability/sustainable development house an alternative to the existing trajectory of unsustainable development that the global economic and social order is pursuing, they possess strategic value (Hattingh 2001:17). Ideas of biological thresholds and the lack of substitutes, for natural processes promote the thinking that the values we have used to steer our lives by have become "inadequate to appropriately respond to changed situations" (Hattingh 2001: 18). By implication, they now require an economy shaped to correspond with limits of environmental carrying capacities, and present a new platform of regulative goals on "the basis of which governments, industry, commerce and consumers can be held accountable for unsustainable practices and policies" (Hattingh 2001: 17).

In an attempt to understand what kind of conceptualisation of sustainability we need, the ecosystem services paradigm has emerged as a powerful concept. Its advancement is that it has developed sustainability criteria that recognise a relationship between human social and ecological systems that are missing from the Brundtland Report's conceptualisation of sustainability. Furthermore, it attempts to more clearly delineate ecosystem thresholds than 'Caring for the earth', and overcome the lack of practical application that characterises a deep ecology approach. This approach plays an important role in enhancing our ecological understanding of the role ecosystems play in the world and the multiple benefits we receive from them. Following, once more, the format of Achterberg's four value-related questions, chapter three focuses on a values analysis of an ecosystem services approach, followed by a critical evaluation of this approach in order to assess whether it gives due consideration to the ecocentric approach, which has been advocated in this chapter.

Chapter Three

1. Introduction

In sustainability circles, much conversation revolves around ecosystems and the idea of ecosystem services. This is likely because "the idea that nature provides services to people is one of the most powerful concepts to have emerged over the last twenty years" (Potschin, Haines-Young, Fish and Turner 2017: i). This power arises from its shaping "our understanding, and language, of the role that biodiverse ecosystems play in valuing the environment and what ecosystems provide humankind with, and is attracting growing global interest in operational and methodological issues surrounding ecosystem services (Potschin *et al.* 2017).

For example, concepts of ecosystem services and natural capital have come to frame environmental policy and management in several countries (Pittock, Cork and Maynard 2012) and have achieved broad acceptance at policy level, evidenced by their inclusion in the United Nations Millennium Ecosystem Assessment (MEA 2005); The Economics of Ecosystems and Biodiversity (TEEB) (2008) (a transdisciplinary global initiative), utilised by the European Union, the United Kingdom National Ecosystem Assessment (2011); and the Global Reporting Initiative (GRI) (2011), that offers leading, comprehensive and up to date guidelines on integrated reporting.

Central to the concept is the idea that the value of ecosystems can be communicated to society in monetary terms, making nature a form of capital, so that the environment can better be taken into consideration in decision-making (Constanza *et al.* 1997, 2017; Potschin *et al.* 2017). Additionally, an ecosystem services paradigm helps us reconceptualise and convey the relationships between people and nature, considered essential to resolving challenges of poverty reduction and sustainable development (Constanza *et al.* 1997, 2017; Potschin *et al.* 2017).

With this in mind, the following chapter gives an overview of what an ecosystem services approach to sustainability comprises. In particular, it focuses on what it does to advance or detract from the debate on sustainability/sustainable development, and its ethical implications. The chapter begins with a brief explanation of ecosystems as complex systems, why they are important, and how it is that we come to speak of 'services' provided by them.

It then goes on to explain the ecosystem services approach as a relatively recent approach to sustainability that emerged from ecological economics, and also giving a short overview of what the approach entails. Finally, with this as a background, at the hand of Achterberg's (1994) value analysis, we are in a position to ascertain what an ecosystem services approach brings to help advance the discourse on sustainability and in what ways this approach is still problematic.

2. Ecosystems as complex systems

To facilitate a richer discussion and discuss what an ecosystem service approach entails, it is perhaps first necessary to conceptually envisage, in simple terms, what an ecosystem is. Ecosystems are complex systems, and any changes that occur calls into question their stability (Rolston 2017). Stability is the extent to which they can resist perturbations and show resilience without changing to some other state, which would then compromise the provision of ecosystem services (Rolston 2017).

The question of stability also recognises critical biological thresholds, which when exceeded, change a given ecosystem, but in a cascade-effect also change other ecosystems with which it connects. Thus, stability is that which enables ecosystems to continue with essential processes, and it is these essential processes that provide humankind with what we term 'ecosystem services' (Constanza *et al.* 2017). An ecosystem services approach has emerged in response to a realisation of the extent of ecosystem degradation and change. The solution it suggests is restoration of these natural systems, such as a wetland, but also their intensive management in human hands, with the goal of continued provision of services (Spash 2009; Rolston 2017).

The ecosystem concept has its roots in theoretical concepts regarding the organization and dynamics of natural systems (https://enviroliteracy.org/ecosystems/ Accessed on July 30, 2018), especially that of inter-connection. The word itself was first suggested by scientist Arthur George Tansley in 1935 to describe the entire system of "living organisms and interacting inanimate factors such as air, water and minerals occupying a given space" (Tansley 1935: 306). The term 'ecosystem services' also appeared in Ehrlich and Ehrlich (1981), and in Ehrlich and Mooney (1983).

In its contemporary usage, however, an ecosystem is generally understood as a "community" (Rolston 2017: 158) of "biotic" (System of Registries United States Environmental Protection agency. Accessed online on 31 October, 2018) organisms, for example, plants, animals, insects, fungus and micro-organisms, living in a particular environment, and the abiotic elements in that environment with which they interact as an "ecological unit" (System of Registries United States Environmental Protection agency. Accessed online on 31 October, 2018).

Daniel Botkin thinks of an ecosystem as "a certain kind of system composed of many individuals of different species … and their environment, making together a network of living and non-living parts that can maintain the flow of energy and the cycling of chemical elements that, in turn, support life" (Botkin 1990: 62, 7 cited Rolston 2017: 168). They are "complex" (Rolston 2017: 167) and "integrated" (2017: 67)

Ecosystems are open systems (Rolston 2017: 159). Open systems have no fixed boundaries. This allows frequent exchange between systems and their environment, from which they constantly receive rich feedback. Where one ecosystem ends and another begins depends less on physical boundaries than on the scale of analysis. Instead, their boundaries are perceived according to the question being examined. Depending on one's interest, they occur on a spectrum of scales, with smaller systems homed within layers of ever-expanding larger systems.

For example, this could be the algae in the pond, the pond as an entity with boundaries, the pond's role in the regional watershed or the pond's existence as part of the wider global hydrological system. An implication of open systems is that they are complex, hard to experiment on and therefore resist analysis (Rolston 2017). This causes much uncertainty about the functioning and implications of the changing nature of ecosystems and confounds their management (2017).

An ecosystem comprises component organisms that generate systemic processes among them that, additionally, "support and integrate tens of thousands of member organisms" (Rolston 2017: 159). The species that make up the ecosystem are involved in a complex web of interrelationships where the behaviour of one species will ultimately, through a series of connections which could be both direct or indirect, affect the experience of others. In it, the appropriate unit of moral concern, Rolston (2017) postulates, is the fundamental capacity for development and survival. This is supported by Botkin's observation of an ecosystem as a certain kind of system that supports life. The capacities for development and survival of ecosystems are appropriate unit for moral concern because they are responsible for creating the conditions that produce and sustain all life on earth (including our own). There is nothing more important than the sustenance of life.

As a complex system, "Ecosystems have various feedback and feed forward loops" (Rolston 2017: 160). These are checks and balances that help the system to self-regulate. In them, "Different animals and plants have their niches" (2017: 160). A niche is the 'fit' a given species enjoys under specific environmental conditions, that determines resources and competition present, and the response of the species to these and other organisms.

Ecosystems are climatically adapted (Rolston 2017). For example, some can be constant, which means that they have dimensions that change little. In an untouched rainforest, the temperature remains much the same all year around, and the species richness and evenness remains much the same, too (2017).

Ecosystems have inertia, that is, the extent of their ability to resist external perturbations (Rolston 2017). This may be as a result of feedback loops that manage to dampen changes. Ecosystems may also be 'elastic' (2017: 160), which means that they "return rapidly to their former state after perturbation" (2017: 160). This will depend on factors such as the degree or "*amplitude* of perturbation" (160), "the area disturbed" (160) and the extent of that disturbance.

Ecosystems may have '*cyclic stability'* (Orians 1975 cited in Rolston 2017: 160), which means that they predictably deviate from and eventually return to some central norm, "or they may have '*trajectory stability*', that is, move steadily along routes of succession" (2017: 160), where "ecological succession is the process by which the structure of a biological community evolves over time" (Encyclopaedia Britannica. Accessed online on October 31, 2018).

What all of this brings to light – constancy, persistence, elasticity, inertia, cycles and trajectories – is the question of the stability of ecosystems and what supports it. "The stability of ecosystems is a dynamic stability" (Rolston 2017:160), which means that it possesses the capacity to regain its original state following a disturbance, or does not change unrecognisably when disturbed. Constancy, persistence, elasticity, inertia, cycles and trajectories demonstrate the various means by which ecosystems manage to achieve and maintain forms of stability that enable them to continue with essential processes. At the same time, they show that there is no one and only stable state that an ecosystem should always have, meaning that they are evolving constantly. The stability of ecosystems is therefore not rigid, but 'dynamic' (2017: 160).

This is in line with latter-day ecological thought, such as that of Pickett, Parker and Fielder, who propose that ecosystems are less stable and more open than originally thought*:* "The classical paradigm in ecology, with its emphasis on the stable state, its suggestion of natural systems as closed and self-regulating, and its resonance with the non-scientific idea of the balance of nature, can no longer serve as an adequate foundation for conservation. The new paradigm, with its recognition of episodic events, openness of ecological systems and multiplicity of locus and kind of regulation, is in fact a more realistic basis" (1992: 84 cited in Rolston 2017: 161).

Certainly, “There are ordered regularities” (Rolston 2017: 161) such as the tides, “mixed with episodic irregularities” (2017: 161) such as a tsunami. “Over much longer time scales there are climatic changes, respeciation, new niches generated and occupied” (161). The dynamic stability of ecosystems embraces “variation and change” (161), rather than avert them, and the history of an ecosystem reflects this dynamic stability. The dynamic nature of ecosystems, observes Claudia Pahl-Wostl, is “chaos and order intertwined” (Pahl-Wostl 1995 cited in Rolston 2017: 162). Rolston adds “Perhaps no equilibria are permanently kept, but ecosystems are equilibrating systems composed of co-evolving organisms, with checks and balances pulsing over time” (2017: 162). An important consequence of this is that “Patterns of growth are orderly and predictable enough to make ecological science possible–and also to make possible an environmental ethics respecting these dynamic, creative, vital processes” (163).

