

# The Many Faces of Sustainability

Describing, analyzing and measuring sustainability  
in the Wadden region



Waddenacademie





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in the Wadden region

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<sup>1</sup> We would like to thank drs. Saskia Benedictus - van den Berg for correcting our English. The remaining mistakes and other choices are the responsibility of the authors

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# Preamble

One of the central themes in every discussion, intervention, or research activity with regard to the Wadden region concerns the issue of “sustainability”. Is what we try to accomplish in the Wadden region relevant for sustainability? Do the actions and interventions within the Wadden area have a positive impact on sustainability? What happens to the Wadden islands in terms of sustainability if, for example, Ameland wants to be energy neutral, even in the tourist season, or if it tries to apply the Cradle-to-Cradle approach? As can easily be seen from the last example, “sustainability” is not only about ecology. A position with regard to sustainability also affects our ways of production and consumption and our individual and social lives. Therefore, sustainability is both about ecological systems and about social and economic structures. Although there is no doubt about our ecological environment being the fundamental starting point, especially in the unique area of the Wadden, it is our individual and collective human behavior that deteriorates or strengthens our ecological environment. With respect to sustainability our ecological and social environment are tightly interconnected.

To guarantee the integrated nature and the associated research programmes, the Wadden Academy proposed in its Integrated Research Agenda (*Knowledge for a sustainable future of the Wadden*, 2009) a limited number of large, umbrella programmes, in which interdisciplinary research should be undertaken. They concern three generic knowledge programmes plus three integrated research programmes, supported by two conditional themes. The three integrated research programmes attempt to fill the gaps which are relevant to policy making and policy evaluation without lapsing into single-issue approaches or an excessively restricted temporal or spatial perspective: Wadden Nature, Wadden Climate and Wadden Well-being.

The Wadden Academy asked us to focus on Wadden Well-being, including the social, economical, psychological, demographical, and geographical domains. Because well-being certainly has to do with the perspectives of people, we decided to interview more than twenty so-called important policymakers, entrepreneurs and researchers living and working in the Wadden region. Using a fixed interview structure, we asked them their view on the Wadden region, and we also asked them to formulate and explain five very important research questions for this region. On request of some of the interviewees the interviews were kept confidential. The interview transcriptions, additional Wadden workshops and literature studies resulted in a research program for Wadden Well-being: “The Wadden area as a laboratory for sustainable social solutions”. (Het Waddengebied als laboratorium voor duurzame sociale oplossingen). This program on Wadden Well-being (see: [www.waddenacademie.knaw.nl](http://www.waddenacademie.knaw.nl)) can be downloaded from the Wadden Academy website.

During our interviews with policymakers and researchers and in meetings with the Wadden Academy, it turned out that “sustainability”, in whatever disguise, was a confusing and often confused concept. To cast some light on this conceptual confusion and to ease future discussions with respect to the Wadden region, we agreed to formulate a position paper on “the many faces of sustainability”. This position paper contains some references to the Wadden region, but it is also meant to give a bird’s-eye view on sustainability. This means that we will not discuss every possible case within the Wadden region – there are just too many –, but that we will focus on conceptual and measurement issues of “sustainability” with only an occasional reference to a practical case. The position paper is written in such a way that it can be applied as soon as a conceptual or measurement problem appears in a practical situation. The variety and multi-level views of the various practical situations prevent a “one-fits-all” approach. We can only offer components, conceptual clarifications, and measurement approaches to sustainability; concrete applications in practical situations will have to be provided by the stakeholders.

In part A of the position paper we will focus on various conceptual issues. In part B we will propose a method to measure the ecological and social (economic) performance of a specific social system (individual, group, organization, sector, or the Wadden region as a whole) regarding specific Areas of Impact (AoI) linked to ecological and social (economic) Well-being, and also closely linked to specific kinds of vital capital (this will be explained later). As we focus on activities, our “sustainability question” is: “Is the performance or impact of the activities of system X sustainable with regard to a specific Area of Impact?”. There are many ecological and social (economic) areas of impact, as described in the Integrated Knowledge Agenda. Examples of ecological Areas of Impact are: biodiversity, clean water, clean air, and fish stocks. Examples of social Areas of Impact are: health, education, housing, community cohesion, etc. Our template and general format lead us to address a wide variety of sustainability issues and questions, as follows:

- Is the performance and impact of organization Y (economically) sustainable regarding job creation and livable wages (social sustainability)?
- Is the performance and impact of the harbor of Delfzijl (ecologically) sustainable regarding CO<sub>2</sub> emissions (ecological and social sustainability)?
- Is the performance and impact of the Wadden region's tourism sector (socially) sustainable, regarding a pleasant social living environment (social and ecological sustainability)?

Our framework can also be used to measure the impact of knowledge creation (in terms of individual and collective human behavior) on the outcomes of social and economic activities.



# 1. Introduction: sustainability, common sense, and points of departure

Sustainable is often positioned as equivalent to long-lasting or enduring. This is understandable, but incomplete. We will argue that sustainability is not the same as long duration or an enduring or prolonged existence. A sustainable car is not the same as a car that exists for a very long time. A sustainable car is a car that is neutral with respect to its energy consumption and with respect to its production process and materials. Neutral means that its input is balanced by its output.

Sustainability is a concept that expresses a relationship. It is an expression of the existence of a dynamic balance between an artificial system and its environment (see also Tietenberg, 2000; Jorna, 2006). Whenever an artificial system uses inputs from its environment, it depends on the capacity of the environment to produce these inputs. The outputs that flow from the artificial system to its environment rely on the capacity of the environment to process these outputs. The precise configuration of the interactions between artificial system and environment, through in- and outputs, results from behavior of the artificial system and the adaptive capacity of system and environment. By definition, behavior of the artificial system depends on behavior of the human(s) operating it. In technical terms, discussions about sustainability require the specification of a quadruple. A system (X) is in relation (r), for example in balance, with an environment (Y) over a period of time t:  $S = \{X, r, Y, t\}$ . This expression, its details, its various conceptualizations, its operationalization, and its measurement are leading in the remainder of this position paper.

Sustainability is also often said to pertain to ecological issues only. Indeed, sustainability concerns our environment, but should not and cannot be restricted to our natural environment. It also concerns our social “Umwelt”. Sustainability applies to every system that is in interaction with its environment. This means that sustainability is applicable to natural environments as well as to social environments. Although this perspective is not new, given the well-known notion of the triple bottom line of “planet, people and profit” (Elkington, 1997), the “people” part is often only operationalized in terms of justice or avoidance of child labor. There is nothing wrong with that, but it is incomplete. We will explain our position in later sections.

Sustainability is often considered to be new or hype. We argue that it is not new, because already in the 17<sup>th</sup> century, in what is now called Germany, the notion of sustainability (“Nachhaltigkeit”) was explicitly used with respect to wood and forest maintenance. Nor is it hype, because if we are not able to solve issues of exhaustion of resources and of emissions this century, future centuries will show a strongly diminished presence of Homo sapiens, especially in its present social and cultural contexts.

Details of the above will be discussed in the next sections, but we will first continue with three points of departure that guide our understanding and treatment of sustainability, i.e., a) a system's view, b) the human individual and collective perspective, and c) measuring (social) sustainability.

Concerning a system's view on the relation between human behavior and issues of sustainability, we use the concept of artificial system (Faber, 2006). This concept is based on Simon's (1969) notion of "the artificial". The artificial system concept originates from systems-theory (e.g., von Bertalanffy, 1951), which provides a general world-view consisting of systems and (their) environments. We define an artificial system as any kind of system that is (i) made by humans, and (ii) operated by humans. For example, a house is an artificial system. However, a farm and its farmland are artificial systems, too. Whereas the example of the house and the farm are trivial, using farmland as an example of an artificial system is not. Although land is natural in origin, it is also an artificial system, because the purpose for which it is designed and used is human-made. The land is demarcated by the farmer and arranged to grow a specific kind of crop or to let cattle graze on it. Furthermore, the land is treated in such a way (e.g., fertilization, irrigation) that it provides the highest yield or the most nutritious grass.

As indicated above, the configuration of the interactions between an artificial system and its environment are considered dynamic in nature (Faber et al., 2005). Through time, the components and structure of the artificial system and its environment will change, affecting the ways they interact, and thus the position of the dynamic balance between the artificial system and its environment. Hence, pursuing the sustainability of the artificial system requires continuous adjustment of the human actors (individually and collectively) who control it. Knowledge (of sustainability) can be identified as the force behind (individual and collective) human (adaptive) behavior and the effects of this behavior on the ecological and social environment. We would like to argue that humans in many cases degrade the environment willingly, but also that they often do so out of ignorance, because they lack sustainability literacy or the knowledge of the ecological and social systems that would withhold them from doing harmful, i.e., unsustainable, things.

A third point of departure is that with regard to the determination of sustainability we argue that in one way or another sustainability should be operationalized such that it can – at least partly – be quantified and measured. Only then can the claim of organizations and societies that they are really sustainable be tested, compared, and if necessary improved. These measurements not only regard our ecological environment, but also and perhaps even more strongly our social environment. Moreover, although quantification is often formulated in terms of money, we believe that this is the easiest and most unsatisfying interpretation of value attribution. In later sections we will explain that there are others ways of measuring sustainability.

The remainder of this paper consists of two parts. In part A, we will conceptualize and criticize various positions with regard to the notion of sustainability. In section 2, we will discuss various definitions and operationalizations and in section 3, we will discuss knowledge of sustainability, innovation, and related concepts. In section 4, we will

discuss the conceptualization of sustainability in terms of capital. Part B is about methodology, operationalization, and measurement. In section 5, we will describe the use of context-based sustainability indicators and metrics, and in section 6 we will organize these context-based performance measurements in a new Performance Scorecard: the Adaptive Quadruple Bottom Line Scorecard). In section 7, we will present our conclusions and formulate a research agenda for the near future.

# PART A: THE CONCEPTUALIZATION OF SUSTAINABILITY

## 2. Sustainability and sustainable development

### 2.1 Introduction

In this section, we show that there are systematic differences between various interpretations of sustainability (2.2). Then we will go into the details of the seemingly endless debate about definitions and indicators of sustainability (2.3). On the one hand, this debate is confusing, on the other hand it is necessary, because if we do not know what we are talking about, how can we then measure and compare X, Y, and r as formulated in the quadruple. In section 2.4, we will discuss the paradox that knowing more about sustainability actually makes it more complex. This increasing complexity cannot be avoided and the only way to deal with that is to make educated choices and present arguments showing “moves and countermoves” with respect to sustainability discussions. Neglecting sustainability issues is not an option and is just burying our head in the sand.

### 2.2 Quasi-logical differences between “sustainable” and “durable”

Sustainability is a complex concept. It can refer to an ideology or philosophy of life, to environmental science, to our natural and our social habitat, and to a resistance to exhaust the resources of our planet. For the last twenty years “sustainable” has mainly been used to provoke attention and sometimes anger to the view that our natural and lately also our social resources seem to be inexhaustible or that they can and should replenish themselves. We now know that sustainability affects all aspects of our

surroundings as well as ourselves. Before elaborating on the sustainability concept in a more structured way, we would first like to illustrate the sustainability theme with one example. We will do this by primarily starting from the ecological perspective (the P of “planet”): the exhaustion of resources.

The history of sustainability in the ecological sense shows that in the past, various resources were used and exhausted. Van Zon et al. (2002) describe the development of the timber industry, the mining industry and population growth. When we look at the timber industry, it is immediately obvious that all the wood existing on earth now could never be sufficient to build all the ships and to construct and heat all our houses. The mining industry, for instance the coal and iron sectors, has shown its limitations, too. Therefore, in Europe coal digging has stopped for the greater part. Nevertheless, new materials have been developed to compensate for the shortages that have arisen and to complement them. The pattern is always more or less the same. Detection of possible use of wood, coal, oil, etc., then abundant use of these resources, then overconsumption and awareness of possible exhaustion of the resources, then innovation to look for alternatives for the exhausted resources, then again detection of new resources for possible use and so on. Two factors seem to be constant: a late -awareness of exhaustion and a flight into new, so-called innovative, raw materials without looking at environmental and social damage. The question is whether this cycle can be changed. It seems necessary to stop this cycle, because expansion of the earth’s resources seems to have come to an end this 21<sup>st</sup> century.

A similar story can be told about population growth. Malthus (around 1800) depicted an image of a world in the year 2000 which would collapse under its human burden. This has not (yet) happened. It seems that we are able to bend developments and, in one way or another, realize and maintain “sustainability”. Therefore, as we will argue in sections 4 and 5, sustainability is environmentally as well as socially relevant.

Anyone who is confronted with sustainability for the first time will soon realize that this concept has no sharp, unambiguous definition. In order to place sustainability within a usable framework, it has to be made clear what it is to distinguish sustainability as a concept from similar concepts, such as “continuity”, “durability”, or “permanency”. For that matter, there is a problem with the Dutch term “duurzaamheid” (“sustainability”). This is a general term (a bulk term) related to the English terms “sustainability”, “durability”, and “renewability”. Therefore, we will not provide a precise definition of sustainability either. The best we can do is to map out the field in a descriptive way, in which the concept has meaning.

Let us begin by establishing that sustainability is not a concept that stands on its own. It is a quality ascribed to certain entities, artifacts, or constructs. We ascribe this quality to things, matters, and constructs, both tangible and intangible. For example, we speak of sustainable coffee, a sustainable society, and sustainable development. By ascribing sustainability to a particular matter, both the sustainable nature and the degree of sustainability are indicated. However, ascribing sustainability to a particular matter remains meaningless if it is not clear what exactly it entails.



Several meanings have been assigned to the concept of sustainability. The Dutch classical dictionary *Van Dale* describes it as follows:

“Sustainable: 0.1 suited to exist for a long time, durable, consistent; 0.2 long lasting, continuous; 1.1 a lasting memory; 2.2 to be permanently divorced; 3.2 to persist durably.” (Van Dale, 1996)

This description shows that ascribing sustainability to a particular matter or thing refers to the degree to which this matter is suitable to exist for a long(er) period of time. However, sustainable coffee does of course not refer to coffee that cannot be used. For example, what does “sustainable coffee” mean according to the given description? Coffee that is suitable to exist for a long time? Well no! The description offered here does not clarify what is meant by a long existence, or which factors determine that a particular matter can exist for a long period of time. After some more reflection, we will come to the conclusion that “sustainable” in “sustainable coffee” refers to the process of producing coffee and not primarily to the product itself unless the theme of the discussion changes to what it will do to our health.

The way in which sustainability is used nowadays, is based on the English term “sustain-ability”, which is an expression of the possibility of a certain matter to be supported. It should be noted that we are not suggesting that organisms or systems live forever. That is impossible, but the issue debated in sustainability discussions is that “health” of systems or organisms is a function of the (internal components of the) system at hand and its surroundings. Apart from the term “sustainability”, the English language also knows the closely related terms “durability” and “endurability”. Freely translated these terms respectively mean “wear-resistant” or “lasting” and “bearable” (easy to bear). This range of terms does not make the discussion about sustainability any easier. However, there are similarities in the terms mentioned. According to the given description, ascribing sustainability to a particular matter expresses the possibility that this matter can exist for a long(er) period of time. In line with the term “sustainability”, the matter can exist longer, because it can be supported. Therefore, as a result, sustainability is not just a characteristic of a particular issue; it connects the issue to its surroundings, its environment: sustainability reflects the possibility that a particular matter can be supported by its environment for a longer period of time. In this way it can be distinguished from related concepts as “durability” or “endurability”. These terms express the “built-in” capacity of a particular matter respectively to fend off or to bear external influences. Rather than connecting the issue to its environment, these terms merely express its inherent quality.

