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Resilient Economics.

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Introduction

This chapter explores the dynamic properties of organisms and ecosystems that make them so resilient and capable of adapting to changing circumstances, allowing them to maintain an overall condition of coherence, wholeness and health while living in balance within the resources of the planet. We suggest some key principles that are required in order to facilitate the emergence of equivalently resilient and creative economies that integrate with the dynamics of earth evolution.

A primary effect of life on the dynamics of terrestrial processes is to accelerate the natural flows and cycles of energy and matter on earth. Life also has the effect of increasing the complexity of these interacting cycles so that they form a rich web of inter-related activities. These involve positive and negative feedback loops that provide both overall stability and adaptive resilience to the whole system, ensuring continuous creative evolutionary change and transformation. This we see in the 3.7 billion years of continuous evolution that has given rise to an immense diversity of species, from microbes and algae to giant redwoods and whales.

In contrast to this dynamically bounded web of creatively adaptive processes, our economic system produces continuous, unstable growth with destruction of cultural and species diversity through homogenisation of global life-styles among humans, the most recently emerged species within the Gaian complex of interacting life forms. Any species that continues to behave in this way seems bound for extinction. At this moment, when the consequences of our economic activities have become clear in the destructive instabilities generated by continuous growth and unregulated capitalism, we have a choice. We can either attempt to restore the economic system using the same basic principles as those prevailing for 200 years, with some corrective modifications; or we can re-examine fundamental economic principles using insights from biological evolution and ecosystem dynamics to establish a radically different foundation for trade and commerce. The latter is what we explore in this chapter.

Effect of Life on Earth.

Life captures much of the abundant energy flux from the sun to create the extraordinary diversity of species that has emerged throughout the past 3-4 billion years of earth's evolution. As shown by Lovelock in his Gaia theory, the interaction of life with the planet's geophysical processes maintains this condition of continuous creativity and abundance on our planet as an integrated whole. It is the dynamics of this process that we need to understand in order to build the resilient wisdom and adaptability of Gaia into our economic system. How does life transform the planet from dying to living?

Life captures solar energy by slowing down the inevitable loss of heat from the earth's surface through the creation of many cycles of production that are all coupled to each other, the output of one being the input to another. There is evidence that the main biogeochemical cycles were essentially operating at around 3.5 billion years ago and that a cycling system similar to the present day earth has been functioning for 2.3 billion years. Life modulates biogeochemical cycles by substantially increasing rates of energy-matter transformation while increasing the overall efficiency of the system by complex feedback loops of energy-matter within system. Some of the feedback loops act as blockers of the flow of matter or valves diverting energy to other processes (negative feedbacks), thus achieving a beautiful balance of self-regulation between flow rate and effectiveness of output. On a Gaian scale, these biogeochemical cycles co-evolved, forming a system of nested cycles that set limits on external energy required to sustain the system.

Figure 1 describes this process by comparing the effect of life on energy capture and transfer on earth with energy loss on a dead planet. On the left we see the many little coupled cycles that arise from the activities of different species, all coupled together in ecosystems so as to produce a coherent process that is the living, evolving earth. On the right is the way energy is lost from a dead planet. The same total loss of energy occurs, but on a living planet it is dramatically delayed through the sharing of the energy among the life cycles of different species.