Many biologists are inclined to see evolutionary nature as a self-organising system (Rolston 2017), in which the properties of a system as a whole determine how the parts behave (2017). This gives the idea of community, where ‘community’ is more than a collection of individuals (2017). In other words, the whole is greater than the sum of the parts. A community, even though it may not comprise “organismic individuals” (Rolston 2017: 166) refers to a context where everything is connected and that possesses “creative stimulus and open-ended potential” (2017: 166).

What is of significance is that in order for an ecosystem to be whole, or have integrity, it must possess the capacity to evolve (Rolston 2017), and this must be born of genetic diversity and dynamic change. Since ecosystems are open systems, this is how they adapt to changes in their environment, ensuring their survival and continued functioning, although perhaps in an altered form.

Dynamic change and changes through time are responsible for the development of an ecosystem, together with the member species in it. Such change over time is made possible by a dynamic “stability that also supports variation” (164: 2017). The implication of this is that the high degree of interconnectedness between ecosystems means that there are many variables to consider when trying to determine the effect of change on ecosystem functioning, making predictions uncertain.

"Ecologists have basic ideas about how ecosystems work" (Rolston 2017: 164), but they do not have overarching theories, or laws that are universally true (2017), largely because of change and openness in ecosystems. Since an ecosystem services approach proposes the management of ecosystems, this poses the question whether it is possible to manage that which we don't fully understand?

It is a pivotal question, and one which we shall return to later. Rolston hints at an answer when he says that while grand theories (such as an ecosystems services approach holding the key to the sustainable conservation of the natural world) contain a measure of truth, in a complex situation they neglect a great many particulars, and this proves to be their undoing. In other words, they are too reductive, and fail to acknowledge vital relationships that connect components to create a 'whole'.

If we are to focus on ecosystems themselves, the threat that ideas of ecosystem management pose can be described as a "threat to ecosystem function, health, integrity, or quality" (Rolston 2017: 165). To recall from chapter two, ecosystem integrity exists where ecosystems have not been modified by human activity (Karr and Chu 1999). This would include human interventions or attempts at management (Rolston 2017). When DDT was discovered in the tissue of penguins in the Arctic, one of the remotest places on earth, the question was raised whether any completely integral ecosystems still exist (Rolston 2017). According to 'Caring for the earth', this could be the case, since its research suggests that "There are virtually no ecosystems in the world that are "natural" in the sense of having escaped human influence" (IUCN, UNEP, WWF 1991: 33).

For this reason, it is probably more appropriate to think in terms of sustaining ecosystem health, rather than integrity. Ecosystem health is oriented toward the conservation of ecosystem functions (Rapport 2003). It refers to ecosystems that, although modified by human intervention, still possess the capacity for self-repair when perturbed (Rolston 2017), making them resilient and able to preserve their dynamic stability over time (Rolston 2017). This means that the "systemic condition is dynamic and stable" and that "the systemic capacity for self-repair when perturbed is present" (Rolston 2017: 165).

In short, "ecosystem health is the state in which" (Rolston 2017:165) it is "active and maintains its organisation and autonomy over time and is resilient to stress" (Constanza, Norton and Haskell 1992: 9), which requires the maintenance of the full spectrum of original biodiversity (Rolston 2017) and can function with minimal management intervention (2017). Whereas ecosystem integrity refers to an original ecosystem, prior to any instance of human intervention or management.

Evidently, within the context of sustainability, the aim of conserving ecosystem health is human wellbeing, but what ecosystems provide is also integral to our economy. This suggests that ecosystem health has economic relevance. Now that we have a basic understanding, superficial as it may be, of what ecosystems are and what the nature of dynamic ecosystem stability in the face of change entails, we can turn our thoughts to the fundamental question as to how humankind is responding to ecosystem change.

Historically, two disciplines that have applied economic thought to the natural environment have been ecological economics and environmental economics (Spash 1999; Rolston 2017). The former is of particular interest to us as ecological economics, which attempts to integrate both social and environmental concerns into economics, is largely at the forefront of articulating the concept of "ecosystem services" (Constanza *et al.* 1997: 253).

3. What are ecosystem services?

A service can be thought of as an activity that is helpful, or that is able to supply or provide needed utilities or commodities. When applied to ecosystems, ecosystem services comprise the essential aspects of the natural world that make it possible for all forms of life, not just human life, to survive and prosper. Without them there would be very little human wellbeing to speak of (Rolston 2017). So, ecosystem services describe the "contributions of natural processes" (2017: 170), without which no economy (or culture) would exist or prosper.

These are the natural processes that are the stuff of life: oxygen, fresh water, fertile soils in which to grow our crops, and the diversity among non-human biological populations. Such processes are responsible for "primary productivity, nutrient dispersal and cycling, pollination, food, fuel, cleansing air and water, soil renewal, and living space that is habitable and pleasant" (Rolston 2017: 170).

In short, ecosystems provide numerous "services" (Constanza 1997: 253) that are of fundamental importance to "human welfare" (1997-259) and survival (Constanza *et al.* 1997; MEA 2005; TEEB Synthesis 2010; Rolston 2017), and are thus critical to notions of human wellbeing (Constanza *et al.* 2014). As already mentioned in Chapter One, but to elaborate here, the MEA (2005), categorised the following ecosystem services, on which the global socio-economic system is acknowledged to depend:

Provisioning services: These are ecosystem services that combine with human, built, and social capital to "produce food, timber or fibre" (Constanza *et al.* 2017:5). They include: "food (crops, livestock, capture fisheries, aquaculture, wild foods); fibre (timber, cotton, hemp, silk, fuel wood); genetic resources, biochemicals, natural medicines, pharmaceuticals and water" (Swilling and Annecke 2012: 29).

Regulating services: These combine with the other human, built and social "capitals to produce flood control, storm protection, water regulation, human disease regulation, water purification, air quality maintenance, pollution, pest control and climate control" (Constanza *et al.* 2017: 5) (global, regional and local), "erosion regulation . . . pollination; natural hazard regulation . . . "(Swilling and Annecke 2012: 29).

Cultural services: "combine with built, human and social capital to produce recreation, aesthetic, scientific, cultural identity, sense of place" (Constanza *et al.* 2017: 5) and "spiritual and religious values or other cultural benefits" (Swilling and Annecke 2012: 29), such as ecotourism.

Supporting services: These "describe basic ecosystem processes such as soil formation, primary productivity, biogeochemistry, nutrient cycling and provisioning of habitat" (Constanza *et al.* 2017: 6). "These ecosystem functions contribute *indirectly* to human wellbeing by maintaining the processes and functions necessary for provisioning, regulating, and cultural services" (2017: 6).

Constanza and colleagues point out that that these contributions to human wellbeing can only be derived from functioning ecosystems, whether people are aware of it or not (1997; 2017). This adds a further dimension to our understanding of ecosystem services in that this view places humankind as not separate from, but integrally connected to, the biosphere and, like all other species as, requiring environmental 'resources' to survive and thrive (Constanza *et al.* 1997; Rolston 2017).

This locates humankind within a greater system and makes it clear that the whole system, and the wellbeing of that system matters (to all species, not just humankind). Failure to recognise this independence with the rest of nature, and dependence on ecosystems in particular, puts the wellbeing of all life forms at risk. The dependence of human wellbeing on ecosystems is what makes them so important to humankind. However, until now a more conscious awareness of these processes has evaded us. Typically, they have been taken for granted and have consequently never been factored into the accounting of classical economics (Rolston 2017; Constanza *et al.* 1997, 2017).

As a result, over the past six decades most countries have made changes to ecosystems that, while they have brought about sizeable increases in human wellbeing and national development, have not been without collateral damage to ecosystems. For example, changes made have been necessary to keep up with on intensifying need for arable land and for food production, which has resulted in reduced malnutrition and improved general health. Owing to a growing human population and hence growing consumption, levels of extraction, use and interference, the natural systems that offer these services are being degraded. Degradation refers to a persistent decrease in the capacity of ecosystems to deliver services (MEA 2005: 17), the finality of which is system collapse or change into a new state.

The principal findings of the MEA established that human actions have managed to alter the "structure and functioning of the world's ecosystems" (MEA 2001: 18), that these ecosystems are changing, and that humankind is "fundamentally, and to a significant extent irreversibly, changing the diversity of life on Earth" (2005: 18). Biodiversity **(**genetic and species diversity) is a key component of ecosystem functioning that underlies all other ecosystem processes and services. It is integral to their functioning and is thus "critical to the supply of all services" (Constanza *et al.* 2017).

In sum, ecosystem change, although it is brought about by human actions, is putting human wellbeing, and economies, at risk. Ecosystem degradation is changing the natural world to the point where the ability of the majority of its ecosystems to sustain future generations is compromised, thereby diminishing the capacity of these natural systems to continue their critical provision. Those most likely to suffer from a deterioration of ecosystem services, or a decline in supply, will be those who depend on the natural world directly for survival – the world's poor (MEA 2005).

4. A brief history of ecosystem services

While the notions of ecological economics and environmental economics might seem similar enough to be interchangeable, they are not the same thing. Environmental economics applies "classical economic thought to natural systems" (Rolston 2017: 168. Also see Spash 1999), whereas ecological economics sought to "understand the dynamics of the Earth and eco-systems" (Swilling and Annecke 2012: 12), and their interaction with humankind (Constanza *et al.* 1997), particularly our economic systems.

Classical economics has, since the age of industrialisation began in the late 1700s, focused on labour, land and capital to create wealth (Rolston 2017). Land is what we today would refer to as natural resources, and in a classical economic outlook, land/natural resources were denied any independent value of their own. Instead, they were seen only as natural givens with which labour and capital could work (Rolston 2017; Constanza *et al.* 2017). Manifest in this equation was the conviction that economic growth was both good and unlimited. It made for increased consumption and therefore, it was assumed, better human welfare – all of this made possible by the efficient organisation of labour and markets (Rolston 2017).

A 'principal technique' (Rolston 2017: 169) when "dealing with natural resources is cost-benefit analysis" (2017: 169). This is a process of identifying and comparing the costs, value and benefits of a project, policy or decision (Buncle *et al.* 2013). Its objective is to figure out whether benefits outweigh costs, and if so by how much relative to other alternatives (2013), with the preferable decision being one that delivers a higher number of benefits at the least cost.

