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Od zrównoważonego rozwoju do zarządzania zrównoważonym eko-socjalnym systemem.

From sustainable development to management of sustainable ecosocial systems

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Abstract

The essay briefly refers to the etymology of 'sustainability' and to its current use in the development of nations, agriculture and ecology. In absence of a singular consensual definition, we are advised to try as best we can to make use of the concept in development efforts. In agriculture, sustainable agroecosystems are designed and implemented to overcome the limitations of the industrialized agriculture with respect to the resource base. In ecosocial system study and management, 'sustainability' characterizes the state of the system. The concepts of ecological, economic and social sustainability as well as capitals, health, integrity and resilience appear to allow different but complementary assessments from different perspectives. Ecological, economic and social sustainability are used to study the response of an African agropastoral system to livestock health improvement. Economic and social sustainability appear to increase, but the progress is not sustained by the changes in ecological sustainability. To improve their livelihood, the agropastoralists are advised to implement rules for the prevention of overgrazing and undertake reproductive health measures in an effort to navigate, in a balanced way, the ecosocial system in ecological, economic and social dimensions.

Keywords: ecological, economic and social sustainability, livestock health improvement, ecosocial system response, ecosocial system navigation

Introduction

Since long times human faced the problem of utilizing natural resources without depleting the basis from which they originate. Under European conditions, for example, the principles of alpine agriculture date back to pre-Roman Rhaetic times (Altieri M. 1991), and there are indications that the implementation of maximum stocking rates for alpine pastures has a long history. Possibly by trial and error, alpine communities learned that the application of strict rules with respect to stocking rates is a prerequisite for erosion control and continuous exploitation of high alpine environments. In fact, alpine communities are among the agricultural systems with a long history of existence in balance with the natural environment and therefore, contributed to the identification of design principles common to long enduring agricultural systems (Anonymous, 1987). In a subsequent section of this essay we will learn that a developing agropastoral community in Ethiopia, East Africa, also faces the problem of restricting stocking rates to prevent overgrazing possibly under more difficult conditions than the ones faced by alpine communities in the past. In forestry, an administrator of the town of Reichenhall defined in 1661 the rule for an 'eternal forest' where the amount of yearly harvested wood should not exceed the amount of regrowth per year. In the 18th century, this practice was qualified in Germany as sustainable use of forests, and the 'harvestable wood' appeared as 'sustainable yield' in the English language (www.wikipedia.com). In the past decades, the term 'sustainable' has been increasingly used to qualify resource management systems and their exploitation, while the term 'sustainability' is often referred to when characterizing the state of a system. Both terms have been used in different contexts and served as a basis for the report of the Club of Rome (Baumgärtner J., at al,2007), for the Brundtland

report of the United Nations (Becker C.D., Ostrom E., 1995), for the declaration of the Rio de Janeiro conference on development, for the recommendations on the re-orientation of Agriculture (Berkes F., Colding J., Folke C., 2002), and for the overall objectives for ecological system management defined by the Ecological Society of America (Carlman I., 2005). These are just few of many possible examples that show the predominant position that the term occupies in modern debates on the needs of human societies in relation to nature sustaining them. In this essay, we will briefly look at the use of the term in the development of nations, agriculture and ecology. Thereafter, a case study will show the important contribution of sustainability assessment to the development of an agropastoral community.

Sustainability in theory

Sustainable development

The Brundtland Commission of the United Nations used 'sustainable' as an adjective to qualify development. Accordingly, sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs (Becker C.D., Ostrom E., 1995). In 1992, the Rio de Janeiro conference committed many countries to environmental restoration, preservation and social development and declared sustainable development as a guiding principle for the development of nations. In spite of its reconciliatory potential, it has failed in practice to resolve enduring conflicts because there apppears to be no consensus on what 'sustainability' means (Christensen N.L., at all. 1996). This problem is illustrated by more than 70 translations into the German language and by the interpretation given by different contributors to the wikipedia encyclopedia (www.wikipedia.com) to sustainable development. For example, the contributor to the Italian version of the wikipedia encyclopedia includes the preservation of the heritage in sustainable development. He might have thought of the words of the Austrian artist Hundertwasser who reportedly wrote that we lose the future if we don't honor the past and that we are unable to grow if we destroy our roots (Comiskey J.A., at al, 1999.). For the contributor to the French version, 'sustainable development' implies equal rights to share resources (space component) and preservation of resources for future generations (time component). According to him and to the Spanish contributor, the consilience of ecological, social and economic preoccupations are the pillars of sustainable development. It has been argued that we should abandon our search for a singular, consensual definition of sustainability, but try as best we can to make progress in the absence of consensus (Christensen N.L., 1996). This is done here by using sustainability to characterize the state of agricultural and ecological-social systems rather than processes and using it to put the development of an agropastoral system in Ethiopia on the three pillars specified above for assessing the state of the system with respect to improvement of the people's livelihood.

