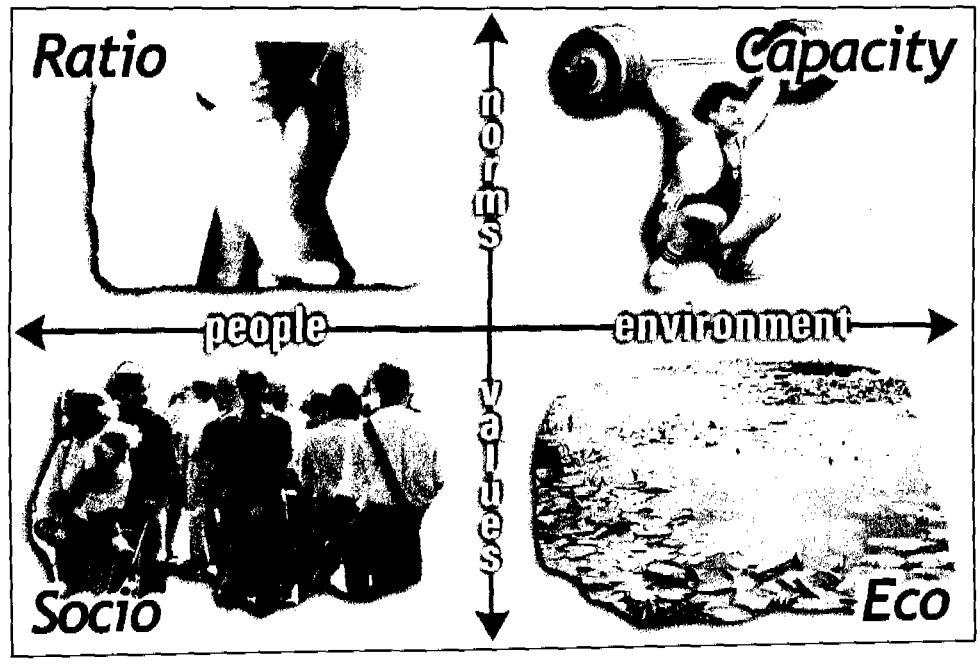
Sustainable Water Management

Four approaches to enhance planning

March 2000

Michiel A. Rijsberman

Communication nr. 85



TU Delft
Technische Universiteit Delft

Faculty of Civil Engineering and Geosciences
Department of Water Management
Section Land and Water Management

Sustainable Water Management

Combining four approaches to enhance planning

Michiel A. Riisberman

Communication of the Department of Water Management nr. 85

TU Delft
Delft University of Technology

Faculty of Civil Engineering and Geosciences
Department of Water Management
Section Land and Water Management

Colophon

A publication of:

Delft University of Technology
Faculty of Civil Engineering and Geosciences
Department of Water Management, section Land and Water Management
P.O.box 5048, 2600 GA Delft, the Netherlands

Report of research co-financed by:

Municipality of Almere
Municipality of Amersfoort
Projectbureau Leidsche Rijn
Institute for Inland Water Management and Wastewater Treatment RIZA

Communication of the Department of Water Management nr. 85
41 pages

ISSN 0169-6246

Table of Contents

1 Introduction

This report contains results from a research project titled "Design and management of sustainable urban water systems", under execution at the Delft University of Technology. The aim of the project is to develop a system for the design and management of sustainable water systems, containing an assessment system for their sustainability. Before such a system can be developed it is necessary to know what of sustainability in water management is. This is the subject of this publication.

Background

A wide range of literature is available on projects that are claimed to be sustainable. A much smaller amount of literature is available on the theoretical background of sustainable water management. Moreover, the available scientific literature is not very accessible to most people and is not used very frequently in (Dutch) practice. In many cases the sustainability of supposedly sustainable projects is demonstrated by mentioning the application of a certain measures. In the case of urban areas these measures usually are alternative ways of dealing with urban drainage and wastewater. Apparently these alternative ways are viewed as inherently sustainable: application of these techniques to a part of the environment is viewed as reason to believe that a situation is sustainable. But is this belief justified? There is no guarantee that a system built entirely from sustainable parts is sustainable as a whole. In most cases no attention is given to what is supposed to make the proposed solution sustainable or whether a sustainable situation is in fact reached. At best, the principles applied are loosely related to themes of sustainability.

Globally, different methods for assessment of sustainability have been developed with varying degrees of success. Most successful are methods for assessing the (relative) sustainability of products and constructions (e.g. the widely accepted life cycle analysis (LCA) method). On a larger (spatial) scale, development of methods is less successful.

In most literature sources the question what sustainability means for water management or whether a sustainable development is reached remains unanswered. Pötz and Bleuzé (1998, p.6) predominantly find recommendations, little foundation of considerations: "Over the past years a large number of publications on sustainable water management has come out. Almost all publications give normative or rather prescriptive recommendations for the use of resources (materials, water, energy)." A possible explanation for this phenomenon is can be found in chapter 3 of the publication, where different approaches to sustainable development are described.

An objective of this publication is to show that different people use different approaches to sustainable development and that these differences can not be neglected. As a consequence of these differences, it is necessary for an assessment system to take these differences into account when the system is supposed to be generally applicable. This report is not about prescriptive recommendations; the subject is not the sustainability of specific measures like domestic use of rainwater or rainwater infiltration facilities. Instead, an attempt is made to provide insight in motivation of and the concepts or notions at the base of sustainable development. In this report a description is given of different approaches that are used in water management in the pursuit of sustainable development.

Outline of this publication

Chapter 2 contains a review of the concepts of sustainability and sustainable development starting from a number of generally accepted definitions. The description of 'core' of the concept is contained in this chapter. Some attention will go to elaboration of the concepts in practice. Different people make different choices when working on sustainable development, as a consequence of the differences in their system of norms and values. Subsequently, in

chapter 3 the most important distinguishing aspects of the approaches to sustainable development used in water management will be discussed, and from these aspects a structure of four basic approaches is proposed in chapter 4. This structure can be used to enhance the sustainability discourse in planning and decision-making. Acknowledging subjectivity in sustainable development has some implications on the way sustainable water management projects are conducted. These are discussed in chapter 5. This report finishes in chapter 6 with a discussion and some conclusions.

Because this report is intended to provide the theoretical basis for subsequent research a good embedding in current literature is sought. This has led to a rather large number of references in the text, which in some places has a negative effect on the readability.

Acknowledgements
The research project of which results are reported here is co-financed by the municipalities of Almere and Amersfoort, Projectbureau Leidsche Rijn (task-group water system) in Utrecht, Institute for Inland Water Management and Waste Water Treatment RIZA in Lelystad and the Delft University of Technology, Delft.

2 Definitions of sustainable development

2.1 Environmental awareness and sustainable development

In 1987 a commission of the United Nations, the World Commission on Environment and Development (WCED), presented the report 'Our Common Future', the so-called Brundtland-report named after the president of the commission. In this report the necessity of sustainable development is made clear (WCED, 1987). With the Brundtland-report the concept of sustainable development has gained wide spread popularity.

The notion of the necessity of sustainable development was not new in 1987, but can be traced back to e.g. the famous report of the Club of Rome, 'Limits to Growth' (Meadows et al., 1972). In short, the Club of Rome stated that humanity should observe the limits to environmental pressure, because the carrying capacity of the world's environment is finite and because certain resources will be depleted otherwise. Excessive pollution of the earth's atmosphere and water resources or the depletion of resources like stocks of fossil fuels will mean a harsh end to (western) society and to prosperity in general, was the grim prediction of the Club of Rome.

Ever since 1972 and especially since 1987 the environment, sustainability and sustainable development have received a lot of attention in research programs, legislation, industry, and other fields. Over the last three decades theory and research of sustainable development bear a clear stamp of the thought that the environment is *limiting* to our development in some way, and research can generally be characterized by a search for these limits (e.g. compare the citation of Pötz and Bleuzé in the introduction in the previous chapter).

Today, at the turn of the century, sustainable development takes a place high on the (international) political agenda. This is demonstrated by the summit meetings on environment and sustainable development in Rio de Janeiro, 1992 (where the well-known Agenda 21 was set), the climate conference in Kyoto, 1998 and the ministerial conferences held at the World Water Forums in Paris, 1998 and The Hague, 2000, to name but a few.

2.2 Five definitions of sustainable development

But what is sustainable development? What constitutes sustainable development is poorly defined. Palmer et al. (1997) call sustainability and sustainable development "fuzzy buzzwords": terms that appear to encapsulate a discrete notion but which actually have multiple interpretations. Sustainability means different things to different people yet appears to unite them under what is actually a falsely shared banner. As a consequence, hundreds of definitions of sustainable development can be found in literature. The concept is explored below on the basis of five quite different definitions, after which key elements of the definitions will be discussed. For the interested reader: a large number of (other) definitions is given by e.g. Pearce et al. (1989, p. 173-185).

1. The Brundtland Commission

The Brundtland Commission defines sustainable development as *'a development that fulfils the needs of the present generation, without compromising the ability of the future generations to fulfil their needs.'* (WCED, 1987, p. 43).

Important elements in this definition are the fulfillment of needs of the present generation on the one hand and of the needs of future generations on the other. The Brundtland-definition is the most commonly accepted and it is used in Dutch national environmental policy.

2. World Conservation Union

'Sustainable development means improving the quality of life while living within the carrying capacity of supporting ecosystems.' (World Conservation Union et al., 1991, as quoted in Expert Group on the Urban Environment, 1996).

This definition is broader than the one of the Brundtland-commission, definition 1. Important elements in this definition are (first) the improvement of the quality of life and (second) the condition of the carrying capacity of supporting ecosystems. The 'improvement of the quality of life' in this definition seems more ambitious than the 'fulfillment of needs' in the Brundtland-definition. 'Improving of the quality of life' can be interpreted as equal to fulfilling needs to a higher degree: the quality of life can be thought of as the amount in which people's needs are fulfilled. With the carrying capacity of supporting ecosystems the environment or nature is introduced as a stringent condition, while definition 1 only refers to present and future generations.

3. Mostert

According to Mostert sustainability *'...implies that the supply of 'natural capital' is maintained.'*(Mostert, 1998)

Furthermore, Mostert states that to sustainable development meeting the following conditions is of vital importance:

- the use of renewable sources – such as water – should not exceed the rate of renewal,
- the use of non-renewable resources – like fossil fuel – should be such that they will not be exhausted before alternative sources are available, and
- fundamental ecological processes and structures should be maintained.

This definition is based on the "Water 21" project, a European research project on sustainable water policy. Partners in this project are from France, Germany, Great Britain, the Netherlands, and Portugal. Sustainable development is seen as a kind of stock management, resulting in the first two conditions. Stock management is elaborated further in paragraph 2.5.1.

With the maintenance of fundamental processes and structures the third element addresses the carrying capacity of supporting systems. This maintenance of the integrity of the system is also referred to as the prevention of system degradation. Carrying capacity is also mentioned in the second definition, of the World Conservation Union. In the third condition, Mostert specifically mentions *fundamental* ecological processes and structures, and not all the original or natural ecological processes. How fundamental ecological processes can be distinguished from non-fundamental ones remains unclear, however.

A definition similar to this third definition is proposed by the environmental-economist Pearce, on the basis of 24 literature-sources (Pearce et al., 1989). Pearce refers to sustainability as 'maintaining the natural resource base of future generations'.

4. Loucks

'Sustainable water systems are designed and managed to fully contribute to the objectives of society, while maintaining their ecological, environmental and hydrological integrity.' (Water Resources Planning and Management Division, ASCE et al., 1998). In addition, Loucks states that sustainable water management systems have to be able to meet the demands to the system without system degradation, now and in the future. With this statement, Loucks concurs with Mostert. In the accompanying explanation he points out the problem of how to know the needs of the future generations. These needs are hidden in the future by their nature.

According to Loucks, changes in a system are allowed, as long as they do not influence system quality negatively: so changes in the system are not precluded, because they do not necessarily constitute system degradation. A related assumption is that of the compensation principle, which will be treated in 2.5.4. Please note that Loucks puts the contribution to the objectives of society first.

5. International Council for Local Environmental Initiatives
Sustainable development is *'... development that delivers basic environmental, social and economic services to all residents of a community without threatening the viability of the natural, built and social systems upon which the delivery of these services depend.'* (ICLEI, 1994, as quoted in Expert Group on the Urban Environment, 1996, p. 9).
This definition is drawn up specifically for the urban environment and is similar to the definition by Loucks et al. (def. 4).

Here, social aspects are central too, while the definition seems to be less ambitious with respect to sustainable development. Where Loucks refers to full contribution to objectives of society, this fifth definition speaks of basic services. Where Loucks excludes system degradation entirely, this fifth definition is limited to 'without threatening the viability of systems'. Hence, In this definition system degradation is allowed to some degree. When 'providing elementary services' is seen as equal to 'fulfilling the needs' this definition is quite similar to the Brundtland definition.