If a quasi-formal (logical) perspective is taken, and if we try to clarify the logical behavior of the notion ‘sustainability’, it can be viewed as a predicate. Take for example the sentence “John is married”. If we look at the logical behavior of the predicate “married” it implies that “married” has two slots, the slots X and Y, and we say, “X is married to Y”. In this sense “married” is irreflexive (one cannot be married to oneself), symmetrical (if you are married to someone else, the other person is married to you), and intransitive (if you are married to someone else, that other person is not married to a third person). In logical terms it can also be stated that “to marry” is a two-place predicate (operator), taking two arguments (slots) and that it is irreflexive, symmetrical,

and intransitive. The same can be done for an analysis of the logical behavior of “sustainable”. If X is sustainable with respect to Y, Y may or may not be sustainable with respect to X (irreflexive and non-symmetrical), and if X is sustainable with respect to Y, Y should be or is sustainable with respect to Z (transitive). If we say, “this car is sustainable”, do we mean that “sustainable” as a predicate has one or two arguments? In our opinion, sustainability should be formulated as a two-place predicate or a dyadic operator. This implies that we should say, “This car is sustainable in relation to Y”. In contrast, the concept of endurance (very much resembling sustainability) is, in logical terms, a one-place predicate or monadic operator. Endurance only says something about the inherent potential of an artifact to withstand hostile, external influences. That is to say, the endurance of an athlete refers to the capability of the athlete to withstand the hardship of a marathon. Endurance only indicates the inherent capability of the athlete to withstand this hardship, but does not say anything about the environment in which the athlete operates. This quasi-formal analysis illustrates clear that ‘endurance’ and ‘sustainability’ are not the same. Without specifying both slots (arguments) of the predicate ‘sustainable’, a discussion of improving sustainability is useless. We argue that sustainability applies to open systems.

### 2.3 The struggle with definitions and indicators of sustainability

“Sustainable” is often used in the area of energy where it is referred to as “renewable”. This means that the use of this type of energy has no limitations, because it can be regained. Especially wind, water, tidal, and solar energy can be used and regained. That is, only as long as the sun will remain to exist, but this scope of time is practically infinite. In particular, the hydrogen cell technology, which is rapidly gaining momentum, claims to be completely sustainable. By means of solar, wind, tidal, or water energy, water can be split up into hydrogen and oxygen. The hydrogen stored in a hydrogen cell provides energy which turns into water. In turn, the energy can be retrieved from the sun, wind, or water (white current). Because of the nature of these energy carriers, this energy is renewable and therefore sustainable. As observed above, sustainability is considered an obvious solution in the framework of dealing wisely with energy and resources. The aim is to make or to keep life on earth possible.

More than 50 official definitions of “sustainability” can be found. The number of indicator lists based on these definitions, in order to make sustainability operational, is a multiple of this (see Faber, et al., 2005). To give an impression of the descriptions of sustainability we will offer three that are well-known:

“Meeting the needs of the present without compromising the ability of the future generations to meet their own needs.” (Brundtland (WCED), 1987). “Sustainable development is a process of change in which the use of resources, the direction of the investments, the orientation of technological development and institutional change are all in harmony, and (all) increase both the current and the future possibilities to meet the human needs and wishes.” (World Commission on Environmental and Development, Our Common Future, 1987).

“An organization is sustainable if a certain minimum performance is attained in the three “P-areas” (Planet, People and Profit).” (Elkington, 1997).

“Finding a balance between economic prosperity, environmental quality, and - the element which business has tended to overlook - social justice, moves organizations in an absolute state of sustainability” (Elkington, 1999).

From an analytical point of view it is striking that in none of the definitions a “definiens” is given. “Sustainability” and “sustainable” are exemplified, not defined. In literature, two categories can be discerned within the exemplification context. The first is especially aimed at society, whereas the second is more focused on the organization. People often are concerned about the future of the earth, about human society, and a balanced allocation of goods, resources, and means in the world. Clashing interests are discerned and admitted, both with respect to society and organization. In many definitions of sustainability, an underlying ethical discussion is involved about the goals humanity should pursue. Often references are given to a kind of ideal-typical final state: a harmonious world or a balanced world. This final state seems to be directional to the situation of today. In section 2.4., we will return to this observation of a directional end state.

Looking back at the recent, more popular history of sustainability, one can say that sustainability was first given world-wide attention by the aforementioned Brundtland Report (WCED, 1987). The Brundtland Report distinguishes three fundamental components of sustainable development:

- In the first place, the protection of the environment is referred to. It is stated that the environment should be protected, so that natural resources are enriched. This is achieved by a gradual adjustment of the way in which technology is developed and used.
- The second component involves economic growth. Brundtland argues that economic growth should be stimulated, whilst developing countries are offered the possibility to experience a growth similar to the growth of the developed countries.

- The third component of sustainable development is social (re)structuring. The Brundtland Report argues that a world-wide gap between the poor and the rich will result in a decline of the environment in poor countries. In this respect, Brundtland defends that in the pursuit of sustainable development, inequality between poor and rich has to be counteracted as much as possible.

The Brundtland Report describes all three components from one perspective, emphasizing the protection of the environment. One approach that focuses more on the organizational perspective is that of the “Triple Bottom Line” or the “Triple P” (“people, planet, profit”). The “Triple P” refers to the three foundations of sustainable development. The Brundtland Report emphasizes the environmental aspects of sustainable development. The foundations “economic growth” and “social structuring” are both viewed in relation to the protection of the environment. The “Triple P” offers a more general approach to sustainability. It does include the three foundations of sustainable development: ecology, economics, and society, but they are not merely viewed from the perspective of environmental protection. This is in line with our general point of view. A particular matter (thing, service, or construct) which is referred to as sustainable, interacts with its supporting environment. With respect to its existence and performance the matter is dependent upon its environment. Depending on the nature of the matter (thing, construct, etc.), certain parts of that environment are addressed. The parts focused on are “people”, “planet”, and “profit”, or in other words the social, ecological, and economic environment. Some also refer to “man”, “environment”, and “added value”. In this respect, it is not the absolute value of the individual components which is relevant, but the combination of the total range of components.

All three aspects contribute to the achievement of sustainability. In this respect, the “Planet” component is mostly considered in terms of biological and physical terminology and variables, the “Profit” component in terms of financial and economical variables, and the “People” component in terms of social structuring, social capital, or social justice. The problem with the last component is that it is difficult to make it operational. Because we consider social capital in the sense of human and organizational opportunities and abilities as the core of (social) “sustainability”, we will return to this in sections 4 and 5.

Within the “Triple Bottom Line” concept as presented by Elkington (1999), we can even go a level deeper. The cause and effect relations of the three P’s can differ enormously. A lack of ecological sustainability is often considered a reason to interfere (technically). Here, the relation of cause and effect is that of “planet” with “planet”. However, a lack of sustainability is often the consequence of a particular design of a company, organization or society. In that case, there is a cause and effect relation between the P of “people” and the P of “planet”. In the work of Carson (1962), Naess (1973), and Sessions (1995), the environmental issue is considered as resulting from a certain design or configuration of human individual and collective behavior, from knowledge use, and from fundamental starting points on which our way of organizing things is based.

The Norwegian philosopher and argumentation theorist Arne Naess, especially, viewed ecology as always related to human behavior and human thinking. In a speech held at the Third World Future Congress (1972), Naess made an important distinction between “shallow” and “deep ecology”. “Shallow ecology” is not primarily eco-oriented; it is people-oriented and in many cases especially aimed at people in the Western world. More complex environmental solutions are often found in managing pollution. One only has to think of the trade in emission rights – an issue discussed at several environmental conferences – which, although strongly criticized, was accepted as the highest achievable aim. Naess puts it as follows (quoted from McElroy, 2003):

“The essence of deep ecology is to ask deeper questions. The adjective ‘deep’ stresses that we ask why and how, where others do not. For instance, ecology as a science does not ask what kind of a society would be the best for maintaining a particular ecosystem; that is considered a question for value theory, for politics, for ethics. As long as ecologists keep narrowly to their science, they do not ask such questions. What we need today is a tremendous expansion of ecological thinking in what I call ecosophy. Sophy comes from the Greek term Sophia, ‘wisdom’, which relates to ethics, norms, rules, and practice. Ecosophy, or deep ecology, then, involves a shift from science to wisdom. For example, we need to ask questions like: why do we think that economic growth and high levels of consumption are so important? The conventional answer would be to point to the economic consequences of not having economic growth. But in deep ecology, we ask whether the present society fulfills basic human needs like love and security and access to nature, and, in so doing, we question our society's underlying assumptions. We ask which society, which education, which form of religion is beneficial for all life on the planet as a whole, and then we ask further what we need to do in order to make the necessary changes. We are not limited to a scientific approach; we have an obligation to verbalize a total view.”

“Deep ecology” is in principle “eco-centric” rather than merely “anthropo-centric”-oriented (or people-oriented). Obviously, it is about the well-being of people, but that is not the only issue. It is aimed at the interaction between man and environment, not only in his natural and biological environment, but also in his social, mental, and knowledge environment. “Deep ecology” sees a biosphere consisting of people rather than one evolving around people. “Deep ecology” asks questions which touch the core of the structure of our ways of working and organizing affairs. This does not mean that technology and science are the problem or provide the answer. Science and technology are both the problem *and* the answer. The discussion about “deep ecology” leads to four conclusions regarding “sustainability”.

- First, Naess makes clear that “sustainability” does not refer to man or environment, but to man *and* environment, or rather: to man, organization, *and* environment.
- Second, the debate on sustainability begins by asking the right questions. Asking questions leads to reflection and from these to creativity and the creation of (new) knowledge.



- Third, Naess' line of thinking shows that an increasing complexity asks for a systems approach. Everything seems to be connected.
- Fourth, it is not true that technology is the cause of or can be blamed for all deficiencies and mistakes. On the contrary, technology has been used to create problems, but it has played and will play a crucial role in solving problems, too. However, this does not alter the fact that aspects relating to social and organizational issues will always play a role, simply because people design, implement and use technology.

Herman Daly, a former, well-known economist of the World Bank, co-originated the field of ecological economics, a transdisciplinary attempt to unite economics and ecology (Daly, 1996, p. 73; Costanza et al, 1997). He and other – if not all – ecological economists, adhere to a Capitals Theory Approach (see section 4) as a fundamental principle in their thinking (Costanza et al, 1997, p. 107). Natural capital, in particular, figures prominently in related literature. Human economies are seen as subsystems of the global ecosystem and not apart from it (Daly, 1996, pp. 6-7; Costanza et al, 1997, p. 7). The implications of this, in terms of what it would mean for a society or an economic system to be sustainable, especially with respect to our natural resources, are succinctly put forward by Daly (1990):

“For the management of renewable resources there are two obvious principles of sustainable development. First, that harvest rates should equal regeneration rates (sustained yield). Second, that waste emission rates should equal [or not exceed] the natural assimilative capacities of the ecosystems into which the wastes are emitted. Regenerative and assimilative capacities must be treated as natural capital, and failure to maintain these capacities must be treated as capital consumption, and therefore not sustainable” (p. 2).

.....

“There remains the category of nonrenewable resources which strictly speaking cannot be maintained intact short of nonuse [...] Yet it is possible to exploit non-renewables in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of renewable substitutes. The quasi-sustainable use of non-renewables requires that any investment in the exploitation of a nonrenewable resource must be paired with a compensating investment in a renewable substitute (e.g., oil extraction paired with tree planting for wood alcohol)” (Ibid., p. 4).

Meadows et al (1992) embraced and summarized Daly's three principles as follows (p. 209): “In order to be physically sustainable [a] society's material and energy throughputs would have to meet Daly's three conditions:

- 1 Its rates of use of renewable resources do not exceed their rates of regeneration;
- 2 Its rates of use of nonrenewable resources do not exceed the rate at which sustainable renewable resources are developed;
- 3 Its rates of pollution emission do not exceed the assimilative capacity of the environment.”

Here, we wish to make two general observations regarding Daly's three principles, or rules. The first is that, as Meadows et al. point out, Daly's principles deal exclusively with the ecological impacts of human activities on natural capital. There is no standard of performance or criterion for social sustainability in his formulation, except to the degree that environmental degradation will ultimately have an impact on human well-being. Still, his formulation is expressed in terms of impacts on natural capital only, and there is no reason to believe that he has anything other than that in mind. The second observation is that Daly works with rates, meaning that he works with a nominator and denominator. There is a ratio of the one in proportion to the other

## 2.4 The increasing complexity of sustainability

The above discussion about the meaning of sustainability settles a number of issues. It is a bulk term that has often been interpreted in different ways. Its basic meaning is positive – how could anyone not wish to be sustainable? In addition, with respect to the sustainability concept, several components can be distinguished: an ecological, an economic (financial) and a social one. Furthermore, “something sustainable” – whether it is goods, matter, or artifacts – is not just there; it is part of a context. It presupposes a relationship, e.g. a balance, between a system and its environment. All this implies that the complexity of sustainability increases. Not only a material object can be sustainable; a construct or immaterial artifact can also be defined as sustainable. Take health care, for example. It can easily be understood that the complexity of the health care system is much bigger than that of a car, and that attributes and aspects at different levels of aggregation are important for health care, such as mortality rates or waiting lists. Over the last 15 years the notion of sustainability has become even more complex for the following three reasons:

- a. the interpretation of sustainability changes from an absolute to a relative notion,
- b. the extension of sustainability changes from a static aspect to a dynamic aspect of system and environment and
- c. the applicability of sustainability requires that various levels of aggregation are taken into account.

- a. *Absolute - relative:* The balance between system and environment and the material or immaterial nature of the artifact leave unexplained the development of the artifact; the direction or route it takes. Which point of reference should be used in determining whether an artifact is sustainable? We distinguish absolute and relative lines of reasoning underlying the specification of what is to be considered sustainable. The distinction between the two is the point of reference used to discriminate between what is and what is not sustainable.

The absolute approach to sustainability identifies a continuum with two extremes: non-sustainable and sustainable. The leading extreme point on this continuum is “sustainable” in its idealized form. The underlying idea is that some form of “(real) sustainability” exists, which is leading when a change from the here and now to the ultimate form of “sustainability” is necessary. The problem is, of course, that

nobody knows what the real form of the ultimately “sustainable” is. However, that often does not prevent people from taking this ultimate form as a guiding principle. In his treatment and analysis of the existence of “ultimate goods” that are omnipresent in Western thinking, from the “ultimate classless society”, to the “ideal market” and the “real rationality”, the philosopher and mathematician Beth (1959) named this principle: “Aristotle’s principle of the Absolute”. Beth reasons as follows: someone working with the notion of an “absolute” starts with a statement that every activity aims at accomplishing a result that is considered good (or Good); conversely some good (or Good) exists that everything aims at. Three different objectives (Goods) exist: activities that aim at serving a direct purpose, activities that serve a purpose that is subordinate to a higher, probably unconscious, purpose, and activities that a higher (unconscious) purpose is again subordinate to an even higher (unconscious) purpose. This last step is expressed by the statement that “the aim of all our activities must be the Good and even the Supreme Good” (Beth, 1959). Beth presents this idea of the existence of a Good and a Supreme Good to accumulate infinitely, and if we apply it to sustainability, the continuum from non-sustainable to sustainable will be infinitely long.