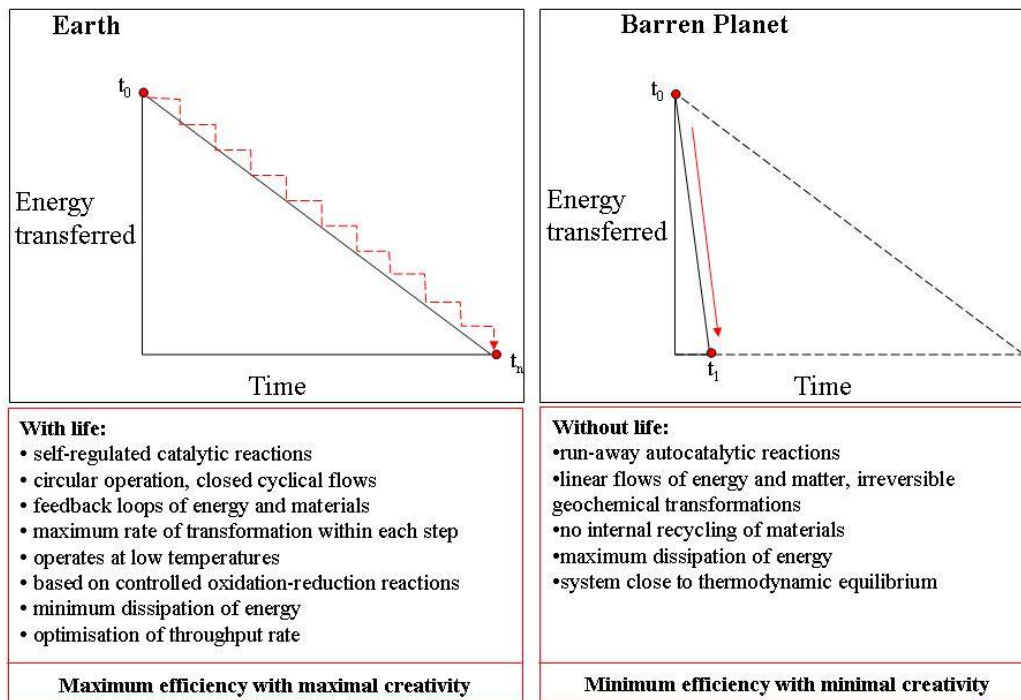


Figure 1. Patterns of energy loss from a living planet like Earth, in comparison with energy loss from a dead planet such as Mars or Venus.

Evolution brings into existence a remarkable diversity of life forms with minimal energy loss (maximum efficiency) and maximal creativity. In contrast to this, our economic system creates products using inefficient processes that accelerate the rate of energy loss and resource depletion. We see this most dramatically in our dissipation of carbon and energy by our use of fossil fuels during the past 200 years: we have burned up vast amounts of stored carbon and energy from subterranean deposits that were deposited as part of the process whereby the earth maintained habitable temperatures for billions of years through regulation of CO₂ in the atmosphere by means of carbon burial. This dissipation has been a runaway process, like an explosion in comparison with normal evolutionary rates of change: a very rapid, inefficient dissipation of energy that has been extremely destructive to the health of other species and the planet as a whole, as observed in the rate of species extinctions during the 20th C. These economic activities take the earth in the direction of a dying, not a living, planet. Our economic system generally proceeds in this manner, using up natural resources such as iron and copper very inefficiently with toxic waste products rather than useful outputs for productive activities, causing soil erosion through inefficient farming practices, and fishing with methods that cause immense destruction to fishery ecosystems in the oceans, to mention just a few examples. What are the basic principles whereby natural systems achieve their cooperative, creative efficiency, and how can we use these in our economic and technological systems? It is useful to start by looking at the way these principles work within individual organisms, and then to see how they are extended to ecosystems.

Basic Postulate: Catalysts Facilitate Flows in Living Systems; Money as Catalyst Facilitates Flows in Economic Systems

Living organisms are fundamentally characterised by a rich network of metabolic cycles that bring about the transformation of one type of molecule into another so that there is a continuous flux of materials through all the parts of the system. The range of metabolites is immense: several hundred thousand different molecular species are continuously synthesised and degraded in a process that maintains an appropriate balance among all the different substances within organisms. These transformations occur at room temperature. They do not require high temperatures and pressures, as many of our synthetic chemical activities do. Metabolic transformations are brought about by specialised substances produced in organisms called enzymes. These are proteins, long chains of basic molecules (amino acids) that fold up into specific shapes with the ability to bind to particular metabolites and bring about their conversion to other forms. This process is called catalysis. It accelerates a thermodynamically-permitted reaction from a rate that would be almost unmeasurable at room temperature to a significant value, often in the region of mols/sec. It is this that makes life as we know it possible.

Economic Implications: money as a catalyst facilitates flows in economic systems

A major feature of catalysis is that the catalyst is not used up in the process so that it can continue to facilitate the reaction for the duration of its life, which for proteins is minutes to hours. In this time one molecule of catalyst can catalyse the transformation of millions of molecules of metabolite. Money in an economic system works in a similar way. It facilitates or accelerates trade transactions that could occur by other means, such as barter; and it is not used up in these transactions so that a unit of currency can be used many thousands of times to facilitate exchange. However, there is a significant difference here from enzyme catalysis: whereas the action of any particular enzyme is specific to a small set of catalytic transformations, facilitating the conversion of one or a few metabolites into other metabolites, money can be used in any trade transaction within a global trading and exchange system. Whereas enzymes are specifically designed for particular transformations, money as we currently use it is non-specific. However, there is no reason why money should not be specifically designed to facilitate particular types of transaction rather than serving as a totally non-specific currency. We will argue that such a diversification of currencies is an essential ingredient of a resilient economic system. We shall return to this question of specificity and design of currencies, especially in connection with local community building, a crucial aspect of stable trading.

Another property of catalysts is that they do not accumulate in quantity. They have a well-defined lifetime so that they are degraded and recycled after a relatively short period of time relative to the lifetime of an organism in which they function. Whereas an organism may live for many years, a catalyst lasts for minutes to hours. Thus unused catalysts are not saved but are degraded and recycled. Similarly, money as a catalyst of exchange should not accumulate but should be continuously used to facilitate transactions. This is realised by the principle of demurrage wherein money progressively loses value if it is stored and not used. This prevents money from accumulating in anyone's hands and results in continuous, efficient facilitation of trade in the economic system.