2.3 Key elements of sustainable development

In the definitions of sustainable development, like the five mentioned above, four key elements can be distinguished. These elements can be considered to constitute the core of the concept of sustainable development: every definition is based on some or all of these elements:

1. needs of the present generation
2. needs of future generations
3. maintaining the components of the system (or: quantity and quality of supporting systems)
4. maintaining system integrity; the coherence between supporting systems

The first two key elements are oriented on 'human' factors, while the last two are oriented on 'environment' factors. All key elements are clarified below.

Needs of the present generation
Although the fulfillment of present needs in the present situation will differ between in most cases, the present needs can be expected to be known or at least possible to derive or draw up to a large extent. With respect to water management these needs can be described in terms of the desires for and demands to the water system, e.g. with respect to water supply, safety from flooding, sanitation, the ecological system, recreation, and aesthetic value. In sustainable development the primary objective is the fulfillment of one or more needs, as in any other deliberate development. However, sustainable development has to meet a number of (additional) conditions before it can be regarded as such.

Needs of future generations
Sustainability means evaluating not only the consequences of choices for the present, but also taking into account the consequences for the (far) future. De Groot (1992, p.265) defines the concept of sustainability exclusively as the long term aspect of what he calls 'all final parameters': health, economic services, spiritual growth, natural diversity, etc.

Consciousness of time is at the base of sustainability; according to the Dutch cultural philosopher Van Peursen (1972, p. 20), consciousness of time even marks one of the differences between humans and higher animals. Being conscious of time however does not bring about knowledge of the needs of future generations. An example is the great number of projects in which Dutch brooks and natural streams have been straightened in order to improve discharge or drainage capacity. The majority of these projects were realized in the 1950's. One can ask whether these projects would have been executed with the same persistence, if the present 'need' for natural brooks and streams would have been foreseen.

Present system properties usually are related to the needs of present users, and it seems obvious to relate the future system properties to the needs of the future system users. Ideally, designs and plans are tested against the needs (or objectives) of the period where the designs and plans have their effect. Consequently, it is not possible to properly test 'sustainable' designs and plans on a set of criteria, based on the present needs.

Publications on sustainability differ widely in the way this uncertainty in the needs of the future is taken into account (see for instance Hoekstra, 1998; Water Resources Planning and Management Division, ASCE et al, 1998; Geldof, 1994; De Groot, 1992; WCED, 1987). The future-aspect of sustainability is sometimes referred to as *futurity* (see for instance Curwell and Cooper, 1998).

Maintaining the components of the system

Our living environment, when regarded as a system, can be divided in various subsystems (like water systems, economic systems, social systems, ecological systems, etc.), that can further be subdivided in subsystems, etcetera. In a sustainable situation, these various subsystems are not to be stressed beyond their carrying capacity, both in quantity as in quality. Otherwise they will collapse.

The importance of the preservation of quantity and quality of the various components of the system can be demonstrated by using a device analogy. When using the device, its components should not be subjected to such an overload that one or more would break. Through the use of the device, the quality of the components should not deteriorate to such a level that the components are not able to function anymore, or their strength becomes insufficient. Van Leeuwen (1973 and 1981) developed the *Eco-device* theory; later Tjallingii (a/o 1996 and 1995) adapted the *Eco-device* theory for urban development and water management.

A solution for the question of sustainability seems to be available: by assessing the carrying capacity of the supporting (eco) systems, the boundaries are found within which a development is sustainable. Examples of attempts at finding these boundaries are plenty, e.g. in Hoekstra (1998), Balkema et al. (1998), Mels et al. (1998), Van de Worp and Don (1996) and in the Dutch Interdepartmental Research Program 'Sustainable Technological Development', where a sustainable urban water cycle is discussed, among other subjects (Meijer et al., 1997; Jansen et al., 1997; Witteveen+Bos, 1994).

The concept of preservation of components of the system most explicitly mentioned in definition 2, and only missing in definition 1, the Brundtland-definition. The other definitions refer to this key element in some way.

Critics of the search for limits or boundaries of the environment argue that it is not feasible to find a meaningful standard for every parameter or process in nature or the environment. Moreover, they say, if it were possible to do so, it is not possible to develop a usable system out of these norms. They pose that it is better to pursue values instead of trying to meet a system of standards (Tjallingii, 1996; Geldof, 1994; De Groot, 1992).

Maintaining system integrity

Maintaining system integrity (for instance between, and of, ecological, environmental, social or economic systems) is closely related to maintaining the components of the system. This key element stresses that not only the physical features of the water system (or supporting ecosystems) are important. The relations and structures within the environment and the water system are at least of the same importance to sustainable development; a system is defined by it's components and their mutual relations. De Groot (1992) describes this notion quite extensively, referring to the principle of logical enumeration.

The importance of relations and a meaningful structure can be demonstrated by using the device-analogy again. A device can consist of high quality components, but without a meaningful structure and coherence (i.e. when the device is not assembled correctly) the 'device' will not function.

2.4 Discussion of the key elements and concluding remarks

The 'watchmaker's tick'

The key elements in the previous paragraph form a quite mechanistic world image, demonstrated by the applicability of the device analogy to the key elements 'maintaining the components of the system', and 'maintaining system integrity'. And a sustainable device or machine (that has to last for a long time) can fulfill needs in the present and in the future. The machine can be thought of as an old clock that has been in the family for many generations and is supposed to remain in the family for generations to come. The clock fulfills a need, it shows the passing of time, for the present generation as well as for the following. To be able to do so, it has to be made of high quality components that do not wear out before they can be replaced by new ones, assemble in the correct way.

However, correctly assembling the right components is not enough. Before the clock can tell time it needs 'a little push'. A running clock contains a movement that is an essential component of the clock, the 'watchmaker's tick'. A clock is more than just a number of assembled components. It is the same for our living environment. Besides a number of related components, there is something we could call 'life'. It is what Dr. Frankenstein tries to give to his monster, after putting the parts in their places. Although it is an essential part of our existence, the element of the watchmaker's tick is not a part of the definitions of sustainable development found in literature. Maybe this element is safeguarded well enough by the care for the other elements? In discussing issues of sustainability, however, 'life' is not an element that should be left out of the discussion completely.

According to chaos theory this observation has consequences: a certain amount of chaos (which can be interpreted as complexity in this context) is necessary in living systems (Geldof, 1994 and 1999). 'Life' is on the border of order and chaos. A drastic reduction of chaos (and complexity) is lethal for living systems. For a quite accessible discussion of complex (policy) issues see e.g. De Bruin et al, 1998.

The quality of life and level of ambition

The Brundtland-definition of sustainability (def.1) is based on the fulfillment of needs of humans, of generations. Other definitions refer to these needs with either 'objectives of society' (def. 4) or 'basic services to all residents of a community' (def. 5). The World Conservation Union speaks of the quality of life (in def. 2). The quality of life can be seen as the measure of the amount in which the needs of people or generations are fulfilled. As the needs of humanity (in the broadest sense of the word) are fulfilled, the quality of life increases. The Water 21 definition (def. 3) does not go directly into the needs and their fulfillment, but is focused on 'environmental factors' or conditions. Apparently, the basic assumption is that it is possible to fulfill the needs of society when these conditions are met.

Definitions 1, 2, 4, and 5 imply that humanity does not have to give up the fulfillment of certain needs, but that with *sustainable* development it is possible to fulfill these needs. Whether, or to what degree, it is possible to fulfill the needs of humanity within conditions like those in definition 3 is unknown, however.

The authors of the definitions differ on the estimation of the degree to which fulfillment of needs is possible: the level of ambition in the definitions differs. The questions which level of ambition remains unanswered, but this is inherent to definitions. However, a level of ambition is also absent in the explanation to the definitions. The relationship between the fulfillment of human needs (i.e. prosperity, in the light of the following paragraph) and the environmental pressure is not determined.

In 1972, Barry Commoner described environmental pressure as the product of three factors: population size, the average prosperity per person and the environmental pressure per unit of prosperity (as used in the Dutch STD-studies, see Jansen, 1997; Witteveen+Bos, 1994 and many others). So with a constant population size there is a linear relationship between

prosperity and environmental pressure. A development that increasingly fulfills the needs of society (increasing prosperity), exerts a pressure on the environment that increases at the same rate. Following Commoner's approach, it seems obvious to combine a high ambition for prosperity with a low ambition for environmental quality, and vice versa.

But where is the sustainable balance between the quality of life on the one hand and the state of supporting systems on the other? Is it possible to realize a balance between these two sides of the same medal, people and environment, acceptable to society? An important aim of Dutch environmental policy is to 'unlink' the growth of the economy from the growth of environmental pressure. In Commoner's view, this means a reduction of environmental pressure per unit of prosperity: in Commoner's calculations this means a reduction to about $1/20^{th}$ of the present environmental pressure (see e.g. Jansen et al, 1997). The factor 20 is based on an expected growth of the global population by 2, a supposedly necessary reduction of the environmental pressure by 2, and an (guessed) global increase of prosperity by a factor 5.

In the light of the arbitrary nature of the numbers in Commoner's equation, there is no basis at all to treat the factor 20 as a stringent condition. The necessary reduction of the environmental pressure per unit of prosperity could just as well be 5 or 50. The conclusion that globally the environmental pressure per unit of prosperity should be reduced is justified, however, although we do not need Commoner's equation to reach this conclusion. Undesired environmental changes do occur at a large scale, like climatic change, acid rain, accelerated sea level rise, and the deterioration of the ozone layer. Moreover, this is occurring while large parts of the global population only are at a level of development where they are hardly capable to contribute to environmental problems. When we want the entire global population to have an acceptable level of development, and thus their needs are sufficiently fulfilled, it is clear that the environmental pressure of what we regard as a 'developed society' should be reduced drastically.

Still, it is not desirable to elaborate sustainability solely from the idea of reduction of environmental pressure, as Commoner's equation might suggest, and is often the case in practice. Sustainable development is more than that: the needs of generations go further than just a clean living environment. Sustainable development also concerns issues like social and esthetic value, and, maybe less obvious with respect to water management, equity. With respect to the latter, the aspect of equity is one of the important additions to environmental or sustainability discourse by the Brundtland-commission, that has been conducted since the publication of the report of the Club of Rome (Meadows et al, 1972). The introduction of equity signifies a broadening of the scope of this discourse from considering the environmental consequences to the sustainable development of society.

Distinction between the key elements

Is the thought behind the last two key elements, 'maintaining the components of the system', and 'maintaining system integrity', not equal to fulfillment of the needs of future generations? Are these elements not overlapping?

It can be stated that these elements do not overlap if and when nature is considered to have intrinsic value. In that case, the carrying capacity and integrity of these systems in themselves are valuable enough to preserve, without considering their relevance to the needs of society. Mostert and Loucks (see section 2.2) seem to hold this view. However, when the supporting systems derive their value from their relevance to society (e.g. living in a stable ecosystem, healthy to humans), then the elements can be regarded as overlapping. After all, when society for it's continued existence needs the carrying capacity of (eco) systems, then the element 'maintaining the components of the system' is covered sufficiently by the 'needs of future generations'. The Brundtland-commission (see section 2.2) seems to hold this view. In chapter 3 the distinction between people and their environment, between culture and nature, is treated in greater detail.

2.5 Themes for the practical elaboration of sustainability

The definitions and their key elements in the previous paragraphs present a rather abstract image of the concepts of sustainability and sustainable development. These definitions and elements are clearly not specific or concrete enough to be applied in a practical situation directly. In literature, the application of sustainability is elaborated along various themes (and basic assumptions, guide principles, or dogmas, etc.). An overview of literature can be found in the list of references at the end of this publication. The most important themes for elaboration are describe in this paragraph shortly. These themes, like life cycle management, pollution and depletion of resources and so on, can be traced back to the *aforementioned definitions and key elements*.

Many approaches can be followed for the classification and elaboration of the themes of sustainable development. The classification presented below in not the only correct one, and the listing is not exhaustive either. The aim of the listing in this paragraph is twofold. On the one hand the overview is included to present a clearer image of what is thought to be sustainable development. On the other hand, it can offer a handle for application in practice. In the following chapter, the approaches leading to choices in the process of elaboration of these themes is treated, like the considerations and choice of level of ambition and the weight assigned to external conditions.

2.5.1 Life cycle or chain management versus stock management

In environmental technology and policy exhaustion, depletion and pollution have received a lot of attention. A well-known strategy to reduce or prevent resource depletion or pollution is the life cycle management strategy. *Life cycle management* deals with the life cycle of products: "extraction – production – use – waste". In Dutch, life cycle management is called *ketenbeheer* or literally translated chain management. Because the life cycle of many products is not closed, in many cases the term chain management is more appropriate than life cycle management, *referring to the chain of stages in the life cycle of a product*. In a life cycle management approach the objective is to reduce the environmental pressure of the entire life cycle using a holistic approach. A life cycle or chain management strategy can be elaborated according to the approach of the four R's (e.g. described in De Wit et al., 1997):

- *reject* - don't use
- *reduce* - use less
- *reuse* - use again
- *recycle* - use again as a base material for production.

