

Areas of Protection

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[Areas of Protection Debate: Phase C](#)

1 Introduction

During the activities of the second SETAC working group on impact assessment (WIA-2) the definitions of the four Areas of Protection (AoPs), as given in Udo de Haes et al. (1999) have for a variety of reasons been questioned within the WIA taskgroup on land use and resources. This discussion merged with the symposium on midpoints and endpoints at the SETAC world conference in Brighton, 2000. During the final WIA-2 meeting in Brighton it was decided that Helias Udo de Haes (CML) and Erwin Lindeijer (TNO Industry) would produce a short paper on this subject, to contribute to the discussion on these matters.

The aim of this discussion is in our opinion a more well-defined and structured framework for relating impact categories with endpoints and societal values. The following issues will be discussed:

- the terminology
- system and environment
- the Life Support System (LSS) as an Area of Protection
- the Man-made Environment as an Area of Protection
- the diagram

2 The Terminology

Udo de Haes et al. (1999) define Areas of Protection (AoPs) as classes of endpoints. According to ISO, endpoints are physical elements in the environmental mechanism of an impact category of direct concern to society. This means that AoPs relate to *physical* elements, although of course the selection of these elements stems from societal values behind. We will discuss this further under the next point. Here it is important to note that the meaning of 'endpoint' as used by ISO is different from that in Environmental Risk Assessment. There it is any physical element in the analysis which is regarded as the dependent variable (in line with David Pennington's remark). In ISO-LCA language endpoints are at the physical damage level (as distinct from the monetary damage level, as indicated by Wolfram Krewitt). For the moment we suggest to keep using the term 'endpoint' in the sense of the level of physical damage (cf. ISO 14042). Then midpoints are all elements in an environmental mechanism of an impact category between the interventions and the endpoints.

Following this difference between midpoints and endpoints, the Life Support System (LSS) is clearly at midpoint level.

So, if we would accept the LSS as a new AoP, then we would have to change the definition of AoPs as given in Udo de Haes et al., 1999: they then would be classes of physical elements (and not only of endpoints) in environmental mechanisms which are of direct concern to society.

Another question was raised by Bengt Steen: should we not change the term 'Area of Protection' into 'safeguard subject'. For us it is clear that with AoP and safeguard subject we mean exactly the same thing. Both are classes of endpoints (or more in general, of physical elements), and not the societal values behind. So, following this terminology, consumer welfare cannot be an AoP or a safeguard subject, as was raised by Ruedi Müller-Wenk; and neither can respect for nature, or cultural values. The reasons why we propose to keep the term AoP is that it is a descriptive term which is more in line with the discussion in ISO (although not strictly defined in ISO), and also that this term is used in our earlier publication.

We realise that a number of important terms are as yet not sufficiently defined. Examples are: depletion, competition, damage, etc, which are often used in LCIA context. However, this goes beyond the present note. We will explain these terms, where necessary, where we use them.

Questions:

1. Can you agree with the use of the term 'endpoint' in ISO 14042 sense (meaning elements at the level of physical damage)?
2. Do you agree that Area of Protection is to be used rather than 'safeguard subject'?

Patrick Hofstetter

- agrees to use 'endpoint' in the sense of ISO 14042, but such endpoints need not be physical
- preference of 'safeguard subject', because this term is clearly value-laden and implies the trade-ability between AoPs (SaSus)

Gjalt Huppes

- AoPs as groups of environmental effects; one should try to aggregate an AoP into one indicator

Notes:

No objections here against using the term 'endpoint' in the ISO 14042 sense.

Are they only physical? We will agree probably with Patrick that income, GNP, or indicators of wellbeing are no endpoints

in our sense, but DALYs and QUALYs are. So, perhaps we should try to change the wording so that these are not excluded (weighted physical elements?).

Regarding the Areas of Protection Patrick is the only one who objects; others, like Bo, Wolfram and Gjalt use the term 'AoP' without problems. So then we think there is not sufficient reason to deviate from ISO.