The fact that money is seen as having value in itself so that people accumulate it arises from a confusion between goods which satisfy basic needs and money as potential for acquiring goods. The source of this confusion lies in the way we generate and distribute money, not in any intrinsic properties of money itself. While some goods will inevitably get scarce at times, in general the diversity of products available can satisfy peoples' needs, though not their greeds, as Gandhi pointed out. Sufficiency is the key. The monetary specialist Bernard Lietaer says the following in an interview examining the foundations of our financial system:

"I believe that greed and competition are not a result of immutable human temperament; I have come to the conclusion that greed and fear of scarcity are in fact being continuously created and amplified as a direct result of the kind of money we are using. For example, we can produce more than enough food to feed everybody, and there is definitely enough work for everybody in the world, but there is clearly not enough money to pay for it all. The scarcity is in our national currencies. In fact, the job of central banks is to create and maintain that currency scarcity. The direct consequence is that we have to fight with each other in order to survive".

(See <http://www.transaction.net/press/interview/lietaer0497.html>)

The confusion between money as facilitator of trading transactions and as something with intrinsic value comes from a failure to distinguish between oikos, the Greek root for economic, and krema, the Greek word for individual wealth which is purely about acquisition. Whereas oikos concerns the satisfaction of real needs in society (Max-Neef, 1991) based on co-operative household management, modelled on nature, the "krematistic" accumulation of money in individual hands was condemned by Aristotle as destructive of community wealth and the intrinsic health of resilient trading and exchange systems. It is the development of an economic culture based on pure money making and acquisition that has shaped our monetary and economic systems rather than ecological principles of management, so that they are intrinsically unstable and destructive.

Ecosystem Catalysts

What acts like a catalyst in ecosystems, accelerating the flows of energy and matter between species? There are many candidates for this, but primary ones are bacteria. They are ubiquitous on earth and immensely diverse in their activities. These unicellular life forms use the organic debris of other species such as shed leaves, dead bodies of insects and other creatures as a source of energy and matter, producing simple molecules such as carbon dioxide, oxygen and methane as their waste products, which are released into the atmosphere. Bacteria act in ecosystems like enzymes within organisms, catalysing the transformation of waste organic material into substances that are essential for the dynamic equilibrium of the planet as a whole. Without bacteria the earth would have no stability in temperature or gaseous composition of the atmosphere that maintains conditions suitable for life itself. This is the insight of the Gaia Hypothesis that recognized the intimate connection between life and the conditions that allow for its continuous evolution on earth (Lovelock, 2000, 2005)

Bacteria achieve their extraordinary powers of transformation by using open-source methods of sharing their evolutionary discoveries with each other, and with other species. They do this by exchanging their genes, so that if one species of bacterium discovers a more efficient way of using organic matter for its metabolism by generating a new gene for an enzyme, this information is passed around to others. The bacterial world discovered the advantages of a bacterial world-wide web billions of years ago and have evolved successfully in this mode for aeons. Furthermore, different species of bacteria act in cooperatives, aggregations of individuals that take decisions collectively to adopt strategies of survival appropriate to ambient circumstances. For example if local food resources become scarcer or water supply is diminished, the colony as a whole adopts a foraging strategy that is more efficient and preserves water more effectively. This is reflected in the morphology of the colony (Ben Jacob et al, 2006). The ultimate strategy for surviving difficult conditions is for the colony to form spores. These are effectively forms of suspended animation in which nearly all the metabolic transformations of the organism cease, with the cell adopting a virtually solid-state or quasi-crystalline condition which is resistant to the harshest environments.

Bacteria are not alone in carrying out essential recycling of materials and energy on which evolution depends. Many different species contribute to this by eating some forms of life and producing waste that is the source of food for others. It is the extreme diversity of the tangled web of interactions that this creates that is the basis of resilience and adaptability of life forms on earth. These interacting networks of creative agents trade in real goods: the wood of the fallen tree serves as energy and material for the growth of fungi; the insect that is captured by the Venus fly trap is digested to feed the needs of the plant and allow it to grow; the calcium released from granite rocks by the growth of lichens on its surface flows down a stream, then travels by river to the ocean where it is used by unicellular organisms to grow a protective shell around its surface. This is the continuous trade in energy and goods that maintains the health and wellbeing of the Gaian system as a cooperative, resilient, evolving network of beings that form an indissoluble unity on the planet. When we allow speculation and gambling into our economic systems in the form of hedge funds and derivatives, we introduce an unregulated source of instability into the system, violating the principles that underlie resilience and adaptability in ecosystems.