However, a shortcoming of this decision-making tool is that in order to be able to make cost comparisons, "all values must be reduced to a single (monetary) scale (Hattingh 2001: 14). This "makes it possible to interchange and, therefore trade off any value with every other one, regardless of the impacts it may have on the health and integrity" (2001: 14) of ecological systems. Additionally, in a situation where all values are monetised, moral aspects, and other non-monetary implications of a decision that might impact ecosystem health, are lost (Hattingh 2001).

From the 1950s onward, two things happened to undermine this model and bring the idea of ecosystems, which had not yet permeated mainstream economic thinking of accounting, to prominence: the effects of ecosystem degradation became apparent while simultaneously, human understanding of ecology was growing, in particular the ecology of ecosystems (Constanza *et al.* 2017). Recognising this, the academic field of ecological economics came about in an attempt to integrate ecological intelligence into economic decision-making (Constanza *et al.* 1997; 2017).

Ecological economics emerged in response to accumulating scientific evidence, from the 1970s onward that highlighted a decline in the components of biodiversity and consequently that prompted questions as to its importance. Increasingly, discussions turned to the role of ecosystems, of which biodiversity is a crucial component, in supporting and fulfilling human life. Ecological economics attempts to take seriously the notion that biodiversity, "ecosystems structure and functioning, and the resources humans build into their cultures are more than a useful component in a welfare-generating economic system" (Spash 1999: 414). Consequently, "ecological economics proposes that the natural world needs to be protected for efficient use, but also from exploitation" (Rolston 2017: 173).

This realisation was marked, in 1997, by "two seminal publications" (Constanza 2017: 2) about the 'services' humankind receives from ecosystems. The first was a book edited by Gretchen Daily titled '*Natures Services: Societal Dependence on Natural Ecosystems*' (Constanza *et al.* 2017: 2). It is significant as a synthesis of all the information assembled on ecosystem services and that later appeared in a quantitative global assessment of the value of ecosystem services (2017). The later "appeared as an article in *Nature* co-researched by a group of ecologists and economists, led by Robert Constanza" (2017: 2). Together these publications triggered significant further commentary, research and policy applications of the idea of ecosystem services (2017), in which natural systems are acknowledged to "contribute to human wellbeing" (Constanza 2017: 3) by providing "benefits that people derive from ecosystems" (2017: 3).

The *Nature* article synthesized assembled information "into a quantitative global assessment of the value of ecological services" (Constanza *et al.* 2017: 2) in an effort to estimate a monetary value of ecosystem services (Rolston 2017).

This amounted to a synthesis of "all existing literature on seventeen ecosystem services across sixteen biomes using a value transfer technique that assumed a constant value per hectare for each of the biomes (Constanza *et al.* 2017:2-3). Constanza and his colleagues arrived at a value of about $33 trillion (Constanza *et al.* 2014: 152), which was more than the global GDP that year of $27 trillion (in 2011, using updated data, this figure was revised to $125 trillion annually). So, they were able to show that the (non-accounted for) value of natural ecosystem services "exceeded the entire output of the global human economy" (Rolston 2017: 170). Their estimation, however broad, was catalytic in bringing about the realisation of the value of what the natural world does for us.

The point Constanza and his colleagues wished to demonstrate with their estimate was "that ecosystem services were much more important to human wellbeing than conventional economic thinking", based on classical economics, had ever considered (Constanza *et al.* 2017: 3). Until then, conventional accounting only valued the products of ecosystems, such as timber, when they were harvested or sold. It failed to account for and value other services provided by forests, such as "regulating climate, controlling flooding and erosion, and providing recreational and aesthetic opportunities" (2017: 3), for example.

The group wanted to demonstrate several things: that intact and well-functioning ecosystems provided many valuable services, mostly unacknowledged, that met or exceeded the value of their extraction and exploitation (Constanza *et al.* 2017), that it was possible to at least estimate their value; and that ecosystem services were important to human wellbeing (and welfare) Constanza *et al.* 1997; 2017*)*. Ecological economics thus focuses on the dependence of human economies on natural systems (Spash 1999; Constanza 2003; Constanza 2009).

Their motivation was to reposition what classical economics perceived as environmental 'externalities' (that is, external to the economy) as critical benefits humankind receives from nature. They belong to no-one and are enjoyed, for free, by all (Rolston 2017). Without them, there would be no economy, or much of a life, and hence, in the face of their ongoing depletion and degradation, "need to be factored into environmental regulations" (Rolston 2017: 170). This represents an attempt to incorporate environmental thinking into economics (Spash 1999) and demonstrates a need to "fundamentally change the current approach to economic analysis" (1999: 414) in order to achieve social and environmental sustainability.

What needs to change is the incorporation of natural systems as "distinctive elements of human production and welfare" (Spash 1999: 414), which an ecosystem services approach attempts to do. Ecological economists have observed that the classical economic aim of constant economic growth, driven by ever increasing consumption, degrades the natural environment and undermines ecosystem services (Rolston 2017). It also has social consequences; while many profit, those who suffer as a result are those who depend directly on ecosystems for survival, the poor (2017).

A classical economic paradigm ignores that the "natural context is of crucial importance" (Rolston 2017: 169) - the human economy is dependent on the natural world -, as it is "inseparably entwined with biological process" (2017:169), creating a 'bioeconomics' (169), a natural context in which it perceives economics to be embedded (Constanza *et al.* 1997, 2017; Spash 1999, MEA 2005).

The bioeconomics field realises that human actions are changing ecosystems, and in turn, changing ecosystems are influencing human actions. It indicates that environmental degradation cannot be analysed separately from economics, and vice versa, and requires moving away from classical economic paradigms that tend to separate or negate the interaction of nature with the economy. Bioeconomics suggests that an ecosystem services approach take seriously the conservation of biodiversity, ecosystems structure and ecosystems functioning, given that our dependence lies as much on the productive or regenerative capacities of ecosystems that produce vital ecosystem services, as it does on the services themselves.

With ecosystem structure and functioning and the goal of protection of the natural world in mind, ecological economics incorporates ideas about resource conservation and the need to recognise biological limits of natural systems (Spash 1999). Carrying capacity (the population density of a species above which its numbers tend to decrease because shortages of food and other resources) "ought to govern resource use rather than maximum exploitation" (Rolston 2017: 169) and "environmental integrity is as important as production, growth profit (2017: 169) (which, in any case, is superimposed on environmental health) (Rolston 2017).

Ecological economists think in terms of a material flow analysis (MFA) (Swilling and Annecke 2012) expressed in terms of stocks and flows (Rolston 2017). When applied to ecosystems it represents natural stocks from which there are flows "of energy and materials that enter and exit the economy as a kind of metabolism**,** digesting such life nutrients, but needing environmental sources and sinks, analogous to organisms in their environment" (Rolston 2017: 169).

According to ecological economists, and using the MFA paradigm, greater sustainability requires respecting biological thresholds. It also necessitates the use of less energy and materials, while pursuing such targets as "poverty eradication through a more equitable distribution of the world's resources" (Swilling and Annecke 2012: 46). The end-point it aspires to is a materially closed system except for inputs of oxygen and water, where the waste products from economic and social systems become the inputs that keep the system going.

5. The concept of natural capital

Thus, ecological economics, and subsequently an ecosystems services approach, incorporates the natural world into economic analysis by viewing it as a form of natural stock and naming it 'natural capital'. Capital is an essential economic concept. It relates to the "material capacity to produce goods and services, thought of as a stock, such as money, buildings, machinery, patents, ongoing through the production process" (Rolston 2017: 170). To these forms of capital, ecological economists now invite us to consider an additional category of capital – natural capital – in which the notion of capital is extended to environmental goods and services (2017). "Natural capital is not the same as nature, but it is the basis of all production in the human economy and the provider of services without which human society could not sustain itself" (Porritt 2006: 123).

Capital is essentially a "stock of natural ecosystems that yields a flow of valuable goods and services into the future" (Rolston 2017: 170). The idea is to maintain the capital stock (and keep it intact) while living off the income. As long as the capital is intact, it should be able to yield a flow of income indefinitely. For example, a (managed) forest has (in theory at least) the capacity to yield an income of trees forever. As trees mature and are felled for timber, so new trees are planted and the cycle recommences.

Natural capital also undertakes services for humankind, where no product is harvested other than the maintenance of a healthy living environment, such as the neutralisation and cycling of wastes, and the provision of potable water. Critically, this "flow of services from ecosystems requires that they function as whole systems, so the structure and diversity of the system are important components of natural capital" (Rolston 2017: 170).

The introduction of the notion of capital shifts from the moral concern for conservation of opportunities for development embedded in the biodiversity of integrated, whole ecosystems, to the more operational economic notion of protecting one's capital (Rolston 2017). At its basis is the need for quantification (in the form of measurement) so that utilisers can know how much natural 'income' they can 'spend' without eroding their capital base and impoverishing themselves or subsequent generations. This suggests the notion of biological limit, a threshold. Scientifically speaking, a threshold refers to "a non-linear transition in the functioning of coupled human-environmental systems" (Schellnhuber 2002; Lenton *et al.* 20018 cited in Rockström *et al.* 2009b). Put another way, we need to know how much of our capital stock is required in order to ensure sustainability, now and into the future.

As previously stated, ecosystems are complex systems, which means that they operate according to a system dynamic of non-linear shifts where, if sufficiently disturbed or degraded, a threshold is crossed and a small amount of further induced change causes the system to 'tip' (MEA 2005). A tipping point refers to a situation where a "threshold is reached and a small amount of further introduced change at a tipping point produces large and relatively rapid adverse changes in the system" (Rolston 2017: 171). This brings about rapid and adverse change, possibly irreversible systemic collapse (MEA 2005).

Problematically, we do not yet know enough about ecosystems, and how they work, to be able to pinpoint with any degree of certainty where these thresholds lie (MEA 2005; Rolston 2017). "The most catastrophic changes in ecosystem services identified in the MA (Millennium Assessment) involved non-linear or abrupt shifts" (Carpenter *et al.* 2006 cited in Rolston 2017: 171). According to Carpenter *et al.,* because our knowledge of relations between "ecosystem services and human wellbeing are poorly understood" (2006 cited in Rolston 2017: 171) "We lack the ability to predict thresholds for such changes, whether or not such a change may be reversible, and how individuals and societies will respond" (2006 cited in Rolston 2017: 171).