3 System and Environment

If LCA is seen as part of environmental systems analysis, we must start from a system with its environment. Taking this discipline as encompassing scientific framework, we have difficulty to put the environment in the centre, as was suggested by David. But, as Bo Weidema points out, we must be more precise with what we mean with the system, what is the boundary with the environment, and consequently what is part of the environment (of the system).

The first point is: at what level do we define the system and its environment. We can distinguish between three different levels: the physical level, the monetary level and the level of societal values.

The step from one level to the other can of course be put in formulas (like in environmental pathway analysis as put forward by Wolfram Krewitt), but still it implies a translation from one type of elements to another type. For the system definition, we focus on the physical level. This means: that all elements and all processes which comprise the system and its environment are of a physical nature. But this does not preclude a relationship with the two levels above. For instance, all kinds of reasons for defining a system in a given way can be very much linked to societal values. And the same holds true for weighting and interpretation. But still: elements and processes, both in the system and in the environment are of a physical nature.

Now for LCA different boundaries can be drawn between system and environment. We can define:

- a product system with its environment (meaning that all other product systems belong to the environment) (this was earlier proposed by Roland Clift as the only correct use of the term 'environment')
- the economy (or more precisely: the physical basis of the economy) with its environment (meaning all product systems together) (here Patrick Hofstetter uses the term 'technosphere')
- society (again the physical basis thereof) with its environment.

For us, it seems rather unpractical to choose for the first level. LCA is part of the 14000 series on environmental management. Here the term 'environment' is much broader and does not include all kinds of products outside a given product system. Note also that in 14040, ISO speaks about 'the' environment, and not about a product system and 'its' environment. So this leaves the two other options. The main difference is that in option two humans are not part of the system and thus are part of the environment, whereas in option 3 they belong to the system. Our proposal is to choose

as a default for the third option: the start from society with its environment. This has as a consequence that both humans as actors, but also, as José Potting rightly remarked, humans as objects of damage, belong to the system and not to the environment.

Now having discussed system and environment, the question is: what are environmental problems, so: with which problems do we deal in LCIA? Clearly not only with problems related to damage *in* the environment, because that would exclude damage on human health as a subject for LCIA. To our opinion the answer should be: problems which are caused *via processes in the environment*. The object of damage can be in the environment, as is the case with biodiversity or with natural resources, but it can also be back in the system, i.e. in society. This also opens the option for the man-made environment as an AoP, which will be discussed under point 4. But this excludes car accidents from LCIA. Not because they are unimportant, and not because the human casualties are part of society, but because car accidents do not involve environmental processes.

But starting from this, we still need further refinement. Is indoor air quality and the air quality in cars, part of the system or of the environment? How about agricultural, railway, canal and city soil quality and city bio-diversity? And how about the competition about water? This more precise definition of the system boundary between society and environment is relevant because it specifies more precisely whether we want to include an item in inventory modelling, in impact assessment or not at all in LCA.

Ruedi Müller-Wenk suggests to come up with positive and negative lists of impacts considered in- or outside of LCIA. We think that this is in principle a good proposal. We can also agree with his examples, but more difficult examples need to be added, as the ones given above. We can also imagine that these two lists will be context dependent, i.e., that the definition of the system boundary depends on the type of application). It can well be that in one context we regard secondary smoking in a building as a purely medical problem, and in another context also as an environmental problem. Important is that the different contexts are defined so clear that another set of system boundaries leads to another subset of issues to be included, in order to remain consistent. The examples should serve as a first means to characterise such consistent sets.

Questions:

3. Do you agree that system and environment are defined at the physical level, although the reasons to define a given system, and the evaluation of impacts on this system clearly will involve higher levels (i.e., the monetary level and the level of societal values)?
4. Do you agree that as a default we should regard human society as the system (of which a given product system is a part), and that 'the environment' relates to the environment of society?
5. Do you agree to exclude from LCA impacts which only involve processes within the system (without an environmental process), such as car accidents

6. Do you agree to include impacts via environmental processes back on elements in society?
7. Do you agree that types of impacts can be included or excluded consistently on basis of a fixed definition of the system and the system boundaries, or do you think that the boundary is at least in part application or context dependent?