The benefit of reducing the extraction of raw materials and the production of waste is obvious. Both activities usually put pressure on the environment and natural resources.

Limitation or reduction of extraction is necessary in the case of a finite resource and as long as no viable alternative is available, and it is necessary in the case of a renewable resource, not to deplete the resource by exceeding the rate of renewal

Limitation or reduction of waste production is necessary because by definition waste is an unusable and worthless material, using up valuable space and generally having a negative impact on the environment. When waste is used for raw material, not only the need for extraction of raw materials from the natural environment is reduced, less waste is produced as well: the knife cuts on both sides. The thought of closing material cycles has advantages that are especially clear when applied to products like glass, paper, building materials and entire buildings.

Not only the environmental impact at the start and the end of the chain should be reduced. In the chain itself the environmental impact should be minimized, for instance during production or use. Examples are (secondary) resource use, production of undesired

secondary products and leaching of heaving metals from building materials. These material flows should form a closed cycle too.

When the cycles of all materials in society are closed, the environmental impact of the now circular chains is nil. And when the energy necessary to keep the cycles going is obtained from a renewable source, maybe even sustainable. The well documented Life Cycle Analysis (LCA), based on the life cycle management strategy, is one of the very few generally accepted methods for quantification of environmental impact and sustainability.

In water management, application of the life cycle management concept is not obvious. Although a cycle exists in the form of the hydrological cycle, water in the environment has no clear life cycle. Water (usually) is not a commodity that is produced, used, and discarded, like e.g. a bottle or a battery is. For the discussion of life cycle management in water management the term *waterchain* is introduced, a term quite commonly used in the Netherlands. The waterchain comprises the whole of abstraction of water, production of drinking water, transport and distribution, use, collection and transport, wastewater treatment, and subsequent discharge. For the waterchain the idea life cycle or chain management is suitable, although not in every case.

For management of the *water system*, for instance the ground and surface water in a river basin, city or polder area, a chain management strategy is not entirely suitable. Stock management is better suited for these situations. The possibilities for application of chain management ideas at the beginning or end of the waterchain (abstraction from and discharge onto the surrounding water system) depend strongly on the specific characteristics of the local water system.

The application of the life cycle management strategy is based on a number of prepositions that are not all valid for the water system. In water system management the following prepositions of life cycle management are not valid in most cases:

- abstraction of the raw material has a negative impact on the environment, because
  - the activity of abstraction itself has a negative impact (like opencut mining or the harvest of tropical hardwood), or
  - the raw material originates from a non-renewable source (like fossil fuel), or
  - the raw material in the source area is renewed at a rate lower than the rate of abstraction (like the relation between groundwater abstraction and desiccation or drought)
- disposal of wastes anywhere in the cycle has a negative environmental impact, because
  - the waste causes deterioration of the quality of the receiving medium (like water and air pollution by discharge of e.g. wastewater, dust, and gasses), or
  - in the receiving area necessary space is not available (like landfills or the discharge large flows in small streams).

Water in the hydrological cycle (or the water system) is not abstracted as such. Water is present in the cycle and is moving or transported. The distribution of water over the various parts of the cycle depends on the seasons, like the difference between wet winters and dry summers, and the (seasonal) storage of water in plants. No water is created and no water is destroyed (or only in insignificant amounts). The cycle is already closed[1]. The point is to manage water resources in such a way that the distribution of water in the hydrological cycle at least does not cause (unacceptable) problems and that this water is of good, or at least sufficient, quality.

[1] Fossil groundwater is an exception. It is abstracted e.g. in Libya on quite a large scale. Khadafi's 'green revolution' is based on water for agriculture from a very finite source.

The examples from practice where problems arise with the mismanagement of certain stocks can readily be found:

- groundwater nuisance, salination, drought, or desiccation can be the consequences of a improperly managed stock of groundwater;
- when the stock of surface water is not managed properly, flooding, eutrofication or drought can be the consequences;
- when the stock of water in the atmosphere is not managed properly, acid rain is the consequence.

From the perspective of stock management it is also clear where a 'close all cycles' strategy for the water chain is useful:

- in those cases where the intended source stock can not supply the desired amount of water without unacceptable consequences for quantity or quality;
- those cases where in the intended receiving stock quantity or quality problems will arise;
- and naturally in all cases where a closed cycle leads to a more efficient operational management or exploitation.

A more efficient operational management or exploitation will not easily be achieved, however. The environment has a certain natural attenuation capacity for pollution. For instance, BOD, bacterial contamination and a large number of organic compounds are degraded very well in surface waters. Depending on the consequences for the water system, this capacity can be used 'for free' an as a consequence has a very high 'value for money'. The notion of stock management, where a 'stock' of water is maintained with respect to its quantity as well as to its quality, makes a dogmatic closing of cycles and prevention of water transfer between watersheds (so-called alien water) superfluous. The intake of surface water alien to an area is unacceptable only when the consequences for the considered source stock or target stock are unacceptable, with respect to quantity as well as to quality.

2.5.2 Equity, or the shifting on of problems

Equity, or the division of e.g. quality of life among people, is closely related to sustainability (WCED, 1987). The poor are affected the most by environmental problems, but are the least capable of solving them. On the other hand, prosperity puts people in a position where they can engage in more environmentally damaging activities (consumption, travel and the like). Social inequity, inequity of prosperity, promotes 'unsustainable' behavior (Expert Group on the Urban Environment, 1996). Generally, a distinction is made between *intra*generational equity and *inter*generational equity. According the Brundtland-commission: 'Even the narrow approach of physical sustainability implies care for social equity between generations, a care that should logically be extended to equity to within every generation' (WCED, 1987).

In many studies a preference for local solutions is justified only by referring to this notion of equity, interpreted as the need to prevent 'shifting problems on'. One can ask why. The principle of prevention of shifting problems on to others or elsewhere follows from the notion of equity. It is not equitable to solve one's own problems at the expense of others. Compensation of the 'problem receiver' is possible, however. Not shifting problems on does not mean that problems should be solved locally. Problems can be transported and solved elsewhere when in this new time or place it is possible to solve the problem more efficiently; an integrated consideration of solutions is necessary in this case.

A condition is however, that the problem is really solved and is not solved at the expense of the 'spare resources' of the problem recipient. From this point-of-view the use of planting forest in developing countries to compensate CO_2-exhaust in e.g. Western Europe is undesirable. The developing countries need their 'spare resources' like space themselves, considering their development deficit (and the related 'environmental pressure deficit'). Shifting problems on to other places is not equitable for the part of the generation the problem is shifted onto (from an *intragenerational* equity point-of-view). Shifting problems on

in time is not equitable for the following generation (from an *intergenerational* equity point-of-view).

2.5.3 Exhaustion, depletion and pollution

The pursuit of an equitable distribution between present and future generations does not imply that finite resources should be preserved (like fossil groundwater that is not replenished naturally). This is suggested in several places because when the present generation would finish finite resources, the ability of future generations to fulfill their needs is reduced. However, this would imply that finite resources would have to be preserved as long as there are future generations (see also Water Resources Planning and Management Division, 1998). Equitable distribution between generations implies that finite resources should be used in such a way that these are not depleted before viable alternatives are available. To prevent exhaustion of renewable resources – like water – the rate of use should be smaller than the rate of renewal (see definition 3, Water 21). This is in keeping with the thought of stock management.

The notion of stock management means that pollution in the broadest sense of the word should be prevented. Because of pollution (or the loss of quality) stocks can be rendered unusable or can only be used against very high cost. This is valid for non-renewable resources like fossil fuel and groundwater as well as for resources of which the global supply can be considered to be more or less constant, like water and space.

2.5.4 System degradation

Fundamental ecological processes and structures or ecological, environmental and hydrological integrity should be maintained (see definitions 3, Water 21 and 4, Loucks). Not just the stocks of the various resources should be maintained, the integrity and relations between these resources and (renewing) processes, the *system quality*, has to be maintained. A loss of system quality can disrupt the natural attenuation capacity of the hydrological cycle, now and in the future.

For the description of system quality the concept of 'capital' is used, like in the Water 21-definition (3). This capital is a measure for the total present value or quality. In such a 'capitalistic' approach to sustainable development, the total capital is maintained on a constant or increasing level. The decrease of capital is an indicator for unsustainability. Generally, three categories of capital are distinguished: natural, social and economic capital (see e.g. Rotmans et al. 1999). This classification goes back to the theory of Karl Marx (1885), who distinguishes 'Warenkapital', 'productiven Kapital', and 'Geldkapital', respectively. Valentin and Spangenberg (1999) add institutional capital, the capital represented by the value of government and the 'constitutional state'. A society sliding towards anarchy is not sustainable from this point-of-view. Societal capital is a usable concept too, that differs from social capital because it more specifically represents value for society and not related to individuals. Societal capital overlaps Valentin and Spangenberg's institutional capital

There are roughly two points-of-view on dealing with the capital-concept that differ with respect to compensation of loss of capital. In a point of view where compensation of capital loss is possible, an amount of natural capital can be sacrificed in order to gain social or economic capital. This view is called the compensation principle.

For example, with the realization of IJburg (an expansion of Amsterdam, 18,000 homes, situated on an artificial island in Lake Ijmeer, see figure 2.1) natural capital is lost. In the present situation the area is a valuable feeding grounds for migratory birds. But the newly built urban area will represent certain social and economic value. When the compensation principle is applied the future situation with IJburg is not necessarily less sustainable than the one without. Without the compensation principle the new city will have

to make an enormous effort to represent the same natural capital; ecologically speaking IJburg, including it's tens of thousands of inhabitants, should be absent or negligible. It's clear that this is practically impossible.

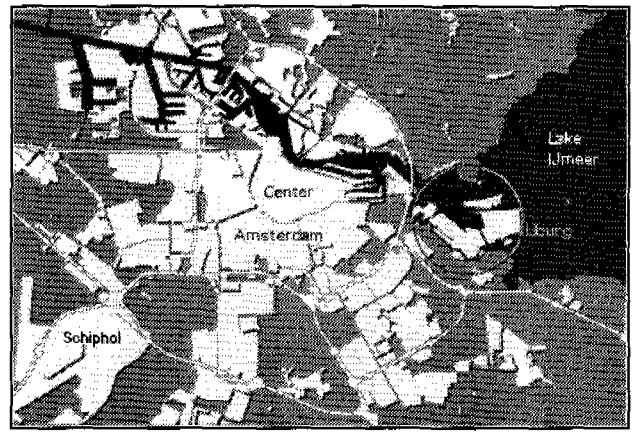


Figure 2.1 IJburg, an expansion of Amsterdam (18,000 homes) in Lake IJmeer, to be built between 2001 and 2010

According to the Water 21-definition the compensation principle is not applicable, as it states that the natural capital should be maintained. Another is provided by Lorenz (1999), who focuses on the preservation of "natural capital", when drawing up indicators for sustainable river management. Indicators for social and economic capital are outside the scope of her research, but nonetheless are considered to be of great importance. Even when the compensation principle is not valid, development of humankind is possible under the assumption that 'in the beginning' the available amount of natural capital was larger than minimum. The minimum amount can not be assessed objectively. The current global environmental threats, like acid rain and global warming, support the notion that humanity has since long used more than the available amount of natural capital.

3 Differences in the approach to sustainability

3.1 Introduction

A major factor influencing the acceptability of a solution and, for that matter, of the assessment of its sustainability, is the approach to sustainability used in finding the solution and the assessment of the solution. In literature the elements of sustainable development described in previous paragraph are elaborated in a large number of concepts, principles and guide principles. Most literature sources do not speak of alternative approaches or views and for all approaches it is possible to find literature in which the approach at hand is shown to be the correct one. Generally, the perspective or approach is not explicitly chosen but apparent from the description of sustainability and its elaboration.

At first, for this study is was attempted to find an unequivocal description of sustainable development in urban water management. The usually implicitly used approaches to the elaboration of sustainability differ, however, a complete survey would not be univocal: when making a classification of the approaches or views it is not possible to make *one* meaningful selection, in which *one* generally applicable concrete approach can be recognized. In hindsight, this was to be expected based on the knowledge of complex problems. The observed impossibility to make one generally applicable view on sustainable development leads to the conclusion that the differences between the approaches are meaningful; the different approaches all have their own area of application. The differences described here are of a more philosophical or conceptual nature and are influencing the choice for and the acceptability of an approach and of the resulting plan or design for sustainable development.

