Available online at www.sciencedirect.com
SCIENCE DIRECT®
Ecological Modelling 178 (2004) 171–175
ECOLOGICAL MODELLING
www.elsevier.com/locate/ecolmodel

Short communication

Applying HT Odum's concepts and principles in developing countries

Vito Comar
State University of Mato Grosso do Sul-UEMS, Dourados, Brazil

1. Introduction

HT Odum developed a powerful visual language (see Brown, this volume) that fosters integration, inventorying and overviewing systems of all scales. With my discovery of his work, I became intrigued at the range of possibilities this new dimension of communication brought to our thinking and understanding of processes. I began working towards using it to better understand the challenging systems I was working with in Brazil. Because of my late introduction to science, having been trained as an architect, I felt I had little to contribute to the appreciation of H.T. Odum's work, but the spirit with which he and Dr. Mark Brown accepted me as a curious and hard-headed apprentice in 1991 convinced me to chance this presentation. This contribution has to be viewed, then, as a personal appraisal of the potential of using symbolic energy language to map and clarify questions within everyday challenges. The paper presents two different uses of systemic language and the perception it offers when used together with the emergy methodology and practice, namely: (a) an experience in integrated formal and informal education program within rural settlements in the Brazilian State of Mato Grosso do Sul; (b) a socio-environmental assessment, using the emergy methodology, of families living within the largest Brazilian National Park, Jau, in Central Amazon.

E-mail address: vito@uems.br (V. Comar).

2. Education and rural settlements, an integrated approach

Recently, our university (State University of Mato Grosso do Sul) was invited by one of the Brazilian Federal Government bodies for the promotion of science and technology to structure, in a joint venture with other teaching and research institutions, an integrated state development program for rural settlements which would involve education, health, agricultural production and a permeating concern for the conservation and protection of natural resources. Although the process involved several phases, I present here the diagram (Rural Settlement, Fig. 1) that initiated our thinking into the workings of the program and which gave us an important insight into the relatedness of formal and informal education to community development, rural production patterns and job generation.

The Historical Process of rural development represents here the driving energies, first circle to the left, whilst the minor influences, or forcing functions, are represented by the agencies that are offering support to the process. All of these are symbolized by circles at the top of the diagram, outside of rural settlements limits, and their imports are applied to specific components within the system. These agencies are: the State University, INCRA (National Institute of Agrarian Reform), CNPq, PRODES (State Secretariat for Production and Development), various other government bodies, non-government organizations (NGOs) and