Patrick Hofstetter

- makes a distinction between systems analysis and decision support and proposes to give priority to decision support
- decision context defines the causal relations to be included [in the system, we suppose]; it also defines which elements have intrinsic values; so there should not be a preferred definition of the system and of the values to be protected; 'it depends'
- system and environment are not only defined at the physical level; too narrow
- terminology: techno-, eco- and value-sphere

Jane Bare

- agrees with Patrick on distinction between systems analysis and decision support
- stresses how many decisions in the framework are value-laden; example: to include or not include accidents
- stresses that the two cannot be separated as is thought to be suggested in the Life Cycle Initiative
- cutting of trees is not an environmental process; still it must be included in LCIA; but then: why dead trees and not dead people? but value choices must decide on this
- starting point should be a most comprehensive list of impact categories

Bo Weidema

- prefers to choose for the economy as the system, because 'society' will give many problems
- also in agreement with first option, but impacts inside technosphere are dealt with in the inventory

Gjalt Huppes

- distinction between system and environment crucial; environmental impacts indeed involve environmental processes
- no problem to include non-environmental effects in LCA as additional effects, like human casualties

Walter Klöpffer

- the term 'environment' has different meanings:
 - system environment, as environment of the product system (including other product systems)
 - natural environment (air, water, soil, organisms, humans)
 - man-made environments (work environment, agricultural land, etc.)
- choice for the second: technosphere vs. environment (is any process which cannot be controlled by society)
- better 'technosphere' than 'society' as opposed to this environment
- environmental LCA should focus on impacts via environment; but LCA can also include impacts within technosphere (e.g., on human health)

Notes:

First Patrick's Hofstetter's comment (supported by Jane Bare) that systems analysis and decision support are not the same thing. In part we agree: one can perform a systems analysis without any relevance for decision support. And one can provide decision support without doing a systems analysis study. However, if one selects relevant input variables which can be steered by society, and output variables which are good indicators for damage and benefits, then a systems analysis study can become very relevant as a means for decision support. This is what we aim at with LCA. Of course we agree that the choice of the damage indicators is absolutely value laden (and of course also other choices). But mark that in the Life Cycle Initiative it is not implied that science and values will be strictly separated. That was rather the line in ISO 14042, but not in the life Cycle Initiative.

Q3. The answers indicate that we should be careful to define system and environment only at a physical level. If society is the system, also all kinds of values are attached to the physical elements; if the system is the economy, at least monetary values are attached. Moreover the function of a product is not physical. So the line could be: processes in the system (however defined), and characteristics of elements within the system, can be at different levels, but including the physical level. For the environment we argue that the limitation to physical elements (with their value of course!) is essentially OK. We do not consider the social environment as part of the environment to be studied in LCIA. And for the endpoints, see above.

Q4. The term 'environment' can have different meanings. Starting from systems analysis, 'environment' is complementary to 'system', and the distinction between the three levels of systems seems to be useful. However, there are problems with the proposal of society as a default system level. We tend to follow Bo Weidema and Walter Klöpffer and take the economy as a default for LCA (being the sum of all product systems), including human health as part of the environment.

Q5. A related matter is what types of impact we should include in LCA-studies. Particularly here there is a plea for flexibility. We continue to argue that environmental impacts should involve environmental processes, or at least deal with elements in the environment (see the wood logging example from Jane Bare). But it is not necessary to restrict the LCA-study to environmental impacts. So we propose to make clear that LCA as an environmental tool can only include environmental impacts, but as a broader tool can include other types of impacts, like car accidents. So as long as these impacts are additional (see Gjalt Huppes' remarks), there is no problem. This seems to our opinion to resolve the concerns expressed on this issue.

Q6 appeared rather simple: no problem to include impacts via environmental processes back on elements in society.

Q7. There can be two types of flexibility. The first is to include additional impacts, which do not involve environmental processes (or elements in the environment). The second is that also the system boundary can be dependent on the study goal. We think that this may well be possible but like to hear examples.