The approach followed in literature seems to be regarded by the authors as the only logically correct one. This is typical for a 'basic attitude', a value-laden view or perspective, manifesting itself in ethic considerations (Maters, 2000). Usually such a basic attitude is not taken consciously. The perspective of the parties involved can explain the way sustainable development is elaborated. Or, like cultural philosopher Van Peursen puts it, 'the strategy followed is related to the perspective of the meaning of the separate processes' (1970, p.21).

A system for design and management of sustainable water systems and the assessment of sustainable development in these design or management plans will have to do justice to the differences in the various approaches for it to be generally applicable. Then the question rises: what are the differences between the approaches?

Here, various basic approaches are distinguished, on the basis of analysis of a literature review in the area of sustainable (urban water) management, e.g. in proceedings like Joliffe and Ball (1999), WIMEK (1998), Sieker and Verworn (1996) and research of Tjallingii (1996) and Pearce et al. (1989) and the European Expert Group on the Urban Environment (1996). The reviewed proceedings contain some 750 papers, of which some 1/3 specifically mentions sustainability as an objective.

3.2 Aspects of approaches

In the concepts, principles and guide principles in literature a number of categories or schools can be distinguished for the elaboration in water management. The perception of sustainable development in the various schools is similar to a large extent, but important differences exist. These differences influence the setting of objectives and of 'sustainable levels' and hence influence the assessment of sustainability. This can be the result of a basic attitude of the author to sustainability.

The most important differences in the approaches can be reduced to:
a) differences in perspective of the relationship between people and the environment
b) the attitude with respect to (quantitative) norms and (qualitative) values

These two aspects are recognizable in the differences between the definitions and their key elements in chapter 2. The way sustainable development is elaborated can be explained on the basis of the perspective (or point-of-view) of the people involved on these two aspects.

3.2.1 People and environment

In this context not only humans, but the social and economic system is seen as part of the domain of 'man' or 'people' as well, together with the built parts of our physical living environment, like buildings, roads, drainage and sewerage. The domain of 'people' contains what sometimes is designated as 'cultural' as opposed to 'natural'. The domain of the environment comprises all natural phenomena, like water, soil, flora and fauna, hydrological cycle, etc. In literature this is sometimes referred to as 'natural' or 'the natural system'.

Two contrasting attitudes towards the relationship between these two domains, people and environment, can be distinguished. These two attitudes differ in the perception of 'dominance' of humanity over the environment. Either people or the environment is the driving force behind the approach to sustainability and the choices made in the elaboration of sustainable development: people-driven and environment-driven. The two contrasting views are described below.

Tjallingii (1996, pp. 59-61) makes a comparable division: he mentions four basic attitudes of people towards nature: man as master, steward, partner or participant. In both the humanity as the master or steward attitudes, man is of a higher hierarchic level than nature. In the master view, nature has no intrinsic value, while in the steward view it does. In the partner attitude as well as in the participant attitude, nature has intrinsic value. In a partner attitude humanity is not a part of nature (a 'two-world' view) as opposed to a participant attitude were it is (a 'one-world' view). In a 'one-world' view man is an integral part of nature; Tjallingii refers in the description of this world-view to the philosopher Spinoza. In a 'two-world' view man and nature are seen as different entities; analogous to the view of a separation between mind and body. This world-view can be related to e.g. the philosopher Descartes (see Tjallingii, 1996 and Cornelis, 1998). Cornelis gives an explanation of this dichotomy from knowledge and cultural philosophy (see section 3.3). The tension between humanity and its environment is not something new or modern, but something more profound. Awareness of this tension can already be found in Greek antiquity. For instance, it played a role in Greek tragedies and is symbolized as the struggle between culture and nature, between city and the landscape (Houben, 1999).

People-driven
In a people-driven approach, people and their desires, needs and objectives are the driving forces behind the perception of sustainable development. People and their desires, needs and objectives are leading and dominate the intercourse with the environment.

The possibilities and features of the environment have no intrinsic value; any value of the environment is derived from is use in service of human objectives, which can be either rational or emotional. Although the environment is limiting in ways, the environment can be adapted to suit the objectives of society. However, there is an awareness that in a people-driven approach it too is not possible to adapt the environment to human needs without limit: "It is with appropriate modesty that we intervene in an environment, aware of the fact that we are mere guests in the age-long history of the area" (adapted from Francine Houben, 1999).

Environment-driven

The environment (or nature), with its possibilities and limitations, is the driving force behind the perception of sustainability and the elaboration of sustainable development. The possibilities and features of the environment (i.e. of nature) have an intrinsic value that can not be ignored. Human objectives and conduct are adapted to the properties of the environment, not the other way around. The boundaries and possibilities of the environment dominate human conduct.

The approach in 'Limits to growth' (Meadows et al., 1972) and the approach of Witteveen+Bos (1994) fits in this approach. They assume a certain carrying capacity of the environment, according to Commoner (treated in §2.4), and subsequently distinguish factors of *un*sustainability; the total unsustainability must not exceed a certain limit set as a condition for sustainability. An approach like the one followed in the Ecopolis-strategy and the Ecological Conditions-approach (Tjallingii, 1995 and 1996) can be called strongly environment-driven as well.

Intermezzo – Inhabitants of deltas

The Warao-indians in the Orinoco-delta live in an area that shares similarities with what the Netherlands must have looked like over 1.000 years ago. The Warao have lived in the delta for thousands of years and have had no apparent influence on the area. In the direct vicinity of their huts they grow crops on a small scale that can be found in the wild as well. They live in huts built out of palm tree trunks and leafs and move away when the hut does not live up to their standards anymore because of rotting. The rainforest rapidly overgrows the remnants of the old hut, and soon making signs of human inhabitation invisible. The average life-expectancy at birth is around 40 years. The Warao have adapted their way of life to the possibilities of their environment to a large extent.

A school, one of the larger buildings in the Orinoco delta (Venezuela)

Newly built houses in Almere, in a polder the Netherlands. The water level of the former sea was around the level of the upstairs windows

The difference in dealing with the environment has led to the fact that the Dutch have changed their living environment drastically. The polders in the west of the Netherlands are in no way resembling the forest and lowland peat swamp it once must have been. None of the present crops grew in the forest or swamp in their present form. The drainage of the area has changed very much. Technically, everything is possible; ponds are created on top of sandy hills, water levels are controlled to the centimeter, and former swamps are drained to the extent where in summer irrigation is necessary to prevent excessive drought damage. The average life expectancy at birth is almost double that of the Warao. The Dutch have adapted their environment to their way of life to a large extent.

3.2.2 Norms and values

Besides the attitude of people towards their environment, the way in which people evaluate this relationship or interaction is important to the approach to sustainable development. Again, two contrasting approaches can be distinguished; (1) a quantitative approach based on norms and (2) a qualitative approach based on values.

Norms-oriented
It is assumed that these norms can be deduced either from properties of the environment or from the objectives for the water system (depending on whether a 'people' or an 'environment' driven approach is followed). For example, for the purpose of the objective and scientific deduction of quantitative norms or standards, Van de Worp and Don (1996) have determined sustainability criteria for the urban water system. Lorenz (1999), Balkema et al. (1998), and Mels et al. (1998) describe normative criteria for sustainable wastewater collection and treatment. They do not use words like stakeholders or objectives. In their environment-driven approach this is not necessary; the boundary conditions set by the environment dominate human conduct and objectives of society have to be adapted to meet these boundary conditions. Van Rooij (1997), following a normative and people-driven approach, poses that society should choose only *measurable* objectives or targets. Van Rooij (1997, p.200) explains in the context of his theory an explanation of his core concepts:

"Targets	image that can be derived from the whole of the targetvalues.
Objectives	the whole or aggregate of target values.
Targetvariable	state variable for which a targetvalues is set.
Targetvalue	(numerical) value of a targetvariable pursued for the end of the future planning period. Points of interest (*i.e. problems–MR*) can be determined on the basis of a targetvalue."

In Van Rooij's view a targetvalue is a project or area specific standard and the change in the numeric value of a targetvariable is a measure for effectiveness of concrete measures. The norm converges with the value or is viewed as an absolute value. A change in the numerical value of a targetvariable is a measure for (among others) the effectiveness of measures. In the case a measure has a result much better than the target level, the measure is 'overdoing it'. This is valued negatively. In a normative approach solutions are optimized or the optimum solution is selected.

Lorenz (1999) follows a comparable approach. In her thesis she derived indicators for sustainable river management. She stases that policy makers should determine the targetvalues for the different proposed indicators; in her view, these are not objectively determined to the state of the environment. She doesn't go into how the policy makers should go about their task. A property of dealing with complex problems is that the result of a process can not be seen as separate from the process itself (and §5.1 will go into complex decision-making processes in greater detail). Because of the separation of deriving indicators and setting targetvalues, the approach followed by Lorenz has the risk of a mismatch between knowledge and process. Such a mismatch is the situation where science provides the answer to a question that in the process is not on the agenda in that form: question and answer do not match (see De Bruin and Ten Heuvelhof, 1999b). In the case of a mismatch the supplied knowledge, in the shape of indicators, is not authoritative and therefore does not have the intended influence on policy making.

Values-oriented
On the other hand, critics of the norms approach state that these norms are not 'value free' as they pretend to be, and hence should not be used without relating directly to the appropriate higher value (De Groot, 1992 pp. 147-156; Cornelis, 1998 p. 501). In this approach numbers are only useful in operationalizing a plan or design; norms are always an

expression of a desired view of reality and therefore subject to discussion. People following a norms-oriented sometimes find this pragmatism weak, inconsistent and 'easy'.

As opposed to the norms-approach, the values-approach does not exclude objectives and criteria that are very hard to measure or can not be measured at all. Vermeulen et al. (1997, p. 12) pose that in the evaluation of complex phenomena (like sustainable development) objective scientific knowledge can not be used exclusively, because uncertainties can not be eliminated when dealing with complex phenomena. When dealing with these uncertainties, conflicts of interest (subjective by definition) partly determine the outcome.

The point-of-view held by Pötz and Bleuzé (1998, p.8) illustrates a values approach: "... that the road via realization of tangible qualities is more successful than that of regulation with do's and don'ts." Another expression typical for the values-approach is that "good is the enemy of better". In a values approach values (that can never be too high) are maximized. A preference for creation of *positive conditions* for desired developments is characteristic for a values approach (e.g. see Geldof, 1999; Gilmore et al., 1999; Ludwig et al., 1997 and Tjallingii, 1996).

3.3 Differences and similarities with comparable classification

In this section some classifications are described, that can be related to the classification on two aspects presented in the previous sections. Notwithstanding a number of differences, the classifications below are not conflicting with the classification presented here. The differences with the approaches below can be explained from the differences in the purposed or objective with which the classification was developed. In theory as well as in practice many classifications are in use that are developed with a different purpose than the one in this publication. In literature no conflicting classifications were found.

3.3.1 Arnold Cornelis – Logic of feeling

In culture and knowledge philosophy many theories can be found on the attitude of an culture towards nature. For instance, ontological and epistemological worldviews are distinguished (see e.g. Van Peursen, 1970). Of special interest to the study at hand is philosophy of the Dutch philosopher Arnold Cornelis (for the description below Cornelis, 1998 was used). Cornelis too observed the distinction described in this publication between people and the environment and between norms and values.

Cornelis describes the existence of three stability layers in culture. A given culture can remain is a stability layer for a long time (hence the name), after which it can move into the following layer in a relatively short time. The transition between stability layers will take place in a crisis.

The first stability layer is the layer of the 'natural system'. So-called primitive people live in such a stability layer. In most cases, the world-view is mythical and culture finds a sense of security in the natural system (as a child with its mother) that controls daily life. European culture was in this stability layer up to the end of the middle ages.

The second stability layer is the one of the 'social rule system'. After the Middle Ages European culture moved into this stability layer. Renaissance, reformation, revolutions and the Enlightenment mark this crisis. In the stability layer of the social rule system culture finds a sense of security in society, and a philosophy of equality and justice is dominant. The individual is a part of the social rule system that dominates life through rules and norms that are valid for everyone. Socialism and communism are examples, but so are the highly religious Amish in North America and reformed Protestant community in the Netherlands.

The third stability layer is the one of 'communicative self-control' (Cornelis calls this layer *communicatieve zelfsturing* in Dutch). Norms and rules are no longer dictated from society. In the process of reaching maturity everybody constructs their own system of norms and values, where the individual can control or steer himself in communication with and

under consideration of the people around him: communicative self-control. In this process, the individual uses norms as an instrument of the related value. These norms can be adapted to any situation, while maintaining the central values. Phenomena from the 20th century that mark the transition from the second to the third stability layer in western culture are the sexual revolution, the protest generation, the fall of communism in the USSR (a typical social rule system). The former USSR is not through it's crisis. Also the deterioration of so-called norms and values in society are related. The communicative self-controlling society does not have generally applicable rules and, as a whole, no need for a religion as an institute setting norms (although individuals can have this need). People control themselves, on the basis of their own, internal values. In this stability layer a philosophy of quality and values is dominant.