Sustainable agroecosystems

Agriculture has developed in response to the needs of the society since its beginnings 10'000 years ago (Cuperus G.W., at all 2004) These needs have contributed to a gradual intensification of agriculture over centuries. During the 1960s, at least in the Western World, this process of intensification has gathered momentum (Cuperus G.W., at all 2004) and profoundly changed farms and landscapes with negative consequences. Today there is a growing concern that modern agriculture destroys its own resource base, probably because of intensive use of external inputs displacing many natural biological and ecological processes and functions in ecosystems (Czeresnia D., 1997). In response to drawbacks resulting from the unilateral reliance on synthetic pesticides, for example, Integrated Pest Management (IPM) schemes were designed and implemented (Daily G.C., 1997). In the past decade, the IPM concept was extended into dimensions of space (crop arrangement), time (rotation), objects for management (crop specific rather than species specific programs) and actors involved (from growers to extensionists and policy makers) (Dent D., 1995). This development bridged the gap between organic agriculture and agricultural production forms relying on intensive chemical inputs and paved the road to a more holistic way of studying and managing agroecosystems with sustainability as a major objective (Flint M.L., van den Bosch R., 1981). According to M. Altieri, University of California, Berkeley, sustainability is the capacity of an agroecosystem to maintain the production through time, facing ecological limitations and long term socio-ecomomic pressures (Berkes F., at all. 2002). S.E. Gliessman, University of California, Santa Cruz, uses 'sustainable' to qualify 'agroecosystems' and promotes sustainable agroecosystems that maintain the resource base upon which they depend, rely on minimum artificial inputs from outside the farm system, manages pests and diseases through internal regulating mechanisms and are able to recover from the disturbances caused by cultivation and harvest (Getachew T., 2006). In his view, agroecology corrects the direction taken by traditional agronomy that focused on individual crop plant or animal and neglected the complementary study of whole agroecosystems in its attempt to deal with complex issues of farm productivity and viability. The central priority in whole-system management is creating a more complex, diverse agroecosystem, because only one with high diversity has the potential for beneficial

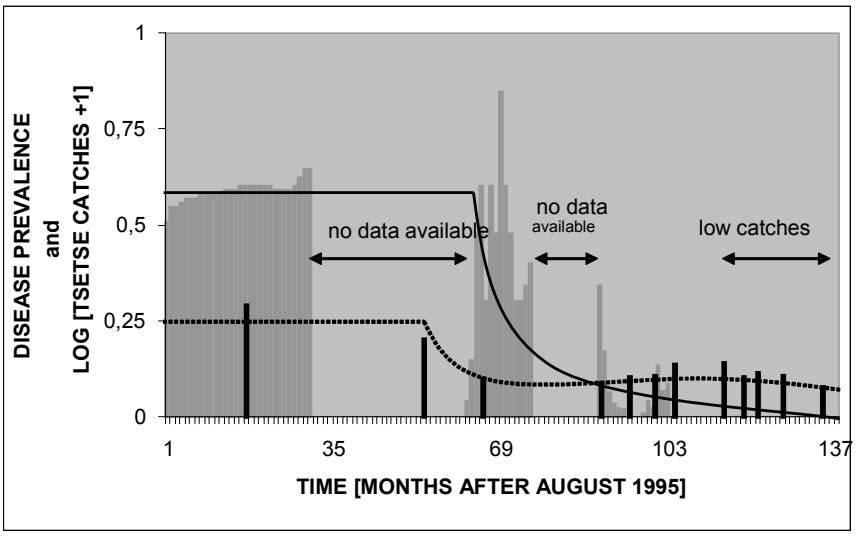
interactions. To evaluate sustainability, he uses unmanaged systems and traditional agroecosystems as reference points and proposes measures of agricultural sustainability including the assessment of soil health, a productivity index and ecological as well as social conditions to be approached. An agroecological approach should take a cultural perspective as it expands to include humans and their impacts on the agricultural environment (Getachew T., at al, 2006).