4 The Life Support System as Area of Protection

First the question, as put forward by Willie Owens: why bother? To our opinion the definition of AoPs helps guiding to choose category indicators. Just the top-down argument as put forward by Patrick Hofstetter, Mark Goedkoop and others. If the LSS is *not* regarded as a separate AoP, there is no fundamental problem in limiting indicators to human health, bio-diversity and resources, as is done in the Eco-indicator approach from Mark Goedkoop. Instead, *if* the LSS is regarded as an AoP of its own, these indicators should be complemented by additional ones. Likewise, adopting the LSS as an AoP, should also lead to changes in midpoint indicators, because the current list may well be rather incomplete regarding life support functions. So it indeed matters.

Now the question: what is the reason for the LSS as an additional AoP? AoPs are (for the moment) classes of physical elements in environmental mechanisms which are of direct concern to society. This is a rather broad definition. It does not say: 'classes of elements which have an intrinsic value to society'. If so, we could only include human life and non-human life, or bio-diversity, and we should also leave out the resources, because these do not have an intrinsic value either we would argue. (Note: biotic resources have, but then this falls under bio-diversity as an AoP).

Elaborating this, we like to make a distinction between *intrinsic* values and *functional* values for society. This come quite close to the distinction made by Patrick Hofstetter between intrinsic and operational safeguard subjects. Human life, bio-diversity and works of art have (first and foremost) intrinsic values; resources have functional values. To our opinion also the LSS is of direct concern of society, not because it would have an intrinsic value, but because of its functional value. It deals with the environmental regulation functions supporting life on earth in general.

With this interpretation we come close to Patrick's idea of 'unknown damage'. But there is a difference. In Patrick Hofstetter's vision, the LSS would vanish with perfect knowledge. In our opinion, it is still there, noting the regulation functions enabling life on earth which continue to be relevant with perfect knowledge. But the two are close. Because much of Patrick Hofstetter's unknown damage rather will be 'unspecified damage', which we cannot specify (e.g., when speaking about the future) or do not want to specify because we regard it as irrelevant in a given context (e.g., when speaking of the value of life on earth in general).

Question:

8. Can you agree with the distinction between intrinsic values and functional values and also with the fact that AoPs can be identified on basis of both types of values?

Wolfram Krewitt

- he misses a clear definition of the LSS as AoP; and he suspects that there is very much overlap with the other 4 AoPs
- uncertainty should not be taken as basis for definition of LSS as AoP; for that we do not need a new AoP; the problem is rather how to combine indicators at various

- places of the environmental mechanism; so including midpoint indicators with their environmental relevance
- LSS as new AoP may lead to double counting (same impact allocated to more AoPs)
- LSS is important, but at another level; LSS addresses midpoint indicators for other AoPs

Bo Weidema

- agrees with LSS as a separate AoP; no problem if this AoP also affects other AoPs
- if biodiversity is moved to resources, then 'natural environment' and LSS will be the same AoP, with LSS being the preferred term

Walter Klöpffer

- likes the idea of the LSS as separate AoP, indicating the inorganic part of the natural environment
- this should be taken rather broad; example: space around the earth

Patrick Hofstetter

- does only see value of LSS with imperfect knowledge; so its value lies in the possibility to deal with uncertainty of impacts
- no problem to make a distinction between functional and intrinsic values

Jane Bare

- does not find the distinction between intrinsic and functional values very helpful

Gjalt Huppes

- Agrees with regarding LSS as a separate AoP, but meaning the sum of most or all relevant midpoint effects

Notes:

Q8 was the wrong question. We should have asked whether the LSS does make sense as a separate AoP. The answers are varied. There seems to be quite some support, but different arguments are used which are not compatible. So we should indeed give a better definition, as Wolfram Krewitt asked.