As an individual every person experiences the three stability layers in their own development, as a child, teenager/adolescent and adult, respectively.

The contrast described in this and the previous chapter between a people-driven and an environment-driven approach is similar to Cornelis' distinction between the first and the second stability layer. Cornelis associates an approach where nature dominates with the stability layer of the natural system and an approach where man dominates with the following layers.

Not only does Cornelis observe the distinction in the attitude towards nature, he also observes a distinction in the attitude towards norms and values. He states that in an norms-oriented approach (to use the terms of this text) norms and values converge. In this case, the norms used are the only just and objective representation of the related value. Such a norms-oriented attitude is a part of the social rule system, in Cornelis' view, and to a degree of the natural system. Such a norm in is universally valid in the stability layer of the social rule system.

Cornelis observes these distinctions. Further, he observes that a certain approach dominates in a certain culture and in his philosophy associates these with a stability layer. The attitude of an individual can not directly be compared to that of a culture. A person following an environment-driven approach is not immediately medieval or primitive.

In Cornelis' communicative self-control norms and values do not converge. Values are 'of universal value', norms are instrumental to these values. This is similar to what is called a values-oriented approach. According to Cornelis, values do not have a history of change like norms, but a history of growing cultural awareness. When pursuing sustainable development, this could mean a preference for values. According to Cornelis, values are constant in time, while a norms-oriented approach would be like 'shooting at a moving target'

A remark that has to be made here is that Cornelis philosophy suggests that a norms-oriented and environment-driven approach is out dated, while a value oriented and people-driven approach would be of the future. This implicit judgement as to the value of the various approaches is not justified, however. The objective of the distinction of the approaches is to structure and enhance the discussion in environmental or water management. The objective is to provide all approaches a full and proper place in the development and assessment of plans for sustainable water management. Considering the fact that the described interpretation of sustainability does not use (universally valid) norms to be set beforehand, but of norms to be developed process by the stakeholders in every planning or design, the conclusion is justified that this interpretation can be classified in the stability layer of communicative self-control.

3.3.2 Hoekstra - Perspectives on Water

In 1998 Arjen Hoekstra published his thesis (Hoekstra, 1998). Based on cultural theory he describes how people deal with uncertainty. The uncertainties Hoekstra is treating are similar to the uncertainties regarding how the different aspects of sustainable development can be weighed and evaluated. He distinguishes two aspects: *world-view* and *management style.*

Here, he uses concepts from cultural theory, *group* and *grid*. *Grid* is a measure for social distinction, the stronger the grid, the stronger the hierarchy on a society. *Group* is a measure for individualism, the weaker the group, the stronger the individualism. He derives four attitudes largely based on the cultural theory of Thompson:

- the hierarchist, strong *grid*, strong *group*, (like in a caste system)
- the egalitarian, weak *grid*, strong *group*,
- the individualist, weak *grid*, weak *group*
- the fatalist, strong *grid*, weak *group*

To the hierarchist and the individualist he assigns a people-driven approach (to speak in the terms of this text). To the hierarchist he assigns more or less normative characteristics and a belief in a society that is 'makable' to a certain degree, equal to Cornelis' social rule system. Problems of scarcity of (e.g.) natural resources the hierarchist will try to solve by trying to change the supply, in an environment that is tolerant to human intervention. The individualist follows an approach oriented more strongly on values. He does not recognize universal norms, norms constitute an instrument that can be adapted to individual situations.

To the egalitarian and the fatalist Hoekstra assigns an environment-driven approach. For these two, the distinction between norms and values is absent i.e. not meaningful. The egalitarian regards the environment as fragile and vulnerable, the fatalist does not. The fatalist takes things as they come. Events will pass as they pass, the fatalist has too insignificant an influence on the mechanisms of his world to control them. An egalitarian tries to solve problems of scarcity of natural resources by adapting human conduct to the possibilities of the environment. The fatalist tries to cope the best he can. He will not try to change the supply of the resource, nor will he try to change his behavior ("both attempts are meaningless anyway, everything depends on external factors").

As a final remark it should be said that this classification knows a hermit too. The hermit places himself outside of society and thus, according to Hoekstra, outside the process of sustainable development. Hoekstra leaves the hermit out of his reflections on this process.

3.3.3 Duijvestein - the socio-design-eco triangle

In his thesis Sybrand Tjallingii (1996) distinguished three qualities of sustainable building. His structure in the flows-actors-areas triangle is aimed at the subject of sustainable building, not to distinguish separate approaches. In 1997 Kees Duijvestein was requested to present an overview or summary of a symposium. Kees Duijvestein used Tjallingii's representation of sustainable building for a classification of approaches of sustainable building:

- flows - environmental quality - eco
- areas - spatial quality - design
- actors - social quality - process or socio

For the classification of the people who presented a paper at the symposium he used a methodology that is used to classify sand: the sand triangle, which has percentages of sand, silt, and clay along the three side of the triangle. Duijvestein's triangle is shown in figure 3.1. Duijvestein translates Tjallingii's three qualities to three points-of-view that can be used to classify an approach (this compares to four 'points-of-view' in this publication). He does not use a distinction between a norms-approach and a values-approach. In the contrast between flows and actors, environmental quality and social quality, and eco – socio the aspect of people-driven versus environment-driven can be recognized. Duijvestein's approach is similar, not conflicting.

Duijvestein further distinguishes a design approach, where spatial quality is leading. To such an approach no explicit attention is awarded in the classification presented in this publication. In the research of approaches of sustainable development in water management spatial quality did not appear as a distinguishing characteristic and as a consequence it is

not included in the classification. This does not mean however that spatial quality is of no importance. On the contrary, spatial quality and relations are of importance in any approach, and as such in any approach attention should be given to the subject.

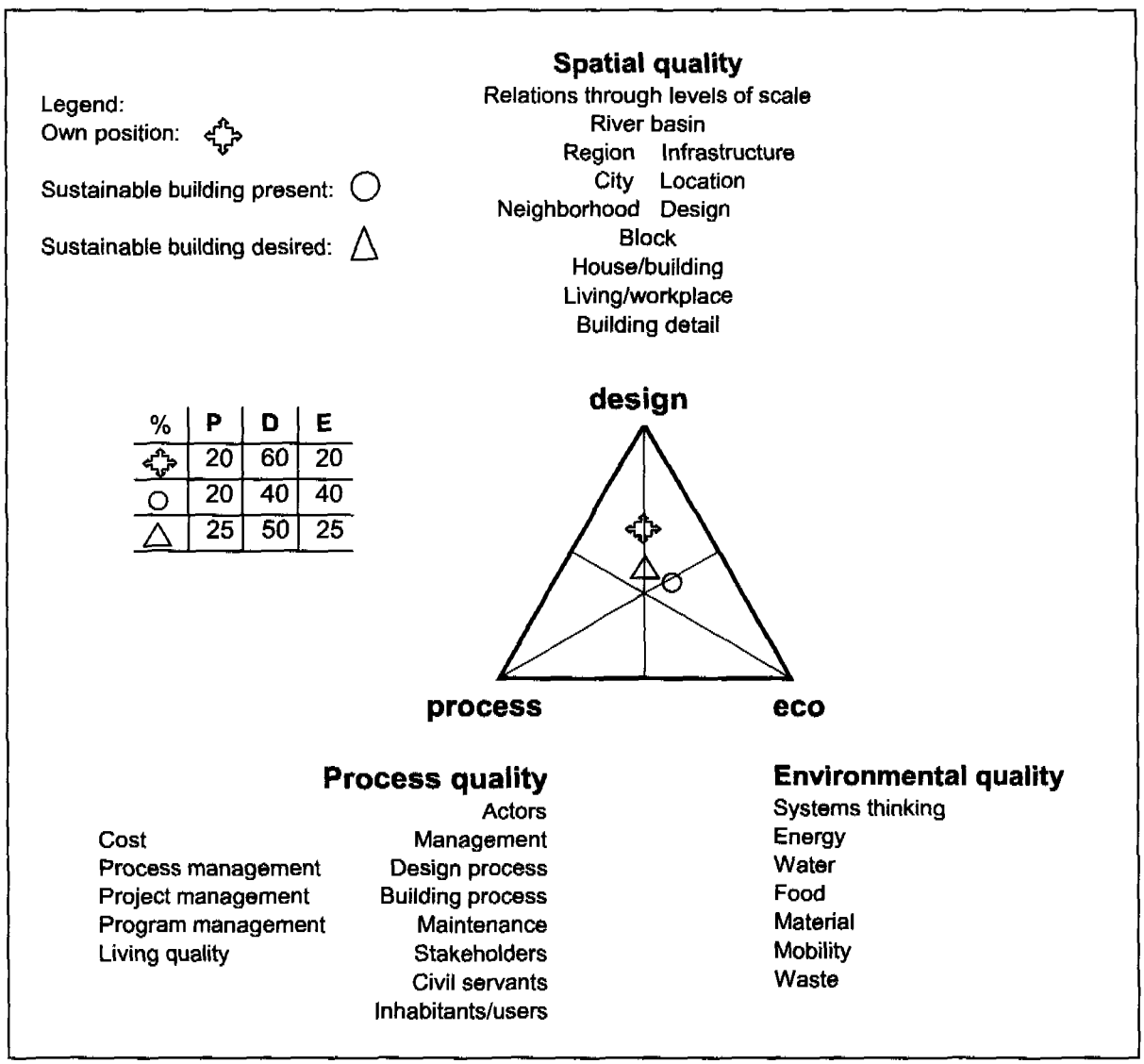


Figure 3.1 The triangle of Duijvestein, filled out as an example (translated from Duijvestein and Kok, 1999)

4 Four approaches to sustainable development

4.1 Two aspects

How can the two components 'people and environment' and 'norms and values' be linked to each other? Starting point of the distinction of the approaches was that the differences between the approaches are valuable; every approach has its value and area of application and it's contribution to the process of sustainable development. Further, the view is taken that the choice of approach has to be made separately for every project and that the choice depends on the problems at hand and the perspective of sustainability, held by the parties involved. This point-of-view can also be found in the concept of the perspectives for action used by the Dutch Scientific Council for Government Policy (WRR). The WRR takes the view that for different situations different perspectives of action provide the most adequate solution (Vermeulen et al., 1997, p. 12). The process leading to the choice of approach (typically one of negotiations) is treated in chapter 5.

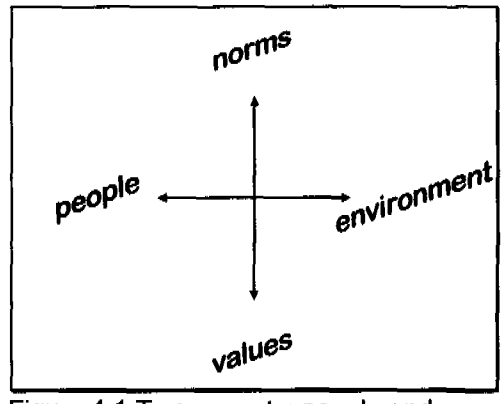


Figure 4.1 Two aspects: people and environment, norms and values

When the two aspects are represented as the axis in a graph (see figure 4.1) the result is a division in four quadrants. The choice for this visualization is based on the preposition that it is not preferable to only distinguish a discrete number of approaches, but that in practice many gradations exists. In every quadrant in figure 4.1 another basic approach is central, formed by one of four combinations of the two aspects. Given the combination of the aspects, the following names have been chosen for the four basic approaches:

1. norms-oriented & environment-driven: carrying capacity approach
2. norms-oriented & people-driven: ratio approach
3. values-oriented & people-driven: socio approach
4. values-oriented & environment-driven: eco approach

The four basic approaches are shown in Figure 4.2. The basic approaches will be characterized in the following sections. The approaches described are extremes. In practice such 'pure' approaches will not be found: The approaches in practice contain characteristics of more than one basic approach.

At the end of this chapter term are added to the chart, clarifying the basic approaches.

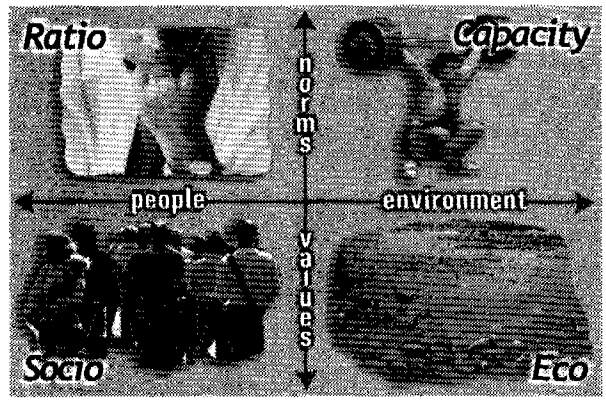


Figure 4.2 Four basic approaches of sustainable development, related to an orientation on the aspects people, environment, norms, and values

4.1.1 Carrying capacity approach

The (carrying) capacity approach is a normative approach focusing on the carrying capacity of the environment. Key element maintaining the components of the system plays an important role in this approach. An example of the carrying capacity approach is the factor 20 approach, derived from Commoner's theory.

