

Sustainable Rural and Urban Ecosystems: Design, Implementation and Operation

Manual for Practice and Study

Bearbeitet von
Gunther Geller, Detlef Glücklich

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Chapter 2

Human Ecosystems

2.1 Ecosystems in General

Ecosystems are systems, consisting of living beings, interrelated among themselves and with their environment (other ecosystems including the planetary ecosystem Gaia).

Ecosystems operate at a specific place, termed ecotop. The relations or fluxes in the ecosystem can be of energy, mass or information. Energy always is one-way with decreasing capacity for available working-power, the last step being low warmth without specific use for human use. Mass or matter in mature natural systems goes in cycles, most of it locally. Information is the relation, that controls the systems and the being's relationships.

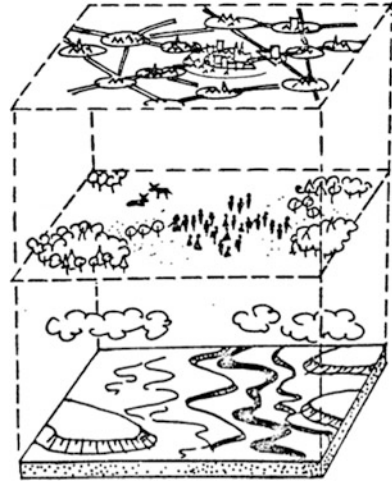
The living beings according to their function in the system can be producers (like green plants, producing oxygen and nutrition), consumers (animals including man) and reducers (organisms that reduce materials to make them available again for the producers).

2.2 Human Ecosystems

The new thing about human ecosystems is that they contain elements and relations/fluxes of a technical-cultural type (Fig. 2.1).

Technical-cultural producers are factories for goods for example, technical-cultural consumers are mass or energy-consuming things like refrigerators, machines, cars etc., technical-cultural reducers are wastewater-treatment plants, biogas-plants or composting-sites. Technical energy can be electricity, technical matter maybe produced goods like cars, technical information shows up as internet and telephone etc.

Fig. 2.1 Levels of ecosystems (technical-cultural components on *top*, living elements in the *middle*, inanimate parts on the *bottom*) (Tomášek 1979)



2.3 Development of Ecosystems

Ecosystems generally develop in space and time.

Development in time, also termed succession, means proceeding from an unripe state to a mature one. In the pioneering first phase ecosystems only have few elements and few connections between the elements and their environment. After many steps in the course of evolution in time they can reach a ripe mature stage, where many diverse elements very intensely are connected by fluxes of information, energy and matter, utilizing the available matter, energy and information at its very best.

A measure of this mature stage is the very small loss of matter; i.e. erosion being of small importance. The same applies to natural and human-made systems likewise. In the final ripe stage, import and export of matter and (technical) energy is small and many diverse elements are connected very intensely and harmoniously.

There are characteristics of mature ecosystems, that can serve as a general orientation for sustainable human ecosystems too:

- Effective use of energy
- High biodiversity
- Closed cycles of minerals
- Low entropy
- High stability
- Self-organisation
- Sophisticated cooperation etc. (see Odum 1971).

To ensure that the human ecosystem takes the course of sustainability, e.g. of a mature system, during the whole development care has to be given to the amount of maturity = quality gained and to improve it if necessary. In quality management it is called circle of quality. Process management very much means management of

information, including among others training, education, public affairs and acceptance inside and outside. The structure of the system in the end of the process must allow this mature ecological system.

The development of a human ecosystem in time makes it compulsory to accompany this process over the whole span of realization, from the first discussions through the planning phase till its final envisioned stage by a lot of measures like maintenance, training, modifying the hierarchy if necessary etc. These measures all serve the aim of gaining the final mature state of the ecological development in ecosystems. The development in time should be in a way that the system is able to adapt to it without losing its balance.

2.4 Relations and Fluxes in Human Ecosystems

There are three types of relations or fluxes in an ecosystem: mass or matter, energy and information. It is important to note that these can have the form of flows or relations, but also that of a structure. Information for example can be in the form of communication (flow) or show up in the form of the hierarchical structure of a university or community.

2.4.1 *Matter/Mass Flow*

For ecosystems the type of mass flow can give a good hint about the maturity of the system. If there is a lot of cycles and little input and output, the system is autarc to some extent. If there is a lot of output, for example as erosion of soil, the system is not sustainable at all.

For the mass flows a balance is helpful for designing a sustainable ecosystem. One of the flows easiest to evaluate and model is water in its various forms.

2.4.2 *Energy*

Energy is a one-way flow: once used it loses its ability to do the same quality service again. In the worst case as low-temperature heat it is lost for human use. In natural ecosystems therefore energy is used on as many steps as possible and as effectively as possible.