Sustainability enhancement in ecosocial systems

In modern ecology, sustained yield, in simplified way, is the yield per unit time being equal to productivity per unit time (Gilioli G., Baumgärtner J., 2007). Ecologists are aware of the limitations. i.e. the method does not take into account the dynamics of the system and focuses on a single biological unit that is managed for maximum economic return, rather than as a component of a larger ecological system (Gilioli G., Baumgärtner J., 2007). This may be seen as an ecosystem that provides services to mankind as described by G.C. Daily, Stanford University, Palo Alto; the services are conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life (Gliessman S.R., 2000). Importantly, the services are not restricted to the provision of goods but also to the provision of life supporting and life fulfilling services as well as to the preservation of options (Gliessman S.R., 2000). S. E. Jørgensen, University of Copenhagen, defined ecosystem as a biotic and functional system or unit, which is able to sustain life and includes all biological and non-biological variables in that unit; spatial and temporal scales are not specified a priori, but are entirely based upon the objectives of the ecosystem study (Czeresnia D., 1997). To emphasize the presence of humans in eocosystems, D. Waltner-Toews, University of Guelph, Ontario, and coworkers introduced the term 'ecosocial' and emphasized that ecosocial systems are complex (Goodland R., 1995). In their view, humans are no longer seen as external managers of systems but become their integral components. A complex system can be distinguished from a simple one by a number of attributes including nonlinearity, uncertainty, emergence, scale and self-organization that limit our ability to predict their dynamics (Gutierrez A.P, at al., in prep.; Czeresnia D., 1997).
Among the objectives for ecosocial system management are the enhancement of sustainability (Carlman I., 2005), the augmentation of ecological, economic and social capital (Gutierrez A.P., Regev U., 2005) and the enhancement of resilience, i.e. the capacity of the system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity (Herren H.R., at al, 2007). R. Goodland, formerly environmental advisor to the World Bank Group, Washington DC, distinguished ecological (environmental), economic and social sustainability. Ecological sustainability refers to the biophysical limitations of the environment in that humans live and supplies the conditions for social sustainability to be approached. Social sustainability refers to the cohesion of the community that is achieved by systematic community participation and strong civil society. Economic sustainability refers to the maintenance of capital that has been used by accountants since the Middle Ages to enable merchant traders to know how much of their sales receipt they and their families could consume without reducing their ability to continue trading (Gutierrez A.P., Regev U., 2005).
Adaptive management is a key strategy for moving ecosocial systems in ecological, economic and social dimensions and enables us to deal with complex systems and their unpredictable dynamics (Holling C.S., 1978, Jørgensen S.E., 2002). Adaptive management is a systematic and cyclic process for continually improving management policies and practices (tactics, strategies) based on lessons learnt from operational activities (Koblet R., 1965). In a continuous process of monitoring, monitoring data analysis and decision support ecologists can participate in ecosocial system development (Jørgensen S.E., 2002). The results of their studies are not directly communicated to end users but incorporated into a facilitation process, where a facilitator assists the people in meeting their management objectives (Kogan M., at al, 1999). In this development process, referred to as navigation (Meadows D.H., at al., 1972), the voyage becomes more important than meeting predefined long-term objectives.
The interpretation of indicators and the development and use of models provide the bases for obtaining insight into the dynamics of ecosocial systems. A.P. Gutierrez, University of California, Berkeley, and U. Regev, Ben Gurion University of the Negev, Beer-Sheva, developed a model that allows the analysis of the trajectory of the system in the phase space permitting an evaluation of resilience and other properties (Owen S., 2003). This model can be viewed as conceptual meta tool that permits the analysis of eco-social change and its consequence, and places the observed "change" in the context of interpretive dimensions (Röling N.G., 1995). With this property, the tool may become helpful to evaluate sustainable development projects carried out at international research canters (Röling N.G., 1995).

Sustainability in praxis

The object under study and management of interest to this essay is an agropastoral community named Luke in Southwestern Ethiopia. The overall aim of our project was to improve the livelihood of the people who suffer from multiple constraints including diseases and limited as well as insecure food supply, and are living in absolute poverty



Sector	Categories	Variable	1995	2005	2006
CATTLE HUSBANDRY	population	total number of cattle	574	2872	2634
		number of oxen	3	136	201
	production	milk [l day^{-1} cow^{-1}]	0.12	1.30	1.40
	reproduction	calving rate [$year^{-1}$ cow^{-1}]	0.068	0.56	0.64
LAND USE	area of Luke	total area	1500	1500	1500
	human food	area ploughed [ha]	12	506	546
	cattle food	area of pastures [ha]	440	295	295
		stocking rate	1.3	9.5	8.9
SOCIO-ECONOMICS	population	number of households	524	524	544
		number of residents	1834	2620	2645
	education	number of schools	0	1	1
		school children per household	0.03	0.42	0.62
		school attendance	10%	92%	94%
	income	income per household per month	15.6 USD	60 USD	148 USD

(Jørgensen S.E., 2002). We presumed that the removal or mitigation of health constraints would pave the road to sustainable development as defined in the aforementioned Brundtland report. In close collaboration with my colleagues A.P. Gutierrez and G. Gilioli, University of Reggio Calabria, Gallina, Reggio Calabria, we evaluated the project and its implications from the perspectives of sustainability enhancement and changes in capitals as well as resilience (Jørgensen S.E., 2002, Röling N.G., 1995, Smith R.L., Smith T.M., 2001).