The carrying capacity is the amount of environmental pressure (an aspect of) the environment can take before it collapses. This approach assumes two possible situations: a sustainable situation and a situation with a gradual (usually irreversible) decay or deterioration of the environment. The Life Cycle Analysis method (LCA) is typical for the carrying capacity approach that in practice is predominantly aimed at the reduction of emissions and the use of resources, including energy.

Dutch national environmental policy (as described in the National Environment Plan 3, Ministry of Housing, Spatial Planning and Environment, 1998) is based on this carrying capacity centric view; it provides e.g. a system of norms for soil quality, presupposing that when the soil meets these norms a sustainable situation is reached. The targetvalues for the concentrations of pollutants are related to the concentration of the toxic material where no or negligible effect is measurable, for instance on microorganisms.

Several researchers try to establish to 'sustainable levels of environmental pressure', like the maximum permissible amount of chemical or biochemical oxygen demand in the effluent of treatment plants. From literature research it turns out that it is very hard or practically impossible to find unequivocal values or standards for sustainability criteria; in many cases only testing variables or indicators are provided (see e.g. Lorenz, 1999; Van de Worp and Don, 1996; and WIMEK, 1998). It is easy to find many hundreds of these indicators, all with slightly different classifications and views.

4.1.2 Ratio approach

In the ratio approach choices are made based on an evaluation of the present situation and considering the objectives, which are set in an evaluation of all interests involved. Solutions to problems (technical or otherwise) are weighed on the basis of a certain number of indicators that usually are directly related to the aims and using an objective method. In this ratiocentric view this makes it possible to find an optimum solution. In this classification, ratio is not equal to rational, however, as all four basic approaches can be viewed rationally.

Multi criteria evaluation methods like the PRIMAVERA-method (Van Rooij, 1997) are an example of a ratiocentric approach. This method weighs solutions or measures on environmental, economic and social aspects with the aid of a mathematical formula, in order to find the (supposed) optimum solution. Problems are defined as the difference between the present situation and the objectives, in sharp contrast to environment-driven approaches. These problems are sometimes euphemistically referred to as points of interest. Environment-driven approaches, like the carrying capacity approach, state that the seriousness and extent of environmental problems should be established objectively from nature. In many cases people following the ratio approach are of the opinion that sustainable development is not concrete enough to be of any practical value; it is hard to establish concrete standards. In this approach maximum effectiveness can be described as the target variables coming as close as possible to the target values.

4.1.3 Socio approach

The socio or sociocentric approach is a qualitative approach. In this approach a central role is played by the interests and opinions of stakeholders, like the residents of a community, fishing clubs and the waterboard. This means that priorities are set in a interactive process. A plan's maximum effectiveness can be described as when '...stakeholders are mobilized and make their full contribution to the objectives. The various public and private stakeholders

have to feel involved with the pursued processes' (Geldof, 1994, p. 84). The socio approach is a qualitative approach; in contrast to e.g. the normative ratiocentric approach where a maximum effectiveness can be defined as approaching an objective as closely as possible.

The socio approach is centered on the value for humanity or society. A good example can be found in Nijhoff and Leenders (1998), called the 'Manifesto of the Watercircle', that describes the various values of water as the total of esthetical value (or value for experience), functional value (or value for use) and future value. It will need no explanation that the value for experience and for use is humanity-related. Future value is defined as the value water represents for future generations, and as such is human related too. In the socio approach a central role is played by the interests and opinions of stakeholders, like the residents of a community, fishing clubs and the waterboard. This means that priorities are set in an interactive process. In a design or plan according to the socio approach values are pursued, standards are usually absent. An important feature is that objectives are not met by trying to meet stringent standards, but by creating positive conditions for desired development. This is typical for a 'values' approach.

Using a socio approach does not mean that the acceptance by society of a solution determines the sustainability of the solution.

4.1.4 Eco approach

In the eco approach 'sustainable' is often viewed as equal to 'ecological'. In this ecocentric view, nature is sustainable by definition and a situation that approaches the natural situation as closely as possible is most likely to be sustainable. Environment has intrinsic value; natural properties of water systems are valued highly, and the importance of artificial features is to be reduced as much as possible.

The view that use and management of a water system should be adapted as much as possible to the local, natural circumstances, is in sharp contrast to the approach in which the environment can be adapted to the intended use, no matter how far removed this is for the original water system. The latter approach is in use and has been for a long time. This is equal to the difference described by Hoekstra between the hierarchist and the individualist on one hand and the egalitarian and the fatalist on the other.
For example the Ecological Conditions-approach (Tjallingii, 1996) mentioned earlier is ecocentric. An important feature is that objectives are not met by trying to meet stringent norms, but by creating positive conditions for desired development, like the socio approach. The character of the 'eco' conditions will be different to the 'socio' conditions, however.

The 'Ecological Conditions'-strategy provides room for human influence on the environment. This fits a worldview in which humanity is an integral part of the environment.

4.2 Disciplined approaches?

A preference for one of the four approaches can be related to disciplines or academic fields, involved in water management. A ratio approach is characteristic for civil engineering or urban drainage; a socio approach can be related to architecture; an eco approach to ecology, and a carry capacity approach to environmental sciences. By imagining the archetypical stances of the disciplines the distinction between the approaches can be illustrated.

This distinction can carry a stigma, however. The combinations apply to the architypical images of the disciplines only (or even only on the caricatures) and do no justice to the versatility and personality of the individuals involved and the ability to adapt oneself to a given situation. Stigmas polarize the discussion and will work counter-productive. This can not be intended when pursuing an integrated, mutual policy of sustainable development.

4.3 Approaches and terms from literature

The four basic approaches to sustainable development are characterized in Figure 4.3 by words used in papers that can be classified in one of the approaches. On classification, it turns out that every approach to some extent has its own word-use. These terms originate from publications in the area of sustainable (urban) water management, e.g. in proceedings like Joliffe and Ball (1999), WIMEK, (1998), and Sieker and Verworn (1996). The reviewed publications contain some 750 papers, of which some 1/3 specifically mentions sustainability as an objective.

It is striking that in the description of many supposedly sustainable projects, aspects of sustainability are only mentioned in the title and/or introduction, but not elsewhere.

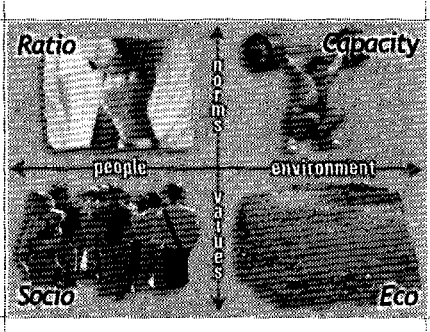
exploit optimize social capital multi criteria analysis	technology deterministic, reductionistic risk/sensitivity analysis frequency, concentration quantitative dogmatic	Life Cycle Analysis environmental science 'ecologically sustainable' natural capital environmental technology
politics interests conflicts planning process stakeholders choices subjective		best practical means objective (ir)reversible resilience best technical means precautionary principle
functional value esthetic value future value	pragmatic qualitative 'courage' complex, holistic ethics	natural value guide principles 'no regret' policy

Figure 4.3 Terms associated to the various aspects and approaches

5 Sustainable development as a process

5.1 Sustainable development: a complex problem

The challenge of sustainable development is a complex problem. The natural, social and economic processes involved are not only highly complex from a conceptual or scientific point of view, they are also complex from a planning or decision-making point-of-view. According to De Bruin et al. (1998) a process approach is necessary for planning and decision making around complex problems (that they also call unstructured issues or wicked problems). Similarly, Vermeulen et al. (1997, p. 12) pose that in the evaluation of complex phenomena (like sustainable development) objective scientific knowledge can not be used solely, because uncertainties can not be eliminated when dealing with complex phenomena. Both sources agree that an interactive planning process involving all stakeholders is necessary. But is sustainable development a complex problem in the sense of De Bruin et al., with all its consequences for planning and decision making?

Characteristics of unstructured issues

What makes sustainable water management a complex problem? Complex problems or unstructured issues have a number of characteristics (based on De Bruin et al., 1998). A very important characteristic is that multiple solutions exist to a complex problem. The different solutions 'score' differently for various aspects, which typically are very hard to compare, like biodiversity, air pollution and resource use. How do we evaluate a trade-off between these aspects? How much biodiversity is equal to a certain discharge ammonium?

Further characteristics include that the problem and its solution influence a large number of stakeholders, like people, companies, ngo's and government agencies. Each stakeholder has specific objectives and interests and hence will evaluate a given solution according to these objectives and interests. And the stakeholders and their interests are dynamic; they change over time. For example, the present views of stakeholders are different from their views on the environment 20 years ago and will most probably continue to change. As a result their interest in a specific solution to the sustainability problem has changed and will continue to change. Another characteristic is that no common understanding exists on the procedure to reach a solution of the problem and perhaps of greater relevance to the subject at hand, no common understanding exists on the assessment of solution of the problem.

Sustainable water management has all of the above characteristics. These characteristics lead to the conclusion that in a specific case no commonly acceptable solution can be determined by knowledge, science and experts alone and that a process management approach is necessary. The necessity of a process management approach has a number of consequences for how sustainability should be dealt with and especially with its assessment in design and management planning for water resources: an evaluation based on centrally established norms is not possible.

5.2 A process is not a project

Complex problems ask for a process approach; not-complex (simplex) problems, or structured issues, can be resolved with a project approach. This can be clarified by describing the difference between a project and a process. The description below is largely based on De Bruin et al. (1998) and De Bruin and Ten Heuvelhof (1999a).

Table 5.1 comparison between project and process (after De Bruin et al., 1998)

Project	Process
Contents fixed (concerned with execution or realization)	Contents are not fixed Issues
No blockages for realization; "everything under control"	Many actors have interests; they have production power and/or obstruction power
As a consequence: Specified solution Fixed deadline	*As a consequence:* Learning processes Connections between issues Package deals Rubber deadlines Accelerations and stagnation

Content follows process
The essence of a process approach is that the content of a solution follows from the process; the content of the result can not be fixed up front. Demands to sustainable development can not only described based on the final content, but can described on the basis of rules for the planning process, the road to the final results (rules for conduct, opting out, agendas, etc.). Subsequently, the decision-making process consists of managing the process according to these rules, agreed upon up front. From the game that is played according to these rules the content of sustainable water management will follow.

Not everything under control
In a process the organization taking the initiative does not have everything under control. There are other actors who have power over the process and the realization of the results of the planning or decision-making process. The process organization is not hierarchical, but can be represented by a network of more or less equivalent parties, all autonomous to a certain degree. In urban water management one can think of the Municipality, Water Board, Water Company, and Provincial government.

No specified solutions
It has been mentioned before, knowledge and experts do not determine the result of a planning or decision-making process. Various actors provide input to the process leading to a decision and so the result of the negotiations can not be determined beforehand. To the assessment of sustainable development this is a very important observation. This observation means that in no case it is possible to prescribe a form of sustainable water management. And when this is not possible, it not possible either to draw up a system of norms, standards, and demands for the intended sustainable development. What is possible to prescribe is the agenda for the negotiations, containing a minimum list of subjects and issues to consider – i.e. a system of criteria for the decision-making process.

Rubber deadlines
In the translation of a design to the realization of a building project, every activity and the effort it takes can be foreseen reasonably well. It is not a process, but a project where the result can be determined up front and concerning the execution.
But in a process, because no solutions can be specified up front, it is not possible to predict the course of the process. For every actor by themselves it is not possible to properly estimate how much effort it will take to reach an agreement that is necessary to start with the next step. As a consequence 'rubber deadlines' are needed. Sometimes a step or stage needs a little more time before it can be finalized in a way that is acceptable to all participants. Strictly enforcing a deadline set before has the risk that one of the participants in the process will opt out of the process.

Haphazard progress of the process
The process does not progress at a constant rate. It is characterized by periods of stagnation and acceleration. Stagnation when participants are in a deadlock about a choice or a (sub) decision. And accelerations when a sub-decision is made opening the way to a great number of subsequent steps (a breakthrough).

Geldof (1999 and 1994) also observed this haphazard course of decision-making processes, which he explains using chaos-theory.

