The paradox of the ecosystem services – Biophysically invaluable but economically unvalued

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A grey reef shark (*Carcharhinus amblyrhynchos)* cruising a coral reef.
Photograph:Albert Kok (Wikimedia commons 2012).

The Maldives are situated far out in the Indian Ocean and the surrounding coral reefs are considered the seventh largest in the world. The reefs provide the nearby humans with a magnificent source of natural capital. For decades, thousands of tonnes of fish have been harvested each year, among the 1,000 species of fish that live there. They also catch grey reef sharks, sea cucumbers and lobsters for export to foreign countries. In a study by Emerton et al. (2009) the benefits of the coral reefs were estimated to be of huge economic importance to the small island nation. The very physical existence of the reefs provide shoreline protection benefits, that alone were valued at $1.3 billion – $2.2 billion per year. The study found other economic benefits of the coral reef, several exist through the tourism industry of the Maldives that employs around 58 % of the nations workforce, contributing an estimated $764 million per year to the nations economy. Put in Gross Domestic Product (GDP), that is a measure of total economic activity for a country, the Maldivian tourism sector accounts for 82%. The fisheries sector contributes only $56 million per year, or 8.5% of GDP, according to the study. According to an estimate by researchers at the James Cook University in Australia, a single gray reef shark could earn a fisherman $32, dead, but that the same shark was worth $3,300 a year to the Maldivian tourism industry, alive. This kind of economic logic of the Maldives coral reefs resulted in a political reprioritization in favor of biological conservation and a total ban on exports from shark fishing.

The problem with money as information

Mankind no longer barters goods and services directly. Instead we use a monetary system of bills and coins certified by our nations central banks. Our current global monetary system is essentially a system of information, similar to a spoken language, but exists to a great extent in digital form. This information system flows on top of a certain agreed mathematical foundation. The information system gets its real strength through the actions of all its participants, but is limited by its mathematical and philosophical foundations that are well protected by national and international law. The global monetary system of today is used by a majority of the worlds human population, to

satisfy their basic needs of survival. Since the world population majority so heavily depends on the monetary system, it has become the worlds by far most powerful human information system.

Ecosystems versus *Homo Economicus*

However, some claim the information system of economics might be flawed by academic inactivity and lack of intellectual discussion. They say that eventhough the natural sciences keep evolving and is growing like never before, the fundamentals of economic theory are still constrained by its connections to ancient perceptions of the natural world. The most striking example of this is probably the idea of *homo economicus* in economic theory. Economic theory postulates a perfectly independant and rational economic agent, often referred to as *homo economicus*, in order for the mathematical foundations of economic theory to obtain explanatory power. But in reality, human actions are most often not entirely rational, and the perception of *homo economicus* is, according to some, probably a kind of hubris relict of the monotheistic religions of the not so distant past. The concept of *homo economicus* has been falsified in thousands of empirical studies in neurobiology, psychology, anthropology and behavioural economics. But empirical evidence seems to be consciously ignored in the academic world of economics.

Economics is said to be the theory of resource distribution, through the desires of human beings. Also imbedded into economic theory, is the exclusion of so-called free resources as air and water. In economics textbooks it is often stated that certain resources exists in such lavish abundance that incorporating them into the resource management system of economics would be meaningless. But since clean air and water, aren't really abundant resources at all, this is also a perception made obsolete by the natural sciences but kept as truthiness by the economic community. By excluding fundamental biophysical phenomena as clean water and air, their production is also excluded and thus also consciously ignored. This is unfortunately true of a variety of invaluable biophysical phenomena, like the biospheres primary and secondary production of biomass and also the informational and technical value of the blue print instructions for various biomolecular conversions accumulated into DNA molecules over approximately 3.8 billion years. The range of applications for these biomolecular conversions, mostly via different enzymes, is incomprehensibly vast. If the reader, which means you, fail to grasp the concept of DNA being our planets by far most valuable resource, you exemplify the kind of theoretical confusion that I am trying to illuminate.

The various flaws in economic theory, combined with the implicative raw power of its current status as the globally dominant information system, have certain uncomfortable consequences. Examples of such consequences are biodiversity loss, habitat destruction and habitat fragmentation. That means, in short, the destruction of the fantastically complex mechanisms that regulates the planets water, air and biomolecules.

Ecosystems to your service!

To refreshen our collective memory: What is it that regulates water, air and biomolecules? It, is the ecosystems. Ecosystems continously donate services to us, services such as: Primary and secondary production of biomass, provisioning of water, timing of water flow, purification of water, regulation of air quality, assimilation and detoxification of waste, pollination, biological control of agricultural pests and human pathogens, regulation of local, regional and global climate. If any of these vital ecosystem services are unknown to you, I urge you to read up on it, google it! They are all absolutely fundamental to human well-being.