The consequences of irreversible systemic collapse occurring are calamitous as they threaten the ability of all life forms (not just humankind) to survive, let alone flourish and live healthy, meaningful lives – the goal of sustainable development. For this reason, Rolston (2017) suggests that, in the face of tremendous uncertainty of how ecosystems function, the wise social path to follow is to allow no further degradation of ecosystems. "Keeping constant the total natural capital ought to be environmental policy as a prudent minimum condition for assuring sustainability" (Rolston 2017: 171. Also see Constanza and Daly 1992).

6. The Millennium Ecosystem Assessment

To better understand the consequences of current changes to ecosystems and to evaluate scenarios for the future, in 2000 the then United Nations Secretary General, Kofi Annan, called for a comprehensive scientific study, the Millennium Ecosystem Assessment. Published in 2005, its findings summarise research into these issues. *Conducted by a global team of over* 1360 experts in 95 countries*, it is* the largest assessment of the earth's ecosystems to date. It is additionally significant being "the first comprehensive analysis of the relationship between 'human well-being' and 'eco-system health'" (Swilling and Annecke 2012: 29). Its publication ensured that the concept of ecosystem services gained even greater attention (Constanza *et al.* 2014).

At the heart of the assessment was an unmistakable warning (Swilling and Annecke 2012). It concluded that 60 percent of the 24 essential ecosystems examined worldwide had become degraded during the last 50 years (2012). What it made clear was that human interference "is putting such strain on the natural functions of the Earth that the ability of the planet's ecosystems to sustain future generations cannot be taken for granted" (MEA 2005: 5). At that early stage 13 years ago, it was already clear that we are eroding our natural capital stocks, when we should be living off the income it provides alone.

The Report's objectives were twofold: to recognise and "assess the consequences of ecosystem change for human well-being and to establish a scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being" (MEA 2005: 9).

The main findings of the MEA were:

1. "Over the past 50 years, humans have changed ecosystems more rapidly than ever before in human history to meet demands for food, fresh water, timber, fibre and fuel. This has caused substantial and "largely irreversible loss in the diversity of life on Earth'" (Swilling and Annecke 2012: 29).
2. "Although ecosystem change has contributed to gains in human wellbeing, the costs are of degradation of eco-systems, increased risk of non-linear changes and increased poverty" (2012: 29).

2.1 Degradation of ecosystems

Approximately "60 percent" (Swilling and Annecke 2012: 30) of the ecosystem services examined by the MEA were "degraded or used unsustainably" (2012: 30), including fresh water, fisheries, air and water purification, and climate regulation. A further aspect of degradation entailed the loss of biodiversity, population size and range of a majority of species and that the "number of species on the planet was declining" (MEA 2005: 19); "Genetic diversity" (2005: 19) globally is in decline.

This was considered critically important as the loss of genetic diversity was reducing the resilience of ecosystems, "which is the level of disturbance that an ecosystem can undergo without crossing a threshold into a different structure or functioning" (MEA 2005: 25). Because ecosystems are interconnected, degradation is often exacerbated by actions taken to increase one ecosystem service having a knock-on effect that brings about the degradation of other services. Ultimately, the report said that degradation of ecosystems detracts from human wellbeing. Some examples of this would be the increased frequency of floods, to which coastal populations are susceptible, and fires that destroy forests and croplands (MEA 2005).

2.2 Exacerbation of poverty

Changes in ecosystems typically yield benefits for some people while simultaneously imposing costs on others. An example would be increased agricultural yield due to the application of fertilization, but where the run off from fields pollutes nearby rivers and eventually, where theses rivers meet the ocean, contributes to ocean eutrophication. These latter groups are usually marginalised from political or economic sources of power – typically the poor, women and indigenous communities (MEA 2005). Ecosystem degradation has negative consequences for people dependent on those ecosystems, most often the poor.

Despite progress achieved in increasing the production and use of ecosystem services, poverty persists, social inequalities are increasing and many people do not enjoy access to a sufficient supply of ecosystem services (2005). For example, a person can live without food for a few weeks, but cannot survive for more than a week without water. Yet some 1.1 billion people still lack access to an improved water supply and a further 2.6 billion lack access to improved sanitation, resulting in disease and death. This contributes to a disproportionate bearing of consequences by the poor and growing inequalities between groups of people (MEA 2005).

- "Degradation is anticipated to get worse over the next 50 years and is a barrier to achieving the Millennium Development Goals (MDGs)" (Swilling and Anneke 2012: 20).

- The reversal of degradation (while simultaneously meeting increasing demands for services) is sometimes possible, but will require "significant changes in policies, institutions and practices" (Swilling and Anneke 2012: 30).

7. Summary: what does an ecosystems services to sustainability approach entail?

In light of the above, an ecosystem services approach has achieved widespread application (Constanza *et al.* 2017; Spash 1999) as a socio-ecological framework that balances the conservation of the productive capacities of ecosystems with their sustainable use. Its framework of sustaining natural capital hopes to offer path to a tenable, equitable and long-term future, key to planning for sustainable development (Potschin *et al.* 2017). While this might seem to contribute to an advancement of the discourse on sustainability, our knowledge as to how ecosystems function still remains imperfect.

This prompts the question of whether there are aspects to an ecosystem services approach that are problematic to its achievement and to the pursuit of a stronger and more ecocentric conceptualisation of sustainability as supported in this thesis?

From an ethical perspective the question asks what relationship with the natural world, in the form of ecosystems, does a natural capital framework prescribe? A relevant question in this regard is how the natural environment is valued in that relationship (Achterberg 1994; Hattingh 2001).

In an attempt to answer these questions, and still bearing in mind that what is valued shapes the choices that governs our decision-making with regards to sustainability/sustainable development, it is helpful to return to the four questions of Achterberg's (1994) value critique. To recall, these relate to (1) what is so valuable that we ought to sustain it; (2) for what reason; (3) how should we go about sustaining it, and (4) what criteria for sustainability does it define?

7.1 What is so valuable that we ought to sustain it?

An ecosystem services approach takes up the language and argument of ecological economists, who point out that classical economics perceives the natural environment narrowly, reducing it to purely economic terms of a resource, and largely fails to allocate it any value beyond its utility. Since it is a point of view in which ecological knowledge is absent, it is unable to locate the relevance of these 'natural resources' within the larger context of complex natural systems that supply humankind with everything essential to our survival, wellbeing and economic prosperity. In contrast, ecological economics proposes a new paradigm that attempts to integrate both social and environmental sustainability (Spash 1999) within an economic framework.

It points out that missing from a classical economic paradigm, and what economics now needs to consider, is recognition of the existence of ecological systems upon which humankind is inextricably dependent, and which provide us with ecosystem services (Rolston 2017). Within an ecosystem services paradigm, it is these ecosystems services, that are so valuable that they should be preserved.

The approach acknowledges that the outcomes of change in ecosystems are not predictable and are most likely negative for humankind. This is especially true of non-linear or abrupt shifts triggered by the transgression of biological thresholds (Carpenter *et al.* 2006).

Thus, insisting on behaviours in the name of development or economic growth that risk exceeding unknown thresholds, means that the poor, who depend directly on ecosystems, will suffer in degraded environments. This "escalates the rich getting richer at the expense of the poor" (Rolston 2017: 171-172).

Hence, the moral imperative is to preserve ecosystem services for the wellbeing of all humankind, but especially for the poor, who suffer the most because they are directly dependent on ecosystem services for survival, receive a disproportionately small share of ecosystem 'benefits' and are likely to be the first hit by negative changes in ecosystems, which they cannot anyway afford to escape (Constanza *et al.* 1997; Rolston 2017). This moral imperative implies a more equitable distribution of ecosystem benefits, now and into the future.

7.2 Why are ecosystems so valuable that we ought to sustain them?

The realisation that ecosystems "comprise ecological life-support systems" (Constanza *et al.* 1997: 253), essential to human wellbeing, and without which "the economies of the world would grind to a halt" (1997: 253) give us two very good reasons to sustain them. In other words, ecosystems are to be conserved for human wellbeing and to provide a basis for the economy.

Consequently, an ecosystem services approach emphasises that humankind, far from being separate from nature, is embedded at the ecosystemic level in a 'natural context' (Rolston 2017: 169). Failure to come to terms with this insight has brought about the environmental crisis in the first place (2017). A natural context recognises that "the environment and the economy interact in fundamental ways" (Spash 1999: 420), and, as bioeconomics tells us, are co-evolving (Rolston 2017), necessitating the conservation of what is left of natural capital.

An important contribution therefore, of an ecosystem services approach, is that it connects humankind firmly to nature (Constanza *et al.* 2014; Rolston 2017), and recognises that human economies and society are located within, and dependent upon, greater natural systems. With this insight in mind, an ecosystem services approach emphasises that these natural systems and provision of services are under threat. In other words, the requisites for human wellbeing are under threat, necessitating their protection.

However, its recognition that human life and economies are dependent upon natural systems also creates ambiguity as to what is so valuable that it motivates their conservation: is conservation to be pursued for the good of human wellbeing and economies, an anthropocentric view? Or, according to a second interpretation, ought we to conserve ecosystems as the basis of the regenerative capacities that create and support all life, a more ecocentric position? This ambiguity persists in an ecosystem services approach, where, if an anthropocentric motivation for the preservation of ecosystems, with its associated attitude of dominance, is adhered to, its capacity to achieve ecological sustainability is weakened.

7.3 How ought we go about sustaining ecosystem services?

An ecosystem services approach frames the path to sustainability in economic terms (Spash 1999), which views ecosystems as a form of capital – natural capital (Constanza and Daly 1992; Constanza *et al.* 1997, 2017). Like other capitals, it represents a fixed capital stock from which income, in the form of benefits, flows (Constanza *et al.* 1997; Rolston 2017). Sustainability of ecosystem services is achieved if stocks of natural capital are maintained over time to ensure a continued flow of benefits and services (Swilling and Annecke 2012; Rolston 2017). To maintain a continued flow, like any other capital stock, they must be managed, which in turn requires their measurement and monetary valuation.

The goal of management is to retain intact what remains of natural capital to prevent any further degradation and curtail further loss of biodiversity, thereby avoiding "the destruction of sources of renewal" (Gallopin 2003: 19). This allows ecosystems to recover and continue their provision. Consequently, this implies that the provision of all goods and services is subject to biological limits.