Negotiated nonsense
An important pitfall of so-called interactive planning and a process management approach is '*negotiated nonsense*': people (in theory) can agree that 1+1=3 and regard this equation as true in the remainder of the process. A process approach can give the impression that everything is negotiable, even fact. This of course is an undesirable situation. But everyone knows the phenomenon that opinions in the course of the process start 'to lead their own lifes'. An educated guess of an expert can be accepted by the participants as true and in a later stage be awarded the status of a fact, which it is not. The participants in that case have forgotten that the 'fact' is based on an estimate, and treat it as a hard fact, not as the 'soft' estimate it is. The result of the complex decision-making process, of which negotiations inherently are a part, must be able to stand the test of science or knowledge: negotiated knowledge. In paragraph 6.1 more attention will go to negotiated nonsense.

5.3 Acceptance, consensus and sustainable development

Acceptance, not consensus
An important factor in the acceptance of the proposed sustainable development (and in that sense the assessment of sustainability) is the view on sustainable development. The trade-offs between different aspects and various interests are unavoidably based on a system of norms and values according to the approach of those who made the trade-offs. Chances are that the proposed solution to the problem of sustainability is accepted by a certain group of stakeholders, but that it is not acceptable to stakeholders whose different interests and system of norms and values would have lead to different trade-offs.

These stakeholders would assess the 'sustainable' solution differently, because they would weigh separate and related issues differently. Whether a solution is *acceptable* to a given stakeholder in itself seems of no direct relevance to the question whether something is sustainable or not. It is relevant however when this stakeholder has influence on the realization or success of the solution. Some stakeholders can actively block or hinder realization or withhold their co-operation. Some stakeholders can sabotage or undermine the success of a solution once it is in place; for this reason the solution will not be sustainable. An example: separated collection of solid waste or the domestic use of reclaimed effluents needs the co-operation of the people living in the city. Building 'sustainable' systems that remain unused can only impact the environment negatively.

Acceptance as a result of negotiations
In the case that an approach to sustainable development is not accepted by all stakeholders, there is a risk that opposition the plan is mobilized. The specific stakeholder can use its influence to prevent or sabotage the realization of the sustainable solution. Also the 'potential creativity' should be used as much as possible. The process should not pursue a compromise on all aspects, but should use the characteristic qualities of the different approaches fully. To do this it is not necessary to reach consensus on every aspect. Acceptance of the participants to the process of the element foreign to their own approach is sufficient. The negotiations during the process provide possibilities for exchanges ("I will

accept this form you, when you will accept that from me") and package deals ("you can only have this from me, when you take that as well").

5.4 An approaches maximization method

After having observed that sustainability is subjective to a certain degree and after having classified the differences in the approaches found in practice, the question rises how the necessary process can be designed. A form of process is needed where all four approaches can be represented in the resulting design or management plan in a balanced manner. The process to be followed should live up to the criteria concerning transparency and bias towards one of the approaches (Rijsberman and Van de Ven, 1999). In this section, a process-format is proposed. This is by no means the only way to design the process, just an example.

For the process of urban planning (or the design of urban areas) BOOM consultants have developed the environment maximization method (Van den Berge et al., 1998). The environmental maximization method (EMM) systematically includes measures to benefit the environment in the process. The method is developed for the design of new urban areas. The core of the method is a maximization of environmental themes in alternative designs, for instance a design maximized for water, for traffic, or for energy.

For each of the environmental themes chosen an urban design is sketched, where the environmental theme will benefit most. Subsequently, the participants in the design process choose one base design they find most appealing. The designs of the other themes then are added to or combined with the base design one by one, in an order agreed upon by the participants. The order of combination is important, because in the course of the process the extended base design is becoming more and more fixed. After the first sketch is combined with the base design there is still a relatively large choice of design elements from the sketches. This choice of course is only of importance when an overlap of conflict exists with the (extended) base design, when this is not the case the design element can simply be added to the base design.

The process of combination does not have to lead to a satisfactory result in one turn. The situation is conceivable that in one of the last designs elements are present that are valued highly and require a thorough adaptation of the base design. In this case the design process iterates and is continued until the result is satisfactory.

For the process leading to sustainable water management a maximization method is proposed, taking into account the various basic approaches: an Approaches Maximization Method (AMM). Here as an example the method is discussed that has been tried in a first 'draft version' in the urban area of Almere Buiten (see Rijsberman and Van Marle, 1999). The method described here is designed for making guiding images by making an inventory of opinions and holding a workshop. In this form it is not a ready recipe for a process that can be used for developing a strategic plan for sustainable urban water management.

In urban design for new building projects or suburbs the notion seems to exist that (somewhat exaggerated) a city is built out of nothing. In water management there is a much stronger notion that a water system that is already there, is being transformed, e.g. from a rural system to an urban system. For this reason in the AMM the present situation has a formal place in the beginning of the process (in the EMM the inclusion of the present situation depends on the specific way a theme-maximization is executed). The process is started with charting the strengths and weaknesses of the present water system and its management and of objectives and/or solutions for the proposed water system and management, as they are assessed from the four different basic approaches. Subsequently, four guiding images are developed that all are maximized for sustainability from one of the approaches. These four guiding images then are analyzed for overlap and conflicts. On the

basis of all results a commonly shared guiding image can be developed, with all the feedback and iterations the process of negotiation needs. The resulting guiding image can be used to elaborate practical measures.

5.5 'The opinion of today'

When planning or designing, the elaboration of sustainability of can not be determined up front, but is the result of negotiations. The way a party involved conducts itself in the negotiations, for instance in a maximization method, depends on the interest of that party.

Just about all the parties involved in water management have interests besides and beyond the interest at stake in the negotiations. And, as mentioned before, these interests are dynamic, they change over time. When, after some time, the process of negotiation would be conducted again, the result most probably will be different. All in all, in practice a specific solution for sustainable development is always bound to the moment in time and its context. Time can be regarded as the third axis in the diagram with the approaches (Figure 4.2) Hence, It is not useful to assess a plan for sustainable development without its planning or decision-making history and context (Rijsberman and Van de Ven, 1999b).

Stakeholders and other parties will judge a the result of a planning process that was executed without their involvement on the basis of their individual norms and values, not on the basis of the norms and values of the 'planners'. They were not involved in the negotiations and the learning process that are part of the planning and decision-making process and a different evaluation of the considerations central to such a plan is most probable. And when these stakeholders and other parties have some influence over the success of the plan, then at least acceptance of the choices in the plan is necessary. As a consequence, it is vital to explicitly include the 'planning-history' and context of a plan for sustainable water management. These are of great importance to the understanding of the choices and the results of the process.

6 Discussion and conclusions

6.1 Discussion

The best solution?

"A process-approach, where content follows from the process and everything seems negotiable, does not lead to the best result, but only to the colorless compromise of consensus." It is a commonly heard criticism to the acknowledgement of subjectivity in complex problems like sustainable water management. However, an objectively optimal solution for such complex problems does not exist. 'Optimum' is always according to the norms and values of the evaluator. A good planning or decision-making process leads to the best realizable solution (for a number of criteria, see e.g. Rijsberman and Van de Ven, 1999b). Although individual experts might say they know a better solution, the solution resulting from a good process is the solution, which is still acceptable and enjoys the support it needs to be realized. An 'objective best' solution according to the norms and values of one or a few of the stakeholders can theoretically be better to the environment, but may never be realized because of lack of support.

Knowledge of nonsense?

'Negotiated nonsense' is a pitfall that should be avoided by feeding the process with relevant knowledge and information from outside the process itself (De Bruin and Ten Heuvelhof, 1999b). As illustrated by the painting by Breughel (Figure 6.1), in a process communication alone (or negotiations alone) does not suffice: the blind leads the other blind to the fall, because he lacks necessary information about his surroundings. Or as Cornelis (1998, p.644) puts it: "...when you follow the opinion of someone without vision, you don't develop a vision of your own and the result of the communication is nil."

Figure 6.1 'The parable of the blind leading the blind' by Pieter Breughel the elder, 1568. Galleria Nazionale, Napels.

Because sustainability is a complex problem, the nature of the problem or information is very hard to objectify and exclude subjective influence. An important question is how parties can access the right information to solve the problem. The answer is simple: when every

stakeholder has his own perspective on the problem, and has relevant expertise, the parties will have to determine in interaction what is 'good' information for solving the problem: *negotiated knowledge*. Negotiating information is not a sign of irresponsible relativation ('everything can be negotiated, even fact'), but the only way to responsibly deal with the existing uncertainties (De Bruin and ten Heuvelhof, 1999a, p.80).

Negotiations concerning the information mean that all parties contribute their expertise and views, thus enriching the information available in the process. The risk of *negotiated nonsense* that is inconsistent with the present state of knowledge can not lead to the conclusion that *negotiated knowledge* should be rejected. On the contrary, to prevent this risk, is can be good to involve parties in the process, solely because of their knowledge in a certain field, like experts and consultants. They contribute their views and insight: they confront the other parties with the state of knowledge and can be questioned on the robustness of the knowledge they contribute. Hence, they facilitate the process of negotiation on information.

A different understanding or an incorrect understanding?
The approaches described in this publication in themselves are not new. Everyone already follows his own approach, that can be classified somewhere in the field between the four basic approaches. People, who have been in discussions between colleagues or government services with varying backgrounds and approaches, possibly recognize the confusion or the so-called 'dialogues of the deaf'. In those situations, the concept of different approaches described here can offer a workable structure for discussion.

In the pursuit of more sustainable water management it is important to recognize and respect each other's points-of-view. When not understanding the others points-of-view, one can try to explain one's own view, probably without result. However, when one sees that the partner in the discussion did not misinterpret the problem, but is using another view or other basic principles, a discussion is possible. A mutual approach, with objectives and conditions to be used can be discussed...

6.2 Conclusions

The key elements of sustainable development
After a extensive review of definitions and descriptions of sustainable development (of which five are included in this report) the conclusion is justified that the concept of sustainable development in present theory and practice typically are characterized by the following key elements:

- the needs of the present generation;
- the needs of future generations;
- maintaining the components of the system;
- maintaining system integrity.

Noticeably, 'life' is absent in the definitions contained in the review. This testifies of a mechanical world-view, where the world is represented by the image of a machine, fulfilling certain functions and consisting of coherent parts.

Several equivalent basic approaches exist to sustainability
Various approaches to sustainable development lead to differences in norms and values, influencing the choices in the assessment of sustainable development. In this publication the differences in these approaches are elaborated, resulting in the distinction of four basic approaches to sustainable development.

The basic approaches differ in their attitude towards (1) the relation between people and their environment, and (2) (quantitative) norms and (qualitative) values. Combining these two aspects leads to four basic approaches, referred to as the (1) ratio, (2) socio, (3)

eco, and (4) carrying capacity approach. Differences in the approaches can lead to differences in problem perception and analysis and subsequently to different solutions. This leads to the conclusion that a planning and design system or methodology for sustainability in water management can not be based on only one basic approach and be generally applicable at the same time. Any system that is generally applicable to some extent will have to provide room for all four basic attitudes.

There are no objective best solutions to the problem of sustainable development
Because sustainable development is a complex problem (or wicked issue), where an evaluation depends on the system of norms and values of the evaluator, there are no objective best solutions to the problem of sustainability. And when it is not possible to prescribe the end-result of sustainable water management, as a consequence it is necessary for the route to the result to meet certain conditions: the planning or decision-making process will have to meet certain criteria in order to produce a sustainable end result.

The considerations at the base of the choice of actors involved, theme's and a spatial delimitation (the who, what and where) will have to meet certain demands, and so will the steps and considerations later in the planning process. These fall outside the scope of this publication.

The process is important
In the introduction of this publication the question was asked whether projects that are supposed to be sustainable really contribute to sustainable development. Although many of the proposed changes in water management undoubtedly mean an improvement for the environment, it can be concluded that there is no reason to assume they really are sustainable, or at least not without further consideration. The proposition is that for every process, project or group of projects sustainability is defined, together with a common agreement on a approach to sustainability.

Because in every project the parties involved are different, the perception or view of sustainable development will be different. A plan or proposal for a project can contain only the results of the process; only the actions to be executed and measures to be realized. When the sustainability of such a plan or proposal for a project is assessed by an organization that did not take part in the planning or design process, it is probable that this organization doesn't agree with the approach to sustainability followed. In this case, as a consequence the assessing organization will judge the solution chosen as not sustainable (enough).

An assessment of plans for sustainable development without taking into account their context and 'process-history' can only be of limited value. This leads to the conclusion that it is important to make the considerations leading to a certain sustainable solution and approach to sustainability explicit, so the parties 'external' to the process can agree with the approach, or at least have an understanding for the end result.

7 References

Balkema, A.J., S.R. Weijers, and F.J.D. Lambert, 1998. On methodologies for comparison of wastewater treatment systems with respect to sustainability. In: *'Options for Closed Water Systems. Sustainable water management'*. Preprints of proceedings international Wimek congress, March 1998. Wageningen Agricultural University, Wageningen.