The beforementioned examples of ecosystem services are of direct unquestionable biophysical and biochemical value to mankind. There are however, thousands of different benefits that spring out as secondary and tertiary effects of the more fundamental biogeochemical and physical processes of ecosystems. These benefit are of a more subjective and anthropocentric nature, but luckily a lot more intuitive to most people. The benefits we get from ecosystems services range from food,

freshwater and clothing fibres, to opportunities for recreation, eco-tourism and spiritual well-being.

In the light of economic theory disregarding ecosystem function, why do we expect every individual economic agent, the theoretical *homo economicus*, to act in a way that will benefit us as a whole, when the real-life *homo sapiens* cannot understand the full consequences of his/her actions? In order for any consumer to act in a sustainable fashion, even in theory, him/her would need perfect information. This is well known to economists. It seems the information system of dollars, renminbi, euros etc. unloads the built in flaws unto the back of the individual economic agent. Via the current economic system, we have effectively tied our daily survival to a flawed information system, one that does not give good predictions of the future and is very poorly fitted to empirical evidence. The monetary system is a blunt tool that needs sharpening by scientific observation and statistical feedback.

How much for that biosphere?

Imagine the impact the concepts of economic values has on our societies and even our own worldview and personal thoughts. It probably goes beyond most peoples imagination. To change the foundations of economic theory is something, at least I find, a task not feasible in a generations time. Disruptions and changes in the game of economics are also something that is not considered desirable from a societal point of view, as economic agents need decades to position themselves and be able to achieve market efficiency. This is something most economist seem to agree upon. Similarly ecologists agree that a ecosystem endure and even prosper with certain levels of disturbance, but that severe disturbances can be disastrous, because populations of different species need a long time, sometimes evolutionary time, to position themselves and move their ecosystem towards higher function efficiency. So ecologists and economists have this in common, they see large amounts of disturbance, with some exceptions, as something highly negative in their respective systems.

So how do we stop forces powered by economic incentives from lowering the biophysical flows of various ecosystem services, without causing large disturbances of the economic status quo. What I am getting at is interdisciplinary work at a grand scale, called ecological economy, a special branch of ecology that has been brewing for decades. If you have heard of it, you are probably also familiar with the controversial study performed by Costanza et al. (1997). In this landmark study, a group of ecologists performed an economic valuation study for the entire planets ecosystems. They tried to answer what the whole biosphere was worth. The answer was somewhere around 42, trillion dollars that is, per year, or somewhere in between US$ 16-54 trillion per year. In that framework, the global GDP was, in comparison, estimated to be around US$ 18 trillion per year.

Costanzas study gave rise to both discussions and harsh criticism from various directions. Economists argued regarding the economic relevance of the study and pointed out various miscalculations and errors made on an economical level. More importantly, a philosophical question of great relevance was put in the spotlight. The question was: *”If we cannot survive without the biosphere, shouldn't the economic value of it be infinite?*” Out of this analytical philosophical truth, that the biosphere and its ecosystems being invaluable, it became clear that a total valution of the biosphere is not desirable. Although I have to say Costanza et al. (1997) did a good job illuminating that the economic value of the biosphere, hydrosphere, lithosphere, atmosphere and of course the sun, is infinite to us humans.

The topic of economic ecology has enough potential political pitfalls to keep a debate going in absurdum. Say, for the sake of good sport, that we both would like to balance the human-centered economic values with important knowledge from the natural sciences, beyond the consciousness of

individual economic agents. Say calculating shadow prices for the patches of ecosystems, often traded off for monetary gain, would be a useful and desirable tool of information. How would we find economic value in a forest besides the world market price for timber, economic value in a rainforest besides its potential agricultural area, in an ocean besides todays price of fish meal, value in mangrove forests besides its short term source of petty cash as a shrimp farm? I could go on and on. How do we find arguments for the economic value of preserving the ecosystems?

The answer is ecological economics, an evolving scientific method for measuring, documenting and modelling various ecosystems processes to estimate economic values through the ecosystems services connection to conventional economic values. Take the value of a habitat of tropical forest in Costa Rica. That strip of forest could contain biomolecules of great value to human kind. The biomolecules could be molecules for future medicinal purposes or perhaps enzymes for biochemical reactions like detoxification of waste or enzymes that can speed up industrial enrichment of valuable substances by manyfolds. The strip of Costa Rican forest might serve as cloud forest draining the passing humid atmosphere of biologically valuable water. Perhaps it cleanses and directs water into a nearby valley with great timing providing the valley with water in times with little rain. Perhaps the existence of this strip of forest reduces the risks of mudslides that could potentially threaten both lives and property. Perhaps the piece of forest helps put the population dynamics of agricultural pests in check. Perhaps the biodiverse forest keep human pathogens at low numbers. Perhaps that forest offer opportunities for children to play games there, and acts a source of inspiration for the childrens imagination and education. What economic value does the nearby human inhabitants assign to being able to stroll happily through the forest, or using it for exercise, not to mention what these opportunities does to nearby property prices. Perhaps the forest cleanses the air that humans use for breaths of fresh air. Perhaps the forest protects a nearby village from annual cyclons sweeping in from a nearby tropical ocean, protecting both lives and property. Perhaps the forest plays a role in harmonizing the local climate in a way that is profitable for nearby residents and businesses. Perhaps the forest plays a role in stabilizing the global climate through binding atmospheric greenhouse gases like carbon dioxide into biomolecules. Perhaps the forest provides habitat for amazing plants and animals gifting its nearby surroundings with opportunities for economic income via tourism. Perhaps the forest provides nearby coffee and cocoa farmers with a diversity of pollinators that insures continuously rich harvests, even during years when one pollinating species are absent. Perhaps the strip of forest does all these things. When the Costa Rican community in and around this amazing strip of forest decide whether or not to cut down the trees for timber and set up a monoagricultural production for economic gain, other economic interests concerning the strip of forest might have been identified and used as an economic incentive to instead conserve the biodiverse ecosystem.