An additional danger of allowing further declines in natural capital stocks (Rolston 2017) is the threat this poses when unknown biological thresholds are violated (Constanza *et al.* 1997, 2017; MEA 2005; Rolston 2017), with catastrophic consequences to human physical and economic wellbeing.

Thus, the goals of maintaining biodiversity and remaining within biological limits strongly suggest that "keeping constant the total natural capital ought to be environmental policy as a prudent minimum condition for assuring sustainability" (Rolston 2017: 171) within an ecosystem services approach. Accordingly, ecological carrying capacity should govern resource use (Rolston 2017).

In this way, environmental health enters the discussion and is elevated to the same level of concern as production, growth and profit (Rolston 2017). To deal with biological limits, and a finite supply of some resources, transition to a sustainable socio-ecological regime implies extremely efficient resource use. The logical end-point of this is a 'materially closed' economic system (Constanza *et al.* 1997; Swilling and Annecke 2012).

Ultimately this envisages a circular economy of "*non-material economic growth"* (Swilling and Annecke 2012: 48), utilising only minimal amounts of non-renewable resources (made possible by improved technological efficiency), the re-use of all waste inputs (a zero-waste economy) (Elkington 2012; Swilling and Annecke 2012), and the replenishment of renewable resources that have been overexploited (such as fish, soils, water supplies, air quality, biomass and biodiversity) (Swilling and Annecke 2012). In this view, growth would take place in the provision of services, technological advances and recyclable manufacturing, in addition to the health, education and recreational aspects of human wellbeing.

Another important aspect of the framing of ecosystems as natural capital has been translating the magnitude of natural contributions to human wellbeing into monetary terms (Constanza *et al.* 2017; Potschin *et al.* 2017). In this way, an ecosystem services approach makes a case for the monetary valuation of ecosystem services as a means of sustaining ecosystems.[3]

[3] Structural transformation suggests the development of circular economies, in which nothing is wasted and pollution is reduced to zero, achieved by production methods that restore and protect ecosystems, and discourage extraction and waste. It implies uncoupling economic activity from ecological impact. See Benyus 1997; Braungart and McDonough 2002; Brown 2003; Blewitt 2008.

The underlying rationale is that financial value translates, in a more tangible, recognised (Constanza *et al.* 1997; Daily 1997) and hence readily comprehensible way, the value of what ecosystems do for us (Constanza *et al.* 2017) and our dependence on them. This allows the transparent incorporation of ecological losses and gains into decision-making when deciding on alternative courses of action (Constanza *et al.* 1997, 2017). It demonstrates a key idea of the ecosystem services approach, "that explicitly and systematically identifying the benefits and beneficiaries of ecological processes which will improve integration of social, economic, and environmental considerations in strategic decision-making" (Pittock *et al.* 2012: 111), and in this regard it advances the discourse on sustainability.

However, the valuation of stocks of natural capital and the benefits that ecosystems provide, requires that they first be quantified and measured. It also implies their management so that, in theory at least, biological limits which would then erode the capital base are not exceeded. A key challenge in accurate measurement and subsequent management is "imperfect information" (Constanza *et al.* 2017: 9).

The process of attempting to value ecosystem services across different temporal and geographic scales, according to individual and societal preferences, and where some regulating services exceed national boundaries (for example a river) and global boundaries (for example climate regulation) – implying shared responsibilities – is exceedingly complex. Add to this incomplete knowledge as to how ecosystems function, the complexity of interactions that lead to ecosystem services production, lack of knowledge of how ecosystems are affected by change and where thresholds lie, and uncertainty will always be an issue. Ecosystem services evaluation, in this light, can only ever hazard a calculated estimation. It introduces the question of whether management of ecosystems, in the conventional sense of the word 'management', is possible.

7.4 What are the criteria for sustainability of an ecosystem services approach?

According to an ecosystem services approach, sustainability of ecosystems is ensured if the following criteria are met:

- The maintenance of natural capital, which houses ecosystems and ecosystem services, requires that remaining natural capital stocks be kept intact and biodiverse in order to maintain ecosystem health.

- Ecosystem health is a precondition for the continued ability of ecosystems to provide humankind with necessary materials and services that underscore human wellbeing.
- To preserve ecosystem health requires that the extraction and use of natural capital must not exceed biological thresholds, and that carrying capacity should govern resource use.
- This requires that stocks of natural capital be measured and allocated monetary value to incorporate them into strategic economic decision-making and management. It also prescribes their increasingly efficient use.
- Ecosystem management is intended to balance the conservation of the productive capacities of ecosystems with their use prescribed by protective boundaries use and a fairer distribution of provisions among all peoples of the world.
- Ecosystem management should be continuous in order to benefit both current and future generations.

7.5 Contributions and detractors of an ecosystem services approach to the conversation on sustainability.

Now that we have an idea of how an ecosystem services approach came about and what it entails, we are in a better position to consider how, in terms of where it places value, it contributes to a stronger, more ecocentric understanding of sustainability which this thesis supports, and in what ways it detracts from it.

Constanza *et al.* (2017) writing in 2017, twenty years after the publication of their seminal article in *Nature*, assert that the idea of ecosystems services has since "become an effective bridge between ecological and economic approaches" (2017: 13), and its transdisciplinary reach is better able "to understand and manage our complex, interconnected system in the Anthropocene" (13).

The importance of an ecosystem services approach lies in it being an integrated system capable of connecting natural systems to human systems. It thereby challenges conventional perceptions of economic growth and human welfare which ignore that economic processes are inextricable from nature. An ecosystem services approach also strongly suggests that prosperity is better understood in terms of wellbeing.

In this way it joins the critique against GDP as an inadequate measure of human wellbeing, highlighting the need for alternative approaches. In this regard, an ecosystem services approach suggests that full-cost accounting is required in business and government, while moving away from short term reinforcement.

The concept of ecosystem services has merit as a communication device (Pittock *et al.* 2012). The tool that greatly assists the acceptance of an ecosystem services approach in business and government policy circles is the language of ecosystems services (Pittock *et al.* 2012). This incorporates economic terms and frameworks of capital, stocks, financial valuation and income, thereby replicating the language of economics that policy makers, government, commerce and industry understand. Its appeal lies in offering a "readily communicable typologies of benefits and beneficiaries of ecosystem processes" (2012: 114)

Moreover, Constanza *et al.* (2014) argue that an economic framing and monetary valuation of ecosystems makes what was previously invisible, visible, thereby making tangible the value of ecosystems in terms of what they do for us, for incorporation into decision-making.

This is in response to the observation that "We already value ecosystems and their services every time we make a decision involving trade-offs concerning them" (Constanza 2014: 154) but this is implicit and hidden from view. In this case, the value of what ecosystems contribute, and by the same token, the consequences of their loss, are largely ignored. By publicly allocating ecosystem services recognised monetary value, the argument goes, greater transparency of ecosystem evaluation that could help make better decisions can be brought about.

In being able to bring this understanding into mainstream policy, an ecosystems services approach has managed to infuse mainstream economic approaches with an awareness of ecology, perhaps the 'bridge' that Constanza and colleagues (2017) referred to. The outcome has been a communication of the complete dependence of our social and economic systems on this natural context. The danger of ecosystem collapse is emphasised as is the need to take steps to prevent this. To this extent, an ecosystem services approach supports, in theory at least, a more ecocentric, and therefore stronger conceptualisation of sustainability, which greatly advances the discourse on sustainability.

However, while an ecosystem services approach emphasises the natural context, thereby drawing attention to the value of the natural world, it still frames this predominantly in terms of economics and human welfare (O'Connor 1993; Constanza *et al.* 1997, 2017; Rolston 2017). This opens the door to contradictions within the approach (O'Connor 1993) that have the potential to undermine critical awareness of that natural context, and the preservation of healthy ecosystems.

This framing still adheres to the notion of capital (O'Connor 1993; Constanza *et al.* 1997, 2017; Rolston 2017), even if in the form of natural capital. In this capitalisation of nature, the economic dynamic mutates from one where nature is external to the economic process, a 'free given' (O'Connor 1993) that provides raw materials and services, to one where these are internalised as an economic asset that need to be managed, in order to conserve natural capital (O'Connor 1993). Thus, an ecosystem services approach distinguishes two forms of natural capital (1993): a type of economic capital, but also the means that creates and supports all forms of life.

The former shifts the perception of what is valuable, and ought to be safeguarded, away from the regenerative capacity of that which constitutes the conditions for life (O'Connor 1993) to the costs and feasibility (O'Connor 1993) of protecting a capital asset (Rolston 2017). This raises the question of what ecosystems are to be managed for, and an ecosystem services approach does not make clear (Rolston 2017): is it the preservation of an economic asset or, the preservation of critical regenerative capacity? It is an important distinction, as each mandates a different set of behavioural responses and values.

Where nature is prized as an economic asset, Rolston argues, it still retains a mindset of 'domination' of nature (Rolston 2017: 16). This employs a logic of 'binary opposites' (2017: 15) to justify relationships of power, privileging higher ranking categories over lower ranking categories. Obvious examples are men over women, white over black, and humans over animals (2017). At its worst, a sense of domination results in humankind seeing ourselves as separate from nature (and not embedded in a natural context), more powerful than nature (and hence able to manage it) and any qualities that nature and humankind might share are ignored. These attitudes underpin the human tendency to degrade and use nature (2017). It is a thoroughly anthropocentric outlook and, to recall from chapter two, constitutes a weak form of sustainability.

Consequently, a sense of domination perpetuates the assumption that nature can be used (as humans inevitably need to do), but it can be exploited too, as a natural 'resource', which through human agency can be transformed into something of value (to humans). As mentioned earlier, a method typical of human resource policy is to institute a "cost-benefit analysis" (Rolston 2017: 169), in which the benefits of a course of action are added up and weighed against the cost.

Where people dominate, their natural assumption is to control that which is perceived as being weaker (O'Connor 1993). When applied to the natural world, it assumes that humankind is capable of both rationally managing ecosystems (1993), and of doing so in ways that conserve more benefits than costs to humans (Rolston 2017). According to Rolston (2017), an anthropocentric, domineering attitude allows humans to continue believing that we are the new forces on Earth who create new ecosystems, and that these need to be adaptively managed. If we are truly entering the "Anthropocene" (Rockström *et al.* 2009a: 472) in which humankind is able to geomorphically alter the planet's surface into, rapidly transforming landscapes (Seastedt, Hobbs and Suding 2008), it confirms that the combined pressures of human population and interference (Seastedt *et al.* 2008) will be creating 'novel ecosystems' (Rolston 2017: 169).