The most important energy, stemming from our sun, comes in a non-material form. It is the most important renewable energy too. In human ecosystems however, energy often is delivered in a material form as oil and coal and wood, thus contributing to the mass flow balance too.

2.4.3 Information

In ecosystems, information is one of the three fluxes (matter and energy being the other two). While it is not the most visible one, it is nevertheless a flux of utmost importance. It is the flux, by which the system is controlled, its course steered and by which all the connections of the various members are started and maintained. Information in ecosystems can take on various forms. Generally there can be types predominant in natural systems, like informing partners about sources of food. In the technical-cultural human ecosystems like villages and cities, the technical-cultural type of information is prevalent. One of the more technical forms is the Internet and telephone connections. More cultural forms are values, ethics, beliefs, rituals, education, intercultural communication, etc.

2.4.3.1 Information as Socio-Cultural Framework

In technical-cultural ecosystems, controlling and managing the ecosystems is partly done by religious and socio-cultural sets of beliefs, mindsets, visions, paradigms, values, ethics, etc. Our belief in the necessity of continuous growth is one of these sets.

Without understanding those kinds of mechanisms, the socio-cultural background of the human system especially, measures from inside and outside will not have the intended long-term effects. This is crucial especially, when people from other cultures are operating in strange socio-cultural frameworks, like in the development business. Thus before and parallel to “doing something” the gaining of understanding of the specific framework first is a must and precondition.

The degree to which the specific human ecosystem will fit in with the global ecosystem, and whether or not the specific ecosystem and its human members will act in accordance with ecological principles, will depend very much on the extent to which ethics and values of the human members emphasize this ecological core.

2.4.3.2 Information as Organisation

Information can not only appear in the form of flux, but also in its structural form, the (hierarchical) organisation of human ecosystems like companies, communities like cities, villages and universities for example. This form of information is especially important in respect to the long-term functioning of the system, i.e. its sustainability.

In case of human ecosystems, one part of the ecosystem is the hierarchical organisation of the community or university itself. The structure of this system very much defines the flow of information inside and outside, the distribution of responsibilities, the general acceptance of people and measures and the availability of financial resources, to name only a few factors.

Thus for the ecological development of human ecosystems it is necessary to have positions on all level of hierarchy responsible for the ecological development and filled with appropriate persons. This person must be capable, trained, willing and given the necessary authority to deal with their tasks.

2.4.3.3 Information as Education, Training and Studies

To gain the necessary awareness and acceptance concerning ecological matters education, training and studies are essential means.

Depending on the kind of human ecosystem we have to deal with, different kinds of education, training and studies may be important. Studies are important for universities especially. For villages and towns specific trainings and educational programs for the inhabitants are essential. This can be empowering specific groups of the community, like women, or the youth members, or do training for specific skills, like operating a biogas plant, composting toilets, solar systems or water cycles.

2.4.3.4 Information as Communication, Acceptance and Public Relations

Human ecosystems will be functional in the long term only, when there is full acceptance inside and outside. To achieve that, distributing information will be necessary, but in itself will not be enough.

It will be necessary to spend time with the stakeholders and to provide possibilities for building up trust and working relationships and also to provide a framework where the involved can grow personally. Albeit its not possible to ensure acceptance and deep communication by measures for sure, however it is possible to provide a favourable environment for that.

Some suitable approaches and methods are: Appreciative Inquiry (Ludema et al. 2003), U-Theory (Scharmer 2007), The-Work-That-Reconnects (Macy & Brown 1999), Circle (Baldwin 1998), World Café (Brown & Isaacs 2005), Music and Dance etc. Examples of this approaches and methods applied at VVU are given later.

2.5 Engineering of Ecosystems

The combination of the holistic way of understanding in ecology and the practical approach in engineering brought forward a new approach, termed “ecological engineering”.

Ecological engineering is existing now since the 60s, with a broad scope of projects and experience.

Ecological engineering could be defined as:

- “Environmental manipulation by man using small amounts of supplementary energy to control systems in which the main energy drives are still coming from natural sources” (Odum 1962) and
- “The design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both” (*Mitsch 1996*).

The main tools of the ecological engineer are ecosystems and their components. Till now, the main focus was on ecosystems, influenced by humans (like rivers) or even completely designed or constructed by humans (like Constructed Wetlands). Human settlements however very rarely have been dealt with as ecosystems, designed, realized and operated according to the principles of natural ecosystems and with all of the components of the human ecosystem as tools.

In the VVU-example this approach of ecological engineering has been tested with the campus of VVU. This manual contains the summary and the practical approach and tools developed thereby.