Exchange and Trade in Ecosystems

At the level of ecosystems, time scales of change and adaptation are extended beyond the lifetimes of organisms to many generations, but the same principle of demurrage operates in relation to facilitation of trade in goods and services by transforming catalysts. Bacteria, for example, as facilitators of recycling and exchange between species, never accumulate where they are not used. Their number is always directly related to their activity. The same is true of all other members of an ecosystem and their contribution to the resilience of the whole. Organisms accumulate only where they function as facilitators of exchange, such as herds of antelope where grass is plentiful on the African savannah, using this resource to produce body mass which then feeds predators, which themselves keep the herds of antelope on the move so that they never accumulate in any one place and destroy the grasslands by overgrazing. Compare this with our un-ecological practice of keeping vast herds of beef cattle in

restricted domains near water sources, without predators to move them on, so that the grasslands become degraded and the soil erodes. Excessive accumulation of anything is a serious error in resource management, where diversity, quantity directly connected to activity, and continuous recycling are basic principles of resilience. Ecological systems produce abundance because each species has the potential for exponential growth in numbers when resources are plentiful, such as bacteria accumulating in their millions under circumstances where organic material such as leaf litter is plentiful, or antelope accumulating when grass is abundant. However, predation limits numbers and populations decrease again when conditions change to scarcity for those particular species while other species thrive under the altered circumstances, resulting in a continuous change of composition of the ecosystem with changing conditions. There is never an uncontrolled increase in populations of particular species because numbers are held in check by negative feedback processes. The equivalent of these negative feedback process in human trading systems will be considered later.

Exchange and trade in ecosystems are always in terms of real goods such as light energy absorbed by leaves to produce organic food, bacteria consumed by organisms like slime moulds in forest leaf litter, organic matter and minerals consumed by worms in soil, antelope bodies consumed by prides of lions on the savannah, and so on. Ecosystems do not engage in speculative trading in future costs of food or minerals because all exchange is in terms of energy and different forms of matter. This keeps the ecosystem grounded in reality in relation to maintenance and continuity. There is of course plenty of creativity in ecosystems. The emergence of new species and innovative partnerships between species is a domain of play with future possibilities as extant organisms explore new combinations of genes within, and interactions among, themselves. This emergence of novelty is very similar to cultural creativity, being based on a process that is sensitive to both history, through genetic inheritance, and sensitive to external context through the generation of forms with appropriate adaptation to the environment. Thus do new forms of organism and communities arise in ecosystems during their resilient evolution. We could say that an adaptive and resilient culture is founded on forms of creativity that are similarly sensitive to history and to ecological context, avoiding the errors that have caused cultures to collapse as described by Diamond (2002)

Short and Long-term Investment in Human Economic Systems and in Ecosystems.

We are now well aware of the dangers of short-term investment and speculation cycles in human economies, as these can lead to bubbles that burst with extensive collateral damage to all economies due to global connectedness. However, there does seem to be an intrinsic tendency in human social history for episodes of creative innovation, during which new modes of living, technologies and power structures are explored in response to changing circumstances within society and in the environment, generating crises of transition that are then resolved through the adoption of new technologies and social structures appropriate to the new styles of living and production. During the past 230 years or so of the industrial revolution, such “technological revolutions” have been described by the Venezuelan economist Carlota Perez (2002) as occurring over roughly 50 year cycles. She describes these

episodes in the following terms:

“each technological revolution irrupts in the space shaped by the previous one and must confront old practices, criteria, habits, ideas and routines, deeply embedded in the minds and lives of the people involved as well as the general institutional framework, established to accommodate the old paradigm. This context, almost by definition, is inadequate for the new.”
(Perez, 2007).

Significantly, Perez demonstrates that each transition goes through distinct periods, starting off with an “irruption” phase during which the innovations are generated, followed by a phase of “frenzy” as investors rush for a stake in the businesses spawned by the innovations; then a phase of “synergy” as the new approach results in a generalised global dispersion of production systems across the economy as a new ‘golden age’.

The first of these recent transitions described by Perez was effectively the beginning of the industrial age, starting around 1771 with the development of machines and the emergence of the mechanized cotton industry as the template for industrialization. The second transition was the “age of steam and railways” that started in 1829 when the steam engine fuelled by coal made it possible to build transportation systems and factories powered by fossil fuels extracted from the earth using new mining technologies. Subsequent cycles were the age of steel, electrification, steel ships and the start of mass consumption of consumables (starting in 1875), the age of oil, automobiles and mass production that began in 1908, then came the age of information and telecommunications starting in the USA in 1971, which spread across the world. Each of these transitions depended on the exploitation of a key natural resource/ecosystem service: soils, cotton and iron from the colonies for the first; coal and iron ore for the second; coal, iron ore copper and agricultural produce for the third; oil plus all the other resources for the fourth; and a conglomeration of oil, metals, biomass and agricultural produce secured via digitally networked trading relationships for the fifth.