These are ecosystems "sufficiently altered in structure and function" (Seastedt *et al.* 2008), with "native and introduced species living under new environmental conditions and new or altered disturbance regimes" (Suding *et al.* 2004 in Seastedt *et al.* 2008: 547), while not necessarily possessing an adaptive fit born of evolutionary millennia. "In this era, historically authentic, co-evolved biotic assemblages are increasingly rare" (Seastedt *et al.* 2008: 547). It suggests that these alterations, under conditions where it is not possible to restore ecosystems to their original state, such as removing alien plant or animal species, could be the starting point for experimental approaches to ecosystem "management" (Rolston 2017: 45) methods.

Our ability to manage ecosystems is a tenuous assumption since there is still so much that we don't know, or understand, about how ecosystems work, or what the consequences of such management would be. It constitutes and enormous risk.

This implies that "We need to consider, and experiment with, novel outcomes and trajectories, rather than simply taking preventative or therapeutic measure" (Seastedt *et al.* 2008 cited in Rolston 2017: 169), i.e. adaptive ecosystem management. In theory, adaptive ecosystem management techniques offer the tools for achieving "resilience of desired states and facilitating transformation of undesirable states". However, the danger posed by an ecosystem services approach that supports adaptive ecosystem management is that these techniques equally present a window for manipulation in which ecosystems are seen as "purely functional production systems" (Spash 1999: 429), to be managed for narrowly defined human ends. Ethically, in this case, there would be little consideration of the needs and wellbeing of other forms of life. Instrumentally, this risks critically undermining biodiversity, upon which the survival and functioning of ecosystems depend.

Thus, the naming of nature as 'capital' retains an instrumental approach (Spash 1999) in which nature is commodified (O'Connor 1993; Spash 1999; Rolston 2017). This means that it is perceived as a product that can be priced, bought and sold. The management objectives of an ecosystem services approach are to re-shape or condition the ecosystems we inhabit (Rolston 2017), and foresee a future in which human technology attempts to control the biosphere (Rolston 2017). To be able to manage ecosystems, one has to be able to model them first, to better understand how they work and the complex processes that interlink them.

The aim of this advanced understanding however, is to facilitate interference by humans, technological and otherwise, with ecosystems, with the goal of maximising extraction of uses and benefits for commodity production at the least cost, but also at the least cost to the environment (O'Connor 1993; Rolston 2017).

However, capital and the commodities derived from it, are usually owned by some entity, but ecosystem services, like the hydrological cycle and climate stabilisation, span the globe and cannot be owned by any individual, government or nation. Therefore, it may be misleading to think of the natural values we wish to protect in terms of capital (Rolston 2017). Two very good reasons for this are that some natural goods are held in common (not owned by anybody) and most natural goods are not factored into the market. Markets determine returns on capital, the growth of investments, and dividends paid (2017).

There are clear returns on natural capital in terms of human survival and wellbeing, but how would financial returns be calculated? And to which 'owners' would these dividends be allocated? (Rolston 2017). It is not clear how, if we convert what is common to natural capital, that such a model would work. As Rolston (2017) says, perhaps commodifying nature is not the answer. It merely further confounds the problem of failing to respect nature in its own right, thereby continuing the practice of reducing all values to economic value.

In other words, value is treated reductively and all values are reduced to, or the only value that counts, is monetary value. Consequently, it leaves the "recognition that non-human entities have value beyond reduction to individual human preferences, expressed either in the market place or political arena, remains an issue for open debate" (Spash 1999: 429) within an ecosystem services approach.

In this regard, where ecosystems are regarded as "purely functional production systems serving human ends . . . there tends to be a concentration on aspects of value which contribute either directly or indirectly to human well-being" (Spash 1999: 429). In this context, there is a danger that any ecosystem service, or life or plant form not deemed sufficiently useful, gets ignored, and only those relevant to human wellbeing receive care. An example is the widespread planting of soy monocultures on Argentinian and Bolivian grasslands causes the extinction of species endemic to the area. Since they play a role in local ecosystems, these ecosystems in turn are being disrupted.

This is a point raised by Pittock *et al.* who concluded that, in an ecosystem services approach, "the full suite of benefits from the environmental are considered strategically" (2012: 116). An extension to this argument is that the pricing of environmental provisions, whether they contribute or detract from human wellbeing, may actually be counterproductive, since it obviates any motivation to behave with consideration of intrinsic value in the natural environment.

This may perhaps be explained by the following hypothesis: we are raised to adhere to certain moral norms regarding our attitudes towards the public good. These norms differ from the norms governing market behaviour, where looking after one's own interests is permitted to a large extent.

When an environmental good is priced, it may create an environment where the environmental good is regarded more like a market good and this lessens any strict moral restrictions in our behaviour towards it.

Additionally, our assumption of rational management is undermined by our inability to predict biological thresholds (Rolston 2017). Due to a lack of information on how ecosystems function, this calculation can only ever be an estimate at best. Lack of certainty is a liability: it threatens to transgress unknown thresholds and can trigger unpredictable, non-linear shifts in ecosystems (Rolston 2017). We don't know whether these changes, once they have occurred, can be reversed, how they will affect societies and how societies will respond to these unpredicted changes (Carpenter 2006; Rolston 2017). Furthermore, any such interference also undermines the ability of the approach to deliver on its stated aim of equity, conserving ecosystems for the benefit of those most immediately reliant on them – the poor – since they are the first who will be affected by negative changes. If we do not know where the thresholds lie, they cannot be respected.

When seen this in way an ecosystem services approach fails to address the issue of constant material growth on a finite resource base (Daly 1977, 1996). This is the fundamental conundrum to which a quest for sustainability seeks to find an answer. The environmental crisis has also shown that failure to respect ecological thresholds tends to destroy the very conditions of economic production on which the economy depends (O'Connor 1993). This brings us to the critical question whether nature *can* be managed at all? While an ecosystem might possess naturally evolved checks and feedbacks, little is known about what will happen with human-induced innovations (Rolston 2017).

Consequently, the human ability to manage ecosystems is couched in scepticism, given their level of complexity and unpredictability, and our limited knowledge of how they work (Rolston 2017). An ecosystem services approach lacks the ability to work with uncertainty, unpredictability and abrupt changes (2012), in other words, with the complexity of ecosystems. On the scale of human duties and responsibilities, we may yet find that respecting dynamic community stability, as suggested by Rolston (2017), is wise advice.

An assumed ability to manage 'natural resources' reduces environmental problems to technical issues, to be solved with advances in technology and clever machination, rather than issues indicating a profound need for a revolution in human perceptions of, and behaviour toward nature. With this in mind, Rolston (2017) says that we need to move away from a hard-wired insistence on perceiving the natural world in economic terms.

If environmental ethics is to be taken seriously, we need different metaphors that emphasise the vital capacity of ecosystems to create and sustain all life forms that we are trying to sustain – such as the community of life (Rolston 2017). Rolston suggests that it is not the products (natural resources) of an ecosystem that are worth sustaining, although these are clearly valuable, but the productivity of ecosystems (2017). In other words, Rolston suggests that it is the ecosystem processes that are valuable, as these are able to produce biodiversity. The resulting communities of life are what "have become our moral responsibility" (2017: 167) because, when viewed holistically, ecosystems today are the "source and support of individual and species life alike" (167). An idea of community also allows for the extension of "moral standing to be given to non-human entities" (Spash 2009: 428).

These are ethical values required by an ecologically sustainable approach. One possible expression of this could be that ecosystem health teaches "that ecosystems are more than an aggregation of component species and the implication is that as entities they can be harmed" (Constanza 1992: 240-241). Society at large struggles to integrate intrinsic value with things that have use-value to humankind, but decisions should be made that address both.

8. Conclusion

The framework and concepts of an ecosystem services approach to sustainability emerged from the realisation that classical economics largely ignores environmental functions and value, and that consequently it is undermining both our natural environment and the economies that depend on it. An ecosystem services approach thus invites consideration of present and future human dependence on ecosystems, and brings into economics considerations of how this relates to future generations, ecological science, and the existence of other species, that are typically excluded from a technical cost-benefit analysis.

Consequently, an ecosystems services approach emphasises the importance of the ecological 'natural context' (Rolston 2012: 169) in which our societies and our economies are embedded, representing a positive conceptual step forward.

In this regard, an ecosystem services paradigm attempts to integrate both social and environmental sustainability within an economic framework. This framework monetises natural capital, raising the salience of ecosystem services in "decision making" (Pittock *et al.* 2012: 111), and employs the language of economics and concepts familiar to government, policy makers and business. The use of such language and monetisation is at once a strength, as it facilitates understanding of ecological value, but it is also a weakness, as economic concepts perpetuate ideas of the use, exploitation and domination of nature.

A further contribution of an ecosystem services approach is that it considers how additional values of intrinsic worth and the preservation of genetic richness can be expressed, alongside instrumental, utilitarian and financial concerns, and which is not possible in a conventional economic paradigm. The values expressed by an ecosystem services approach mostly relate to humankind in the form of "poverty alleviation and inter-generational equity" (Pittock *et al.*1999: 429), but also allude toward a responsibility to support the regenerative capacity of ecosystems for the wellbeing of all life, not just human life.

To the extent that an ecosystems services approach supports the visibility of ecosystems in decision-making, our natural context, and suggests respect for all life, it advances a stronger, more ecocentric interpretation of sustainability. Since it is clear that humankind can only flourish where supporting ecosystems are functioning well, that is to say, healthy if not integral (Rolston 2017), the point of an ecosystem services approach is to slow down and eventually halt ecosystem degradation. It also implies the recognition of ecosystem constraints in the form of biological thresholds.

However, in an ecosystem services paradigm, the environmental problem is framed as a management problem that can be overcome through better new management approaches or technological advances (Hattingh 2001). The paradigm therefore proposes that enduring sustainability lies in a combination of ecosystem management within biological thresholds.

However, at this point the effectiveness of the paradigm begins to break down in the face of ambiguity, since it does not specify what ecosystems are to be managed for, namely either:

- The regenerative capacity of ecosystems that support continuing ecological productivity for wellbeing of all life, which would require the protection of whole ecosystems (an ecocentric interpretation), or;
- The management of a capital asset, to extract the maximum possible from ecosystems (a more economic and anthropocentric interpretation)?