This view was supported by the villagers who readily identified arthropod-transmitted diseases of people (malaria) and livestock (trypanosomiasis) as key constraints. Since they give priority to cattle health over human health, we provided assistance for developing and implementing an adaptive disease management system relying on odour baited traps to monitor and control tsetse vectors and drugs administered to infected cattle. The trap technology was selected because it was considered as a control strategy that is acceptable from ecological, economic and social standpoints (Walker B., 2004). The Figure shows that the project suppressed tsetse vectors and was highly successful in improving animal health, expressed in disease prevalence (Waltner-Toews D., at al, 2003).

During project execution, we occasionally monitored some ecological, economic and social variables. The data clearly show that the intervention (cause) not only resulted in animal health improvement but also in multiple and unpredictable responses as expected from a complex system. For example, the productivity of animal husbandry greatly improved, the availability of oxen permitted a substantial increase in the area under cultivation, and cattle numbers increased due to increased calving rates, decreased cattle mortality and purchase of animals (Waltner-Toews

D., at al, 2003). Moreover, the change from a predominantly pastoral to an agropastoral system increased ecosystem biodiversity that basically has the potential to contributing to enhancing sustainability and improve ecosystem service provision. However, the number of animals per unit area of pastures reached the levels far beyond the recommended stocking rates (Waltner-Toews D., at al, 2003). Consequently, the capacity of the resource base (pasture) to sustain the cattle decreased as has the sustainability of the agricultural system according to S.E. Gliessman's definition (Getachew T., at al, 2006). This trend is further aggravated by intensive land cultivation for human food production without undertaking adequate measures to enhance soil fertility. From the standpoint of ecosystem service provision (Gliessman S.R., 2000), the shift towards agricultural development may have eroded the capacity of the ecosystem to provide life support to the Luke community.

The Table also shows that an assessment of the effects of the intervention should go beyond animal health and agriculture. We observe an increase in income and investments into animal husbandry (purchase of cattle) and a school. Both investments may reflect an enhancement of economic sustainability. Trap maintenance and service for tsetse monitoring and control, drug administration and management of a school require a more complex social organization and a more cohesive society than was present at the beginning of the project. This change is seen as an increase in social sustainability. However, we also expect a decrease in the fertility of cultivated land and a decreasing capacity of the pastures to provide food for the cattle. In other words, the depletion rates are higher than the rate at which renewable substitutes can be created. Hence, there is a decrease in ecological sustainability. We are afraid that the ecological system is unable to sustain the increasing human population and that there will be serious consequences for the livelihood of the people. The results appear to confirm R. Goodland's assertion that ecological sustainability is the basis for social sustainability and support our recommendation to seek sustainability enhancement through a balanced move in ecological, economic and social dimensions (Jørgensen S.E., 2002).

A further analysis of ecosocial system responses indicates that the assessment of sustainability provides useful albeit limited insight into the structure and functioning of the system. Possibly, an assessment of system health and integrity could be useful but has not been done so far. The complementary assessment of ecological, economic and social capitals, however, provides additional insight (Jørgensen S.E., 2002). Possibly, the ecosocial system has become more vulnerable to disturbances such as drought indicating a decrease in resilience with serious consequences for an increasing human population. The concepts of ecological, economic and social sustainability as well as capitals, health, integrity and resilience appear to allow different but complementary assessments from different perspectives. Hence, the system navigation principle (Meadows D.H., at al., 1972., Gutierrez A.P, at al, in prep.) should be used in an adaptive management framework that continuously tests and evaluates systems against several complementary characteristics.

The ecosocial variables appearing on the Table may be seen as indicators that allow the assessment of the ecosocial system as done in the previous paragraphs. The bioeconomic model (Owen S., 2003) further improves the insight into ecosococial system evolution, structure and dynamics and provides decision support for the corrections of actions undertaken to navigate the ecosocial system. Specifically, the bioecomic model is able to explain changes in sustainability and other ecosocial system characteristics and stresses the need to seek societal rather than competitive solutions (Owen S., 2003, Röling N.G., 1995). In other words, the Luke community may follow the example of alpine farmers referred to at the beginning of the essay and implement strict rules for stocking rates. They are also advised to undertake reproductive health measures in their attempt to navigate the ecosocial system in ecological, economic and social dimension for improving the livelihood of the people and achieving sustainable development.

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