“Aristotle’s principle of the Absolute” (Beth, 1959) defines a state or existing purpose that is the ultimate goal, achieved by human activity. If this idea of an existing, ultimate good is abandoned, the idea of an ultimate goal that needs to be strived for, no longer holds. Instead, a more pragmatic perspective is applicable, leading to what we call a relative way of approaching sustainability. A relative approach starts with the present state of affairs and identifies existing problems which people subsequently attempt to solve. Improvements take place incrementally within this relative approach to sustainability. It is an approach of small steps instead of a grand design. In contrast to the absolute approach, the focus of this relative approach is not the good, but the less worse or the better. Making the distinction between the absolute and the relative greatly resembles the distinction between the utopian and the pragmatist in action. The utopian will always dedicate his efforts to his struggle for the ultimate situation: Utopia. The pragmatist, on the other hand, will focus on the problems at hand and try to solve those in order to make the world a little bit better. With respect to sustainability this relative goal orientation increases, of course, the use and applicability of sustainability.

- b. *Behavioral interaction*: static - dynamic: Furthermore, with respect to system and environment the question is whether the dynamics of the system (artifact) and of the environment are accounted for. This aspect originates from the idea that artifacts and their environments experience changes of their component parts and internal structure, caused by exogenous forces resulting from their interactions, and endogenous forces originating from within. The attribution of sustainability to an artifact can either account for changes of both artifact and environment or assume that these remain unchanged. In a static perspective, the artifact is dynamic, whereas the environment is only static. Within this approach, the relation between the artifact and its environment remains unchanged. However, it is possible that the component parts and the internal structure of the artifact change. The only element of interest concerning the sustainability balance between the artifact and its environment is the magnitude of the interaction between artifact and environment. Obedience to the

limitations of its environment ensures the artifact's sustainability, which from the static perspective is everlasting by definition. An example of the neglect of a changing context is asbestos. In the 1960s, the use of asbestos was regarded sustainable due to its fireproof characteristics. Nowadays, the dangers involved in processing asbestos keep anyone from using it (McElroy, 2002). In general, ignorance of the possible dangers of technologies, which is common within the static perspective, is dangerous (Wynne, 1992) and unsustainable.

From a dynamic perspective, exogenous and endogenous forces impose changes upon both artifact and environment, thereby influencing the sustainability balance. In order to reach sustainability, the artifact continuously keeps track of changes in its environment and adapts to these changes to keep the balance intact. Open organizations adapt to their organizational environments continuously; for the organization to ensure its sustainability, adaptation to these exogenous forces is necessary. Next to these exogenous forces, organizations are subject to endogenous forces. These endogenous forces can be an important cause of the unsustainability of the organization. Both exogenous and endogenous forces exist, requiring the organization to adapt continuously in order to be sustainable. Here, again we see an increasing complexity of the notion of sustainability.

- c. *Levels of description/analysis*: The advantage of working with the notion of "system" is that its applicability is unlimited. At the same time, this prevents the fine-tuning that is necessary to apply sustainability to specific contexts. Especially when studying social sustainability, it is helpful to make a distinction in levels of analysis or description. We discern the following aggregation levels: individual, team or group, organization or firm, network of organizations, and society. Starting at the lowest level of aggregation, namely that of the individual, it becomes clear that research with respect to the sustainability of individuals is nearly absent. It is evident that this is the case. By definition, individuals are mortal and therefore sustainability is not easily applicable to them. It is therefore more productive to look at teams or groups. A group can be sustainable with respect to its social structure, its capacity to adapt to new members, or its abilities to create or apply (new) knowledge. At a higher aggregation level is the organization. What is of importance here is its size, its organizational structure, its coordination mechanism, and its absorptive capacity and learning potential. The tension between the level of the individual and the level of the organization, between not applying and applying sustainability, can be studied by looking at organizations as multi-actor systems. The multi-actor perspective sees people as combinations of functions, roles, and expertise which, in combination with communication patterns and organizational forms, have to achieve sustainability. At the level of companies or organizations within networks (cooperations or markets), it is common usage to work with sustainability. One aggregation level higher takes us to clusters of organizations at the regional level, which can be very successful in certain combinations (McElroy, 2008). The Cradle-to-Cradle structure of organizations that we will discuss in section 5 is an example of such a cluster of organizations where waste of one is resource for the other. Finally, there is the level of countries and above that, we deal with the sustainability of planet Earth.

The level of aggregation is a very accurate but complex frame of demarcation to discern the entities to which sustainability is applicable. Another complicating factor is the artifact to which sustainability is applied. Examples are sustainable healthcare, a sustainable energy household or sustainable agriculture. Here, the complexity of aggregation levels mixes with the complexity of artifacts such as agriculture or health.



# 3. Sustainability, Knowledge, Learning and Innovation patterns

## 3.1 Introduction

The Wadden Academy focuses on knowledge; knowledge created and used for a sustainable future of the Wadden region. Therefore, in this section, we will explore the relationship between knowledge, knowledge management, knowledge processes and sustainability issues. In section 2, we conceptualized an artificial system as human-made and human-operated. This means that the sustainability of an artificial system is mostly determined by how people act. Their behavior follows from knowledge they possess (in their minds) – knowledge in terms of *content* – and their operational patterns (behavior or actions) can be seen as “existing knowledge in use”. Artificial systems also have problem-solving patterns to develop and create new knowledge; here it is about how this new knowledge is processed. This holds for individual as well as for collective knowledge and actions. This knowledge has to be shared, stored, distributed, used, and created, and, therefore, in section 3.2, we will shortly discuss knowledge management, as the discipline that focuses on knowledge processes. We developed a conceptual framework to operationalize the relationship between sustainability and knowledge that we will discuss in section 3.3. There are two interpretations of knowledge management, 1<sup>st</sup> and 2<sup>nd</sup> generation, and because sustainable thinking implies a change in the use and creation of knowledge, we will explicitly discuss learning and innovation in relation to sustainability in section 3.4.

## 3.2 Generations of Knowledge Management

Because we act on the basis of what we know, the knowledge discussion shows the relevance of knowledge management for (social) sustainability issues. Knowledge management (KM) is a relatively young discipline in both research and practice (Dalkir, 2005). From the start, the main objective of KM has been to get the right information to the right people at the right time in the right quality in the right shape at the lowest costs (Schreiber et al., 2000; McElroy, 2003). According to McElroy (2003), KM was highly technocratic in the beginning. Information technological applications dominated KM practice from the start (Ruggles, 1998). This is understandable, for KM has been perceived in its beginning, as nothing more than the distribution, delivery, and transformation of information. McElroy calls this kind of KM, 1st generation KM. Today, especially in relation to sustainability, this approach within KM does not suffice anymore. KM, in its present 2nd generation, has become much more than just delivering and transforming information and using information technology. It is now also about knowledge creation and knowledge production (see section 3.4).

Based on McElroy (2003), we start with a general picture of (1<sup>st</sup> generation) knowledge management in organizations. Within an organizational environment, we see an organization as consisting of business processes (BP) with subjective and objective, coded and theoretical, and tacit and explicit knowledge in what can be called a distributed organization knowledge base (DOKB). First generation KM is recognized as the general form of KM by scientists and practitioners and is known for its shortcomings, especially related to a lack of focus on the “knowledge capture and creation” phase of the Knowledge Lifecycle (KLC) (Firestone & McElroy, 2003). The latter type, 2<sup>nd</sup> generation KM, is a new framework, developed in the beginning of this century. Second generation KM accommodates knowledge management theory and practice aiming to improve the 1<sup>st</sup> generation KM.

First generation KM focuses on capturing, encoding, storing, sharing, and distributing knowledge. These knowledge processes provide (or push) knowledge workers with valuable knowledge and are called supply-side knowledge processes. This way of practicing knowledge management emerged when researchers and practitioners assigned the success of flourishing companies to their knowledge processing capabilities. The rise of ICT, also in the late 80s and 90s, boosted this form of knowledge management even more. It is therefore quite understandable that ICT and knowledge management are often named in one breath. ICT-based knowledge systems and decision supports systems (DSSs) are well-known examples and are often regarded as flag-bearers of 1st generation KM.

As can be concluded from the above, the purpose of 1<sup>st</sup> generation KM practice is to enhance the deployment of knowledge (McElroy, 2003), the exploitation of knowledge (Jorna, 2006), or the utility of knowledge (Boisot and MacMillan, 2004). KM in this form does not support processes like knowledge creation, knowledge evaluation, and knowledge interpretation. This observation raises some fascinating questions. Where can the origin of the knowledge to be deployed or exploited be found? How has this knowledge been created? Who is responsible for validating, judging, and criticizing the created knowledge? First generation KM cannot provide answers to these questions. This is remarkable, because processes like interpretation and evaluation are also knowledge processes (Jorna, 2001). By failing to consider these processes, knowledge management is actually nothing more than information management (Firestone and McElroy, 2005). Moreover, it just assumes that valuable knowledge – the knowledge which made some companies in the early 90s (and even now) so successful – has already been created in an organization. First generation KM neglects the fact that valuable knowledge has to be (re)created, interpreted, and evaluated.

McElroy (2003) states that KM is based on two assumptions that, he says, do not match with reality. The first assumption is that knowledge that is needed by individuals to perform a certain task is already there; it exists. From this assumption, the need arises to capture and codify knowledge to make it easy to handle, to transform it into manageable pieces of information that can be easily transported. The choice for information technology as an instrument for KM is logical, for it brings forth tools that realize fast transport of information and in this way contributes to the realization of organizational efficiency. From the first assumption, McElroy derives a second assumption that underlies KM: the equivalence of information and knowledge. Knowledge solely

depends on humans as carriers or social processes as distributors. McElroy concludes that within an organization one presupposes that just feeding humans with the information they need, will result in desired outcomes and will make organizations perform better.

The two assumptions lead to two consequences for KM. First, because knowledge by definition already exists, one only has to focus on the transfer of knowledge. Just making sure that the right information reaches an individual at the right time, in the right shape and quality, is sufficient from this KM perspective. Here we have a problem with knowledge of sustainability, because this knowledge often is not available or at least controversial. Second, information technology is the key technology within knowledge management. Therefore, KM is all about information transfer against the lowest costs. Information technology enables a fast transfer and transformation of all kinds of information at relatively low costs. In other words, information technology is knowledge management's 'silver bullet'. Again, this is a problem for knowledge of sustainability, because non-existing or controversial knowledge cannot be used or shared.

The codified perspective of information management resulting in 1<sup>st</sup> generation KM, presupposes that human actors are controllable and predictable. It, therefore, suffices to prescribe behavior they are allowed to display in rules and policies. Furthermore, the controllability of humans enforces the use of information technology. Because humans will behave as predicted, the inflexibility that often characterizes information technology does not stand in the way of efficient organizational behavior. If the two assumptions hold, KM should pursue the mentioned objective making strong use of information technology. Meeting the objective then should result in organizational performance as if they were well-oiled machines.

Of course, problems arise when one or both of the assumptions do not hold. What should be done in case not all knowledge exists already and if, therefore, knowledge transfer is insufficient? Alternatively, what should be done if human interactive behavior as such does matter regarding knowledge creation and use?

Several authors have abandoned the assumption that knowledge already exists. This is especially relevant for knowledge of sustainability. Many authors suggested that KM theories need a broader basis (Nonaka & Takeuchi, 1995; McElroy, 2003; Jorna, 2007). If all knowledge existed, innovations would not have to be realized or would not be necessary anymore. The focus on information systems in 1st generation KM has resulted in a neglect of knowledge creation and production within KM. McElroy and others suggested broadening and transforming the "old KM school" with structures to cover the creation of knowledge: 2<sup>nd</sup> generation KM.

The second assumption underlying KM – the similarity of information and knowledge – contrasts with our notion of knowledge in which only humans are carriers. Knowledge is something human actors possess and use, also in social interactions. McElroy (2003) concludes that, in addition to including a structure for knowledge creation, a sound theory of KM should focus on humans and social processes. This bridges the gap between sustainability as the result of individual and collective human actions and the

one-sided view of sustainability as a merely ecological issue. Ecological sustainability needs human and social learning in combination with 2<sup>nd</sup> generation KM

### 3.3 Knowledge of Sustainability and Sustainability of Knowledge

The distinction between knowledge in terms of content and processes forms the basis of two concepts in our framework: Knowledge of Sustainability (KoS) and Sustainability of Knowledge (SoK). KoS indicates (i) knowledge content about the actual state of the relationship between {X, Y} and causes that underlie environmental, organizational, social, and individual problems, and (ii) the knowledge by which such problems can be resolved. The improvement of the behavior of an organization, i.e., improving the sustainability of an organization, builds on the problem-solving capabilities in which the firm applies KoS, and builds on the learning processes on the basis of which the organizations learns SoK. This SoK focuses on the knowledge processes that govern the production, creation, and integration of knowledge or KoS.

Adaptation and learning are essential for any form of sustainability. When we assume that artificial systems exist in continuously changing environments, the human(s) who control these systems need to adapt their behavior to these changes and hence often need to acquire or create new knowledge. The newly generated knowledge should eventually result in knowledge use, i.e. humans need to incorporate new knowledge into their existing behavior. As indicated, Sustainability of Knowledge (SoK) denotes the aspect that humans need adequate, open processes to acquire new knowledge and integrate this new knowledge into their behavior. SoK is about how individuals and groups learn, how people interact adequately, how knowledge is transferred, and how it is developed. This also requires that they have Knowledge of Sustainability (KoS). This kind of knowledge is used to fulfill the needs of an artificial system to be updated and adjusted continuously. Individuals, who control the artificial system, including themselves, have to cope with the changes of the system to maintain a balance between the system and its environment. Furthermore, it is not certain that all knowledge concerning sustainability is available, applicable, designed, and organized in the right way at this moment. In other words, SoK needs to be targeted at the development of new KoS, and hence at the improvement of sustainability.

The two sides of the coin: Knowledge of Sustainability (KoS) and Sustainability of Knowledge (SoK) are based on various kinds of feedback loops, on internal and external dynamics, and on learning. For example, as we perceive discrepancies between desired and actual states, we take actions that will, we hope, cause the real world to move toward the desired state. New information about the state of the world causes us to revise our perceptions and the decisions we make in the future. We know that not only we, but the world also changes continuously.

### 3.4 Learning and innovation: SoK in more detail

In the remainder of this section, especially in relation to sustainability, we will focus on Sustainability of Knowledge (SoK) because this is directly related to 2<sup>nd</sup> generation KM and knowledge creation. We claim that 2<sup>nd</sup> generation KM theory facilitates the discussion about sustainability and innovation in organizations. Although 2<sup>nd</sup> generation KM is still in its early stages, judging by its theoretical foundations it seems a promising approach.

Fundamental in all discussions about knowledge and sustainability is that we have to include human actors, mental models, learning and change (Jorna 2007; Jorna et al. 2009). If human actors learn and organizations change, what kinds of adaptation, progress, or development can we distinguish, and what are the implications of these distinctions? We already made a start with sustainability, but we have to give more details of adaptation, because organizational sustainability presupposes adaptation.

In organizational literature, adaptation is explained in many ways. Terms that are used in this regard are *innovation* and *organizational learning* and *single* and *double loop learning* (Argyris & Schön, 1978). March (1991) explains adaptation (and learning) of organizations in terms of exploration and exploitation. Exploitation indicates that an organization utilizes its current configuration to generate as much benefits as possible. In this regard, exploitation fits neatly into 1st generation KM: knowledge that enables the organization to generate benefits that already exist and only need to be used in the appropriate organizational processes by the appropriate people or actors. March calls this the “exploitation of old certainties” (March, 1991, p.71), comparable with what we call routine learning. On the other hand, March’s exploration points to 2<sup>nd</sup> generation KM. Exploration means that an organization actively searches for new ways to configure itself, in order to improve its fit with the environment. From this perspective, knowledge is not expected to exist, but needs to be developed: “the exploration of new possibilities” (March, 1991, p.71), comparable with what we called creative learning. The concept of innovation is explained along similar lines.