Since we cannot accurately predict where biological thresholds lie, this creates uncertainty in all our plans, and while the former interpretation supports ecological sustainability, the latter interpretation weakens it. Additionally, our uncertainty regarding critical thresholds combined with the complexity of ecosystems and the fact that we do not fully understand how they work, questions whether ecosystems can be managed at all, effectively undermining an ecosystem services approach.

This leaves us with the question of what kind of ecological conceptualisation of sustainability we need. In other words, while an ecosystem services approach emphasises the value of the regenerative capacity of healthy ecosystems for all life, and the need for its protection, the paradigm's perpetuation of an economic framing, together with uncertainty as to where ecological thresholds lie, means that it is still unable to ensure ecological sustainability. The question of what still needs to be fathomed is the focus of the concluding chapter.

What is clear is that we need a better understanding of thresholds, but also a break away from destructive human behaviours that would be nothing short of radical. Hence, while science is able to investigate the problem of thresholds, the shift in human behaviour asks what humankind, at level of society, business and policy do? The problems that sustainability seeks to address ultimately have to do with human behaviour, which would suggest that where a technical/managerial attitude toward the natural environment is maintained, we neglect the human and moral aspects of sustainability. These need to be brought to the fore in a conceptualisation of sustainability.

Conclusion

The challenge to collective human thinking that a quest for sustainability/sustainable development is the realisation that, far from being separate from nature and assumedly in control of it, humankind is inextricably a part of nature, and that our wellbeing is contingent on its healthy functioning. The reason for this is that the natural systems that exist on land, in the oceans and in our atmosphere produce everything we need, and without whose healthy functioning there would be little survival, let alone wellbeing, to speak of.

This brings to the fore an incontrovertible relationship between human and natural systems, and forms the basis of why an ecological interpretation of sustainability is necessary. That this should be done for human wellbeing is evident, but it is less so for the wellbeing of other forms of life. Consequently, an ecological conceptualisation of sustainability/sustainable development further challenges us with the question as to how, in theory and in practice, to durably, and fairly, integrate environmental conservation with human economic and social prosperity.

Integration suggests that limits to ensure ecosystem health need to be imposed, but the question in a context of ever-expanding extraction to satisfy growing human need, exacerbated by only partial knowledge of how ecosystems function, is how should these limits be conceptualized, where should they be placed, and how should they be maintained? Over time, a few efforts, or paradigms, have emerged to address this problem of biological limits. Of these, we have had a look at four prominent conceptualisations of sustainability and sustainable development that acquaint us with a range of values and proposed solutions.

The pursuit of finding a durable solution to our global environmental and social injustice problems, in the form of sustainability and sustainable development, poses an unprecedented and relatively new challenge to humankind. These concepts first appeared only thirty years ago in the Brundtland Report, which, despite its shortcomings, possibly formulated our most well-known definition of these concepts. While it is to be applauded as our first prominent step toward defining sustainability and sustainable development, it is weakened by its anthropocentric approach that evaluates the natural environment purely in terms of its usefulness to humankind, thereby empowering perceptions of human dominance. It condones the use of nature to serve as a basis for social activities now and into the future.

This highlights the fundamental tension between the economy and the preservation of nature, in which ecological sustainability remains secondary. Essentially, the Brundtland Report's definition disregards the notion that finite biological boundaries limit the scope of human activities, leaving its understanding of sustainability unable to protect ecosystems that support the human economy, thereby undermining its goal of economic growth.

Furthermore, the Brundtland Report's economic framing of the natural environment as a form of capital assumes that the value of natural capital can be substituted with human, manufactured and financial capital, regardless of the impact this may have on the functioning of healthy ecosystems. This affords the critical and regenerative capacities of ecosystems little protection, both at present and in the long term. Since the implementation of this understanding does not stipulate that adjustments be made to current economic and social structures, it maintains current unequal patterns with regard to the sharing of natural provisions that exclude the poor and favours development that does not consider the needs of future generations.

The Brundtland Report's definition of sustainability and sustainable development falsely separates humankind from our natural environment by ignoring the biological relationship we share with it. Its weakness therefore, is that it lacks ecological relevance, continues to undermine the very resources necessary to maintain human economic and social wellbeing and hence is unsustainable in the long term. Additionally, this renders it inadequate to counter anthropogenically induced global warming and resultant climate change, showing its understanding of sustainability to be dangerously outdated.

The realisation of the impossibility of humankind replicating, or compensating for, critical processes in nature prompted considerations of an alternative, and stronger, approach. This appeared in 'Caring for the earth'. It is an approach that suggests that nature possess intrinsic value, and as such it is able to make a number of vital contributions to an ecological understanding of sustainability. In 'Caring for the earth' an understanding of sustainability is linked to a process in which natural assets are restored and kept intact through adherence to biological limits. This not only recognises, but allows for the preservation of the "regenerative and creative systems in nature, not acknowledged by an anthropocentric point of view" (Hattingh 2001: 9) in order that they may continue functioning indefinitely (2001).

However, ‘Caring for the earth’, despite its recognition of ecological value, is weakened by its unwillingness to adhere to the moral strictures imposed by intrinsic value. Consequently, tension is created where the moral obligation to protect imposed by the intrinsic value of nature, conflicts with human use of and economic interference with nature. The result is a trade-off where human interests still take precedence, allowing for the use of ecosystems even if within certain limits.

Hence, in our conceptualisations of ecological sustainability ‘Caring for the earth’ is significant in that it introduces the idea of intrinsic value of species other than humankind, but it is still unable to wholly liberate itself from the constraints imposed by associated moral obligations. The upshot is that it still maintains current economic and social structures, conducive to the retention of prevailing perceptions of dominance, although in an enlightened form. This does not equip us adequately to foster the fundamental socio-economic change needed to ensure greater social equity, nor protect ecosystems and biodiversity.

A more robust approach in ecological terms, that takes the notion of intrinsic value in nature seriously, is deep ecology. In a reversal of the Brundtland Report and to a lesser extent, ‘Caring for the earth’, deep ecology describes sustainability as a situation in which it is people who integrate with their natural environment, and not the other way around. Consequently, it adheres to a very strong conception of sustainability, in which humankind allocates as much respect, and environmental provisions, to the natural world as it expects for itself. To achieve this, it prescribes radical institutional and behavioural change. These changes are pursuant of highly simplified lifestyles lived out in small communities, in which humankind treads very lightly upon the earth. This is achieved by adopting ways of life that do not damage ecosystems, taking only what is strictly essential, thereby perpetuating the health and integrity of the natural environment.

However, such lifestyles prescribe reverting to pre-industrial times and a much reduced human population. Since deep ecology fails to fathom practical means for accomplishing this, other than suggesting we decrease the human population by humane means, it lacks operationalisability. Its commitment to intrinsic value in nature, nevertheless, remains exemplary, and it alludes to the magnitude of the structural shift necessary to live respectfully of life-forms present in ecosystems, whose intrinsic value dictates an ethic of non-interference.

Informed by advances in ecological science, an ecosystem services approach emerged as an attempt that could combine both practicality with the conservation of nature. The point of an ecosystem services approach is to slow down and eventually halt ecosystem degradation. There are practical reasons for this (economic prosperity and the assurance of human wellbeing) as well as moral, arising from the realisation of the need to preserve the regenerative capacities of ecosystems upon which all life is dependent.

With this in mind, the advance brought about by an ecosystem services approach is its prescription of the need to preserve a rich state of biodiversity, ensured by observing biological limits. As such, it emphasises the natural context in which we find ourselves embedded and the responsibility to support the regenerative capacity of ecosystems, which are integral to an ecological understanding of sustainability. In this regard, an ecosystem services paradigm attempts to integrate both social and environmental sustainability within an economic framework.

This framework is at once a strength: the monetisation of natural capital raises the visibility of the value of ecosystem services in decision making, and the economic language and concepts it promotes are familiar to government, policy makers and business, which further facilitate the understanding of ecological value. However, an economic framing also constitutes a weakness, since framing the natural world as a form of capital perpetuates ideas of use and domination of nature.

However, perhaps what is most significant about the approach is its advocation of the management of ecosystems, though it does not make clear, and leaves open, to what ends ecosystems should be managed. As a result, tension, or contradiction, surrounds what exactly it is we are striving to sustain in an ecosystem services approach. Goals could equally be interpreted as human economic benefit, environmental health, or, the regenerative capacity of ecosystems, each with distinctly different consequences for ecological sustainability. Additionally, we lack certainty as to how ecosystems function and where ecological thresholds lie, which fundamentally calls into question whether ecosystems can be managed at all.

Hence, as far as ecosystem services are concerned, the approach is undermined by an inability to pinpoint where thresholds lie, and therefore where to impose boundaries. For it to work we need a better understanding of thresholds. This uncertainty, and the suggestion that human beings are smart enough to potentially manage ecosystems (including the planetary climate), but not as yet, means that it is still unable to ensure ecological sustainability. However, to the extent that an ecosystems services approach highlights the value of ecosystems in decision making, our natural context, and suggests respect for all life, it advances a stronger, more ecocentric interpretation of sustainability.

So far, we have seen that an ecological understanding of sustainability requires structural changes within our societies and economies in order to achieve a lasting solution to our environmental problems. This would imply keeping our supporting ecological systems healthy, if not intact, by staying well within the thresholds of biological limits, to restore and protect their fundamental regenerative capacity. Above all, it would require that we respect human and non-human life, in the 'community of life' (Rolston 2017), to which Rolston refers.

This means taking natural thresholds into account, which negates the notion of substitutability, and constitute "non-negotiable moral constraints on human activities" (Hattingh 2001: 15). The challenges that a notion of sustainability/sustainable development therefore places on the table are the maintenance of our ecosystems, and in a context of climate change, our planetary systems (Rockström *et al.* 2009; Steffen *et al.* 2018; IPCC 2007), for current as well as future generations (Hattingh 2001).

However, environmental degradation and inequality continue, which implies that our attempts at sustainability and sustainable development so far have failed to achieve what they set out to do. While each conception has taken the discourse on sustainability and sustainable development a step further, it appears that they have somehow not gone far enough, and have fallen short of envisioning, in theory and in terms of practical action a solution to sustainability/sustainable development, that is both durable and just.

