Ecological Open System Management for Human Impacted Ecosystems

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Abstract

Only a few decades ago, it was cleared that our global ecosystem cannot be assumed as infinity. Thus to seek an answer about a question: "how our society can be robust in a limited space", this preface was introduced, and two paper were invited from young researcher to make a discussion.

In this preface, a consistent rule was sought on four desiderata to discuss about ecological open dissipative system (ODS) management. Then basing on Kitano(1999) 's hypothesis, the trade off among the three systematic characters, such as robustness, resource demands, and performance, and locally another trade off between robustness and fragility were considered. In this order, a simple Boolean algebra from Bayes' theorem was shown to analyze the structural profiling for ODS.

Preface

Only a few decades ago, it was cleared that our global ecosystem cannot be assumed as infinity (Meadows *et al.* 1972), hence it also expressed wherever on the earth, any parson is already implicated chronic problem originated from historical human activities. The issues such as "Rapid Globalization" and "Global Environmental Problems" had been permeated to our obvious essential habitat of the global ecosystem. After the definition of worldwide human impact inundation, it already becomes our responsibility to seek solutions for the issues in the sense of sustainable ecosystem management. A science of our living space, so called, ecology is biology of ecosystem (Margalef 1968), which is the study of systems at a level in which individuals or whole organisms may be considered elements of interaction, either among themselves, or with a loosely organized environmental matrix (Margalef 1968). In this point of view a unit of ecosystem is a mate of interdependent subunits, which exchanges resources with adjacent elements. Fore example, land almost always appears as a mosaic from an airplane. A mosaics of a landscape appear as a patterned of land use patches with a regional background. The mosaic patterns are found at all spatial scales, from submicroscopic to the planet and universe, where ecological units are fully integrated holistic entity. Here, the meaning "whole" is more than the sum of its parts and that should, there fore, be studied in its functional totality (Toroll 1971). Here, it can be said that nonlinear is one of the most intrinsic characters of an ecosystem, so that the systematic wise use of ecological material and management of the dependability among its subsystems become natural demand for sustainability.

Before making discussions about sustainable ecosystem management for human impacted ecosystem, I would

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like to propose a set of desiderata that is a natural desire for our discussion to illustrate our logical position. The first is open system (i). Living system, from cell organelles to organisms or to ecosystems, are open dissipative systems in the sense of Prigogine (1961), which involve both open dissipative systems (ODS) with and without gene. Needless to say, in the narrow sense, open dissipative systems function with gene is the only essential for living system; nevertheless I apply wide sense to open dissipative systems to deal faithfully with the discussion for ecological ODS management. The second is mathematical context (ii). If we accept an idea which discussion is a consequence of Jaynes' desiderata (Jaynes 2003), such as a) representation of degrees of plausibility by real numbers; b) qualitative correspondence with commonsense; c) consistency, namely a uniquely determined a set of qualitative rules exists for conducting inference. The third is management (iii). Because only ODS in operation state can be administrated (Tokoro 2009), and because ecosystem is to be nonlinear system, an ODS is considered to have attitude to monitors its behavior of all part of the system at any one time, then the system architecture has been improved. Such an autopoietic-continuous behavior actualize character in both evolution and robustness of an ODS (Tokoro 2009). There fore to approach a solution of the generally considerable public problems, fore example, energy, population, food, biodiversity, disparity and security, needs to be considered via continuous improvement of ODS plausibility. The fourth is robustness (iv). According to Kitano (1999)'s hypothesis, robustness is an intrinsic property of biological systems, which can be extended to ODS, and which enables ODS to maintain their functions in the face of various perturbations (Kitano 1999; Csete & Doyle 2002, 2004). In addition a biological system have to be robust yet evolvable, which requires trade-offs among the three systematic characters, such as robustness, resource demands, and performance; locally, there are another trade off between robustness and fragility (Kitano 1999). This imposes constraints on the type of architecture and mechanisms that constitute ecological systems.

From this line, let us seek a consistent rule on the desiderata relating ecological ODS management. The desideratum (i) is the intrinsic structural requirements of ecosystems. It is a sense that an ecosystem is defined as a set of ODS, which take the form of "holes" opened across a socio-ecological gradient through which power can be extracted and made to perform work (Margalef 1996). In relation to such a definition, any ecological equilibrium such as an individual, a population, a community, a watershed, a country, a culture, and a social regulation also are to be ODS, which charging free energy (negative entropy) and discharging waste (positive entropy). Here important definition is that human beings are also taking a part of great ODS of global ecosystem as an adaptive –self organized subsystem. Desiderata (ii) turns out uniquely determine the rules by which any ecosystem behavior must reason, *i.e.* there is only one set of mathematical operations form manipulating plausibility of a ecosystem properties. It gives logic of plausibility of ecosystem elements assigned to its proposition. Fore example, when sub-ecosystem type A will, in general, depend on whether related factor B is true, following the notation of Keynes (1921) and Cox (1961), we indicate this by the symbol $A|B$, which we may call "the conditional plausibility that A is true, given that B is true". It stands for some real number. Thus, fore example, $A|BC$ represents the plausibility that A is true, given that both B and C are true. Or $(A+B)|BC$ represent the plausibility that at least one of the propositions A and B is true, given that both B and C are true, and so on. Thus, if it has old ecosystem type C_1 that gets updated to C_2 in such a way that the plausibility for A is increased: $(A|C_2) > (A|C_1)$. Then, when segregation of the ecosystem between C_1 and C_2 shows better plausibility as system C, the subecosystem types coexist as components of the ecosystem C, respectively. Here, when a ecosystem C is composed of sub-ecosystems such as C_1, C_2, C_3, $\cdots C_i$, plausibility among these components shod be equal, and a Boolean algebra from Bayes' theorem could be applied to analyze the structural profiling, such as,