Innovation is strongly connected to creativity (e.g. Pahl & Beitz, 1996). Jorna (2006) identifies the two phases of conceptualization and commercialization within innovation. The former refers to the generation of new, creative ideas, similar to March’s exploration. The latter denotes the transformation of these new ideas into real products or services, which links to March’s exploitation. Whatever term is used to refer to organizational change, the production of new knowledge is essential.

Again, we build on the insights of McElroy (2003) regarding KM, particularly the management of knowledge production (creation) processes. He argues that learning and development of new knowledge are basic natural processes of human actors. Humans will constantly recognize problems while performing tasks within organizations, and search for solutions. In this search, they will gather information, share insights with others, formulate new knowledge claims, and put these claims to the test. Because knowledge creation is a natural process, KM should provide the environment in which the processes of the formulation and testing of knowledge claims can take place. However, patterns of innovation and knowledge creation in most social systems today are dysfunctional and incapable of helping these systems to become more sustainable.

They often have the unintended consequence of limiting human actors in numerous and significant ways that alter organizational viability. These include tendencies to hinder people's ability and willingness to learn effectively, to recognize, and solve non-trivial problems, and operate in more sustainable ways.

McElroy (2003) formulates four prerequisites that need to be met to ensure that knowledge creation functions well within an organizational context. First, individual human actors should be able to dictate their own learning agenda concerning what they want to learn. The organization provides a context that allows individuals to organize their own learning ambitions alone or in collaboration with others. The second prerequisite concerns the allocation of knowledge creation processes. The idea is that knowledge creation should take place throughout the entire organization, and not be concentrated in specialized units, such as R&D departments. In this way, an organization is able to utilize the knowledge creation capacities of all individuals. The third prerequisite is that knowledge creation processes are performed by individuals with various backgrounds and that this variety in knowledge content should be valued (diversity). The fourth prerequisite is the ability of individuals to communicate freely throughout the organization. Innovation and knowledge creation can only function in open communities. The idea is that when all these prerequisites are met, knowledge creation can occur more forcefully (for more details, see McElroy, 2003, p.106-108).

In all discussions on 2<sup>nd</sup> generation KM and in McElroy's prerequisites for knowledge production, the focus is on change, on learning, on creation, and on adaptation. All are essential for sustainability. Change and learning are preconditions for knowledge creation, which is necessary for sustainability.

At this point in our article, we have the following line of reasoning: we see many partly conflicting definitions and indicators of sustainability. This concerns social as well as environmental issues. As far as we now know, many environmental problems are results of our inadequate management of natural resources, pollutions, and emissions. We also showed that sustainability is a relational concept, combining system and environment of the system. System and environment are in a dynamic balance, a subtle equilibrium, in which long term distortion is detrimental to both system and environment. Because we are talking about human-made and human-operated artifacts, we need knowledge of various aspects of sustainability (KoS) in order to change detrimental effects. A systematic perspective on learning, innovation, and knowledge creation is necessary and this is what we called Sustainability of Knowledge (SoK). The quality of sustainability outcomes of an organization depends on the quality of its actions, which depend on the quality of Knowledge of Sustainability (KoS), which depends on sustainable learning and knowledge creation, which we call Sustainability of Knowledge (SoK).

## 4. A capital approach to sustainability

### 4.1 Introduction

In this section, we end our theoretical survey and return to our generic formula and the concept of a dynamic balance in order to take it one step further. Each system looks for “health” and survival, and in sections 2 and 3 we described an “internal view” of a system, in terms like *being* (the state of existence in which systems need to keep their identity, form, and structure intact), *doing* (the state of activity, with operational processes in place), and *thinking* (the state of sentience, with knowledge and innovation processes to be able to adapt and learn). Each system is dependent on an inflow of energy, resources, and information and has an outflow to be used by other co-evolving systems. In terms of nesting systems, these open systems are interconnected, where one system's dissipation is another system's energy; one system's residues are another's resources; and where information does not need to be conserved, as it can be passed on without losing it. The combination of systems and interconnections is such that each system's requisite inflows are provided by the outflows of other systems, and vice versa. These are common in nature as ecologies, and economies and societies can operate similarly, both at micro and macro levels (Hitchins, 2007). As each human artificial system uses resources, we will introduce the notions of *impact* and *reducing negative impact* to further refine and define our concept of a dynamic balance as a step further towards a systemic theory and perspective on sustainability.

Impact is often seen in terms of ecological impact, but activities of systems and organizations have an impact on the social environment as well (the often-forgotten dimension). The term *impact* has negative connotations, but we use it in a neutral sense. Impact can be negative, neutral, or positive. Impacts are mostly seen as negative and as externalities, such as burdening, harming, destroying, or exploiting the environment. But impacts can also be positive, such as an organization which has a positive impact on its local community.

We defined sustainability as a two-slot predicate, and we implied that a system X might exist in some sort of balance with its environment Y. We can distill a more general description of sustainability as a problem of impact. In general, not being sustainable (in the ecological and social sense) means that a system or actor X has a negative impact (R or r, in our quadruple) on actor Y within a certain time horizon (t). Thus, logically, we can state that impact is a functional concept with at least four arguments (i.e., it is a four-place operator). When we use these definitions, impact becomes a function that transforms the initial state of variables X, Y, and R into a new state over a period t. In order to get a grip on sustainability and the reduction of negative impact, it is essential to determine X, Y, R, and t. A particular entity X or Y is always in interaction with



something outside its own system boundaries. The negative aspect of impact emerges when the interaction is no longer there and when only the negative consequences of R caused by an X on a Y prevail. A reduction in negative impact (with a set of interventions) can concern any of R, X, Y, or t as well as a combination of the four. Reduction of negative impact is about closing the sustainability gap which exists between the actual impact and what such impacts ought to be (in order to ensure the well-being of the artificial system(s)). It can also be seen as closing a gap in well-being. It is always about a fair share and whether the inflow equals the outflow. But what is the “thing” connected with impact? In the next section we propose to use vital capitals for the R in our formula, as vital capitals are the common resources used by the system and its surrounding world, which produce goods and/or services needed for well-being. We will introduce the Triple Bottom Line as their organizing principle.

Reducing negative impact implies achieving a dynamic balance between human impacts and the capacity of the natural world that can be sustained indefinitely, taking into account three interdependent elements: the environment, the economy, and the social system. The integrated research agenda of the Wadden Academy uses a similar notion with three main integrated research programs: (1) Wadden Climate (sustainable, safe, climate-neutral), (2) Wadden Nature (protection, development, adaptation), and (3) Wadden Well-being (sustainable economy, livable community, quality landscape). The focus of the research agenda is on nature, man, their relationship, and their well-being. It uses a systems approach (see section 2) and looks at the Wadden Sea region as an interlinked natural/socio-economic/cultural system, stressing the importance of the resilience and adaptive capacity of this region. The research agenda aims to realize progress toward sustainability and the ecological, economic, and social well-being of the Wadden Sea region by means of innovation and the creation of scientific knowledge to be used in evidence-based policy making.

The Wadden Sea area is, first of all, about nature and the ecosystems in place. Nature has impact on humans and humans have impact on nature, but these days there is abundant evidence that many human-dominated ecosystems, including various biophysical systems at regional and local levels, have become highly stressed and dysfunctional. The “services” provided by these ecosystems are extremely important to human well-being. As stressed ecosystems have become highly degraded, they have also become incapable of supplying services to the same level as in the past. The capacity of the environment to sustain economic activity and human health and well-being has, therefore, been reduced (Rapport et al., 1998). Next to natural ecosystems, there are social and economic systems in the Wadden Sea area, which also produce services for the well-being of humans who live, work, and recreate in this area. Here we see a similar development of stressed systems, where the capacity to provide social and economic services and activities in support of human well-being is reduced. Just look at issues like the financial crisis, unemployment, crimes, conflicts, poverty etc.

Sustainability management involves a choice or decision regarding the school of thought to be used as a basis for practice. In this paper we will follow the Integral Research Agenda (Kabat et al, 2009, p. 24 ) and apply the theoretical concept of vital capitals to define and describe R (as the “thing” that generates services and well-being), and we use the Triple Bottom Line as the organizing principle and basis for our

approach to sustainability management (see 4.2). We end this section (4.3) with an exploration of the notions *progress* and *well-being* at the level of the Wadden Sea region, based on a conceptual framework developed by the OECD (2009).

## 4.2 Vital capitals and the Triple Bottom Line

John Elkington (1997) wrote in *Cannibals with Forks - The Triple Bottom Line of 21<sup>st</sup> Century Business* “Today we think in terms of a “triple bottom line”, focusing on economic prosperity, environmental quality, and – the element which business had preferred to overlook – social justice”. TBL is explicitly pluralistic in its orientation: economic, environmental, and social. Arguably, it is the dominant sustainability paradigm in use today, including its influence on the Global Reporting Initiative (GRI), the leading reporting standard. TBL is the basis of our approach to sustainability management. There are many mainstream tools and methods in use in sustainability management, and they can be categorized into principle based standards, process standards, measurement standards, performance standards, and hybrid standards (Oakly & Buckland, 2004, McElroy 2008). But what exactly is our reference when we measure performance? We will deal with the issue of measurement and performance in section 5, where we advocate the use of the Ecological and Social Footprint Method for measuring performance against standards of performance (in terms of ecological limits and social needs respectively). More particularly, we will explore a quotients-based approach to sustainability management.

As we discussed in section 2.3., Herman Daly (1997) formulated three rules, indicating that to be sustainable a social system (e.g., an organization) should not exceed its rate of regeneration. If one uses more than one can replenish, not only an ecological but also a social system is doomed to disappear. Daly’s rules focus on ecological sustainability and form the basis for its measurement. They are closely connected to the ecological footprint (EF) and natural capital as the “thing” that the EF is measuring. His rules are part of his views on (un)economic growth, a steady state economy, and well-being. Unlimited quantitative growth on a finite planet cannot be sustainable. Daly’s work underlies the many present initiatives at a national level to measure progress and well-being beyond GDP (Gross Domestic Product) (see also section 5). The ecological footprint method measures the impacts of human activities on the environment (also known as “natural” capital). Capital is “a stock of anything that yields a flow of valuable goods and services to humans (and non-humans), who, in turn, rely on it for their well-being” (Costanza 2005; Porritt, 2005). Natural capital produces natural resources and eco-system services and is generally fixed in supply (as we have one Earth). It is about reducing our use and demand. In short, the ecological footprint measures impacts on natural capital. In particular, we can say that it is a measure of the impact of human activities on the “carrying capacity” of natural capital. The environmental bottom line, then, can be thought of as a measure of human impacts on natural capital (see figure 1).

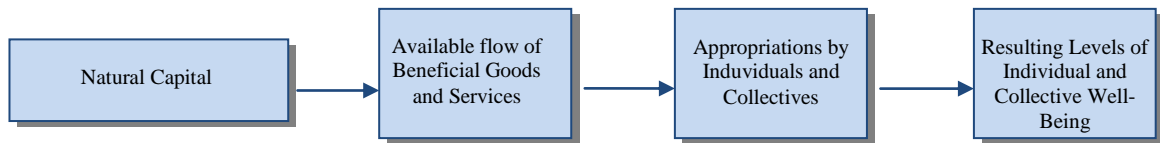


Figure 1: The Environmental Bottom Line

Elkington (1997) stated “Among the questions business people will need to ask are the following. What forms of natural capital are affected by our current operations – and will they be affected by our planned activities? [...] Is the overall level of stress properly understood and likely to be sustainable?”

But what about the other bottom lines: the social and the economic bottom line? Can we also take a capital-based approach there, and, if so, what are the corresponding capitals? What are the underlying capitals for the social and economic bottom lines? There are three other types of capital required for human well-being: human, social, and constructed or built capital.

- 1 Human Capital, consisting of personal health, knowledge, skills, experience, and other resources (including human rights and ethical requirements) required for *individuals* to satisfy their needs;
- 2 Social Capital, consisting of social networks and mutually held knowledge required for *collectives* to satisfy their needs;
- 3 Constructed Capital, consisting of material goods and physical infrastructures in society, such as roads, utilities etc. that people build in order to satisfy their needs.

The Wadden region reflects all four kinds of capitals. It is natural capital because of its land, water, tides, and island structures. It incorporates human and social capital because of human efforts from 800 AD on to adapt the Wadden region to human use. As a result of the combination of natural and social capital, the Wadden area resulted in much constructed capital, for example in the form of dykes, stream adaptation, land, and mounds, with as its last great accomplishment the *Afsluitdijk*.

The combination of the three types of vital, non-natural capital we call anthro capital (a term coined by McElroy in 2006). Why “anthro”? Because unlike natural capital, anthro capital is human-made, and we can always produce more of it if we choose to. In this case it is not so much about reducing demand and use, but about increasing supply (or reducing negative gaps in supply). Following Daly’s example, McElroy (2008) formulated the following rule for a social system to be socially sustainable (with regard to anthro capital): “A human system is socially sustainable if and only if its net impact on available anthro capital (i.e., social, human, and constructed capital) in the world meets or exceeds its proportionate share of contributions required to close related gaps

between *capital or resources available* and *capital or resources needed* in order to meet basic human needs”. The social bottom line is the bottom line related to the impact on this anthro capital. Both natural capital and anthro capital form the basis of the *capitals-based theory of sustainability*, to which we subscribe (see figure 2)

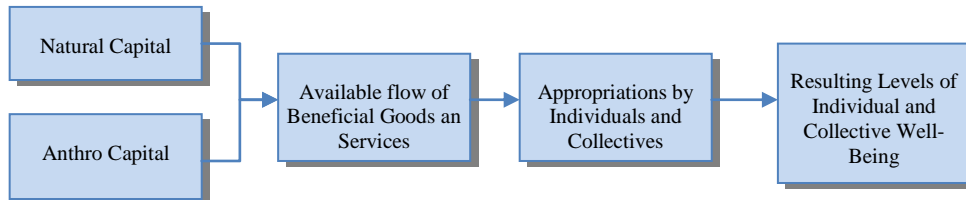


Figure 2. Capitals-based theory of sustainability (Non-financial capitals and well-being)

For us impact on R, therefore, means impact on vital capitals. A capitals-based theory is a perspective shared with many others. Capital frameworks are used in many different disciplines, such as ecological economics (Costanza 2008; Daly 2000; Ekins, 1992), sustainability (Forum of the Future, 2000; Porritt, 2005; Munasinghe, 1997), community development (Flora & Flora, 2004; DIFD), Health (Morgan & Ziglio, 2007), system dynamics (Meadows, 1999) etc. TBL is an organizing principle for taking non-financial sustainability measures. TBL literature, however, is ambiguous and inconsistent regarding the meaning of the so-called economic bottom line and its relationship with the social bottom line. Some interpret it in terms of financial performance (i.e. the financial bottom line, or profit and loss), while others interpret it in terms of an organization’s impact on the economies in which it does business. We subscribe to the latter interpretation, since sustainability management is fundamentally about non-financial performance. For us this also means that the economic bottom line is just a special case of the social bottom line, as it is also related to impacts on anthro capital that affect individual or collective *economic* well-being. It is also important to avoid confusing financial impacts (Financial Bottom Lines) with economic impacts (Economic Bottom Lines). This is the least developed area of TBL. Jennings (2004) states “So, while the economic component of the triple bottom line is often assumed to be synonymous with financial performance, in fact, there are significant differences between the two. [Economics] is the means by which society uses human and natural resources in the pursuit of human welfare”. If the economic bottom line is just a type of social bottom line, it is also a function of impacts on anthro capital. Let us call this anthro (economic) capital. It is about:

- Human capital as it relates to the functioning of economies (societies);
- Social capital as it relates to the functioning of economies (societies);
- Constructed capital as it relates to the functioning of economies (societies).

meaning of the term we use. We could also see the triple bottom line as a multi-bottom line framework. In figure 3 we describe four bottom lines: the financial bottom line and non-financial bottom lines (= triple bottom line) with their capitals.