doi:10.1016/j.ecolmodel.2003.12.011

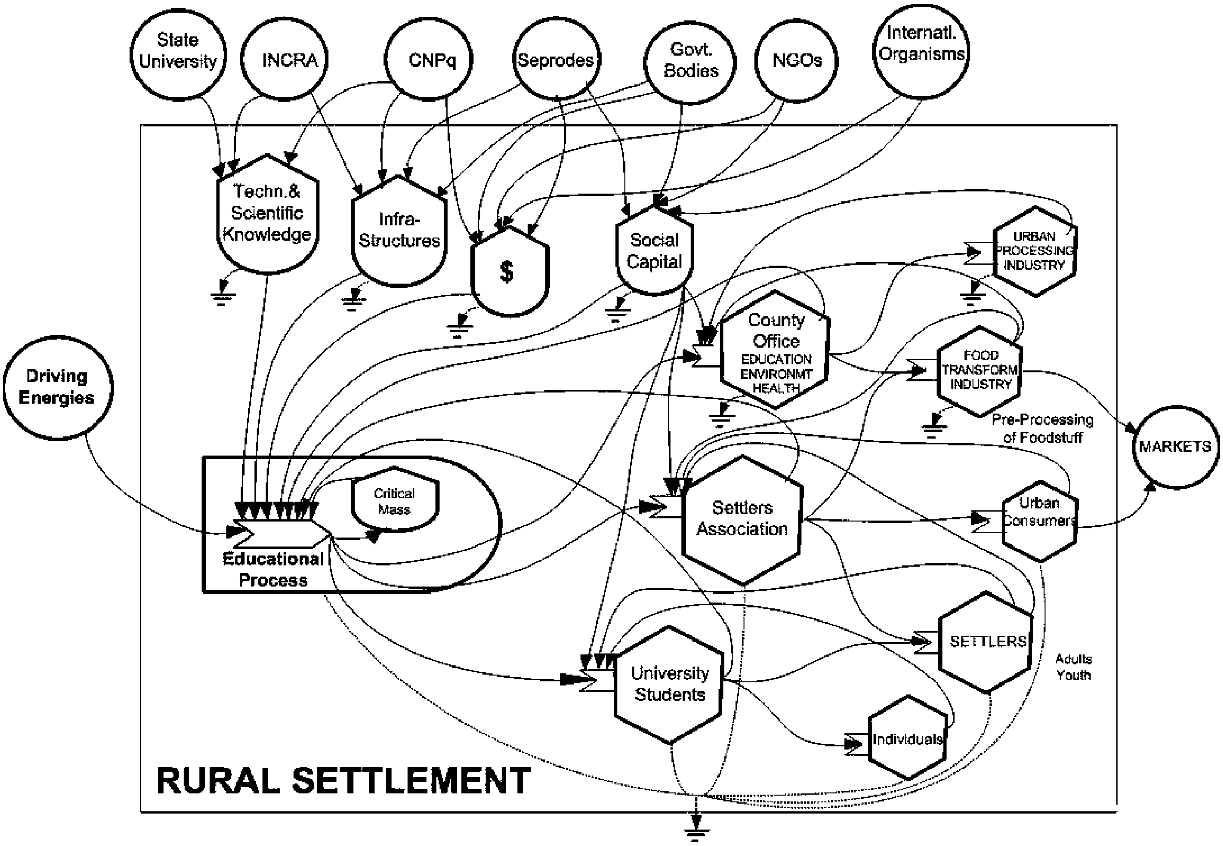

Fig. 1. Energy systems diagram of a rural settlement that was used to develop insight into the relationships between formal and informal education to community development, rural production patterns and job generation.

international funding organizations. Together, they provide, besides funding and administrative structure, scientific knowledge, infra-structure and 'social capital'[1], that act as stocks to project development.

The main production function here is the Educational Process, represented as a bullet type symbol to the center left of the diagram. This process, and the critical mass it generates within the settlements, is conceived systemically as the fundamental factor within a novel socio-cultural dynamics aimed at establishing a more harmonious relationship between man and environment.

For production to occur smoothly it receives contributions from all stocks (scientific knowledge, infra-structure, funds and social capital) and constantly needs information received in the form of feedback from all potential 'users' (county office, settlers and university students). As any live system, the Educational Process has to build structure, its '*critical mass*', which represents the core of faculty, extension officers and community agents working within the project. Ample time and resources have to be allocated and planned for to strengthen this inner core and the implementation of the processes it recognizes as fundamental to the achievement of project goals.

The Settlers' Association, the County Office and the University Students involved, represent the

[1] *Social capital* can be defined as a system of shared ethical values, transparent administrative procedures and participative community processes that facilitate the identification of local potentialities and fragilities, the construction of a common vision, the design and implementation, monitoring and revaluation of society's goals within a collective action plan.

immediate, or primary, consumers of the educational process and are characterized by the hexagons. Rural and associated urban production systems are then secondary consumers, with their products going to outside Markets (circle to the extreme left). Products price is another important factor for this integrated system of production and food processing.

Diagrams of this type helped with the overall implementation and participatory processes in the community education program. We used HT Odum's concept of a systems language as he originally intended. in his book "Environment Power and Society"

> ... "Many of the advances of mankind have come from microscopic dissections. Yet in the twentieth century the ever-accelerating knowledge of the microscopic view has not provided us with the solution of some classes of problems concerned with man's environment, his social systems, his economies, and his survival, for the missing information is not wholly in the microscopic components or in identification of the parts. Man now sees the world of parts well indeed. But he is only beginning to see the systems of which he is one of the parts ... we find the contemporary world beginning to look through a macroscope of systems science and acquiring ways to discern the broad features and mechanisms of a system of parts."

In conclusion, the diagram was able to assist in integrating team participants, proposing administrative procedures and helping with project evaluation, besides stressing the importance of establishing constant feedback mechanisms to grant efficient monitoring and a participation-based project design and implementation.

3. Jau's National Park, Central Brazilian Amazon

3.1. Emergy and socio-environmental assessment

Jau's National Park, in the Central Brazilian Amazon, is the largest Brazilian National Park, with an area of 22,720 km^2 (a rectangle of approximately 300 km × 100 km). Established in 1986, it was designed to protect the Jau River Basin, draining into the Rio Negro River, and encompassed the Paunini and the Unini Rivers on the North and the Carabinani River, on the Southern limit of the Jau's watershed. At the time of this social-environmental assessment, in 1992, the park housed around 300 families, settled along these four rivers. The assessment initiative came from the Vitoria Amazonica Foundation which had already carried out a demographic survey in the previous year, 1991. The Foundation's main objective was to understand the dynamics of the relationship between the resident human population and its natural resource use, to be able to produce a management plan and clear guidelines for public policies for the park.

