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DESIGN FOR A LAND ECOLOGICAL SURVEY OF NATURE PROTECTION

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Abstract

In connection with nature protection, land ecology primarily deals with geographical forces ruling the suitability of any place on earth for nature, i.e. for any of its organisms. These geographical forces differ basically from the bio-physiologically operational stimuli organisms respond to. Physically, the latter are fluxes, resulting from driving forces and transmissivity factors in the surroundings of the organisms.

In planning of surveys as well as policy, macroscopic models of the deducted system may show useful. The above tripartition of environmental factors has been explored as a possible basis for such a macroscopic systems model. For shortness of future communication, several words have been introduced. Fundamental concepts are the ecodevice and ecological field ones. Reference has been made to other publications using this model or some or more of its elements or forbears. This paper can be regarded an addendum to these publications and a call for broadened discussion.

Examples of application have not been given in the paper. Some studies are mentioned, however, which more or less explicitely do so.

Introduction

Nature protection aims at regulation of the environment to have certain organisms survive. In The Netherlands, mainly biological effort is put forward to combat the deterioration of habitats, suited for several organisms of nature. The processes involved in this deterioration continuing, widely available bio-ecological knowledge is confirmed daily: many human activities are far 'more' anyhow than most organisms can stand in their habitats. A change of species composition is noticed: obviously, common species become more common and rare ones still more rare, they become threatened with extinction from a region at least.

If it is agreed biological species fit a specific environmental template, which may be coproduced by other species, the interest is not primarily in the specification of this template or the way species get around with it, but in the question whether it will be affected by human activities or not. So the problem appears to be one of transfer of change in the environment. If change is transmitted as a result of transports of clearly defined physical quantities (including chemical or biological matter), key points will be linking the organisms sense of change to physical quantities and routing these change agents through the system.

A maior step in the technique of nature protection in The Netherlands has been the introduction of the concept 'milieudynamiek' or environmental inconstancy by van Leeuwen (1966) in his Theory of Relations (see also: Bakker, 1979 and Westhoff et al., 1970-1973). As their is uncertainty about the analytical nature of this deductive quantity, it will be kept vague in this paper by referring to it as 'midy' shortly.

According to this theory now, every place is said to have a certain amount of midy of its own, to which a supplementary amount is added by the continued human use of the site. Organisms that tend to become rarer as their stations become more intensively used by Man, apparently hate high amounts of midy, whereas those, becoming commoner, love it. Thus, organisms can be used as midy indicators, by just monitoring their occurrence in areas influenced by midy import. This is virtually all of The Netherlands today, as only some isolated nature reserves seem to escape from the processes involved. Yet, in the early stages of human occupation, use of the environment is by regionally redistributing midy, for instance by mowing and grazing large and remote areas of the region in favour of having arable fields close to the settlements. As many species endangered with extinction in The Netherlands now, showed an apparent increase in the past in the remote areas just mentioned, we cannot but conclude the natural amount of midy of those areas was negatively influenced by the addition of some operational human midy. With respect to this, it is convenient to suppose there are latent or inactive forms of midy, next to active forms. Biomass would represent an inactive form of midy, which can be transported by applying a relatively small amount of active midy. If, in a more or less equilibriated geobiocoenose, the mean annual storage rate equals or only slightly exceeds the mean annual activation rate, disposal of stored midy will eventually lead to a decrease of active midy.

Van Leeuwen has derived some rules for guessing midy from physically known aspects of the environment. For instance, several aspects of energy and mass represent midy positively: warm > cold, rich in nutrients > poor in nutrients, wet > dry, moving > calm. In the application of these rules, it is necessary to have some knowledge of the interaction of these midy-components. If an area is made drier, for instance, this may lead to an increase of midy. Physically, this can be understood by assuming nutrient supply has increased by diminishing wetness impact on soil mineralization processes. A relatively high degree of movement of groundwater may, in other cases, be important to maintain high calcium-levels in a soil, thus effectively controling phosphorus uptake by plants and resulting in the presence of apparent midy-haters. Users of the midy concept in The Netherlands know a lot of these things by experience from a wide range of types of land. They are therefore regarded a kind of sorcerers by those trying to translate randomly gathered ecological data into midy. The latter category even tends to ban the whole subject from official science. In an attempt to bridge this gap between expert judgment and formal science, Van Leeuwen and I have worked together from 1975 onwards, developing descriptive tools in order to enable more formal scientists to reconstruct the lines of thought. The present paper is, in addition to that by Van Leeuwen (1981), meant to draw attention to some of those tools.

