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Biodiversity viewed from three sustainability models, and two systems ecology textbooks

1. Intro

Biodiversity is identified as one of the major environmental sustainability issues, alongside with global warming, and is often defined including the three levels genes, species, and landscape.

In this paper the concept of biodiversity is viewed from five different angles, see sections 2.1 to 2.5.

2.1 The Daly model

Herman Daly's model of a full or empty world show a finite world of 1) sources for energy and natural resources, and 2) so-called sink capacity, the biosphere's ability to assimilate our wastes in solid, liquid, and gaseous form (Figure 2). Biodiversity, on the resource side, is a diversity of organisms for the economy to choose from; on the sink side a biodiversity of, mainly, microorganisms that enhance the decomposing capacity to assimilate more types of solid, liquid, and gaseous waste.

A difference between biodiversity and other resources are, however, that the biodiversity in itself is not used up. The biodiversity can be seen as working similar to a catalyzer, building structure by converting resources of different types to goods and services in society.

2.2 The Natural Step

The model behind The Natural Steps four systems condition framework is similar to Daly's model in having society embedded in a biosphere where resources are delivered to society and wastes from society are assimilated (Figure 1). Similar to Daly's model the biodiversity is not necessarily used up but widening the basis of the input and output quality.

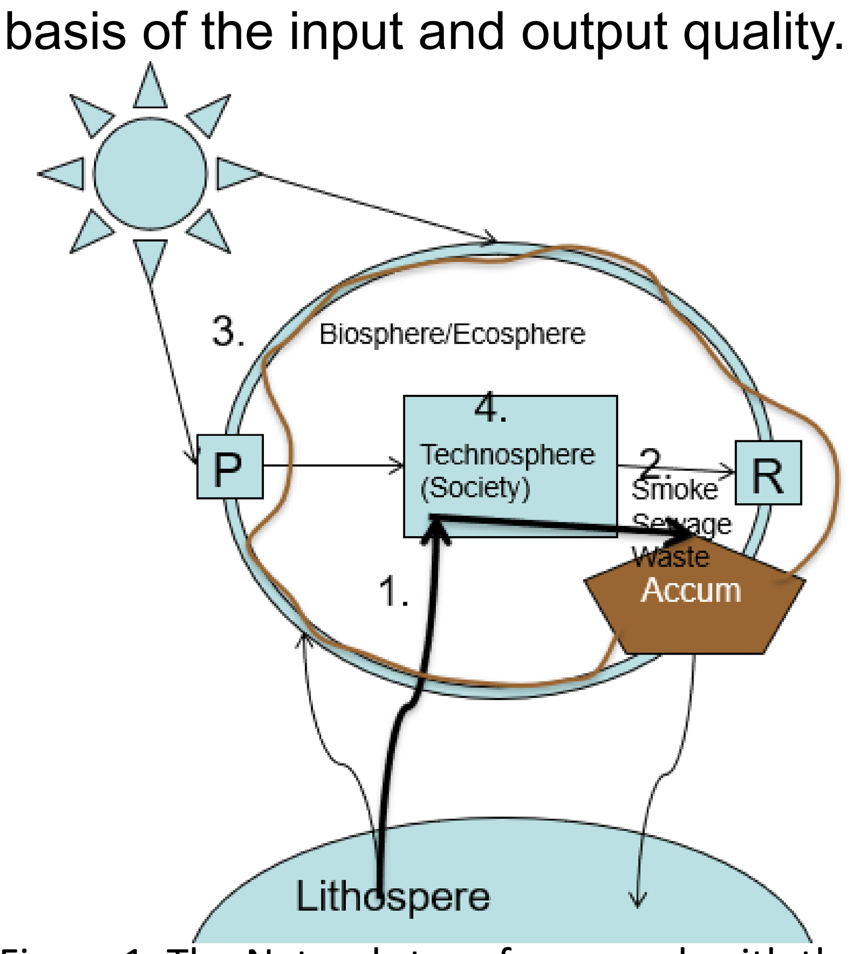


Figure 1. The Natural steps framework with the four systems conditions (also called socio-ecological principles) depicted as number 1-4.

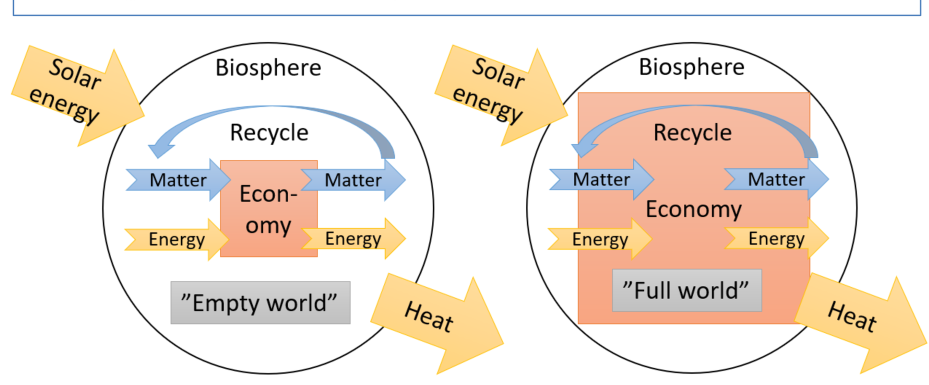


Figure 2. Daly's full and empty world model.