These recent transition cycles need to be embedded in the much longer transition periods that human societies and their ecosystems have undergone, though these are more difficult to characterise and much less well understood in their origins and their impacts. Among them are the discovery and use of fire by humans some 250,000 years ago, an innovation that has had serious impacts on the ecosystems within which humans have developed their societies. Another is the emergence of language, dating from some 40,000 years ago. Language clearly facilitates communication and stimulates creativity such as tool-making, and cooperative activities such as hunting and construction of dwellings, which have significant ecosystem impacts. The transition to agriculture some 10,500 years ago was another major transformation of life-style that has had lasting consequences on the health and diversity of ecosystems and species. All of these reveal periods of innovation followed by ecological impacts, the prehistoric transitions having much longer intervals between them than the recent ones described during the industrial age. As we are all well aware, human history is speeding up. However, it may well be that periods of innovation followed by episodes of consolidation are also intrinsic to ecosystem dynamics, so that human cultures are following natural dynamic patterns.

Within ecosystem evolution, clearly the short-term innovators are the microbes and viruses with their open source information sharing that allow new adaptive discoveries to be made available to other microorganisms. This can be seen from a human perspective in the rapid adaptation of bacteria to our health defence discoveries such as drugs and antibiotics. Bacteria evolve new enzymes capable of destroying antibiotics and de-toxifying drugs so that they become resistant to these products. They also learn to change their identity markers on the cell surface so that our immune systems fail to identify and destroy them, or to continually alter their genetic structure so that the immune system cannot recognize them as foreign, as in the strategy of HIV. Bacteria and viruses have behaved this way throughout evolution, adapting to changing circumstances and learning new strategies of living on their hosts, the larger animals and plants. It is the macroflora and macrophyta that are the long-term investors in ecosystems, having much longer life-cycles than microbes and hence being much slower to adapt to changing circumstances. They depend upon stability in the ecosystem, much as long-term economic investors depend upon stability in economic policy and conditions of investment. Whereas microbes can adapt to major changes in conditions on earth, such as the emergence of oxygen as a major component of the atmosphere during the transition from an anaerobic to an aerobic planet resulting from the innovation of photosynthesis, the macrobiota respond much more slowly and need long periods of stability to discover effective life-cycle strategies. They then contribute substantially to this stability by introducing complex diversity into ecosystems, enhancing resilience for the evolutionary process. Resilience and diversity are intimately linked and we need to take account of this in our economic systems, which have recently suffered from a combination of global homogenization of economic systems and the destabilizing effects of short-term investment activities whose sole goal is profit, not diversifying the economy with real innovations that can help to stabilize the process.

To be creatively resilient and adaptable, economies require similarly rich webs of interaction between companies of different size and complexity that trade in real goods and recycle resources efficiently among each other. Businesses clearly go through phases of growth and expansion as they discover a new niche for trading, followed by down-sizing and possible extinction as their contributions to and relevance for the trading system decline.

The Resilient Diversity of Gaia is Based on Local Bioregions

The diversity of interacting life forms that give earth its resilient diversity is based on the evolutionary adaptation of organisms to local bioregions such as rainforests, savannahs, coral reefs, wetlands, and so on. Thus the foundation of global stability in Gaia is patterns of interaction in local communities that have evolved to survive in different conditions (Harding, 2009). Global adaptability and resilience is grounded in appropriate local behaviour. It is not based on the application of a single principle of exchange and trade in a homogeneous system, as is our global economic system. In fact we cannot design rationally a global economic system that would ever work because this is precisely the wrong approach. Evolution experiments with a diversity of local life cycle strategies that co-evolve to give coherent patterns of interaction. Similarly, we need to explore a diversity of economic and currency systems that are

appropriate to the cultures that have emerged in different bioregions. We know that the different human languages and cultures that have evolved are deeply sensitive to their ecological contexts, reflecting an intimate understanding of the subtleties of appropriate relationship to other species, the land and its climate, the seasons and their rhythms. This sensitivity we have lost by imposing a global economic system on the planet that is based on precisely the wrong principles for resilient evolution. As a result we are losing human cultures and languages, as well as species and ecosystems, at an alarming rate. The great mistake of economic design up to now has been the assumption that we can rationally put in place a system that will work globally, once and for all. The destructive human behaviour that results from the hubris of this type of belief is very baldly expressed by Naomi Klein in her thoroughly researched and documented book “The Shock Doctrine” (2007) in connection with the doctrine of neoclassical economics, the most recent attempt to impose a single economic and trading system on the planet:

“..the entire thirty-year history of the Chicago School experiment has been one of mass corruption and corporatist collusion between security states and large corporations, from Chile's piranhas, to Argentina's crony privatisations, to Russia's oligarch's, to Enron's energy shell game, to Iraq's "free fraud zone". The point of shock therapy is to open up a window for enormous profits to be made quickly - not despite the lawlessness but precisely because of it. "Russia has become a Klondike for International Fund Speculators", ran a headline in a Russian newspaper in 1997, while Forbes described Russia and central Europe as "the new frontier". The colonial-era terms were entirely appropriate". (p 241) This is dissipation of earth resources at a deadly rate, moving the earth towards the condition of a dying planet”.

A similar type of universal vision lies behind the belief of modern Western science in finding ‘the truth’ and explaining the world in terms of a few basic principles that allow us to exercise control over nature. Chaos, complexity, and Gaia theories revealed the limitations of such a vision, useful as it is in restricted contexts, for nature is intrinsically and unpredictably creative. This new integrated or holistic vision requires a move to transdisciplinarity in our educational systems (Max-Neef, 2005). Designing successful economies in such an interconnected world requires that we be as intrinsically and unpredictably creative as our natural context, so we must proceed by inspiration, humility, trial and error.

Exploring Resilient Economic Systems.

“What is the meaning of democracy, freedom, human dignity, standard of living, self-realisation, fulfilment? Is it a matter of goods, or of people? Of course it is a matter of people. But people can be themselves only in small comprehensible groups. Therefore we must learn to think in terms of an articulated structure that can cope with a multiplicity of small-scale units.” E.F Schumacher. *Small Is Beautiful*.

Schumacher has been an inspiration for the environmental movement and as a refuge for economists seeking a more humane and ecological approach. His insights for a re-localised economy comprising a multiplicity of small scale units can be extended to enable sharing of information and knowledge both within and across local communities, enabled by the internet. Maximising autonomy at the micro level

combined with maximizing coherence at the macro level is a characteristic of health and resilience in ecosystems that has clear applications to our economic systems.

There is a basic principle that is fundamental to our belief that human communities need to be organized on the appropriate local scale in order for people to achieve creatively innovative but overall stable trading and exchange systems like those that are the foundation of ecosystem stability. This is the recognition that there is a natural regulator of human trading activity that balances quantitative satisfaction of needs with qualitative value of lived experience; that is, that brings into harmonious balance quantity of goods and services with quality of life. However, this regulator is effective only when human communities have the appropriate size or scale. The reason for this is that if communities grow too large then the social structure tends to get fragmented. As a result individuals no longer have a direct experience of living in community, that is, sharing with others through direct contact and interaction in their daily activities. They have to travel long distances for work purposes so that their home and community life is restricted and there is limited sharing of experience. This shared experience is how people monitor the quality of their lives. When this monitoring occurs then people become aware of what is happening to them in relation to their potential for living a life of meaning, getting satisfaction from their relationships and feeling their own growth towards greater fulfilment. Being aware of this process is what alerts people to the destructive aspect of scale and social fragmentation, and can result in people making deliberate choices for improved quality of life rather than increased quantities of consumer goods, the usual anodyne for loss of meaning in fragmented communities. Hence it can act as a regulator of excessive trading activity beyond a level that satisfies basic needs and provides the freedom for people to explore the meaning of their lives in relation to others. This acts like a negative feedback process in ecosystems, regulating growth and maintaining balance, but it is based on distinctly human qualities.

The issue of scale is critical to ecosystem health and equally to economic health. The globalised scale of our current trading, money and capital systems is extremely fragile and highly dependent on a ready and cheap supply of fossil fuels – particularly oil. This level of scale can neither be sustained nor is desirable. The rapid move towards re-localisation, (with high priority on basic needs such as food and energy) and the emergence of diversified technologies, governance and legal structures and strengthened local communities is the transition which is urgently needed. The swing from globalization to re-localisation is perhaps another feature of self regulating feedback characteristic of natural systems.

Another important side of this natural regulator is the positive effect of trade on human communities in providing people with basic needs and services so that their quality of life improves beyond the most basic level of survival. This is well recognized as the primary stimulus for increased production and the growth of the money supply so that quality of life can improve for all. However, the economic system that we currently experience fails to distribute money, goods and services equitably throughout society because money is not understood as a catalyst that should not accumulate in anyone's hands. Rather it is allowed to flow in directions resulting from positive feedback loops (to him that hath more shall be given; those with money invest with interest and their money supply grows exponentially, without bound). These are deeply destructive of social cohesion, causing the very

fragmentation that prevents people from monitoring quality of life and correcting these unstable, runaway processes from taking over.