Odum (1996) has said, "One way to predict the consequences of change in a system is to draw a systems diagram as a model, including values for flows and storages. The relative magnitude of the change can be compared with the normal. Such approaches, which relate the parts and configurations of their connections to performance, are in the realm of the science of systems." To evaluate flows and storages of the Park and its inhabitants we developed a systems diagram for inventorying the main flows and storages and then employed emergy evaluation (see Hau and Bakshi this volume) techniques to assign values.

The systems diagram in Fig. 2 shows the three main producing sub-systems: (a) forests, from whence locals obtained vines and non-wood extractive products; (b) settlers' grown mandioc fields; (c) orchards dispersed within the forest. Hunting and fishing were also very important activities for the local population, although, being a National Park, it was difficult to obtain information on them and much of it had to be inferred. Goods (mainly sugar, coffee, some foodstuff, batteries, remedies, gunpowder and ammunition, etc.) had to be bought from riverboats monthly visits. These boats also left with locally extracted or produced goods (a variety of natural vines, latex-rubber, mandioc flour, etc.).

The diagram shows the three main producing sub-systems: (a) forests, from whence locals obtained vines and non-wood extractive products; (b) settlers' grown mandioc (tuberous arbustive plant) fields; (c) planted orchards and fruit trees dispersed within the forest. These products represented in emergy terms 7E11 sej per year and the received total yearly income for them was of US$ 113,414.00. With this money, the settlers bought US$ 123,283,00 worth of goods per year, which leaves US$ 9,869.00 unaccounted for. The inference is that this extra income came partly

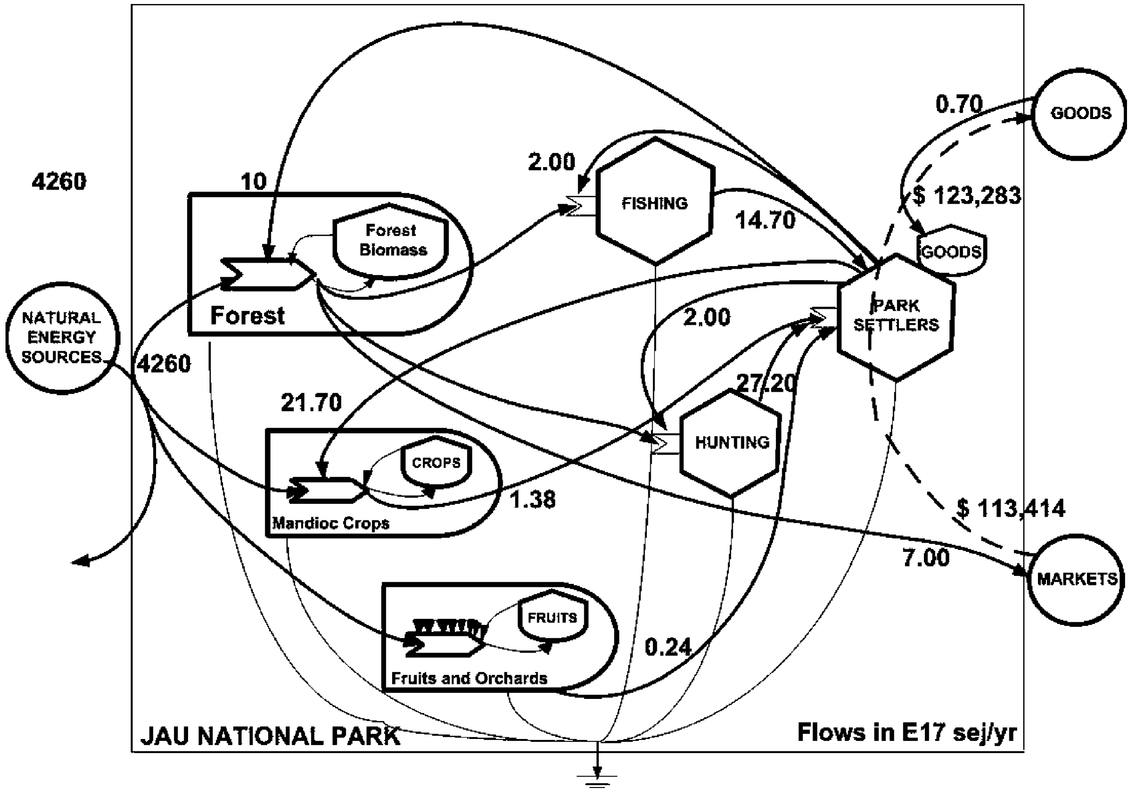

Fig. 2. Energy systems diagram of Jau National Park in the Central Brazilian Amazon.

from illicit sale of products, probably live and/or dead fauna, and was also partly due to gifts or direct payment from politicians in exchange for goods and services. This is a common procedure in the region for there were constant reports of 'important people' coming to fish in the park and returning to Manaus with boats full of fish catch.