Berge, A. van den, M. Brouwer, C.A.J. Duijvestein, A. Hoogers, and A. Wijnants, 1998. *De Milieu Maximalisatie Methode; structurerende inbreng van milieu in stedenbouwkundige planvorming* (The Environment Maximalization Method; structuring input of environment in urban planning – in Dutch). Stichting Stuurgroep Experimenten Volkshuisvesting, Rotterdam.

Bruin, J.A. de, E.F. ten Heuvelhof, and R.J. in 't Veld, 1998. *Procesmanagement; over procesontwerp en besluitvorming.* (Process management, about process design and decision making – in Dutch). Academic service, Schoonhoven.

Bruin, J.A. de, and E.F. ten Heuvelhof, 1999a. *Management in netwerken* (Management in Networks – in Dutch). Lemma, Utrecht.

Bruin, J.A. de, and E.F. ten Heuvelhof, 1999b. Scientific expertise in complex decision-making processes. In: *Science and Public Policy,* vol. 26, nr. 3, 179-184 (1999).

Cornelis, A., 1998. *Logica van het gevoel; filosofie van de stabiliteitslagen in de cultuur als nesteling der emoties* (Logic of feeling; philosophy of the layers of stability in culture as nesting of emotions – in Dutch). 8th extended imprint. Stichting Essence, Amsterdam/Brussel/Middelburg.

Curwell, S., and I. Cooper, 1998. The implications of urban sustainability. In: *Building Research & Information* (1998) 26(1), 17-28

Duijvestein, C.A.J., and M. Kok, 1999. De proces-design-eco driehoek. In: *Op weg naar de Ecologische stad, DIOC-Duurzaam gebouwde omgeving 1997-1998.* (The process-design-eco triangle. In: En route to the ecological city, DIOC-sustainable built environment 1997-1998 – in Dutch) K.J. Canters, A.J. Dijkstra, and M.A. Kaiser (eds.). Æneas, Best, and DIOC-DGO 'De Ecologische Stad', Delft.

European Expert Group on the Urban Environment, 1996. *European Sustainable Cities.* European Commission, DG XI, Office for Official publications of the European Commission, Brussels.

Geldof, G.D, 1994. *Adaptief waterbeheer* (Adaptive water management – in Dutch). Tauw, Deventer

Gilmour, A., G. Walkerden, and J. Scandol. 1999. Adaptive management of the water cycle on the urban fringe: three Australian case studies. *Conservation Ecology* **3**(1): 11. [online] URL: http://www.consecol.org/vol3/iss1/art11

Groot, W. de, 1992. *Environmental Science Theory. Concepts and Methods in a One World, Problem-Oriented Paradigm.* Thesis, Leiden University, Leiden.

Hoekstra, A.Y., 1998. *Perspectives on water; An integrated model-based exploration of the future.* Thesis, Delft University of Technology. International Books, Utrecht

Houben, F., 1999. Het maakbaarste land van de wereld, duurzaam bouwen in Nederland. (The most 'makable' country in the world, sustainable building in the Netherlands – in Dutch) In: *Symposiummap 'Onderweg naar de Ecologische stad'*, Oct 5, 1999, Vlaardingen. TU Delft, DIOC 'De Ecologische Stad', Delft.

International Council for Local Environmental Initiatives, 1994. *Local Agenda 21 Participants handbook.* Local Agenda 21 Model Communities Programme. ICLEI, Toronto.

Jansen, L., C. Bakker, H. Bouwmeester, T. Kievid, G. van Grootveld, and P. Vergragt, 1997. *DTO visie 2040-1998. Technologie, sleutel tot een duurzame welvaart.* (STD vision 2040-1998. Technology, key to sustainable prosperity – in Dutch). IRP Sustainable Technological Development, Delft, and Ten Hagen & Stam, The Hague.

Joliffe, I, and J. Ball (eds.), 1999. *Eighth International Conference on Urban Storm Drainage. Proceedings volume I, II, III and IV.* IAHR/IAWQ Joint Committee on Urban Storm Drainage, aug. 30 -sep. 3, 1999, Sydney, Australia. Institution of Engineers, Sydney.

Karl Marx, 1885. Das Kapital; Kritik der politischen Ökonomie, Zweiter Band, Buch II: Der Zirkulationsprozeß des Kapitals. Nach der zweiten, von Friedrich Engels herausgegebenen Auflage. (The Capital; critique of the political economy, book II: the circulation process of capital – in German). In: *Karl Marx –Friedrich Engels - Werke,* **Band 24,** 7-518 (1963). Dietz Verlag, Berlin, DDR.

Leeuwen, C.G. van, 1973. *Ekologie.* (Ecology – in Dutch). Delft UT, Faculty of Architecture, Delft.

Leeuwen, C.G. van, 1981. From Ecosystem to Ecodevice. In: S.P. Tjallingii and A.A. de Veer (eds.), 1981. *Perspectives in Landscape Ecology*; proc. Int. Congr. Netherlands Society for Landscape Ecology, Veldhoven 1981. Pudoc, Wageningen.

Lorenz, C.M., 1999. *Indicators for Sustainable Management of Rivers.* Thesis Free University, Amsterdam. Research School for the Socio-Economic and Natural sciences of the Environment, Amsterdam.

Ludwig, D., B. Walker, and C. S. Holling. 1997. Sustainability, stability, and resilience. In: *Conservation Ecology* **1**(1): 7. [online] Available from the Internet. URL: http://www.consecol.org/vol1/iss1/art7

Maters, G., 2000. Beleving van water door inwoners van Gennep (Experience of water by inhabitants of Gennep – in Dutch). In: *H_2O,* volume 33, nr. 5, 44-45 (2000)

Meadows, D.H., D.L. Meadows, J. Randers, and W.W. Behrens, 1972. *The limits to growth. A report for the Club of Rome's project on the predicament of mankind.* Universe Books, New York.

Meijer, H., J. van Leeuwen, L. Jansen, C. Bakker, H. Bouwmeester, T. Kievid, G. van Grootveld, and P. Vergragt, 1997. *DTO sleutel Water. Modellen van een duurzame waterketen.* (STD key Water. Models of a sustainable water chain – in Dutch). IRP Sustainable Technological Development, Delft, and Uitgeverij Ten Hagen & Stam, The Hague.

Mels, A.R., A.F. van Nieuwenhuijzen, J.H.J.M. van der Graaf, B. Klapwijk, J. de Koning, and W.H. Rulkens, 1998. Sustainability criteria as a tool in the development of new sewage treatment methods. In: *'Options for Closed Water Systems. Sustainable water management'.* Preprints of proceedings international Wimek congress, March 1998. Wageningen Agricultural University, Wageningen.

Ministeries van Housing, Spatial Planning and environment, Economic affair, Traffic, Finance, and Development co-operation, 1998. *Nationaal Milieubeleidsplan 3.* (National Environment Policy Plan 3 – in Dutch). Ministerie van VROM, The Hague

Mostert, E., 1998. *Beyond sustainability indicators.* Paper for NWO international conference "Beyond sustainability", November 1998, Amsterdam. NWO, The Hague.

Nijhoff, A., and M. Leenders, 1998. *De Waarden van Water. Manifest van de Waterkring.* (The values of water. Manifesto of the Watercircle - -in Dutch). De Waterkring, place unknown.

Palmer, J., I. Cooper, and R. van der Vorst, 1997. Mapping out fuzzy buzzwords – who sits where on sustainability and sustainable development. In: *Sustainable Development*, Vol. 5, 87-93 (1997).

Pearce, D.W., A. Markandya, and E.B. Barbier, 1989. *Blueprint for a green economy.* Earthscan Publications ltd. , Londen.

Peursen, C.A. van, 1970. Strategie van de Cultuur. Een beeld van de veranderingen in de hedendaagse denk- en leefwereld. (Strategy of Culture. An image of the changes in current thinking and living environment – in Dutch). Elsevier, Amsterdam/Brussel.

Pötz, H., and P. Bleuzé, 1998. *Zichtbaar, tastbaar, zinvol. De integratie van natuur en techniek in de vormgeving van stedelijk water.* (Visible, touchable, meaningful. The integration of nature and technology in the design of urban waters – in Dutch). Nai Uitgevers, Rotterdam.

Rijsberman, M.A., and F.H.M. van de Ven, 1999a. De betekenis van duurzaamheid in het waterbeheer (The meaning of sustainability in water management – in Dutch). In: *H_2O,* volume 32, nr. 18.

Rijsberman, M.A., and F.H.M. Van de Ven, 1999b. Different approaches to assessment of design and management of sustainable urban water systems. In: *Assessment Methodologies for sustainable urban infrastructure, proceedings.* Workshop COST Action C8 'Best practices for sustainable urban infrastructure', September 1999. Byggforskningsrådet, Stockholm.

Rijsberman, M.A., and F.H.M. van de Ven, 1999c. Concepts and approaches to sustainable development in urban water management. In: *8th International Conference on Urban Storm Drainage, Proceedings Volume 1*. pp. 42-49. Joliffe, I.B., and J.E. Ball (eds.). The Institution of Engineers, Sydney, Australia

Rijsberman, M.A., and M.J. Van Marle, 1999. *Streefbeelden voor Almere Buiten. Onderdeel van het onderzoek 'Ontwerp en beheer van duurzame stedelijke watersystemen'*. (Objectives for Almere Buiten. Part of the study 'Design and management of sustainable urban water systems – in Dutch). Delft University of Technology, Fac. of Civil Engineering and Geosciences, Water Management Department, Delft.

Rooij, P.T.J.C. van, 1997. *Interactieve Planvorming gericht op Effectiviteit and Acceptatie*. (Interactive Planning aimed at Effectiveness and Acceptance – in Dutch). STOWA, Utrecht.

Rotmans, J., M. van Asselt, Pier Vellinga, and Richard Rockwel, 1999. An Integrated framework for Sustainable Cities. In: *Assessment methodologies for urban infrastructure, proceedings*. Workshop COST Action C8 'Best practices in urban infrastructure', September 1999, Stockholm. Byggforskningsrådet, Stockholm.

Sieker, F, and H-R. Verworn (eds.,1996). *7ICUSD Proceedings volume I-III, Seventh International Conference on Urban Storm Drainage*. IAHR/IAWQ Joint Comm, on Urban Storm Drainage Drainage, at University of Hannover. SuG-Verlagsgesellschaft, Hannover.

Tjallingii, S.P., 1995. *Ecopolis. Strategies for ecologically sound urban development*. Backhuys Publishers, Leiden.

Tjallingii, S.P., 1996. *Ecological Conditions. Strategies and structures in environmental planning*. IBN Scientific Contributions 2, DLO Institute for Forestry and Nature research, Wageningen.

Tweed, C., and P. Jones, 1999. Modelling as an approach to urban sustainability. In: *Assessment methodologies for urban infrastructure, proceedings*. Workshop COST Action C8 C8 'Best practices in urban infrastructure', September 1999, Stockholm. Byggforskningsrådet, Stockholm.

Valentin, A., and J.H. Spangenberg, 1999. Indicators for sustainable communities. In: *Assessment methodologies for urban infrastructure, proceedings*. COST Action C8 workshop, September 1999, Stockholm. Byggforskningsrådet, Stockholm

Vermeulen, W.J., J.F.M van der Waals, H. Ernste and P. Glasbergen, 1997. *Duurzaamheid als uitdaging*. (Sustainability as a challenge – in Dutch). Sdu Uitgevers, The Hague.

Water Resources Planning and Management Division, ASCE, and UNESCO/IHP IV Project M-4.3 Task Committee on Sustainability Criteria, 1998. *Sustainability Criteria for Water Resource Systems*. American Society of Civil Engineers, Reston.

Wimek, 1998. *'Options for Closed Water Systems. sustainable water management'*. Preprints of proceedings of an international Wimek congress, held in Wageningen (NL), March 1998. Wageningen Agricultural University, Wageningen.

Wit, R.H. de, J.F. Hekman, R. Nijssen, J.G. Groeneveld, and N.A. Hofstra (Eds.), 1997. *Creating Tomorrow's Business. Research into the management of sustainability*. LCSE 'le manageur', Rotterdam.

Witteveen+Bos, 1994,. *Duurzame Stedelijke Waterkringloop. Verkennende studie DTO-water*. (Sustainable Urban Water cycle, survey STD Water; in Dutch). IRP Sustainable Technological Development, Delft.

World Commission on Environment and Development, 1987. *Our Common Future*. Oxford University Press, Oxford.

World Conservation Union, UN Environment Programme, and World Wide Fund for Nature, 1991. *Caring for the Earth*. IUCP/UNEP/WWF, Gland.

Worp, J.J.M. van de, and J.A. Don, 1996. *Definiëring criteria voor duurzaamheid voor het stedelijk watersysteem*. (Defining criteria for sustainability for the urban water system; in Dutch). TNO Milieu, Energie and Processinnovatie/IRP Sustainable Technological Development, Apeldoorn.