Our idea was: the total of basic regulation functions, or more precisely, the physical basis for those functions. This is somewhat different from what Gjalt Huppes and Walter Klöpffer suggested (all midpoint variables), because not all midpoint variables are related to the basic regulation functions. The LSS also needs not to be purely abiotic, like Walter Klöpffer suggested; soil fertility, as part of the LSS, to a large part is based on biotic organisms and processes. And it is not fully the same as Patrick's idea, who chooses for the uncertain impacts; but surely there is a correspondence here. We think we are most close to Bo Weidema, separating the natural environment in the LSS, and biodiversity and other resources. This is also true for his suggestion to bring biodiversity under the resources. Regarding the issue of intrinsic versus functional values we may just say that these two types of values can be relevant for AoPs (and not only the intrinsic ones). This would mean that we drop the idea of a clear distinction between these two types of values, as was suggested by Göran Finnveden, in line with the remark from Jane Bare.

5 The Man-made Environment as Area of Protection

We proposed in Udo de Haes et al. 1999 to include an AoP 'Man-made Environment', covering crops, production forests, buildings and materials. The reason is that without this AoP we would not have a basis to include impacts into the analysis of acid rain on silviculture or on monuments, or of ozone impacts on agriculture. A top-down argument, for that matter. However, Ruedi Müller-Wenk was afraid that this would open up LCA to many issues which can not be included consistently in an LCA study. At that moment he gave examples which did not include environmental processes, such as car accidents. Agreeing on this argumentation about the requirement of environmental processes, he now comes up with a new list of examples which would have to be included in an LCA-study, but which usually are not: particularly dealing with interventions which cause damage on nature but which also have economic benefits. His examples are in themselves straightforward: indeed the economic benefits are due to environmental processes.

Still we are not convinced that these examples imply that we should exclude the man-made environment. To our opinion his examples rather raise the question whether we should only deal with damage, or that we should also include beneficial impacts in LCIA. Should we take the reduction of climate change into account due to the emission of soot, SO₂ or dimethylsulfide? Should we accept that in some regions tropospheric ozone creation is diminished by an increase of NO_x emissions? We argue that we should make a clear and consistent choice on this issue. If we choose for the inclusion of benefits, then we should also open up LCIA for the benefits given by Ruedi Müller-Wenk, in as far as these indeed involve environmental processes. If not, the benefits presented by Ruedi Müller-Wenk are out, but also the benefits of SO₂ and others.

Questions:

- 8. Should we in general include positive side effects of environmental interventions in LCIA?
- 9. If so, should we also include side effects in LCIA, which have positive economic benefits?

Wolfram Krewitt

- agrees with man-made environment as separate AoP

Bo Weidema

- agrees that man-made environment can be an AoP, but prefers the term 'man-made structures and ecosystems'; the domesticated animals are not included in this AoP

Patrick Hofstetter

- In general we should indeed also include positive impacts, but it may depend on the type of study

Jane Bare

- of course we should include beneficial impacts, particularly if they are intended

Note:

Taken these points together, this would mean that there are no fundamental objections to include the types of impact in LCIA, as mentioned by Ruedi Müller-Wenk. We also have our reservations here, like Ruedi Müller-Wenk. It would be quite a change. Can anybody further comment?

Thus, once impacts back on society are allowed in principle (if involving environmental processes) according to our proposal at section 2, the man-made elements could include all physical parts of society except from human health (because that is covered already). With respect to the values behind, these parts may relate to intrinsic values such as monuments, or to functional values such as man-made resources. The same can be said about impacts in the environment itself, although there the two types of values are traditionally separated (at least in part) into natural resources and natural environment. It is thus a question whether both types of man-made items should be considered together and whether the term 'man-made environment' is the best choice (see below).

Note:

Bo Weidema suggests here to bring monuments and man-made resources together into one AoP. In the moment that we drop the distinction between functional and intrinsic values, as a leading principle, this is logical. Only the proposed term 'man-made structures and ecosystems' is to our opinion too complicated. An option could be to include the monuments in 'man-made environment'. The problem only is that this environment is actually part of the system, with impacts backfiring on society (or the economy). So a suggestion could be: 'man-made structures'. For the moment we keep it like that.

We first have a look at the diagram.