The main points combine into design requirements for landecological survey for nature protection, organized in some macroscopic systems model. Some parts of this model will be loosely discussed below, with emphasis on their description, relation to published concepts, and use. Tools for the execution of a real survey will not be given: they can be found in several textbooks on such fields of knowledge as soil science, hydrology, water chemistry and others. The macroscopic systems model just helps in the design of the survey; it is made to learn what available tools should be used at what instances in the execution of a survey. Or: if important things are found by chance, this model should help to increase the chance to find important things, but it does not change the rules for scientific proof.

The organism to be protected is invariable

Accept, for the moment, nature protection aims at regulation of the environment to have certain organisms (those, otherwise threatened with extinction) survive in acceptable numbers.

Suppose, now, all individuals of a biological taxon react with their environment according to the same predetermined main part of their, say, biological program. At the lower hierarchical levels of taxonomy, and typically in species, this main part is nearly all of the biological program available. Noisy behaviour of individuals is neglectable. Exchange of biological program is controlled by heredity and can usually be considered without any alterations. In Homo sapiens, however, the biological program contains a routine, capable of generating technological program interactively with the environment and the prevailing contents of the continually growing technological program bank. Technological program exchange between individuals does not use heredity control and is not by exact duplication. Predictable trends have been detected by the social sciences. Yet, in land (systems) ecology, technological program is safely dealt with as (alternative) constraints, to be defined in scenarios. Requirements to have scenarios realized or probabilities of scenarios to become reality should be afforded by social scientists.

Consequently, an organism's biological program determines the environmental template it needs to feed on and discharge into: the habitat it fits. Saying the habitat is surrounding concentrations, the milieu of its inhabitant is the feeding and discharging fluxes it is subject to in the habitat. If, with irreversible thermodynamics, the complex of concentration gradients in the habitat-organism interface is the generalized driving force in producing the organism's milieu, the milieu is generalized fluxes, the organism's envelope representing transmissivity factors or phenomenological coefficients. Strictly speaking, habitat and milieu are only there , once the organism is in. If an organism moves around, it is supposed to carry both along with it. Measuring milieu will therefore be limited to large and homogeneous habitats, surrounding more or less spherical organims (microcosms with free-floating algae) or to the use of dummy inhabitants. (Most measuring tools are not too realistic as dummies). In nature protection, habitat and milieu must be considered inaccessible for operational regulation. The organism as a subject of protective regulation may thus be replaced by a lump of universe which contains it and which is equal to or greater than the organism plus its milieu plus its habitat. This lump of universe, in a systems approach, is an ecologically 'working' black box.

Note that, with regard to this, nature protection differs from, for instance, agriculture. In agriculture, it is possible to develop new organisms, provided with biological programs making them more suited for breeding purposes. Moreover, in addition to protective regulation as nature protection uses it, agricultural regulation may be executed in the habitat itself. Examples are the supply of water and nutrients or the removal of 'natural ennemies'. In doing so, agricultural Man as it were by himself partly replaces the lump of soil which he would use in nature protection. The organisms concerned will presumably die back when Man does. For this reason, even when it would seem possible to do so, nature protection should not use regulation within the habitat. Here is the main difference between culturing and protection.

Ecodevices in an ecological field yield suitable habitats

Apparently, organism and remoter environment coproduce habitat and milieu in a supply and demand system. The organism part in this system is, by its biological program, invariable. If a certain habitat continues to exist, in spite of the organism feeding on and discharging into it, this is most likely caused by an upkeeping or protective machinery in the remoter environment. In the design of a survey for nature protection, this machinery is the black box lump of soil mentioned in the earlier paragraph. At the same time, this machinery may be able to stabilize the driving forces in spite of environmental oscillations or trends. Destruction or generation of habitats can thus be attributed to variations in the performance of this machinery, and, the other way round, man can improve it to deliberately protect habitats. The most typical example of such an improved habitat protecting device, is the human house. The type of machinery meant is therefore called ecodevices (Both & van Wirdum 1979, van Leeuwen 1981, van Wirdum 1979a), and, from the point of view of nature protection, classified according to the immediate user organism. Ecodevices, driven to produce or improve or protect the habitat of Homo sapiens are called humecs (houses, towns, arable fields, meadows, recreational areas, water purification plants, rubbish-dumpts, etc.), whereas those for the protection of nature (against the side effects of humec driving!) are called natecs (van Wirdum, 1981). There is some discussion about the use of the combination nature reserve today, but, typically, natecs are nature reserves and, anyhow, all nature reserves are natecs.

