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Discussion

H.T. Odum and E.C. Odum, the prosperous way down

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For six billion people deeply indoctrinated in the ethics of growth, a turndown and descent of civilization is unthinkable. That this descent could be prosperous is so inconceivable that it is unmentionable. . . . Showing a good way down is a call for everyone to think ahead and plan.

–Odum and Odum (2001)

1. The carousel of progress

A political leader will never talk about descent, the Odums seem to suggest, because "for leaders to speak of a non-growth period is viewed as political suicide". The paradigm of growth is so deeply ingrained in our life style that we are unable to think any differently. Most of my high school and university education was affected by a very simple concept, namely that science would allow a continuous growth, removing all technological obstacles and solving all problems, for a prosperous life ahead. The concept of any "limit to growth", let alone of a "way down", never really appeared on my horizon until many years later. Certainly, the "limits to growth" paradigm, including the book by that name (Meadows et al., 1972), gained the attention of policy makers (without too much consensus, however). The original impact of that book has been enormously diluted by the incessant nay saying of all kind of experts who consistently berate the predictions of that model without bothering to verify to what extent its predictions are correct. However, the Odums move a step ahead. Their book, "The Prosperous Way Down" warns us that the "limits to growth" strategy is only a (good) transition step within an "up-and-down" cycle—The *"growth is progress" ethic of the industrially expanding world is being replaced now by "sustainability is good" for a world that is no longer growing much. Next, as people learn to live with descent, the ideal will be "down is better."* Such an ethic flies in the face of all our studies that have lead to the recent proliferation of papers on sustainability, and our hopes and dreams for a sustainable-for-ever steady-state. The Odums seem to suggest. . . Forget it, folks . . . you'd better start thinking of a "pulsing paradigm".

2. A tale of growth and descent

The pulsing paradigm has always been in front of our eyes. Forest ecosystems never did anything different, with short pulsing cycles that we were able to see and understand. Deciduous trees bloom and grow in spring, make fruits and seeds (stored information) in summer, lose their leaves in autumn (for recycling by soil microorganisms), and seem to sleep and recover in winter-time, when available resources (solar energy) are less. On a longer time scale forests develop, grow, and then either senesce or are obliterated by very natural disturbances. Very similar resource-dependent patterns characterize all the other living species on Earth, including humans. Human societies grow and decline. The Roman Empire is now over and through its demise we may be able to recognize this trend. It took more than one thousand years for the whole cycle to run

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and about 300 years for the descent only. The longer pulsing "wave-length" makes it difficult for us to recognize the cycle of which we are part, while recognizing the shorter pulsing cycles of ecosystems. Tainter (1988) gives us so many examples of once-proud and enormous civilizations that remain only as stones under desert sands or the vegetation of jungles.

3. Adapting to environmental oscillations

If human societies are regulated by the same principles as other ecosystems and species on Earth, then it would not be a good policy "to paddle countercurrent", trying to force societies to grow when resources are scarce or to descend when resources are abundant. Instead, it would be a good policy to recognize the descent ahead and begin managing for it to be prosperous instead of impecunious.

"Policies based on understanding could be the difference between a soft landing and a crash"—this is, in my opinion, the main message of this book. H.T. Odum and his wife and partner Betty Odum spent most of their life trying to understand the principles and the characteristics of this pulsing trend as well as of each step of the cycle. They recognized four main stages of the pulsing cycle—(1) growth on abundant available resources, with sharp increases in a system's population, structure, and assets, based on low-efficiency and high-competition; (2) climax and transition, when the system reaches the maximum size allowed by the available resources, increases efficiency, develops collaborative competition patterns, and prepares for descent by storing information; (3) descent, with adaptations to less resources available, a decrease in population and assets, an increase in recycling patterns, and a transmission of information in a way that minimizes losses; (4) low-energy restoration, with no-growth, consumption smaller than accumulation, and storage of resources for a new cycle ahead.

4. Where in the cycle is the present human society?

According to the Odums' analysis, developed human societies are in the climax and transition phase, facing descent, but they still behave according to growth attitudes inherited from centuries of growth. The book explains and emphasizes the scientific principles, which govern the cycle, so that societies may become able to shift to new, non-growth attitudes, by being aware of what's going to happen in the time ahead. However, "Make no mistake, this is not a proposal for less growth. It is recognition that general systems principles of energy, matter, and information are operating to force society into a different stage in a long-range cycle". The Authors give a picture of the problem first, review most published papers on the topic, list the general systems principles governing society's dynamics, then try to extract suggestions and plans for the prosperous way down ahead, consistent with the resource oscillations. The book is fascinating, but the solutions presented are not the most important part. They are sometimes very attractive, sometimes questionable. What is new in this book is, in my opinion, the "systems view", a set of general principles, a new-Thermodynamics framework. The reader is driven towards the search for solutions within a well-defined frame, never losing the thread of the resource–growth relationship.

5. A new thermodynamics

The whole of Odum's scientific work converged into the search for systems principles within natural dynamics and into their application to human society. This book is more than just a legacy. It is a plan, a blueprint for survival and, at the same time, it is the basis for a new Thermodynamics made up with a set of different performances, each one fitting a different stage of the oscillation. The following is a look at some of these principles.

5.1. Pulsing

Pulsing is the main feature of the new scientific principles that may provide guidance for the times ahead. "It appears to be a general principle that pulsing systems prevail in the long run, perhaps because they generate more productivity, empower, and performance than steady states or those that boom and bust . . . Operations that pulse transform more energy than those at steady state".