This concludes our theoretical exploration of the R in the formula. We consider it as capital that generates a flow of goods and services (the objective dimension of well-being), but humans (both individually as well as collectively) also appropriate this flow of services, which is the subjective part of well-being.

Area of Impact  Bottom Line		Monetary Capital	Natural Capital	ANTHRO Capital		
				Human Capital	Social Capital	Constructed Capital
Financial Bottom Line		●				
Environmental Bottom Line	Internal Stakeholders		●			
	External Stakeholders		●			
Social Bottom Line	Internal Stakeholders			●	●	●
	External Stakeholders			●	●	●
Economic Bottom Line	Internal Stakeholders			●	●	●
	External Stakeholders			●	●	●

Figure 3: The 4 Bottom Lines and their capitals

The Millennium Ecosystem Assessment report (MA, 2005) describes “ecosystem services” in four categories: “*provisioning services*”, such as food, water, timber, and fiber; “*regulating services*”, which affect climate, flood control, disease, waste, and water quality; “*cultural services*”, which provide recreational, aesthetic, and spiritual benefits; and “*supporting services*”, such as soil formation, photosynthesis, and nutrient cycling. We humans are fundamentally dependent upon the constant and reliable flow of ecosystem services to secure our well-being. The MA also identifies the essential constituents of human well-being as having access to the basic materials for a good life (such as food, shelter, and clothing), sound health, good social relations, security, and freedom of choice and action. Finally, the MA makes the connection between a healthy functioning of the planet and the healthy functioning of humans, as the planet's most powerful species.

“Services” are a means to an end and this end is considered to be well-being. Human well-being has a subjective and an objective dimension. There is a growing body of research studying the link between the societal concept of sustainable development with the individual model of human needs, Quality Of Life (QOL), and the objective and subjective measurement of well-being or happiness (Costanza 2009, Rauschmayer et al, 2008). They state that our primary goal should be the increase in well-being for present and future generations. Well-being improves our abilities or capabilities to meet human needs as well as our perception of how well these needs are met. However, while we cannot directly invest in human needs, we can invest in built, natural, human, and social capital in ways that create the opportunities for people to meet their needs (Costanza, 2009).

Having arrived at this point, we define sustainability as the subject of a social or management discipline that studies the dynamic balance of an artificial system and its environment, using a capital theory approach to study the impacts of human activity on the carrying capacity of vital capitals in the world, as required by humans and non-humans alike for their well-being

### 4.3. Progress and Well-being

What does it mean to make progress towards well-being at the level of the Wadden Sea region? What is “progress” and what is “well-being” at this societal level? From a very neo-classical, narrow-minded, economic perspective, in our society progress is expressed in terms of economic growth, with GDP as its measurement tool. Because GDP is relatively easy to measure, it has been used together with unemployment as the main indicator of our prosperity and well-being in, for instance, EU regional policy, for quite some time.

GDP is mostly about (unlimited) quantitative growth in production and consumption and not so much about qualitative development. Are there no limits to this growth? In April 1968 a small international group of professionals from the fields of diplomacy, industry, academia, and civil society met at a quiet villa in Rome. Invited by Italian industrialist Aurelio Peccei and Scottish scientist Alexander King, they came together to discuss the dilemma of prevailing short-term thinking in international affairs and, in particular, the concerns regarding unlimited resource consumption in an increasingly interdependent world. Based on extended discussion a report was issued (Meadows, 1972: *The Limits to growth: a global challenge*). We now know that unlimited growth also deteriorates our ecological and social systems, depleting its natural, human, and social capital. With the present financial and economic crises, the momentum and dialogue is growing to design new measures for prosperity and well-being, which include indicators for the health of ecological and social systems (Stiglitz et al. 2009; Jackson, 2009, see section 5), while moving towards a Steady State Economy (Daly, 1972). A steady state economy is a viable alternative to a growth-oriented economy, which has become a more appropriate goal in large, wealthy economies. Daly (1997) defines a steady state economy as: “an economy with constant stocks of people and artifacts, maintained at some desired, sufficient levels by low rates of maintenance through-put, that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption.” It is a green economy which aims for a stable population and a stable consumption of energy and materials at sustainable levels. This kind of stability is a *dynamic balance*: it changes and develops over time, but it remains balanced with its natural environment. It is an economy where energy and resource use are reduced to a level which is within ecological limits, and where the goal of maximizing GDP is replaced by the goal of maximizing quality of life. Assessing progress towards sustainable development, therefore, has to be guided by the goal to deliver well-being within the capacity of the biosphere and society to sustain it for future generations. It is more about qualitative growth, development, and well-being than about quantitative growth, and we have to look beyond GDP to measure well-being.

Looking at the four big systems in place (financial, economic, societal, and ecological), we seem to have lost sight of the question which system constitutes the environment of which other system. The quest for economic growth related to our GDP seems to be the main cause of many of our present problems. For many economists and politicians, the global economy is *the* system, within which everything else (human society, the planet, and all other species) can be subsumed as entities or subsystems. Unfortunately, this is as close to biological and thermodynamic illiteracy as it is possible to get. The place of the economy is, firstly, a subsystem of human society (the economy may well have appropriated more and more of that broader societal territory, but there is still a lot more to human life than the economic activity we engage in), which is itself, secondly, a subsystem of the totality of life on Earth (the biosphere). And no subsystem can expand beyond the capacity of the total system of which it is part (Porritt, 2005). Established principles of physics and ecology indicate that there is a limit to economic growth, and there is increasing evidence that this global economic growth has negative effects on long-term ecological and economic welfare and on human well-being.

To explore the notions of “progress” and “well-being” we adopt the views of OECD’s Global Project on “Measuring the Progress of Societies” (2009). Societies (and regions) are based on two systems: the Human System and the Ecosystem (see figure 4). They are linked through two different channels: “Resources Management” and “Ecosystem services”. Resources management represents the effects of the human system on the ecosystem through resource depletion, pollution etc. Ecosystem services link the two systems. The ecosystem makes the human system prosper through positive services like food, clean water etc., but it can also do damage through things like earthquakes and floods. The human system may also provide positive services to the ecosystem (or its capacity for supporting life): for example through the construction of dams and activities with respect to reclamation (of land).

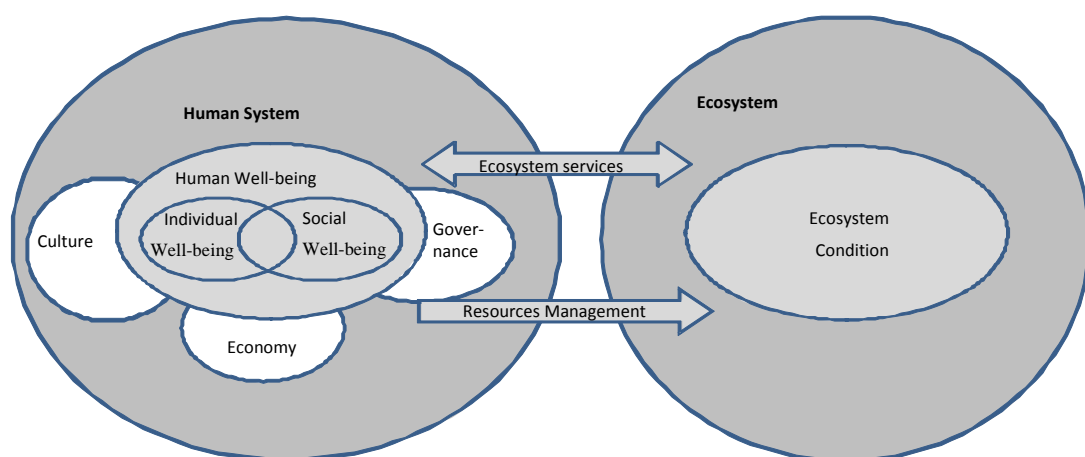


Figure 4: The framework of the progress of societies

Human well-being is the key domain and its dimensions represent the “reasons for action” (Alkire, 2002). It comprises the core human goals that societies pursue; an increase in human well-being is the ultimate *goal* of progress. Human well-being can be considered as comprising individual and social outcomes. In fact, human well-being

may be conceived of as a collection of attributes that characterize the kind of life that each person pursues and their level of freedom – in the sense of the range of opportunities open to people (Sen, 1999). Some of these attributes will be specific to each person (one’s own state of health, knowledge, etc.) and can be clustered together as attributes of “individual well-being”. Other attributes are shared with other people (those living within the same family, neighborhood, or region) reflect the relations between them (e.g. the extent and quality of relationships with others), or reflect to what extent a society is peaceful, resilient, cohesive, and they can be clustered together as “social well-being” (OECD, 2009).

Human well-being is further supported by three other human domains: economy, culture, and governance. They are seen as important insofar as they are key supporting pillars (with its services) to human well-being, rather than seen as important for their own sake. Having a strong economy, effective governance, and vibrant culture is not well-being in itself, but these factors do – typically – provide an enabling social environment in which human well-being will improve. Therefore, they are considered “*intermediate goals*”. The ecosystem only has one domain (ecosystem condition), which represents the well-being of the ecosystem. Ecosystem well-being is equally important if one sees the ecosystem as important in its own right or if one takes a more anthropocentric view, where one sees the ecosystem as important, simply because it provides the human system with resources and services which contribute to human health and well-being. But it should be clear that the Human System is part of, and embedded in the Ecosphere<sup>2</sup>.

The “well-being of a society” (or societal well-being) could be defined as the sum of human well-being and the ecosystem condition; the “progress of a society” (or societal progress) as the improvement of human well-being. However, it is also important to recognize the role played by inequalities in human well-being and ecosystem conditions across and within societies or geographical regions (spatial) and the between generations (temporal). Therefore, the well-being of a society also depends on the way in which the various items that shape people’s lives are distributed in society, and it cannot be assessed without considering its sustainability over time and/or the well-being of the future generations, too. “Societal progress” is therefore defined as occurring when there is improvement in the “sustainable and equitable well-being of a society” (and their relative importance depends on social fairness and justice).

For the domains used in figure 4 to become useful for those who want to measure societal progress, more precise dimensions need to be defined. In paragraph 5.3 we will present the dimensions and taxonomy of societal progress proposed by the OECD and discuss other tools for measuring well-being, as such, at a (regional) societal level. First we will address the question of how to measure impact on vital capitals (paragraph 5.2).

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2 An alternative way to represent this framework is to show the Human System within the Ecosphere in order to underline how much the former is strictly embedded in the latter.



# PART B:

# MEASURING AND

# QUANTIFYING

# SUSTAINABILITY

## 5 Context-based sustainability indicators and metrics

### 5.1 Introduction

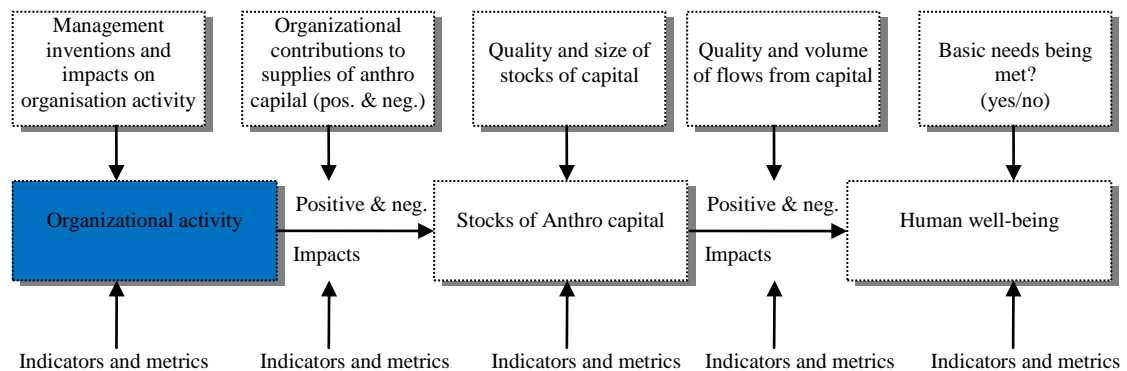
In order to measure and manage its corporate responsibility and sustainability strategies (CSR), business needs an approach to non-financial key performance indicators (KPIs). The same is relevant for communities or regions. The financial performance of a company is measured by established financial indicators. However, how can organizations obtain an overall assessment of their performance, which includes sustainability management? Non-financial key performance indicators or KPIs enable companies to measure the result of their environmental, health, and sustainability initiatives. By incorporating the appropriate KPIs into their business process, companies gain a more comprehensive understanding of how well they are meeting their sustainability objectives. Financial performance measures alone do not satisfy the demands for a complete indicator of a company's health. External stakeholders look at a range of non-financial performance measures to assess how well a company meets its CSR and sustainability objectives. These are seen as a proxy for good management, and in order to communicate this information, companies require non-financial KPIs. KPIs connect sustainability to performance. KPIs provide business with a means of measuring progress toward achieving objectives. They provide quantitative and qualitative forms of feedback reflecting performance in the context of their business strategy. The IISD (2009) has developed a set of general principles to guide the totality of a sustainability measurement and assessment process: Bellagio STAMP.

For us, non-financial sustainability KPIs will have to be Context-Based Indicators or Metrics (CBMs) which deal with the impact measurements of its business in the world and which take the form of a quotient. Here we advocate the use of CBMs developed by McElroy (2008) to measure the impact on vital capitals. This means that to include a specific non-financial area of impact, a specific indicator for the sustainability of the impact of business operations or processes has to be expressed in terms of its actual impact over its normative impact (or standard of performance) (McElroy, 2008). Measuring the performance of a system often happens in terms of indicators/metrics for its input, process, output, and outcome. However, strategic sustainability performance management and measurement is mainly focused on measuring “outcomes” and “impact”. But, how should we measure and report impacts? In section 5.2 we will explore measurement of impact, and in section 5.3 we will refer to other strategic indicator sets that were developed to measure progress and well-being (at a regional or societal level).

## 5.2 Context-Based Metrics

In figure 5, we add an artificial social system X (e.g. an organization) to the mix of our capital based view to highlight our measurement approach. How can we measure and report the impact of its activities on vital capital (R)? What kind of indicators or metrics do we need to use? How can we determine whether its impacts are positive, neutral, or negative? It should be clear that we aim to measure impact on vital capitals and not the state of well-being of Y as such.

The list of companies in the world committed to measuring and reporting the sustainability of their operations using the Global Reporting Initiative (GRI) framework is growing. As an international standard for corporate sustainability reporting, however, GRI is not quite finished, yet. Strictly speaking, reports prepared in accordance with its guidelines do not actually make it possible to determine the sustainability of the organization involved. This is because they usually fail to include what GRI itself refers to as "a sustainability context". In the latest G3 version of GRI (2006) sustainability context is explained as follows: “Performance information should be placed in context.



**Figure 5: Adding organizations, indicators, and metrics to a causal theory of well-being**

The underlying question of sustainability reporting is how an organization contributes to the improvement or deterioration of economic, environmental, and social conditions at the local, regional, or global level. Simply reporting on trends in individual performance (or on the efficiency of the organization) will fail to respond to this underlying question. Reporting organizations should therefore seek ways to express their individual performance in relation to broader environmental and social sustainability”.