We have confirmed in our discussion thus far that sustainability/sustainable development is a contested and complex moral concept characterised by numerous internal tensions (Hattingh 2001). If a weak model of sustainability/sustainable development is followed, the emphasis falls on issues of maintenance of current patterns of production and consumption.

A slightly stronger attempt introduces the idea of intrinsic value, but still adheres to the notion of use within natural boundaries, thus calling for minor adjustments to socio-economic structures to ensure the continuance of a resource base for humans, and to a lesser extent, non-humans. In a more radical model, the emphasis falls on structural changes to the economy, institutions and lifestyles to ensure a fairer distribution of the earth's natural provisions, among all inhabitants of the earth, for this generation and multiple generations thereafter, while adhering to ecological thresholds (Hattingh 2001).

The significance of this overview is that it creates a basic conceptual map of the values that shape the different meanings, and implementation, of sustainability/sustainable development. What emerges is that "the implementation of sustainable development, therefore, is not merely a matter of applying an already defined concept whose meaning can be determined in clear and distinct terms" (Hattingh 2001: 16), but that its implementation entails a "process of interpretation in which certain crucial and mostly very difficult moral choices are required" (2001: 16).

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I would now like to return to the initial question that was formulated at the beginning of this thesis, namely, what kind of an ecological conceptualisation of sustainability/sustainable development do we need? Another way to state it is, how is sustainability to be understood? And what does it ask of us? These are questions that still haunt us and need to be figured out, even if only in provisional terms.

What is clear is that we need a better understanding of thresholds, but also a break away from the status quo of destructive human behaviours in which we appear to be stuck. While science is able to investigate the problem of thresholds (it is not my place to do this here, as I am not an ecologist), the question asks what can we, at the level of society, business and policy do? The problems that sustainability seeks to address ultimately have to do with human behaviour, which would suggest that where a technical or managerial attitude toward the natural environment is maintained, we neglect the human and moral aspects of sustainability, and that these need to be brought to the fore in a conceptualisation of sustainability. Since our values shape and steer our behaviour, and bear ethical implications, the suggestion I would like to make is that it is our sense of what is valuable that needs revision.

Eventually, to navigate beyond a destructive attitude toward nature, we need to shift away from values that perpetuate this, such as a sense of domination, and viewing nature from a strictly instrumental and utilitarian perspective, toward values that are more compassionate, fair and just. Compassion and fairness ultimately sound the call for us to think of others (Rolston 2017), in the form of future generations, but also non-human forms of life.

It suggests that a more radical conceptualisation of sustainability is needed, in which we, on a global socio-economic level, learn to identify and live well within the limits of supporting ecosystems (supporting a high degree of environmental protection and ensuring the heath of ecosystems), work towards a just share of natural provisions, now and into the future, to support the quality of human life, and all communities of life.

In practical terms, this conceptualisation should allow no further decline in natural capital, given our dependence on ecosystems, or adherence to the notion that critical ecosystem services, like the oxygen-producing capacity of forests, can be substituted for without a loss in human and non-human wellbeing. This adheres to the principle that to take precautionary steps is intelligent, as we do not know where ecosystem thresholds lie and the consequences of infringing them can be catastrophic.

When a threshold is reached, a small amount of further introduced change creates a tipping point, which triggers "large and relatively rapid adverse changes" (Rolston 2017: 171), due to the phenomenon of non-linear shifts in complex systems. These point out that knowledge of where these thresholds are, and at what point they can be transgressed, is key. A threshold can be thought of as a transition point in the functioning of coupled human-environmental systems (Schellnhuber 2002 in Rockström *et al.* 2009b).

In this regard, science can help us. Thresholds are key features of complex ecological and earth systems and there is much uncertainty about them, arising from our incomplete knowledge of how complex systems behave and the unpredictability of feedback mechanisms. In order for the threshold concept to help us, the important questions when dealing with thresholds are where are they "located", and when will we "reach" or surpass them? The implication is that until we gain more certainty as to where critical biological thresholds lie, it takes away any suggestion that human being can manage ecosystems.

Boundaries, on the other hand, are determined not by science, but by human values, setting them at a safe 'distance' (Rockström *et al.* 2009b) from a dangerous level (for processes without known thresholds) (2009b). To gain insight into how thresholds and boundaries affect our understanding of sustainability/sustainable development, Earth System science, and the concept of planetary boundaries, can help us.

The planetary boundaries approach (Rockström *et al.* 2009a; 2009b), which sees the planet as a vast and complex living organism (Swilling and Annecke 2012), elevates our field of vision from a regional ecosystemic level to a planetary level, that we imperfectly understand. Its significance lies in its capacity to scientifically identify, quantify and integrate these quantifications into tangible planetary boundaries that should not be transgressed if we want to achieve enduring social and environmental sustainability. Unlike an ecosystem services approach, a planetary boundaries approach enables a more accurate grasp of limits.

These include some key markers, such as not exceeding 350 parts per million of CO_2 in the atmosphere, or an extinction rate of 10 per million species per year, or global freshwater use of 4000 km^3 per year (Swilling and Annecke 2012: 29; also see Rockström *et al.* 2009b). The imperative of staying within these tangible thresholds to avoid the implications of global environmental change (Rockström *et al.* 2009a), suggests that planetary boundaries, and their management, should be incorporated into our understanding of sustainability/sustainable development.

The approach identifies boundaries for nine key Earth System processes, or subsystems, which, as long as we remain within them, define a "safe operating space for humanity" (Rockström *et al.* 2009a: 472), namely: climate change, rate of biodiversity loss (terrestrial and marine), interference with nitrogen and phosphorous cycles, stratospheric ozone depletion, ocean acidification, global freshwater use, change in land use, chemical pollution, and atmospheric aerosol loading (2009a: 472). Of these, three processes – climate change, rate of biodiversity loss, and interference with the nitrogen cycle – have already been transgressed, and we are approaching the boundaries for freshwater use, change of land use, ocean acidification, and interference with the global phosphorus cycle (Rockström *et al.* 2009a).

A widespread consensus is emerging, however, that the present system of production and consumption can only be maintained if planetary boundaries are ignored (Swilling and Annecke 2012). This supports the view that our mainstream economic growth model "is inconsistent with the finite nature of the planet" (2012: 99), and implies that the time when policies will be required to radically alter this model (Swilling and Annecke 2012) is here.

Hence, while we have science that informs our problems of thresholds and establishes boundaries to human behaviour, what can we, at the level of society, business, and policy do in the meantime? Is there an attitude, or stance, which we can adopt that takes up the insights of this science? Adhering to these boundaries still comes down to human action, and the impacts or consequences of that action. So, when it comes to thinking of what we have to do, it points to trying to understand how we as humans can become 'unstuck' from the multiple-layered crisis in which we find ourselves, in the sense of the core ideas of self-realization, wellbeing, resource use, and the "management" and "control" of nature that initially put us there.

One thing we can do is to sound out, for business and policy-making alike, where a technical or managerial attitude toward the natural environment is adopted (something that a managerial interpretation of an ecosystem services approach creates a conducive environment for), that there are aspects of human behaviour, morals and values that just do not feature in it. These we just neglect, or don't bring to the fore.

In terms of conceptualisation, there are also a few metaphors that we need to avoid, most prominently framing nature in economic terms and thinking of it as a form of capital that can be managed. Rolston suggests we need to find new metaphors, and for the path that lies ahead, there are one or two metaphors that seem to be valuable, such as Rolston's (2017) sense of community.

The metaphor of community suggests sharing, mutual relations, connections, or residing in the same place together. It alludes to being part of something outside of yourself and bigger in scope, something that sustains you in some way. With this in mind, Rolston suggests that in an ecological context, the idea of community acts as a means of "experiencing non-human community with others" (Rolston 2017: 59).

Furthermore, “in this kinship we have moral concern with them” (Rolston 2017: 64) since the growth in “ethical sensitivity” (2017: 64) prescribed by environmental ethics “requires enlarging the circle of neighbours” (64). Our neighbours in this case, include other forms of life, for example animals, organisms and biotic communities, and our moral concern for this wide community is directed at protecting and preserving the regenerative capacity of all life, that is housed within these communities.

In this regard, Rolston (2017) suggests that ecology, which refers to the relations and interactions between organisms and their environment, “dissolves any firm boundary between humans and the natural world” (2017: 189). Boundaries, to recall, are constructs imagined by us, not tangible ecological fact. Put differently, the separation between man and nature is artificial, and it is humankind who has put it up. As living organisms, humankind is automatically part of the ecological community. As such, we have entwined destinies with the natural world, and “our richest quality of life involves a larger identification with these communities” (189). Iterating ideas of deep ecology, Rolston says that this would amount to a form of “personal transformation”, and one that would “result in an appropriate care for the environment” (189).

“Management does require humanising the landscapes on which we reside” (Rolston 2017: 189). Given that human influence is pervasive across the earth (Rolston 2017) it implies a near future (if not already) where there is no pristine nature left, just varying degrees of managed nature (2017). “The future will be, over most of the landscape, inescapably, a managed world” (2017: 189) but, what does need to shift is our human arrogance about our domination of the natural world. We are inseparable from it, it is always around us (2017). Nature can survive without us, but not us without it. As such, a sense of respect, and gratitude born of dependency, might be a more intelligent human response.

Accordingly, Rolston argues that “Management does require humanising the landscapes on which we reside” (Rolston 2017: 189). However, this kind of management would not entail for him an arrogant domination of the earth; on the contrary: “Caring for humanity requires caring for the Earth; These are compliments – not opposites as so often argued. One does not need to sacrifice nature to benefit people, rather people benefit from a nature that is protected and conserved” (Rolston 2017: 10).

Thus, sustainable development "may be defined as the kind of human activity that nourishes and perpetuates the historical fulfilment of the whole community of life on Earth" (Ronald Engel 1990: 10-11 in Rolston 2017: 10).

I declare that I fully concur with these values and these reasons, but I also would like hold on the right to life for all forms of life, not just as a means to continue the regenerative capacities of ecosystems for human use, but out of concern, compassion, and the realisation that as we wish and feel entitled to life, and a flourishing, happy, peaceful, compassionate one at that, and we have all we need to do this, material and emotional, so might non-human life. I argue for a position on sustainability and sustainable development that gives more than just rights, which we summon when threatened as a form of protection, but gives intrinsic value. While we still need rights, and they are important, we could still need something deeper. Fundamental respect.

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