6 The Diagram

The above reasoning can be presented in a diagram. To stimulate thinking, we present two possibilities. The first starts from society as the system and puts the AoPs around it in the environment. It disregards, that some of the AoPs are back in society. This diagram (Fig. 1) looks as follows: The society is in the middle, surrounded by its environment. And

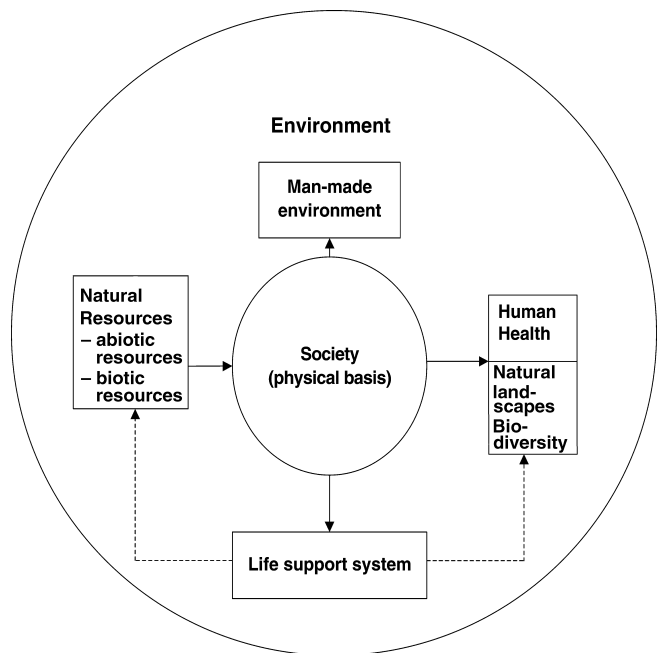


Fig. 1

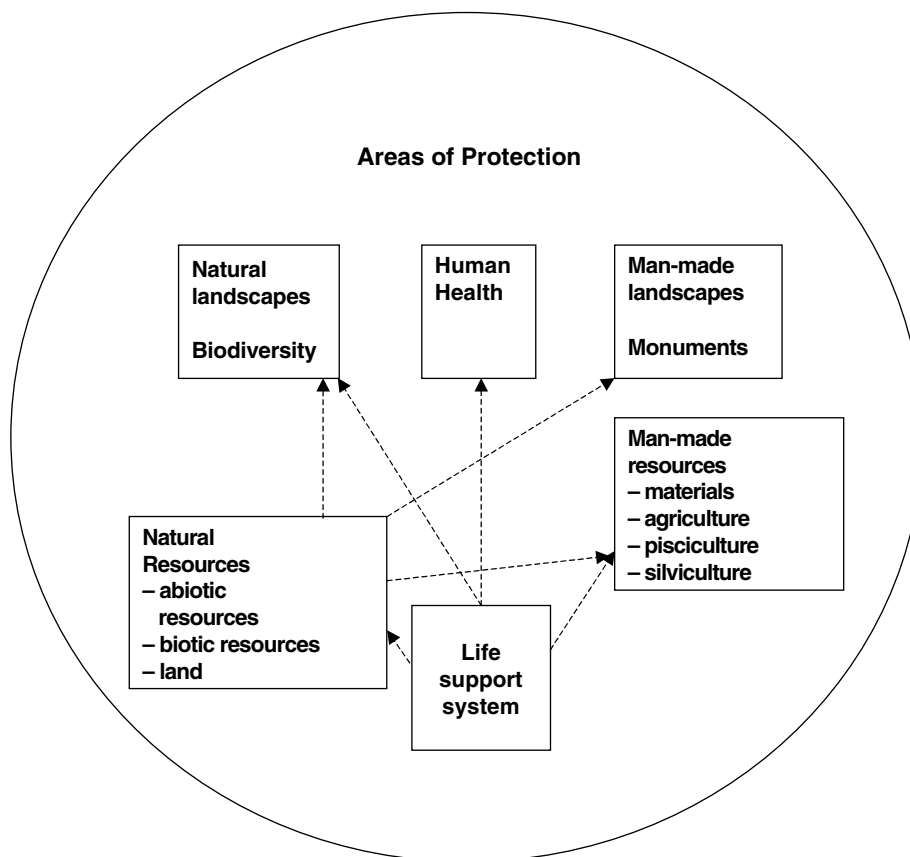


Fig. 2

the LSS is indicated separately. Göran Finnveden had suggested to put it as a sub-AoP of the AoP 'natural environment'. We have not done that, because then also the natural resources would have to be put under that AoP. The man-made environment is not drawn any more at the boundary of the society because then the same would have been necessary with human health.