We agree, but we have hardly ever seen a corporate sustainability report prepared in accordance with GRI that does this. In a very real and unsettling sense, then, most of what passes for mainstream sustainability reporting in the world today arguably fails to report on sustainability at all. Why? Because the sustainability context required to draw meaningful, bottom-line conclusions, is missing! Most of what passes for mainstream metrics in corporate sustainability measurement and reporting, including GRI, arguably fails to do the one thing it purports to do, which is to make it possible to understand the sustainability performance of an organization (McElroy, 2008). Can it be done differently? We believe that the footprint method is a step forward.

An example of an impact measurement and reporting tool is the *ecological footprint* (Wackernagel & Rees, 1996). A more recent example is the *social footprint method* (McElroy, 2008). McElroy proposes to codify social and ecological sustainability in the form of a quotient,  $S = A/N$ , that makes enables sustainability managers to operationalize the idea in organizational settings. The sustainability performance (S) of an organization is a measure of its *actual* social and/or environmental impacts (A) on the carrying capacities of vital capitals, relative to what its *normative* impacts (N) on the same carrying capacities of capitals must or ought to be (in order to ensure stakeholder well-being). The latter is typically determined by reference to environmental limits or social conditions in the world. In other words, the numerator of this quotient represents an organization’s actual impact on a vital capital, and the denominator represents a norm for this impact. One can do this calculation for all sustainability duties and obligations an organization may have. Once a quotient has been determined, the resulting score can be plotted on a common sustainability performance scale. For social and economic impacts, scores of  $\geq 1.0$  signify sustainable operations (performance

meets or exceeds stakeholder needs); for environmental impacts, scores of  $\leq 1.0$  do the same (performance falls within environmental limits) (McElroy, 2009b).

It is possible to measure the bottom-line economic, ecological, and social sustainability performance of organizations by using this quotient. The sustainability of an organization is thereby primarily defined as maintaining and enhancing the carrying capacity of natural and anthro-capital. Effectiveness is seen as a sustainability quotient where the numerator is the actual net quantitative impact of an organization's activities on capital, and the denominator is the net quantitative impact on capital that an organization expects to have (McElroy, 2008). A living system's behavior is sustainable if its impact on the capitals on which it relies for well-being does not unduly degrade or diminish the related stocks of capital. We advocate the use of this quotient-based method since it explicitly takes "context" into account and looks for a "social contract" with organizational stakeholders regarding impact on vital capitals.

The quotients approach to non-financial sustainability metrics is consistent with GRI's call for "sustainability context" in sustainability measurement and reporting. We call the sustainability quotients of context-based sustainability management: Context-Based Metrics (CBMs). CBMs bring "context" into the design and application of sustainability metrics, by factoring actual social, economic, and/or environmental conditions in the world as they pertain to basic levels of human well-being (McElroy, 2009a). It is a quantitative method for computing meaningful bottom lines for social, environmental, and economic performance, being actual measures of true sustainability performance. Thus, impacts on water and other natural resources are measured against empirical rates of regeneration and/or waste assimilation, and impacts on society and economy are measured against human, social, and/or infrastructure conditions – all relative to levels required to ensure human well-being. The question that a sustainability metric must answer is not a monetary one; rather it is a normative one: *were the organization's impacts on vital capitals what they should have been in order to ensure stakeholder well-being?* (McElroy, 2009b).

Sustainability quotients are models for sustainability metrics that make it possible to measure non-financial organizational performance (e.g., the triple bottom line) against standards of performance. Numerators express actual impacts on vital capitals in the world, and denominators express norms for what such impacts ought to be in order to ensure human well-being. The key success factors for the use of non-financial KPIs (=CBMs) are focusing on the most strategic CBMs, embedding them into day-to-day management of the organization, and selecting the right CBMs, namely the ones that are important to the company and their stakeholders. The CBMs that a business develops, manages for, and ultimately reports – whether internally or externally – will depend on its strategic corporate priorities and will reflect the unique nature of the organization. "What is measured is managed", and it is important to measure what will protect and create value for the company and its stakeholders. Unfortunately, the tendency is to manage what is easy to measure. CBMs can help companies to plan and manage their environmental, social, and economic priorities – particularly when CBMs are linked to core business strategies through action plans that include performance targets. When communicated internally and externally, these CBMs form a critical foundation of a

company's sustainability reporting about its social contract with its internal and external stakeholders.

In the quotient-based approach, the numerator is about actual impact and the denominator is about the normative impact on vital capitals. Denominators are normative, but they are usually grounded in factual claims about the world (ecological limits and societal conditions relative to needs for well-being). This is also the place where principle-based standards come in. Daly's rules can be applied to the denominator (in case of ecological quotients) in order to determine whether a social system (e.g., an organization) is sustainable or not.

The implications of this thesis are that sustainability is always about performance versus *standards of performance*, in which norms must be involved. We must be able to tie metrics to a demonstrable duty or obligation to produce and/or maintain vital capitals in general and to their carrying capacities in particular. These duties and obligations must be attainable –“ought implies can” and tied to ecological or social well-being in a way that involves related thresholds of vital capitals. Here, sustainability is seen as a measure or property of *activities* (not products) determined as a function of impacts on vital capitals. It should be noted that most so-called footprints are not sustainability measures at all, since no denominators are involved. We advocate the use of *ecological* and *social footprints methods*, based on the “capital theory approach” to sustainability and the sustainability quotients concept as a measurement model.

The capital theory approach defines the sustainability status or performance of a human collective as a function of its impacts on vital capitals in the world. This means that people rely on vital capitals for their well-being. Humans can enhance and/or diminish their quality and sufficiency. Sustainability performance, then, is a measure of their impacts (human activities) on the quality and/or sufficiency of vital capitals relative to what such impacts ought to be. In the case of ecological impacts it is about natural capital, and in the case of social impacts it is about anthro capital. Natural capital is non-anthropogenic, and it is also fixed, as there is only one world, one reservoir of capital, with limited resources that must be shared. Anthro capital is anthropogenic and non-fixed – one world, but containing as many reservoirs of capital that we care to create and/or maintain. In addition, as sustainability is always about aligning needs and capital resources, this means that we must manage demand or use with regard to natural capital, and that we must manage supply with regard to anthro capital, too. In the case of ecological bottom lines the sustainability performance is, therefore, about whether or not use and demand are at the level of supply or below it, where it should be in order for activities to be sustainable. In the case of social (or economic) bottom lines, it is about whether or not supply is at the level of demand or above it, where it should be in order for activities to be sustainable.

Denominators are also closely linked to stakeholders of an organization. We see organizations as complex adaptive social systems, where humans fulfill two roles. There is an internal, instrumental role e.g. as a worker and the role of external stakeholder (judging and sense making). The relationship between internal and external stakeholders and the company can be seen as an implicit social contract (McElroy 2008). The revival of the social contract (White, 2007) is one of the most pressing issues for 21<sup>st</sup> century

business. Stakeholders minimally consist of groups whose interests are impacted by the organization's operations and who are therefore entitled to be taken into consideration. It also includes groups whose interests ought to be impacted by an organization as part of its social contract with society. Stakeholder groups can include employees, owners/shareholders, customers, trading partners, communities at multiple levels, governments, and even ecological systems. They all scrutinize non-financial performance, highlighting the need for effective CSM goals that can be measured and communicated. For each group the organization should ask itself: What duties or obligations do we have to have impact on vital capitals that are of importance to our stakeholders according to our social contract (McElroy 2008)? What are the risks and opportunities for each group related to each capital and each bottom line?

The content of the contract specifies what a company's duties and obligations are to society, expressed in terms of its relevant stakeholder groups. The theoretical basis of a social contract is "the license to operate" that a company receives from society, in return for which it arguably owes certain duties and obligations to help ensure human well-being. Generally speaking, the duties and obligations of a company to help ensure the satisfaction and well-being of its stakeholders will be expressed in the form of normative principles and policies regarding what its impacts on vital capitals should be (McElroy 2008). Corporate sustainability management therefore begs to make the social contract more explicit and to define it in advance of constructing metrics or using quotient based tools and methods to measure and report. So, one first needs to identify stakeholders to whom duties and obligations are owed relative to ensuring their well-being and then to determine which specific duties are owed to each stakeholder group, expressed in terms of normative impacts on related vital capital types (i.e. monetary, natural, human, social, or constructed). These duties or obligations become the basis for and the source of norms reflected in the denominators of the quotient-based method. We believe every company's sustainability performance is best thought of as a function of (a) who its stakeholders are, and (b) what its duties and obligations are regarding the impact on vital capitals on which its stakeholders rely for their own well-being.

We explored the notions of Context-based Sustainability and context-based metrics, as the impact of an artificial system which has to be related to its ("sustainability") context. The main benefits of this approach are that it:

- improves quality of management information (for performance and risk management);
- increases transparency and responsiveness to stakeholders, such as
  - Shareholders
  - Customers
  - Trading partners
  - Communities
  - Employees;
- complies better with measurement and reporting standards (e.g. GRI); and
- confers to competitive advantage (a best practice)

### 5.3 Indicator sets

We finish this section about measurement by giving an example of a strategic set of Context Based Metrics (or quotient-based footprints) to illustrate our capital approach for the non-financial bottom lines. The broad impact of the Environmental Bottom Line is natural capital. Daly (1996) stated: “Natural capital is the stock that yields the flow of natural resources. [...] The natural income yielded by natural capital consists of natural services as well as natural resources”. Natural capital has both living elements (living organisms) and non-living elements (air, land, water). When we extract energy or materials from the environment, we potentially have impact on both non-living and living forms of natural capital, which in turn can affect their ability to yield a flow of benefits *for both human and non-human purposes*. In table 1 we give some examples of environmental bottom line metrics. They consist of functional descriptions for multi-issue context-based metrics at the level of a regional system like the Wadden Sea Area.

TBL type		Areas of Impact	Vital Capital Affected	Functional description of metric
Triple Bottom Line	Environmental	Climate	Natural capital	An indicator that measures regional greenhouse gas emissions relative to an allocated share of the earth's assimilative capacity to safely absorb them.
		Air	Natural capital	An indicator that measures regional impacts on air quality, relative to standards for what such impacts ought to be in order to ensure human well-being.
		Water	Natural Capital	An indicator that measures regional water use relative to an allocated share of locally available renewable supplies.
		Other natural material resources	Natural Capital	An indicator that measures regional use of and/or impacts on non-water natural material resources, including space, relative to standards for what such usage or impacts ought to be.
		Solid Waste Assimilation	Natural Capital	An indicator that measures regional emission of solid waste relative to an allocated share of the earth's assimilative capacity to safely absorb them (e.g. landfill capacities).
		Ecosystems	Natural Capital	An indicator that measures regional impacts on ecosystem health and habitats relative to an allocated share of related carrying capacities and/or impacts on non-human well-being.
		Life	Natural Capital	An indicator that measures regional impacts on flora, fauna, and biodiversity, relative to the standards for what such impacts ought to be in order to ensure human and non-human well-being

Table 1: True Sustainability Index TM (Adopted from McElroy (2009))

No indication is given with respect to space and time. It is, of course, necessary to demarcate the area and the time horizon. At the moment various attempts are being developed to use space and time coordinates in so called “context-based sustainability metrics” (see McElroy, 2008).

In table 2 we present some social bottom line metrics for a region and we give some examples of economic bottom lines metrics at an organizational level. In paragraph 4.3 we explored the theoretical conceptual framework of the OECD regarding the notions

of progress and well-being at a societal or regional level. This global project is work in progress (see table 3 for its taxonomy), which seeks to integrate the many measurement initiatives that have been developed over the years.

TBL type		Areas of Impact	Vital Capital Affected	Functional description of metric
Triple Bottom Line	Social	Human Health	Human Capital	An indicator that measures regional impacts on human health, relative to standards for what such impacts ought to be in order to ensure well-being.
		Social Institutions	Social Capital	An indicator that measures regional contributions to creating and/or maintaining social institutions required for human well-being relative to standards for what such contributions ought to be.
		Social Infrastructure/ Material Goods	Constructed Capital	An indicator that measures regional contributions to creating and/or maintaining social infrastructure and/or material goods required for human well-being, relative to standards for what such contributions ought to be.
		Climate change mitigation	Human, Social and Constructed Capital	An indicator that measures regional contributions to restoring greenhouse gas concentrations in the earth's atmosphere to safe and stable levels, relative to standards for what such contributions ought to be.
	Economic	Livable wages	Human Capital	An indicator that measures the extent to which an organization pays its workers a livable wage, relative to local standards.
		Business Ethics	Human Capital	An indicator that measures the extent to which an organization treats its employees ethically, relative to ethical norms.
		Economic Institutions	Social Capital	An indicator that measures organizational contributions to creating and/or maintaining economic institutions required for human (economic) well-being, relative to standards for what such contributions ought to be.
		Economic Infrastructure/ Material Goods	Constructed Capital	An indicator that measures organizational contributions to creating and/or maintaining economic infrastructure and/or material goods required for human well-being, relative to standards for what such contributions ought to be.

Table 2: True Sustainability Index TM Adopted from McElroy (2009)

There are many other tools and indicator sets which can be incorporated in this framework, starting with a general framework of needs, such as Maslow's hierarchy (1998), the work of Max-Neef (1993), and Sen's Capability approach (1999).



**FINAL GOALS***Ecosystem Condition: outcomes for the environment*

- Land (geosphere)
- Freshwater, oceans, and seas (hydrosphere)
- Biodiversity (biosphere)
- Air (atmosphere)

*Human well-being: outcomes for people*

- Physical and mental health
- Knowledge and understanding
- Work
- Material well-being
- Freedom and self-determination
- Interpersonal relationships

**INTERMEDIATE GOALS***Economy*

- National income
- National wealth

*Governance*

- Human rights
- Civic and political engagement
- Security and violence
- Trust
- Access to services

*Culture*

- Cultural heritage
- Arts and leisure

**LINKS BETWEEN THE TWO SETS OF GOALS***Resource management, use, development, and protection*

- Resource extraction and consumption
- Pollution

*Ecosystem services*

- Resources and processes provided
- Impact of natural events

**CROSS-CUTTING PERSPECTIVES***Intra-generational: equity/inequality**Inter-generational aspects: sustainability/vulnerability/resilience***Table 3: Taxonomy OECD Global Project**

Next, there are reports of various studies comparing standards of living or satisfaction with life across countries. Some – such as the Human Development Index (1990), the Quality of Life Index, and the Genuine Progress Indicator (Daly & Cobb, 1994) – rely on crunching already existing national statistics and data from academic publications. Others tend to utilize direct surveys or a combination of direct surveys and observed data. Examples of the latter type include the Happy Planet Index and the Legatum Prosperity Index.

However, despite the multitude of such initiatives and approaches, the academic community, governments, and other policymakers very often continue to use and cite GDP and – sometimes but it is not generally accepted – unemployment as the main indicators of economic prosperity. Needless to say, we are all constantly exposed to news reports on the latest GDP figures, coupled with all-important projections for the next quarter or year. But is GDP good enough as a measure of overall societal well-being? If not, what is wrong? The human economy, which people have traditionally considered independent of the “natural” Earth system, is actually embedded within and dependent upon this global environment. We emphasize this fact, as global population and economic growth stretch the ability of the environment to provide the raw materials, energy, waste absorption, and other ecosystem services critical to life on Earth. Recognizing these facts, we will have to improve upon traditional market measures, like GDP and corporate profit, by accurately incorporating natural, social, and human capital in true profit, or better prosperity. We may well be on the threshold of a new era, and there are now many indicators and tools being developed to express this shift in mindset to a more broad notion of well-being. New initiatives are emerging.