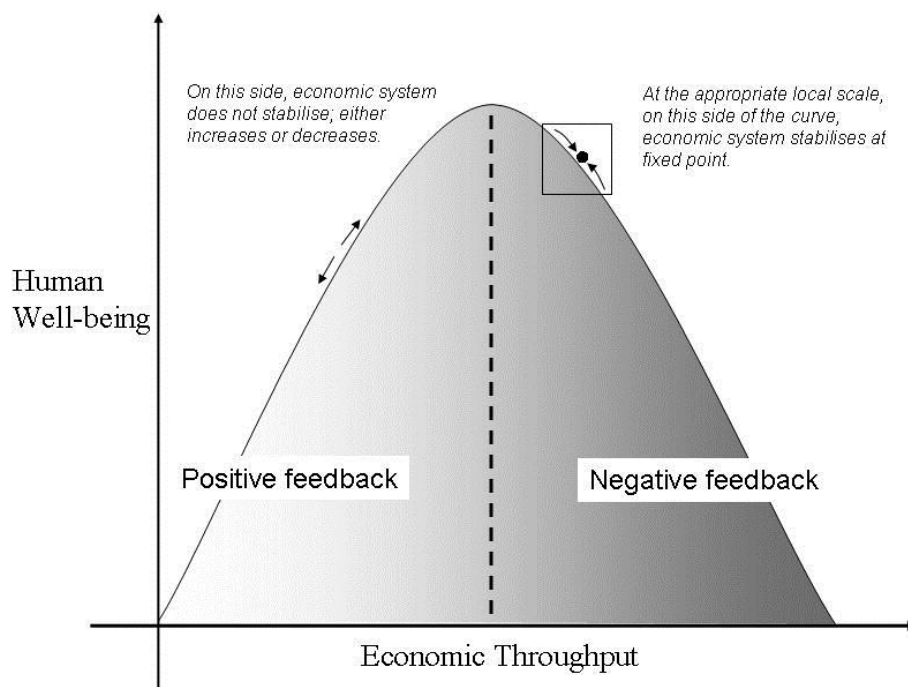


Figure 2. The dynamic regulator of human economic activity, balancing quantity of goods that satisfy basic needs with quality of life in community.

The dynamics of this regulation process is described by the graph in Figure 2. The abscissa or x-axis measures the trading activity in a community while the ordinate or y-axis defines human well-being in terms of the quality of life experienced. Initially, as trading activity increases in a community, facilitated by money as the medium of exchange, basic needs are satisfied and quality of life is experienced to increase as people have more opportunity to find out who they are and how their particular gifts serve their community and the broader culture. This is the part of the curve that we have been exploring through many thousands of years of human history, since the beginning of the agricultural revolution 10,000 or so years ago. The past 200 years have seen a dramatic acceleration of the accumulation of consumer goods and money. However, at the same time there has been an enslavement of people to trading activity as work became separated from domestic and community life and people were forced to spend more and more time struggling for scarce money, an artificial aspect of our financial system.

Regulatory principles similar to those described in Figure 2 have been explored by other authors as foundations for reformed economic activities, in particular Lietaer *et al* (2008) in a paper entitled 'White Paper on All the Options for Managing a Systemic Bank Crisis'.

Gaia is the model for the economic system that will allow humans to continue their own particular evolution on earth in cooperation with all the other members of this planetary partnership. As recognized above, we cannot simply design a new economic system based on our limited understanding of how ecosystems work. It is necessary to approach this challenge with the creativity and uncertainty that characterizes all evolutionary processes. We need to experiment with different models in different communities to find patterns of production and exchange appropriate to local regions.

What is the equivalent for human economies of the fluid, changing, and overall abundant quality of life that characterizes ecosystems? As a species humans have accumulated in numbers well beyond the carrying capacity of the earth in relation to our current practices of resource management and land use. It is impossible to know exactly what level of human population can be sustained in conditions of equity and plenty when it is in balance with earth's ecosystems, and we will only find out by exploring radically different patterns of economic practice. We suggest that some fundamental steps in this direction are the following.