In fact studies of pollination and functional diversity is a good example of when conservation of biodiverse habitat fragments is a sound economic investment for insuring a steady supply of visiting pollinators and thereby a bigger harvest. According to Costanza et al. (1997) pollination is worth around $120 billion each year to farmers. Another study estimated that non-domesticated pollinators help produce fruit and vegetables worth around $3 billion each year in the United States alone. Despite of the enormous revenue generated by pollination, non-domesticated pollination and its resilience is outside the reach of our current economic system.

Ecology to the rescue

Luckily there is an entire science that has been dedicated to understanding the relations between living organisms and their environment for over a hundred years, ecology. Ecology teaches us how the mindblowingly complex ecosystems is a constantly changing unit where everything is connected. Through ecology and its scientific approach we can learn more about how the fantastically beneficial ecosystem services is linked to the ecosystems composition. Biodiversity plays a key role in these links, and within ecology the awareness of the importance of biodiversity

for ecosystem function seems to be steadily growing. One explanation for this is the mechanism of niche complementarity. Niche complementarity occurs when a high species richness increases functional effectiveness by increasing the efficiency of resource use. This happens because species utilize resources in different ways and when many different species exist together they increase the total turnover of resources used and assimilated. Another explanation for why biodiversity increases ecosystem function is called functional facilitation. Functional facilitation is when one species has a positive effect on another, for instance when one organism produces waste that feeds a second organism.

A high level of biodiversity also protects ecosystem function against disturbances as a drop in the abundance of one species doesn't lead to a drop in that organisms niche function because other species can fill that gap and perform similar functions. This is often referred to as the resilience of an ecosystem and works as an insurance system preventing high amplitude fluctuations that are potentially damaging to ecosystem health. According to some studies, resilience also protects against invasive species. Often an ecosystem can withstand high levels of disturbance, up to a certain point, where it can collapse with a dramatic drop in ecosystem function. These non-linear threshold effects can occur when the ecosystems resilience is lowered and it is important that we gain more knowledge about ecosystem processes and their relation to these sudden collapsing thresholds.

There is a great need for small scale valuation studies of ecosystems. Valuation studies of ecosystems should be spatiotemporally explicit because ecosystem services have geographically specific directions and vary in magnitude from location to location depending on many factors like species composition, species abundance, geology, climate etc. A valuation study should also be expressed in terms of marginal fragment units, as decisions are rarely made on the fate of entire ecosystems, luckily, but more often on smaller fragments, for example on landuse change affecting a habitat fragment like a small forest.

For the field of ecological economy to grow there is much more ecology to learn. We must find out more of particular species interaction and their connections to different kinds of biodiversity and ecosystem function. When we have good information about the mechanisms that provide us with the ecosystem services, we need to develop tools of mapping them in real life and making predictive models into the future. When it comes to ecosystem services, we must first be able to properly measure them, in order to treasure them.

To some of you critics out there. This is not placing a price on nature, so that we can cash in on biodiversity. It is putting a value on nature, that better reflect their fundamental function in supporting our quality of life. The reason for expressing that value in €s, ¥s, $s, £s or even more abstract terms like relative income, is only because the economic system is the dominant value system, and is protected by constitutions, like the European Unions declaration of human rights that give strong protection for individual property rights, and is likely to continue to do so.

If you would rather revolutionize everything and miraculously replace the economic system with a better, more fair and stable system for everyone to enjoy, thats great, but I must ask exactly what you are waiting for. Could it be, that a system, like the economic system is likely to be needed by humankind for a few decades to come? We need a system for material distribution, and right now that is our economic system. If we do not have the option to ignore humankind's need for a system like the economic one. Then what is our action plan? The world is a complex place, far to complex for any one individual to grasp. That is why we invented our written languages, cultural norms, religions, laws and sciences. I believe stopping halfway into designing a fair material distribution system would be disastrous. We need to keep evolving our resource distribution system towards something better and more sustainable, we have our collective brains and wonderful technology to

help us with the task.

Further reading

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