To safeguard minimum and maximum concentrations in the habitat to be protected, an ecodevice must be able to enlarge or diminish both the incoming and the outgoing flows. This combines into four basic functions: supply, disposal, resistance and retention (compare also van Leeuwen, 1979). It is convenient to use the generalized driving forces - phenomenological coefficients - generalized fluxes idea again, the phenomenological coefficients being represented by the ecodevice this time. As the driving forces show geographical gradients, they are described by an ecological field. The type of relation of the field, the device and the habitat (more precisely still: the milieu) with the organism is intuitively talked about as positional, conditional and operational respectively (van Wirdum, 1979b). Bad performance of an ecodevice can have two main causes: device failures or field failures. Organisms, however, do not fail. Main trends in environmental and nature protection are: striving at constancy in the ecological field; adapting otherwise unsuited local field properties; and reconstruct ecodevices. Examples of these respective trends are: emission control by law; surrounding a natec with buffer zones; and digging down a natec soil. It is possible to have a single grain of sand as an ecodevice, as well as the whole earth. Most applications however will concern devices of a degree of complexity somewhere inbetween. Smaller devices will be dealt with in practice as ecodevice components.

Ecosystems can serve to understand the use of ecodevices

Destruction or generation of habitats has been attributed to variations in the performance of ecodevices, and, the other way round, it has been said, man can improve ecodevices and drive them to deliberately protect habitats. It would have been convenient to name the human conception of real devices, in advance of their deliberate use, ecosystems. The system, thus, is a mental abstraction which helps man to understand things of nature. The device would be the realization of a modified system, helping man to have nature do things he wants it to. For this reason, van Wirdum (1979a) tried: 'An ecosystem is an explanatory system of extra-individual relations between a particular phenomenon of living nature and its environment'. The mentioned phenomenon, or 'ecotopic', should itself be considered a dependent factor. The ecotopic can be an individual organism (marginal case), a species, a population, a set of such things, or, probably, the occurrence of certain soil types, (un)polluted waters, etc., which can be regarded phenomena due to living nature. Sloep (1980) hit at an apparent lack of formal rigidity in this definition and made a pro parte reconstruction, which should be accepted as a typical case: 'An ecosystem is a system of formal non-trivial relations of properties of a biological species and properties of its environment'. He argues this typical case is a very unusual one, as it allows for a species to be the subject. Is the present ecosystem the same logical entity other authors on ecosystems seek to talk about? Three points can be made with respect to this question.

At first, many authors say you can walk in an ecosystem, photograph it and identify it with an identification key (Ellenberg, 1973). Straightforwardly, Odum (1975) makes it a synonym of the biogeocoenose (compare also Fortescue, 1980). Yet, Tansley (1935), claimed the ecosystem is the fundamental concept appropriate to a biome considered together with all the effective inorganic factors of its environment. Effectiveness, now, might be slightly different from just being there! Moreover, Odum stresses the holistic idea with the wellknown example of the water molecule, the properties of which are supposed to be different from what can be expected from the properties of both elements present. Exactly this key point of systems is lost in the way biogeocoenoses are recognized: a biogeocoenose is determined by saying, to put it that way, two H plus one O is water. It might well be that the only property that can be ascribed to what is conceived as a system in the whole thing, is just the occurrence of certain species. So, if a particular phenomenon of living nature (which may be a biological species) is the emerging property of a certain biogeocoenose as a system, it is all perfectly in order. If, however, the local presence of the biogeocoenose is the emerging property, the abiotic factors considered effective, will only rarely be confined to the same horizontal area where the biogeocoenose can be recognized and so the whole system will.