At a European level, the European Commission (2009) presented ways forward to *go beyond* GDP and to complement this in order to steer our policies towards green growth and a low carbon, resource-efficient, and inclusive society. GDP is the best-known macro-economic measure of the performance of the market economy of a nation. Although by design and purpose it is not a measure of well-being, it has also come to be regarded as a proxy indicator for overall societal development and progress in general. GDP however is not an environmental sustainability or social inclusion measure. Economic indicators such as GDP and unemployment were never designed or intended to be comprehensive measures of well-being. Complementary indicators are needed that are as clear and appealing as GDP but more inclusive of other dimensions of progress – in particular environmental and social aspects, like social cohesion or even happiness. We need adequate indicators to address global challenges such as climate change, poverty, resource depletion, and human health. Another initiative to look for a broader measurement of well-being, rather than GDP alone, is the report of “The Commission on the measurement of economic performance and social progress” by Stiglitz, Sen, and Fitoussi (2009) presented to the French government. In England, there is the National Accounts of Well-being (NEF, 2009). In Canada, the Canadian Index of Well-being is being developed (Michalos, 2008), and Bhutan has its Gross National Happiness (Ura & Galay, 2004).

Apart from well-being, several sets of indicators have been proposed over time to measure sustainable development, in most cases using the “three pillar” (triple P) approach and with a focus on capital. The capital approach to measure sustainability aims at accounting for a broader set of assets, including natural, human, social, and constructed capital (System of National Accounts, SNA). Finally, the EU’s Sustainable Development Indicators, SDI, reflect the new EC Sustainable Development Strategy (2007).

# 6 Integral Scorecard for Strategic Performance Measurement

## 6.1 Introduction

Sustainability performance management is a new, emerging term in the debate about business, CSR, and sustainability. It aims at addressing the social, environmental, and economic (performance) aspects of corporate management in general and of corporate sustainability management in particular. The management of sustainability performance in all its perspectives and facets requires a sound management framework which on the one hand links environmental and social management with the business and competitive strategy and management and, on the other hand, integrates environmental and social information with economic business information and sustainability reporting. It is about a strategic information and management approach with sustainability accounting as a supporting measurement approach and sustainability reporting for communication and reporting.

However, what does an Integral Strategic Performance Scorecard for an artificial system (e.g., an organization), incorporating all the theoretical concepts we developed so far, look like in practice? How should we measure operational processes and its management? How should we measure knowledge processes and the outcomes or impact of knowledge management? How should we measure the social (economic) and ecological sustainability performance of artificial systems for internal and external stakeholders? How should we organize all these CBMs at an organizational level? In this section we will connect all these points and describe a new kind of Performance scorecard, which we call The Adaptive *Quadruple Bottom Line* Scorecard (AQLSC). We use an Adaptive Maturity Model to illustrate how it develops and emerges from the Balanced Scorecard (BSC), which at present is the mainstream tool in use (Kaplan and Norton, 1996).

We describe a different way of viewing performance scorecards. Our life cycle approach enables managers and policymakers both (1) to design more complex scorecards to account for more variables, and (2) to assess more types of organizational performance: not only financial, environmental, social, and economic performance, but also performance regarding knowledge, learning, organizational intelligence, and organizational adaptation. The AQLSC is a tool for measuring organizational performance that not only considers standard metrics such as financial, customer, business process, and employee development, but that also evaluates: organizational learning and intelligence, social responsibility issues, the sustainability of its operations, and the organizational adaptive capacity.

## 6.2 Balanced Scorecard and Adaptive Scorecard

Many companies use the Balanced Scorecard as a strategic map. It is a four-perspective framework of indicators, designed to measure organizational performance in a way that is integrative and does more than only measuring operational financial performance. It adds the customer, internal business process, and learning and growth perspectives to the financial perspective (see Table 4).

	Operational Performance Measures
Financial	
Customer	
Internal Business	
Learning and Growth	

Table 4: The Balanced Scorecard

It is not designed, however, to consider organizational sustainability performance issues like sustainability, broader arrays of stakeholders, adaptation, and KM. It is therefore not an Adaptive and Sustainability Scorecard. Its focus is narrow, dealing with a limited set of stakeholders such as customers, shareholders, and employees.

To accommodate notions such as adaptive capacity, learning, and knowledge creation, Firestone (2006a) introduced the idea of an Adaptive Scorecard, based on the distinction between single and double-loop, or routine and creative (deeper) learning (see section 3). Routine learning occurs when we are trying to close a gap between what we want and what we have, or between the way we think the world is and the way we think it should be. In routine learning, we make new knowledge (that is, we learn) only by applying *old* knowledge in the form of rules or mental models we have already developed. Routine learning is non-problematic in nature. It gives way to creative learning, when things become problematic and we recognize that there is a knowledge gap. In order to close that gap, we have to create *new* knowledge. Creative learning is adaptive in a way that routine learning is not. Routine learning uses previous knowledge (rules and mental models) to learn about specific conditions surrounding operational process activity. However, creative learning – as a deeper level of learning – focuses on learning new general rules and models for transforming the ways in which we perform operational process activity. Firestone started with the original BSC, which uses operational performance measures regarding Financial, Customer, Internal Business, and Learning and Growth. These BSCs do not recognize the distinction between routine and creative learning. They do not recognize that we can distinguish operational performance measures related to routine learning and intelligence performance measures related to creative learning. By intelligence performance measures, we mean measures of the capacity of an organization to learn about problems and the solutions in the various frames of the BSC as well as measures of actual success in creative learning.

The distinction between operational and intelligence performance measures is the basis for the idea of the Adaptive Scorecard (see Table 5).

Creative, deep learning at the organizational level is at the heart of organizational adaptive functioning, and this idea involves the following categories of intelligence performance measures: decision processing, knowledge processing, knowledge management processing, and their information and knowledge outcomes. These intelligence performance measures cannot easily be measured using the range of indicators and the very simple measurement models used in the Balanced Scorecard. Instead, intelligence performance measures must be developed using group decision process, panel-based human judgment methods, and content analysis methods using text sources.

	Operational Performance Measures	Intelligence Performance Measures
Financial		
Customer		
Internal Business		
Learning and Growth		

Table 5: The Adaptive Scorecard

An Adaptive Scorecard distinguishes measures of the capacity for creative learning and actual success in creative learning from business function measures. In other words, it draws a clear distinction between operational performance and intelligence performance measures. However, it retains the original four BSC factors in its framework. It also includes a set of categories of intelligence performance measures parallel to the original set of categories of operational performance measures (Firestone 2006a).

Two additional versions of the Adaptive Scorecard have been developed over time: (1) Firestone (2006) incorporated measures connected to the dichotomies: process/outcome and managing/doing (see Table 6) and (2) Firestone, Hadders & Cavaleri (2009) developed a next level of the adaptive Scorecard, accommodating sustainability issues: The Adaptive *Quadruple Bottom Line* Scorecard (AQLSC, see Table 7). The AQLSC combines deeper ways of thinking and acting with a (whole) systems view in a “life cycle” scorecard (combining the Knowledge Life Cycle with the cycle(s) of Life.

Concerning 1, the breakdown of all scorecard perspectives into process and outcome measures highlights the fact that outcomes are produced by processes and that organizational strategy models that directly interlink outcomes without going through processes miss some vital links (Firestone, 2006). The process/outcome distinction is incorporated in the initial BSC framework by restricting the financial, customer, and learning and growth perspectives to outcomes, while the internal business process perspective incorporates all the process measures and indicators in the enterprise. This distinction, however, has many conceptual disadvantages reviewed in Firestone (2006), and, in addition, it fails to acknowledge the trend within organizations toward cascading Executive Scorecards. The inclusion of the doing/managing distinction highlights the problem of evaluating the quality of managing in a Scorecard context.

	Operational Performance Measures				Intelligence Performance Measures			
	Doing		Managing		Doing		Managing	
	Process	Outcome	Process	Outcome	Process	Outcome	Process	Outcome
Financial								
Customer								
Internal Business								
Learning and Growth								

Table 6: The Adaptive Scorecard plus the Process/Outcome and Managing/Doing Dichotomies

We now have an Adaptive Scorecard connected to an adaptation-based theory of sustainability with KM metrics in its Intelligence Performance segment. But what about the Triple Bottom Line and capital-based theories? What about their relationship to Corporate Sustainability Management? One thing that is striking within the BSC framework, is the absence of any external-facing perspectives other than the customer perspective. We think an *external impact* perspective is essential because organizations are open, complex, adaptive systems that co-evolve in interaction with their natural, social, and cultural environments. If we do not measure that kind of impact, as well as the response of the environment to the organization, we cannot take into account the side effects of the organizational strategy that may threaten its very survival.

### 6.3 The Adaptive Quadruple Bottom Line Scorecard

Concerning 2 (the AQBLSC), many researchers have adapted the BSC to address sustainability concerns, either by adding a fifth external perspective, or by incorporating sustainability issues in each of the four original perspectives. However, a more fundamental transformation is needed. McElroy (2009) suggested an AQBLSC (level 4) linking the Adaptive Scorecard to Triple Bottom Line theory. This constitutes the final level of the Adaptive Scorecard, connecting business processes with deeper “learning” and “sustainability” feedback loops. The following enhancements are made:

- 1 Replacing the original four BSC perspectives by four new perspectives: four Bottom Lines, each differentiated by an internal and external area of impact (see McElroy, 2008 for a taxonomy of sustainability metrics), and
- 2 Adding “impact” to the process-outcome category and linking both to a capital-based view. In Table 7, we show the end result, leaving out the “process” category to highlight our approach.

		Business Processing (BP) and Management (BM)				Knowledge Processing (KP) and Management (KM)			
		Operational Performance Measures				Intelligence Performance Measures			
		Doing (BP)		Managing (BM)		Doing (KP)		Managing (KM)	
		Outcome	Impact	Outcome	Impact	Outcome	Impact	Outcome	Impact
Financial Bottom Line									
Environmental Bottom Line	Internal Stakeholders								
	External Stakeholders								
Social Bottom Line	Internal Stakeholders								
	External Stakeholders								
Economic Bottom Line	Internal Stakeholders								
	External Stakeholders								

Table 7: The Adaptive Quadruple Bottom Line Scorecard

This approach reflects the view that organizational performance can be seen in terms of a Quadruple Bottom Line (financial, environmental, social, and economic). This is the logical extension of what Kaplan and Norton have discussed in the past years. Their financial perspective pertains to a financial bottom line, and their customer, internal business, and learning and growth perspectives all pertain to a social and/or economic bottom line. Consequently, the measures in the intelligence and operational part of the scorecard now become more connected to the notion of *exploitation* (or business processing and management) and *exploration* (or knowledge processing and management). It combines deeper levels of acting and thinking of the organization aligned with its environment: the monetary, economic, social, and ecological systems (and their stakeholders).

The AQBLSC accounts for an “external impact” perspective and indicators (Firestone, 2006), while acknowledging that such an external impact can in fact occur in three areas of impact. The Financial Bottom Line has not been split into internal and external areas of impact. This is because an organization's duties and obligations to have impact on monetary capital are not split into internal versus external stakeholders, whereas they are split for the other kinds of capital. Whether a shareholder, for example, is an employee, is irrelevant to the organization's duties and obligations to have impact on shareholder value. This is not the case for the other categories, where an organization's duties and obligations to have impact on the respective capitals involved, can, in fact, be very different for employees versus non-employees. Thus, in such cases we need separate categories for separate metrics or indicators.

Beyond Kaplan and Norton, new alternative approaches emerge linked to tangible and intangible resources: Value Creation Maps and Value Dynamics Frameworks. We already proposed a vital capital framework as a lens to look at internal and external areas of impact (section 4) and to calculate impact as capital-impact (section 5). In Table 8 we show the relationships of the different form of capitals with the four bottom



lines. This is another way of looking at things. For example, knowledge as part of the original learning and growth perspective is here seen as part of human and social capital. Exploiting knowledge and not investing in it, therefore, means depleting human capital (individual) and social capital (collective).

Area of Impact  Bottom Line		Monetary Capital	Natural Capital	ANTHRO Capital		
				Human Capital	Social Capital	Constructed Capital
Financial Bottom Line		●				
Environmental Bottom Line	Internal Stakeholders		●			
	External Stakeholders		●			
Social Bottom Line	Internal Stakeholders			●	●	●
	External Stakeholders			●	●	●
Economic Bottom Line	Internal Stakeholders			●	●	●
	External Stakeholders			●	●	●

Table 8: Quadruple Bottom Line and Areas of (capital) Impact

We added *impact* as a separate category, since impact is not the same as *outcome*. The impact that an organization has on any given outcome can be calculated by measuring the actual outcome and subtracting what would have happened anyway. Or, by using capital-impact statements and performance targets reflecting thresholds, the “sustainability gap” can be calculated as the gap between actual performance and what could be considered a sustainable level of impact. This shows what it would take to become sustainable, highlighting the shadow costs and how they would affect the bottom line(s). Accounting for environmental, social, and economic impacts encompasses internal practices as well as externalities – the wider social, environmental, and economic impacts of the organization’s activities and operations on the “health” of these systems. Impact measurement in social processes remains problematic.

In short, each bottom line is connected with its own capitals and introduces its own accountability, accounting, and auditing issues, next to indicators, reporting, risk rating, and benchmarking (Elkington, 2001). The AQBLSC can also help to highlight the fact that knowledge processing, for example, is too often geared towards improving financial performance and impacts only, and not towards environmental, social, or economic ones.

It should come as no surprise that we advocate the use of Context-Based Metrics (McElroy, 2008) as an impact-measurement tool for the impacts-columns related to the non-financial bottom line in our AQBLSC. We discussed CBMs (or quotient based footprints) as a tool for measuring impact in section 5. We also advocate the use of System Dynamics as a corresponding impact-modeling tool.

## 7. Conclusions and a research agenda for the future

The journey that we made to see the many faces of sustainability has come to an end. However, it is only an end for the time being. We believe that new perspectives on sustainability will be developed in the years to come. That is necessary, because this century will be decisive in whether we come to terms with our environment. At least, if we want to keep adequate standards of living – not only for a happy few, but for all of mankind (using a per capita philosophy). Sustainability is about adaptation, and the choice we humans presently have is a very simple one: either we, as a general human system, adapt to our environment, or the environment will adapt us. We do not know of any other possibilities. We only have one earth and other “earths” are far way in time and space. This is not meant as a pessimistic ending of our journey. We humans are able to destroy and to create; we are able to divide and to combine; to do things on our own and to join physical and mental forces. It is, therefore, the moment to reflect, here, on what we already know about sustainability and to show some glimpses of a research agenda about knowledge of sustainability as well as about sustainability of knowledge. This research agenda regards ecological and social sustainability.