A second possible diagram (Fig. 2) leaves out society as physical basis and only presents the AoPs. This diagram focusses on the relation between the AoPs, and is closely related to Table 1.

Both diagrams have the limitation that they do not clearly show the difference between AoPs inside the environment and AoPs back in society. This rather can be presented in a table. In Table 1, two dimensions are distinguished: the distinction between AoPs in the environment, and AoPs back in the system (i.e., society). The other axis concerns the distinction between intrinsic values and functional values.

Table 1

Values	AoPs in the environment	AoPs back in society
Intrinsic value	Natural landscapes Bio-diversity	Man-made landscapes Monuments Human health
Functional value	Natural resources Life Support System	Man-made resources (materials, buildings, crops, forests)

Finally, as an **annex**, another diagram is shown (see Fig. 3), drawn by Bo Weidema. We just add it, including his argumentation.

Questions:

- 11. What do you prefer: only a diagram, only a table or both?
- 12. Which of the three diagrams do you prefer and why (we are not interested in votes, only in arguments)?
- 13. Should we change the term 'man-made environment' into 'man-made resources', because this term is not dependent on the precise definition of the system boundary (i.e., it can include elements which are back in society)?

Gjalt Huppes:

- follow rules of systems analysis; arrows should follow causality, not physical flows; so arrow from society to resources indicating resource depletion; society as a process, so it should be in a rectangle; society is not only physical but includes the higher levels

Bo Weidema:

- system boundary discussion should be separate from choice of AoPs; therefor all AoPs not connected to the system (both for man-made environment and for resources)
- biodiversity under resources, not as a separate AoP; resources are the irreversibly depletable aspect of the natural environment; they include:

- deposits of materials and energy carriers
- genetic/biotic resources (biodiversity?)
- land with potential use for agriculture
- unique types of landscapes
- unique cultural assets (but possibly under man-made environment)
- a clear distinction with man-made environment (man-made structures and ecosystems) is necessary
- expand human health; also accidents, welfare affected by others impacts than disease; also domesticated animals
- LSS fuses with natural environment; call it 'Life Support Functions'
- Arrows from LSS and man-made structures to other AoPs, not other way around

Walter Klöpffer:

- outer circle is reach of human activities

Notes:

We will make a new diagram which follows the above suggestions. This means: the economy (= technosphere) as system, surrounded by its environment (i.e., of the economy). Further largely following the suggestions made by Bo Weidema, with some further thinking about terms. And where possible with better use of the rules of systems analysis. We like the meaning given to the circle by Walter Klöpffer.

In addition, there is also the table in Udo de Haes 1999, showing the causal links; this table should be brought in line with the present ideas about AoPs. This table will then replace our diagram 2 (Fig. 2).

Further, there is the table presented above (Table 1). This table has in its present form lost its significance, because we will play down the distinction between functional and intrinsic values. On the other hand a new table may be interesting which would show the AoPs, with different definitions of the system boundary. This may help to show the consequences of different ways of system definition.