Settlers eat mainly fish and game for protein and complement their diet with mandioc flour, locally grown grains and fruits.

Tending crops and making mandioc flour are the greatest emergy investment for the community, 21.70 E17 sej per year, as against 1.38 E17 sej per year of produced flour, most of which they consumed. They combined this activity with extracting forest products, 10.00 E17 sej per year invested for a production of 7.00 E17 sej per year, which are mostly sold, collecting fruits in the forests or planted orchards, almost no effort to 0.24 E17 sej per year produced, and fishing, 2.00 E17 sej per year in effort for 14.70 E17 sej per year and hunting, also 2.00 E17 sej per year invested, for 27.20 E17 sej per year, as summarized in Table 1.

Fishing and hunting are very lucrative on an energy and emergy balance, as just 2.00 E17 sej per year of fishing or hunting efforts result in high gains. Normally, fishing should be more advantageous then hunting, but data was inadequate and probably vitiated by the fear of being punished by government authorities.

One of the most important findings that the assessment pointed to was the net advantage the world outside the park was receiving from the settlers' products, exactly 10 times more, from an exported 7.00 E17 sej per year, to a meagre 0.70 E17 sej per year in products bought, and still with a deficit of US$ 9,869.00 per year. US$ 32.89 per family is quite a lot per year, considering we are dealing with a 90% informal barter economy, where cash is hard to find. This is analogous to what happens to 'donor countries' of the poor world, which sell primary products and receive almost no value in return, whilst degrading

Table 1

Activity	Investment in activity E17 sej per year	Total activity (%)	Production in E17 sej per year	Total production (%)
Mandioc production	21.70	60.78	1.38	2.73
Forest products extraction	10.00	28.01	7.00	13.86
Orchards–fruit picking	Negligible	Negligible	0.24	0.48
Fishing	2.00	5.60	14.70	29.10
Hunting	2.00	5.60	27.20	53.84

their natural resource base and worsening their social condition.

The other insight was the impact of even a relatively small human population and its very low density on local fauna (53.84% of all production) and the urgent need for a program of environmental education that would enable authorities to convert traditional hunters into park husbandmen and caretakers.

4. Conclusions

HT Odum's work, and especially his systems diagrams, inspired me to have the courage to think in terms of overall systems dynamics, to consider the real forcing functions behind processes, would they be related to biophysical and social principles or historical happenings. It trained me to consider possibilities and define them in diagrammatic form, thus being able to share them with colleagues and general public, when involved in the decision making processes. His 'maximum power principle' continuously echoes in my thinking as one of his major breakthroughs in helping to identify more adequate lines of actions amongst alternatives. Finally, the insight that emergy calculations and indices-especially the graduated scale of 'transformities', giving a perspective of relative value of products or processes in society-provide about the relationships between environmental contributions to human production systems do foster new strategies for human survival within his "Prosperous Way Down".

Although surrounded by brilliant minds and assiduous collaborators, HT Odum's figure tends to stand as a solitary beacon of light for those who search for meaning in our past, present and future relationship to nature. To him go our gratefulness, admiration and joy to see his work being progressively recognized and his lessons gradually learnt and applied for a better civilization, especially in the developing countries, hoping that they might not incur in all the avoidable mistakes of industrialized economies.

Reference

Odum, H.T., 1996. Environmental Accounting-Emergy and Environmental Decision Making. Wiley, New York, 263 p.

Further Reading

Gadotti, M., Romão, J.E., 1995. Educação de Jovens e Adultos-Teoria, prática e Proposta. Cortez, São Paulo, Brazil.

INCRA, 1996. Relatório da Educação nos Projetos de Assentamentos de Reforma Agrária do INCRA em Mato Grosso do Sul-1996: Situação de "Estudo" e de "Nível de Escolaridade" Field Data. Campo Grande, Brazil, pp. 17–61.

Ministério Extraordinário De Política Fundiária, 1998. Todorov, J.C., Viero, B.S., Cortes, M.D.N., Couto, S.R., I Censo da Reforma Agrária do Brasil. Centro de Seleção e Promoção de Eventos, Governo Federal, Brasília, Brazil, 133 p.

Odum, H.T., Odum, E., 2001. The Prosperous Way Down.

Pronera, 1998. Programa Nacional de Educação na Reforma Agrária. Operational Manual, Brasília, Brazil.