At second, many authors mix up their holistic views with the idea of superorganisms. To be operational, my definition requires the user to state how much explanation is desired. Otherwise, the ecosystem concept would converge with the universe one. Here, Margalef (1968) is found paving my way: "Any ecosystem under study has to be delimited by arbitrary decision, but one has to remember always that the imposed boundaries are open, and that the sort of interaction going on across such boundaries is dependent on the properties of the two systems on either side of the boundary. With this proviso, all the problems of defining closed ecosystems, limiting superorganisms, etc., happily vanish. The open ecosystem is also suggested by Jenny (1958). The arbitrary decision in defining the extent of a system is indicated in many more or less fundamental systems texts. The point probably is, studying a moorland pool algae vegetation as a microcosm, differs from being a conservationist involved in the protection of species bound to land gradient belts. Consequently, however, also the recognizability of biomes and biogeocoenoses is doubtful, unless it is done by systems analysis as defended herein.

At third, there is discussion whether a system is some concrete part of reality (like with Margalef and also like a biogeocoenose), or an abstraction of it. In physical sciences, such definitions as (just an example is quoted): "The part of the universe under study in thermodynamics is called the system" (Levine, 1978), can be found. Obviously, however, the students of those systems have a very abstract picture of the universe, provided with frictionless axes, adiabatic walls and more of this type of phantasy things (see textbooks, e.g. Kronig, 1966) and they seem to hate too open systems. In Systems Theory, much emphasis is on the abstraction to be made (compare Pask, 1961), and Sachs (1976), dividing between a teleological and a structural-relational approach in systems science, is clear about the latter:"... this approach fails to capture the essence of the notion of system, as that term is generally understood among systems scientists". If we accept that the reality of those physicists mentioned is just their mental image of reality, having more or less closed systems justifies the fact they do not always confine their systems according to definite would-be emerging properties. Land ecological reality however probably does not afford this type of systems. As it has been stated in the second point, ecosystems are fundamentally open. Now, effort in finding boundaries in reality is no longer mainly to limit the system, but to limit what one is going to study the system of. Thus proceeding, systems will gradually build up ones operational image of reality.

In the setting of nature protection, the ecosystem concept tells there is more than just directly operational influences of man on populations of threatened species. Protection is to be done by improving their 'houses', which we conceive as ecosystems. The systems idea should guide inquiries of real devices of unknown internal composition and handling instructions. In the whole process of inquiry, the internal composition may stay unknown, but knowledge of the handling instructions must be gained to enable the draft of a user's manual, refering to the organization of the device. This organization is the system.

Organisms are used in driving ecodevices

The ecodevice is deliberately used by bringing the most damageable elements of reality in the regulatory part of the ecosystem under human protective control. Thus, the beneficiary will be made less sensitive to undesired environmental influences. The organism is the typical beneficiary of ecodevices, but it is also used as part in the devices themselves. The internal structure of an organism is only considered by saying it is provided with a fixed biological program. If there is no organism available which has the biological program desired, it can sometimes be made e.g. by a process of adaptation to a standard available ecodevice: domestication. Of course, this does not apply to an organism which has to be protected.

According to their type, organisms are applied in driving ecodevices, either as working or as sensory parts, or they are the goal of the whole thing. In the use of organisms, no stochastic behaviour of any importance should be allowed.

Apparently, three types of organisms can be distinguished:

a) Goal organisms (goalos), their presence being the emergent property of an ecosystem and the goal of an ecodevice. Examples: Homo sapiens is the goalo in all humec driving. In the independent use of specialized partial humecs, as in agriculture, e.g. cow is used as a substitute goalo. Carex dioica is a goalo in nature protection in The Netherlands. If more eatable or less demanding stuff or species can be made or found, agriculture will drop cow; if Carex dioica is no longer threatened in

The Netherlands, it will be dropped by nature protection. Man will presumably never be dropped as a goalo.

b) Working ecodevice component organisms (wecos), doing physical labour within the ecodevice. Examples: cow can be an important weco in nature protection. Horse formerly was in agriculture and urban technique. Now, it has been replaced by tractor and car respectively.

c) Sensory ecodevice component organisms or indicatory organisms (indos), sensing changes of ecodevice performance and informing the ecodevice driver about this. Examples: lichen species are indos in the atmospheric branch of environmental hygiënics, like Escherichia coli is in the water branch. Dirkse (1977) gives an interlocking series of indos, composed of Carex species, each of which is most useful once the next is goalo in nature protection. If improvement is aimed at, as it basically is in techniques, the first missing species in the series should be goalo until it is there and indicates moving on to a next goalo is opportune.

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