We first notice that to fully understand sustainability a system’s view is required. This is an accepted view within the Wadden Academy and applies to the Wadden Sea Area in general. As the word “system” indicates, it concerns a combination of components that are placed and work together to behave as one singularity. That being said, we immediately take an analytic stance. The synthetic perspective of “everything is connected to everything else” is not a fruitful approach. However, it reminds us of the fact that although we have to tear things apart, somewhere in the background we have to realize that the separated things are connected in one way or another. A system’s perspective is the best way to express that. However, a system’s perspective is always an empty perspective. A house is a system, a village or city can be a system, healthcare can be a system, but the earth is also a system. There is hardly any natural or artificial object that cannot be a system. This means, on the one hand, that to study a specific system, knowledge of a specific content is required, ranging from buildings to spatial lay-out and from health to natural resources as oil or wind. On the other hand, a more highly aggregated analytic level approach is necessary as has been formulated by Herbert Simon in his classic study *The Sciences of the Artificial* (1969). Sustainability is about the study of artificial or human-made systems in relation to their environments. This means that a system always has an environment and that sustainability deals with the relationship between the two. When we formulated the quadruple  $\{X, Y, r, t\}$ , we meant to express that there is relationship  $r$ , between system  $X$  and environment  $Y$ , over a time period  $t$ . The fact that we are talking about human-made or artificial systems means that sustainability has to be looked at from an individual and from a collective human perspective. Sustainability is our concern. The fact that some species of animals become extinct is part of life on earth and as such it is beyond our reach. However, if this extinction occurs because of our behavior in certain parts of the planet, or because we did not realize that some endangered animals (e.g., whales in the sea or certain kinds

of birds in the Wadden Sea) are part of a larger food chain, it affects us or is effected by us.

Secondly, because sustainability is an expression of a relationship between system and environment, we note that sustainable is not the same as endurable or long-lasting. In the latter situation, we are talking about a feature or property of an entity or object, in the former case of a balance, an equilibrium, or a relationship between two entities. We argue that everything that is sustainable is long-lasting, but not the other way around. In technical terms, this means that sustainability is a dyadic and not a monadic operator. As a (logical) function it takes two arguments. As a consequence, a discussion about an absolute, sustainable Wadden Sea area is not very interesting and logically incorrect. A system, for example an island or a harbor or tourism, is or is not sustainable with respect to an environment that has to be demarcated in time and in space, concerning e.g. water supplies, soil contamination, social cohesion, or leisure quality.

We state, thirdly, that knowledge of sustainability is essential. Very often, in all kinds of sectors, we discover that we do not know enough about specific domains. We sometimes lack knowledge of the effects of fishing, or of social structures, or of our regional habitat. And if we have enough knowledge of a domain, what we often lack is “relational” knowledge. This is especially true for a complex system like the Wadden Sea Area, e.g., energy production with geo terminal structures. What are the effects of interventions and policies, and what is affected by interventions and policies? Concerning sustainability, things are even more complicated, because various levels of aggregation are involved. What is adequate for an individual may be devastating for a region, and what is good for a certain community may be detrimental for a specific family. If we include the various species in such an analysis, tourism stimulation may be healthy for a local community, but may disturb the rest of certain birds. This doubling complexity is an inherent property of any sustainability discussion and cannot be avoided. That is why well-being, which we formulated as part of social sustainability, is dynamic in all senses of the word. Having knowledge of sustainability in various domains is a necessary condition for every sustainability discussion, but it is not a sufficient condition. The knowledge has to be incorporated in new behavior, in measures, in interventions, and in policies, such that our organizations, regions, societies, and communities become more and more sustainable. Managing or processing sustainability is what we mean by sustainability of knowledge. If we are able to design or create structures that are inherently sustainable, we have the adequate structure of an intermittent mixture of KoS and SoK. The Integral Knowledge and Research Agenda of the Wadden Academy realizes this mixture.

In the fourth place, we hope we showed that sustainability is not (only) about environmental issues. Of course, without natural capital we, humans, cannot survive. But how we survive and how we (ought to) behave is a matter of social sustainability. Besides, to be honest, we have done a lot to abuse natural capital the last hundred years. However, we are also able to stimulate anthro-po-capital to compensate for this decay of natural capital. With respect to activities in the Wadden region one can think of the construction of the Afsluitdijk in the 1930s in the first place, but also, in a much more interesting second place, of new developments of blue energy production along the same Afsluitdijk. In this sense, we adhere to a specific interpretation of the weak

sustainability concept. Referred to as strong versus weak sustainability schools of thought, they generally differ on the question of how much capital of one sort or another can be consumed or destroyed relative to the remaining supplies of the others, while still maintaining human and ecological well-being. The disagreements between both schools of thought concern the issue of substitutability, or how much of a loss of natural capital can be substituted or compensated for by another type of capital (i.e., anthropo or human-made capital).

Strong sustainability theorists hold to the notion of no, or low, substitutability between natural and artificial capitals (Daly, 1973, 1977, 1996; Daly and Cobb, 1989; Costanza et al, 1997; Dresner, 2002; Ekins et al, 2002). Weak sustainability theorists contend, by contrast, that human-made capitals, such as technology and other anthropogenic innovations, can, with a few exceptions, be substituted for natural capital, and that independently managing and maintaining separate capital stocks is unnecessary. Instead, they argue, it is the overall size, or aggregate, of all capitals that must be maintained in order to safeguard human and ecological well-being (Pearce et al, 1989; Gutes, 1996). Our interpretation of weak sustainability means that we, humans, are able to correct our misbehavior or abuse of natural capital in the present time by innovation and creativity (social and intellectual capital) so that we find and develop new resources or that we produce new natural capital. The big problem, however, is that these innovations take much time. If immediate substitution is not required, we adhere to weak sustainability; if immediate replacement is necessary, we adhere to strong sustainability.

The discussion about the various forms of sustainability emphasizes the triple bottom line of Planet, People, and Prosperity (Profit). The triple bottom line concerns thresholds of natural and anthropo capital beneath which we should not go. We should realize that individual or collective human behavior is not neutral or value free. If we want to continue driving cars, this has many benefits, such as visiting relatives in hospitals or earning money for the community, but it also has a price, for example producing more carbon dioxide than the earth can absorb, or exhausting the resources that my third-generation offspring will not be able to use anymore. The initiative on Ameland to work with the Cradle-to-Cradle approach (waste is “food”) is an example of reducing devolvement and implies looking at benefits and costs in the long run.

Naess was right in his statement that knowledge of sustainability and sustainability of knowledge (our terms) require a new way of thinking. As a systemic philosopher and argumentation theorist, Naess coined this new reflection “ecosophy”. In this 21<sup>st</sup> century, we should ask ourselves questions like “if we use natural capital X, does it contribute to our well being?”, or, “if we put so much effort in implementing social structure or design Y, what are its effects on this part (region) of our natural habitat?” This brings us to a kind of ecology that combines social and natural areas of impact, that goes formulates assertions that go deeper than just “I want to save certain birds” or “We want to guard this old village”. This is not meant to criticize those who are concerned with birds or with cultural heritage; it is meant to look at a local problem and in the same time combine that with the larger puzzle.

In the sixth place, we showed that many developments concerning sustainability in the near future will be about determining, measuring, and quantifying sustainability. Not for the sake of elegant algorithms, but to compare, to intervene, or to evaluate what we are doing. We believe that that is where the big challenges for empirical research lie. Whether we use capitals in its various forms – the ratio or the quotient approach that we discussed – or Key Performance Indicators and the various interpretations of the Balance Scorecard, we have to come up with indicator lists to see the effects of the many Areas of Impact. In sections 5 and 6, we gave a glimpse of the many efforts in the world that have been started. None of these methods is ready yet, but we had a long way to go: from conquering the world and unknown territories to sustaining our world. Concerning the Wadden region, we mention two examples. Suppose the Wadden region community wants to exploit an existing harbor better, such as Delfzijl, and wants to compare it with Harlingen. Determining the various Areas of Impact in both cases will result in better choices. Suppose a small village in the wide Wadden region wants to keep its existing health services and services for the elderly in an old building that needs to be renovated and wants to compare the situation with another village ten kilometers away. The systematic structure of Areas of Impact or KPI's enables the communities to make a better choice between the various options.

One thing we have not discussed here is the issue of overpopulation. If trends continue, the world population will grow from 6,7 billion people in 2010 to 9,5 billion in 2040. It is just a matter of simple calculation to see that whatever we do to our natural and anthropo capital, such a future state will not last. At this moment there is no serious world-wide policy to counter this development. For religious, national(istic), family, cultural, or strange ethical reasons, we seem to forget that all our efforts to deal with ecological and social sustainability or to reduce devolvment are fruitless, if we are not able to reduce the human population. It is interesting to see that we have enough knowledge of sustainability, but that we are not able to create an adequate sustainability of knowledge. The very near future will confront humankind with this development. This may look like an esoteric discussion, given a diminishing and declining population in certain parts of the Wadden region. However, it may give this region an advantage with respect to developments that will happen for the better and the worse. One can think of two concrete questions. How can we handle the concentration of populations in bigger cities in the Wadden region, e.g. Leeuwarden and Groningen? What kind of dedicated and advanced Internet services are possible in sparsely populated Wadden areas, and what are the effects on individual and social well-being?

We will end our theoretical survey with a short summary. After that we will give directions for future research. Based on our theoretical approach, we have identified a number of relevant concepts, and we use a (high level) framework (figure 6) to illustrate and summarize them. We postulated that for an artificial system to be sustainable, it needs (1) high quality knowledge about sustainability and knowledge of its impacts on the world (KoS) and (2) the capacity to learn and innovate in response (SoK). Organizational Sustainability can be seen as a capability with two aspects. The first is the organization's ability to *adapt* to environmental challenges, and the second is the ability to *interact* with the environment in a healthy way, or in such a way that the organization does not degrade levels of resources beyond the levels needed by humans for their own well-being.

# A Reference Model

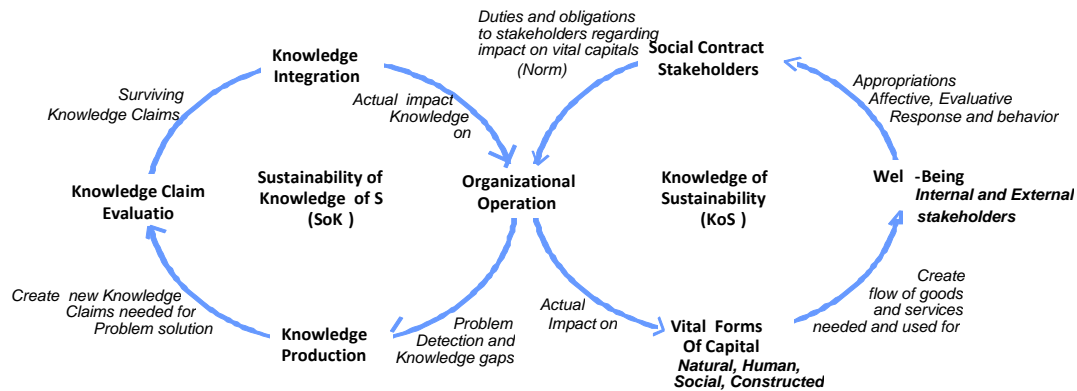


Figure 6: A Reference Model for Organizations, Knowledge (management) and sustainability,

The reference model highlights these two capabilities and their main underlying concepts, using two cycles. We focused on the sustainability of organizational activities or operations, and operations have an actual impact on vital forms of capital (which are natural, human, social, and constructed capital). These vital capitals create a flow of goods and services needed and used for well-being. Internal and external stakeholders appropriate this. Changes in well-being lead to a response and specific behavior towards the organization. Although the social contract is mostly implicit, we have plotted it here to show that issues about normative impact arise from stakeholder engagement, expressing the organization's duties and obligations. Organizational business processes make these circles or cycles most of the time, encountering and solving behavioral gaps; it is all about existing knowledge in use, or knowledge *of sustainability* in use.

But every now and then a problem or knowledge gap arises that creates the need to develop *new* knowledge to be used in business processing and operations. This knowledge processing is done through processes like knowledge production, knowledge claim evaluation, and knowledge integration. It is about knowledge creation in open relationship with stakeholders, and the focus is to maintain and enhance social capital. Unfortunately most of our organizational learning and knowledge processing systems are dysfunctional and unsustainable.

The Wadden Academy started in 2009 with an integrated research agenda that included a matrix with on the one axis a domain perspective: climate, nature, and well-being and on the other axis a time perspective of past, present, and future. In the above sections we discussed the issue of sustainability from different angles. If we combine our distinction between knowledge of sustainability (KoS) and sustainability of knowledge (SoK) with the domain axis, we can develop a matrix in which we can place what we know and what has to be studied in the near future.

Sustainability	KoS	SoK
Ecological-Nature	1. Much knowledge available	4. Little knowledge available
Ecological-Climate	2. Much knowledge available	5. Little knowledge available
Social-Human	3. Little knowledge available	6. Little knowledge available

Table 9: Research agenda Wadden and KoS and SoK

We estimate (table 9) that four cells in particular are important for the future research agenda (cells 3, 4, 5, and 6). Those estimations are relative; we do not mean that KoS should stop (cells 1 and 2), on the contrary.

The Research Agenda of the Wadden Academy is about scientific KoS (content) and SoK (processes), linked to a knowledge infrastructure. SoK concerns monitoring knowledge, intervening, finding out about the relations between domains, engineering, and designing. The Research Agenda uses an integrated, overall view. We identify nine main topics relevant for future research.

The existing scientific knowledge base of KoS is mostly filled with knowledge about ecological (nature, climate) issues. There is relatively little knowledge about sustainability available within and from the behavioral and social sciences. This needs to be stimulated (topic 1).

Scientific KoS fulfills an important role in our approach, as it is needed to specify norms or the denominator. This also means that scientific KoS should be focused on the identification and specification of *limits*. Or, to be more precise, creating knowledge about ecological thresholds and limits and knowledge about societal needs, which are necessary to realize well-being (topic 2), is important.

Existing high quality scientific KoS has to be used by actors in their actions and behavior, with regard to operational processes and policy making. However, often the scientific KoS available is not used or disregarded by individuals or collectives. We need to look closer at how collectives evaluate different knowledge claims and which methods and epistemologies they use to decide which knowledge claims survive and are used in actions (topic 3). We also need more research regarding the mental models of individual actors; how do they think about and in terms of sustainability (topic 4).

Knowledge transfer and the science-policy interface still pose a lot of problems, and we need more knowledge about how to solve these problems (what new structures, processes, incentives etc. are needed) (topic 5). A well-functioning knowledge infrastructure (SoK) has to be designed and implemented (topic 6). When problems and scientific knowledge gaps are detected, new scientific knowledge is created and integrated in practice, with measurement and monitoring systems in place. Here the goal is to maintain the high quality of scientific knowledge, preventing it from becoming obsolete (see also The Triple Helix literature). We advocate the use of our impact measurement approach as an integral part of the Wadden Monitor systems (topic 7). Another topic that will become relevant within our view of a system and its environment (stakeholders) is how to embed knowledge management in relationships (topic 8) and how to create knowledge, innovation, and social capital in close collaboration and cooperation with stakeholders. Finally we see strategy, scenario

development, and social simulation models using a capital-based view as an essential part of community development and the use of social contracts (topic 9). Further research in this domain is needed.



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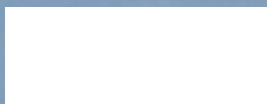
Photography: Huneman Waddenfotografie

Printed by: Hollandridderkerk

© 2010 Waddenacademie

ISBN/EAN 978-94-90289-19-5

Serial number 2010-02





It is the ambition of the Wadden Academy to develop the Wadden Sea Region into an incubator for widely applicable integrated knowledge of sustainable development of a coastal area, in which natural values are a key element and form the foundations of the local and regional economy. The region is a meeting place for scientists from the Netherlands and elsewhere, administrators, policy makers and management agencies. Together, they develop sustainable and innovative solutions based on interdisciplinary knowledge. By 2020, the trilateral Wadden Sea Region will be the best monitored and best understood coastal system in the world.

The Wadden Academy is co-financed by the Wadden Fund