Annex 1: The AoPs (see Fig. 3) according to Bo Weidema

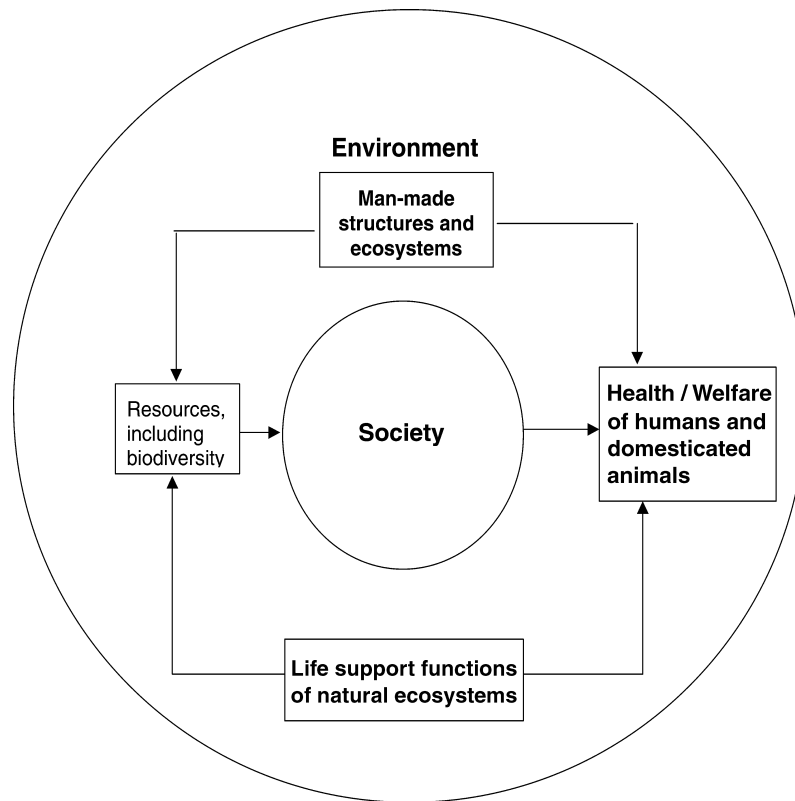


Fig. 3

Bo Weidema: I agree that the man-made environment may and may not be an endpoint, and therefore is rightly placed on the border between society and environment (However, I have elsewhere questioned the use of 'environmental processes' as the criteria for inclusion in impact assessment, and have instead suggested a more stringent division between

the product systems (technosphere) and the environment based on the issue of predictability). Following the same logic, resources can be placed on this border. Here, it should be noted that my concept of resources may be different from yours. In my understanding, resources cover:

- Deposits of materials and energy carriers
- Genetic (or biotic) resources (which you name biodiversity??)
- Land with potential for agriculture
- Unique types of landscapes
- Unique cultural assets (which I believe you include under man-made environment?).

My argument for this classification is that I seek a clear definition of what is a resource: Natural resources may be any part of the natural environment, but the protection area is only affected if availability to future generations is affected, i.e. through irreversible depletion. Thus, the irreversibly depletable aspect of the natural environment: 'Genetic (or biotic) resources' belongs under 'Resources'. Similarly, the protection area 'Man-made environment' includes aspects which are of concern to future generations (unique cultural assets), and aspects that are only of current value (e.g. ordinary buildings and current crop yields), which makes it useful to rename (redefine?) the protection area 'Man-made environment' into 'Man-made structures and ecosystems', leaving the unique cultural aspects under 'Resources', which thus becomes not only 'Natural resources'.

The reason for moving the biodiversity box from right to left in the figure follows from the above.

I do not find any problem in having an AoP 'Life support functions' even though this also affects other AoPs. But when moving biodiversity and landscapes to the resource head-

ing, it is no longer possible to distinguish 'Natural environment' and 'Life support systems' (following your own argumentation). Thus, I have moved 'Natural Environment' to melt with LSS, the latter being my preferred term.

And finally, 'Life support systems' as well as 'Man-made structures and ecosystems' both have arrows to both resources (esp. biodiversity) and human health, while resources and human health do not affect the other AoP.

Additional comments from Bo Weidema:

- I think that the issue of system boundary should be solved aside from the definition of the AoP, thus I have moved all 4 AoP's away from the central circle.
- I have included biodiversity under the heading resources, which is more logically correct.
- I suggest to use the more precise term 'Life-support functions of the natural ecosystems' rather than 'Life support systems'.
- I suggest to expand the area human health to cover all welfare aspects (i.e. including human death by accidents, reduced welfare by other means than disease) as well as all organisms that have ethical status similar to humans (i.e. domesticated animals). While this expansion may be questioned by some, it does make the figure and our concepts complete. If one does not want to assign weight to the added items, one may simply weight these items 0 in the weighting.