The utility of using tools to evaluate the ecosystem support in human driven activities.

Angela Daniela La Rosa
University of Catania, Department of Physical and Chemical Methodologies for Engineering.
e-mail: larosa.angeladaniela@gmail.com

Summary
In this conceptual paper, some considerations are presented about the utility of carrying quantitative analyses in order to assess the work done by the biosphere to guarantee the ecosystems services which fulfill the basic needs of humankind. Emergy synthesis, energy analysis, exergy analysis, embodied analysis, ecological footprint' etc.., are some examples of tools used to evaluate the ecosystem support of anthropic activities. The utility of these tools is that the results obtained could be integrated with socio-economical inputs in order to gain a better understanding of the sustainability of the system under study. This approach could give useful information especially to decision makers.

Key words: sustainability, complex systems, environmental accounting, emergy synthesis.

Introduction
The goal of sustainable development is to create and maintain prosperous social, economic, and ecological systems (Folke et al., 2002). These systems are complex systems and their understanding can be reached by combining the knowledge and perspectives from many different ways of knowing. Integration of many perspectives is needed to understand social-ecological systems. What happens commonly is that scientists study the ecology of a region with models that largely ignores human impact on the ecosystem and on the other hand, sociologists and anthropologists study the people of the same system without recognizing the impact that the ecosystem can have on their interactions.
It is necessary to link material and energy flows to social organization. Appropriate and feasible methods to quantify material and energy flows of socio-economic systems are required. Some methods already exist, but they need to be improved and integrated.

Analysis and discussion
It is world wide recognized that we are facing an era of ecological changes. When looking at the literature production on human impacts on the planet over the last century, new concepts have been formulated in order to understand the changes involved with nature. In 1926 the famous Russian scientist V.I.Vernadsky, developed the concept of biosphere and he defined ecology as the science of the biosphere (Vernadsky, 1926; Vernadsky, 1998). Vernadsky also developed the concept of noosphere (Vernadsky, 1945), the sphere of reason (the term introduced in 1922 by a French philisopher and mathematician Edouard Le Roy), as the third in a succession of phases of development of the Earth, after the geosphere (inanimate matter) and the biosphere (biological life). Vernadsky stated: " Mankind's power is connected not with its matter but with its brain, its thoughts and its works, guided by its mind. In the geological history of the biosphere, a great future is opened to Man if he realizes it and does not direct his mind and work to self-destruction." (Vernadsky, 2007). More recently, Paul Crutzen, Nobel Laureate in chemistry for his studies on the atmosphere, proposed to use the term "Anthropocene" for the current geological epoch. The term was coined in 2000 regarding the influence of human behavior on the Earth in recent centuries as so significant as to constitute a new geological era. On this respect, the geologist Zalasiewicz and his collegues claim that, since the start of the Industrial Revolution, Earth has endured changes sufficient to leave a global stratigraphic signature distinct from that of the Holocene or of previous Pleistocene

interglacial phases. These changes are sufficiently distinct and robustly established for suggestions of a Holocene–Anthropocene boundary in the recent historical past to be geologically reasonable. (Zalasiewicz et al., 2008).

The concept of the Anthropocene may serve the purpose of focusing our minds on what we are doing to the planet.

Crutzen continues saying that: "To develop a world-wide accepted strategy leading to sustainability of ecosystems against human induced stresses will be one of the great future tasks of mankind, requiring intensive research efforts and wise application of the knowledge thus acquired in the noösphere, better known as knowledge or information society. An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management. (Crutzen and Stoermer, 2000).

At the same time, the German scientist Schellnhuber, has introduced the concept of an entity defined as the 'global subject', which represents the collective action of humanity as a self-conscious control force that has conquered our planet. "The global subject is real, although immaterial. One key to its emergence from the physical basis is worldwide communication. Global telecommunication will ultimately establish a cooperative system generating values, preferences and decisions as crucial commonalities of humanity online. ..The global subject will reign over the centuries to come. One of its most responsible tasks will be to seek out a tolerable environmental future. In other words, the global subject must guarantee sustainable development." (Schellnhuber, 1999).

While, from the more philosophical point of view these new concepts have been introduced, from the more ecological perspective other approaches have been used. One of these approaches is the concept of systems ecology, an interdisciplinary field of ecology which focuses on interactions and transactions within and between biological and ecological systems, and is especially concerned with the way the functioning of ecosystems can be influenced by human interventions. As a mode of scientific enquiry a central feature of systems ecology is the general application of the principles of energetics to all systems at any scale. Perhaps the most notable proponent of this view was Howard T. Odum - sometimes considered the father of ecosystems ecology. In this approach the principles of energetics constitute ecosystem principles. The emergy synthesis is the method developed by H.T.Odum during his entire life (Odum, 1996). It represents a valuable quantitative methodology which aims at internalizing some inputs (sun, wind, arable land, water availability, soil erosion, loss of topsoil, etc..) that are usually considered for free from nature.

In order to understand the usefulness of the emergy methodology we can consider the case of fossil fuels. Fossil fuels are sometimes referred to as "stored sunshine" because solar energy initially went into growing the plant and animal matter. Fossil fuels gained such a high energy density because this solar energy has been concentrated over geologic time.

All the energy inputs to produce fossil fuels are considered "free" because they came from nature. (Santa Barbara, J., 2007). The energy that has been invested in the global production process of the fuels is no longer available to do work as it has been completely used up. We can think that it is "embodied" in the thermodynamic state of the product. For example, 1 kg of refined oil (fuel, gasoline) supply 44.5 MJ of energy (exergy) and 1J of available energy from fuels contains $1.1\ 10^5$ sej of used up energy or emergy. To evaluate the emergy content of petroleum from its formation means to consider the solar energy that was needed over time; the work that the biosphere has performed during past eras (Bastianoni et al. 2005).

The wide perspective provided by the Emergy approach is that as results of an Emergy evaluation we can obtain, for example, that renewable can be not sustainable (land, water, labor, etc., usually considered renewable, might become constrains for the sustainability of the system). One explicative example is the evaluation of the emergy performance indicators for biofuel produced from corn and compared with the emergy indicators calculated for fossil fuels (Giampietro and Ulgiati, 2005). Biofuels have the highest transformity values, greater than those of fossil fuels. In emergy language, the higher the transformity, the higher the environmental support that is needed to make that product. The conclusion is that the natural processes to produce fossil fuels have been globally more efficient than human-driven process of cropping for biofuel.

Conclusions

Tools to evaluate the ecosystem support of human activities can be very useful for gaining an understanding of the concept of sustainability from an ecological perspective. But the question is: "How can these information be used for a sustainable urban and rural development? How to integrate with social and economic aspects?"

In their work on post-normal science, Funtowicz & Ravetz have analysed how : "the presence of irreducible uncertainty and complexity in environmental and technological policy issues necessitates the development of alternative problem-solving approaches".

What we need is looking for different approaches to science for governance when dealing with sustainability issues in order to create useful networks between different actors.

The challenge will be to link the methodologies used to evaluate the ecosystem support (ecosystem goods and services) with the complexity, interdependence and co-evolutionary dynamics of socio-ecological systems.

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