5.2. The maximum empower principle

Expressing resources in emergy and transformity terms permits a re-statement of Lotka's Maximum Power Principle (Lotka, 1922) into a more suitable Maximum Empower Principle, according to which the simultaneous maximization of empower (emergy throughput flows) at all system's levels is required for sustainability. Hierarchies develop within each system, with higher levels feeding back and controlling the lower levels. High-transformity flows interact with low-transformity ones for maximum empower output. These principles provide a framework through which apparently chaotic patterns can be described and their behavior understood. It follows that the maximization of the available resource basis to maintain prosperity requires different strategies in different stages of development: fast competition in times of growth, efficiency in times of climax, decrease of population and assets in times of descent, low-growth attitudes in times of restoration.

5.3. The emergy yield ratio

To extract emergy out of a process (mining, cropping, electricity conversion, etc.) some emergy must be invested. The ratio of the total emergy of the product to the emergy invested is the so-called emergy yield ratio (EYR) and measures the net emergy benefit that a source provides to the economy. Oil has an average EYR equal to 6 to 1, that results from the unpaid accumulation of environmental work over million years of oil-making. An economy benefits from using or importing high-EYR resources, because the return on investment is proportionally amplified. Fossil fuels show high but declining EYRs, because the more favourable storages were exploited long ago, and progressively less favourable ones are being exploited today. Renewable energy sources and nuclear energy presently show lower EYRs than fossil fuels. Furthermore, renewables (sun, wind, rain and deep heat) already have a role in nature's self organization processes, so that diverting them to support an economic process reduces their input to useful natural processes. In so doing they may not always provide a net gain, due to the decreased indirect contribution of the environment. Unless unexpected (and unlikely) high-EYR energy sources are found to replace the declining fossil fuels, lower EYRs will generate lower growth and eventually no-growth patterns.

5.4. The emergy ethics and equity of trade

Money is not real wealth, according to the Odums. Real wealth is food, minerals, fuels, fertile land, houses, information, arts, and so on, and can be measured in emergy units. Money measures our willingness-to-pay for real wealth and only pays for the labor of those who make this emergy available to us. We do not pay nature for making minerals or cycling water. When a developed country imports primary resources (e.g. minerals, fuels, forest products) from a less-developed country, their cost is low, because labor cost is generally low in countries exporting primary resources and resources may still be abundant and of high quality. Money is in turn used to purchase emergy in the form of manufactured goods from the developed country. Since money pays for labor and labor cost in developed countries is high, only a small amount of real wealth goes to the less-developed country in exchange for the primary resource. Therefore, the emergy exchange (real wealth received versus real wealth exported) is uneven. Benefits only go to the already-developed nations, which become day-by-day wealthier. The long term stability of the global system is affected by these uneven exchanges.

5.5. Information

Since accurate and high quality information (not to be confused with digital "information" chocking the media and internet) requires a huge emergy support to be created, copied, disseminated and maintained, future societies will need to invest a large share of their high-quality resources, with special attention to the availability of electricity (a favourite energy carrier for information storage and use) toward the goal of storing information. "Mature systems contain large concentrations of information. The more complex a system, the more parts and interactions it has and the more information it must store in order to operate .... In mature stages of primitive human societies information was accumulated in the genes of their population and in the wisdom of their elders' experience. Our present human economy at maturity has great stores of information in libraries, universities,

educated people, complex technology, and computer networks".

Special care should be paid to sharing and transmitting information. Shared information (common beliefs and values) helps stabilize societies at national and international levels, which may be crucial in times of descent. Universities may play the important role of long-range thinking, preserving and transmitting information, and developing new concepts. This may be more important in the long run than developing short-run research for industry or emphasizing patents and profits. However, information cannot replace the biophysical activities of, for example, agriculture, industry, and commerce. Contrary to many predictions of a decade ago, economies using high levels of information, have not become independent of resources. Italy, for example, has fuelled its recent prosperity on Algerian natural gas (among other fuel imports) even as ancient Rome was dependant upon the grain energy from Egypt.

6. Getting ready

Can the descent ahead be avoided? "Instead of denial, it is time for people at all levels of society to plan for a better world .... Coming down doesn't mean going back to ways of the past. In general, descent means new ways". The Odums call for less-growth and for a no-growth attitude. They also call for task-forces working for the prosperous descent. New, smooth strategies are not easy since they require education and preparation, and involve many if not all of the aspects of our daily life: money, welfare, school, housing, transport, population dynamics, international trade, religion, peace and war. Are the scientific, economic and social communities ready to receive this legacy and start working on it? To be honest, I do not think they are. Books like "The Prosperous Way Down" may lead the way, but much more remains to be done. The "growth paradigm" is still the winning option at the global level. However, the first signs of increasing awareness of a turndown ahead, as well as, of the need for a transition to a lower-energy future encourage us towards an additional effort in teaching systems principles and researching, planning and testing new solutions and strategies. If the Odums' picture is correct, the descent will not find us unprepared.

References

Lotka, A.J., 1922. Contribution to the energetics of evolution. Natural selection as a physical principle. Proc. Natl. Acad. Sci. U.S.A. 9, 169–177.

Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W.W. III, 1972. The Limits to Growth. Potomac Associates Book, Wasgington, DC, p. 205.

Odum, H.T., Odum, E.C., 2001. A Prosperous Way Down: Principles and Policies. University Press of Colorado.

Tainter, J., 1988. The Collapse of Complex Societies. Cambridge University Press, Cambridge, England.