$$F(C_i|A) = \{F(C_i)\, F(A|C_i)\} \,|\, \Sigma\, \{F(C_j)\, F(A|C_j)\}$$

where F is flux of ecological material, C_j is a sub-ecosystems (k=1, 2,$\cdots$, j), $\cdots$, C_i is one of these (k=i), and A is

ecological material, $F(C_k|A)$ is supplement of ecological material to C_k, and $F(A|C_k)$ is capture of ecological material by sub-ecosystem C_k as likelihood. In this sense, as ecology is biology of ecosystem, ecological complex system should be analyzed as problem of allocation of ecological material among sub-ecosystems (C_j). Then $\Sigma F(C_i|A)$ could be indicator for optimization problems of C.

The desideratum (iii) is attempt of deducible inner working of an ecosystem. Fore example in a human impacted ODS of which human being is already a part of itself, accordingly, in a natural sense, a ODS is to be analyzed in a concepts of continuous system management (so called total quality management, adaptive system management, project cycle management, and so on). In the case, according to our ordinal sense, the artificial improvement of human impacted ODS through time is always being in the direction of increasing constancy. It may because the next state of the ecological system is more predictable and consistency is also better, however, such a higher performance requires additional resource. In addition, a new challenge to seek a better management adds only a small plausibility (Margaleff 1968), so that such a management system would be conservative. Here an ecological and economical problem is hidden. On the contrary, if the future state of the system is less predictable against the internal and external perturbations, the system cannot contain much subecosystem (in other word, *i.e.* information), and such a regime requires lower resource, moreover new attempt represents a relatively important contribution. Such system architecture would be more adaptive. Above all, it can be said that if a ecological system prone stability in the face of internal and external perturbations, according to desiderata iv-1, more resource requirement and more complexity would be a consequence. However inconveniently, it is already clear that human being need to survive in restricted habitat of our global ecosystem by limited resources (Meadows *et al.* 1972), so that "how our society can be robust in limited space" is to be the critical issue. In this preface of featured articles, in no case do I pretend to revolutionize the table of contents of any future textbook of ecology. My aim is only to state the context in which I believe it is possible to speak of a theory of ecological open system management. A simple example to tackle an environmental problem (at level C) is activities to optimize the resource allocation among its subsystems (C_j), or to create new subsystem against a particular problem via introduction of additional resource and technology. However according to desiderata iv-2, it also consequence that easy introduction of new resource is coincide with existing new problem of the waste (positive entropy) management, so that to symplize the system architecture or saving the material flowing are also being intrinsic consequences.

In this context, Shazwin *et al.* (2010) has discussed harmonization the environmental problems between biomass waste management and energy supply via implementation of the Japanese technologies to Asian developing countries. It may contribute to evoke the pressure on natural resource utilization and generate excessive amount of waste, and increase the greenhouse gasses emission. Of course to implement a new ecosystem element (C_j) may provide new performance but it require resources, however as if it successfully charge enough free energy (negative entropy) in the particular ecosystem, that attempt is considerable to improve the environmental problem at the system level (C). On the other hand Luchman and Nakagoshi (2010) has issued the responsible travel to a natural area with the objectives of studying and enjoying the scenery, that form of environmentally sound business and clean industry (*i.e.* Ecotourism). The geographic data was stored in a computer system and analyzed via GIS. Then destination design was simulated based on spatial distribution information of tourism capitals and their bio-physical characteristics. The synthesized design of environmental information for Ecotourism is expected to function the advantages in order to accommodate tourism needs and biodiversity conservation. Such an information oriented environmental sound business is also can be defined as a new ecosystem element (C_j) in the research site.

In this featured articles, following two papers discuss to create new sub-ecosystem element to prevent particular environmental problem, but it is not discuss whether these contribute to robustness or fragility of the ecosystem. It is challenging however to develop a study to answer a question: "how our society can be robust in a limited space" that will naturally be important in environmental study in coming decades, we would like to continue a discussion.

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