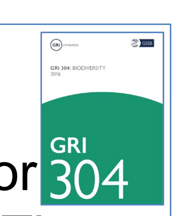
2.3 Source, sink, integrity sustainability

Both the Herman Daly model and the The Natural Step model highlights the feature of not overusing either the resources nor the assimilative capacity on the input and output side of the system. Even though not commonly used, the terms source and sink sustainability seem relevant to use in this context, indicating a long-term, sustainable, use of resources and assimilative capacity.

However, as pointed out biodiversity may be distinguished from this source and sink sustainability, since the diversity is more of a system property that is not used up in the process from input to output and recycling. In systems science this feature is sometimes called the integrity of the system (Richmond 2001, Meadows 2008) suggesting a third sustainability term called systems sustainability. Since this is a very general term, a more unique term can be used instead: integrity sustainability.

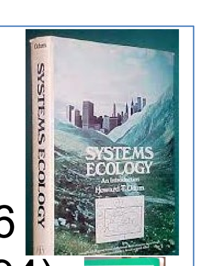
In the Natural Step model condition 2 represents the sink sustainability, and condition 3 represents the source sustainability. Both of them can, however, also be said to have an integrity sustainability aspect, where enough capacity must be maintained on both sides.

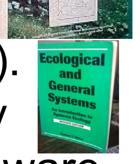
2.4 GRI (Global Reporting Initiative)



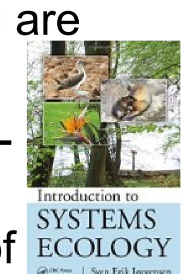
GRI is a widespread voluntary reporting framework for sustainability work by companies and organisations. The environmental part of GRI (the 300-series) consists of the basic approach of energy and mass balances (301, 302, 303), and then the three typical sorts of waste: solid (306), sewage and gaseous waste (305). Biodiversity (304) differs substantially from the other categories by not being quantitative or use performance indicators in a similar way. Again, the label integrity sustainability fits better to biodiversity, while source and sink sustainability fits to the others.

2.5 Two systems ecology textbooks





The H.T. Odum textbooks does not mention the term biodiversity. A possible reason for this may be that the term biodiversity did not have a major breakthrough until 1986 at the famous conference hosted by Edward O. Wilsson and others (see Worster, 1994). Odum's first edition was published in 1983, and is mainly adjusted regarding the energy hierarchy concept in the 1994 second edition. It is, though apparent that Odum is well aware of the aspect, since the term diversity have several entrances in the book index, and are important parts of several models in the book.



Jørgensen (2012) devotes a full chapter to diversity in ecosystems (chaper 10). Noticing that biodiversity is often defined by the three levels mentioned at the beginning (genes, species, landscape), Jørgensen takes a more detailed grip on the concept of diversity. Noting earlier in the textbook that ecosystems have a hierarchical organization, he discuss and calculate the theoreticly possible diversity for each one of the hierarchical levels from molecules, genes, cell types, organs, individuals, species, populations, communities, ecological networks, and finally the ecosystem level. For each one of these levels, he gives calculation examples showing that the possibilities for diversity - the number of possible combinations - is overwhelming, often of the theoretical size 10^200 and similar.

A major difference between Odum's and Jørgensen's textbook's are that Odum takes the human presence for granted in his approach. The last part of the book (part four) is named "Systems of nature and humanity", and alongside with natural ecosystems are presented also economic systems of nations (chapter 23), ecosystems with humans (chapter 24), cities and regions (chapter 25), and world patterns (chapter 26). A summary chapter (27) concludes the unity of systems whether human dominated or natural.

Jørgensen on the other hand, don't explicitly omit humans from the systems, but have no examples where humans are parts of the systems other than disturbing it with eutrophication and toxic substances – the traditional environmental impact approach. One way of capturing this is using the categorization by Jablonka and Lamb (2005, 2014) to different types of information carriers where Jørgensen has a main focus of the the two first levels, genetic and epigenetic, while Odum includes also the third level of behavioral evolution.

3. Conclusions

The paper concludes that biodiversity stands out compared to other environmental issues when viewed from the first three angles chosen. While source and sink sustainability are good labels for most environmental issues, integrity sustainability may be a better label for the biodiversity type. The two textbooks also underline biodiversity as a systems property, where integrity sustainability may be a better term. Jørgensen explicitly points out several more hierarchical levels of diversity than the three levels usually pointed out by the biodiversity concept. Finally, the paper also speculates if economic, social, and cultural sustainability can be better captured with the integrity sustainability label.

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