1. Encourage the emergence of self-organising local communities that are based on the same principles of creative experimentation that occur in ecosystems, giving them the properties of resilient adaptation to changing circumstances. Fundamental to this process is the recognition of the need to fundamentally change human cultural awareness from focus on gratification of human desires through consumption to satisfaction of needs and quality of life in balance with nature. This can lead to humans expressing their potential through lives of meaning realized through service to each other and to the planet. The transition movement is a clear expression of this objective, as described in *The Transition Handbook* (Rob Hopkins, 2008) and in the Structure Document for localized self-organisation (see transitionculture.org.) A case study of the Transition Network is given below.
2. Encourage the localization of food production, energy generation, healthcare, education and political decision-making so that these are all located in and around communities that have grown up within bioregions and know them well. Each community needs to explore its own form of production and community welfare, and to share with other communities the information it uses together with the results of its experiments so that an open-source network is created. This will involve the emergence of local businesses and creative innovation locally. The result is the generation of local diversity of production and social welfare systems appropriate to bioregions, regulated by local decision-making. These localization movements can occur on different scales of regions, countries, trading networks, and so on. They will need appropriate protection legislation to allow new enterprises to develop and flourish.

“The networked environment makes possible a new modality of organizing production: radically decentralized, collaborative, and non-proprietary; based on sharing resources and outputs among widely distributed, loosely connected individuals who co-operate with each other without relying on either market signals or managerial commands.” (Yochai Benkler 2006)

3. Encourage experiments in alternative local currencies and banking practices that are based on principles of no growth in scarce resource use and promote growth in green technologies that reduce carbon emissions. This is the Green New Deal with finance based on community banking systems that involve no interest on loans and demurrage on accumulated money that does not return to the trading system. This type of community banking already exists as evidenced by the Swedish JAK bank, time banks, and Wirtshaftsring in Switzerland. Examples of local currencies in current practice can be found in Berkshares in Vermont, the Chiemgauer currency in Germany, and in the recent introduction of the Totnes and the Lewes pounds in the UK as part of the transition movement.
4. Stimulate the development and construction of renewable energy networks through the investment mechanism of the Green New Deal and community owned decentralized renewable energy systems. However, this involves continuous growth and so the Green New Deal needs to be embedded within a fundamentally changed economic system as described above.

Following the radical economic thinking of Frederick Soddy (1926) who is mostly known as the 1921 Nobel Laureate in chemistry, and the economist Herman Daly (1999), the following strategic points should be considered:

- 100% reserve requirement for commercial banks, thus depriving these private institutions of the right to create and destroy money;
 - policy of maintaining a constant price index, hence keeping the purchasing power of money constant; the creation and destruction of money is vested in the authorities;
 - local currencies; freely fluctuating exchange rates
5. We advocate an urgent economic reform that is more aligned with ecological principles

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**Julie Richardson: Case Study for the International Conference on Rural Reconstruction and Sustainability, Southwest University, Chongqing, China
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Putting Resilience into Practice: The Transition Network

The dual challenges of peak oil and climate change has spawned a growing international network of Transition Towns (www.transitiontowns.org). The objective of this movement is to support community led responses to peak oil and climate change, building resilience and happiness'. The concept of ecological resilience and its application to local economy is hard wired into the values and emerging structure of the wide network of transition communities across the globe.

Resilience replaces sustainable economic growth as the mechanism to ensure quality of life based on individual transformation and community empowerment. The Transition Network defines resilience as 'the capacity of a system to absorb disturbance and reorganize while undergoing change, so as to still retain essentially the same function, structure, identity and feedbacks'. (Walker et al 2004).

This is an excellent example of an experiment in self organizing local community responses to the dual shocks of climate change and peak oil. The Transition Network does not offer a standardized, homogenized plan for economic and community life beyond oil dependence. Rather it offers 5 stages or 'ingredients' of transition that enable a diversified response rooted in local context.

The first stage, 'starting out', is about people coming together in their community to raise awareness, create a vision for a sustainable future for their community, form working groups and initiate the process. The second stage, 'deepening', is about building momentum and developing practical projects drawing on inspiration from initiatives in other areas. The third stage, 'connecting', involves taking transition to a wider audience, such as local government, business, schools and universities. The fourth stage, 'building', involves a more strategic approach as transition communities set up social enterprises, energy companies, local currencies, eco-villages, community supported agriculture schemes and community land trusts. The final stage, 'dreaming', completes the cycle with a vision about what the wider region and nation could become if Transition initiatives join together to form food networks, learning networks, energy networks and together create a new culture of social enterprise.

Many attribute the success and phenomenal growth of the Transition Network (over 1000 initiatives spanning 34 countries have sprung up since its initial emergence in Kinsale in 2005 as at June 2012) to its emerging holographic structure that mimics cell growth within living organisms.

Ecological Resilience, Economic Resilience and the Transition Network

What can we learn from the principles of resilient ecosystems outlined in this discussion paper and apply them to evolve principles for new resilient economies? Table 1 demonstrates how principles from resilient ecosystems can be applied to the economy, with examples of what this means in practice drawn from the Transition Network. Illustrations of practical transition projects related to building resilience in the food sector are explored in the following section.

Table 1: Resilient Ecosystems, Resilient Economies and the Transition Network

Resilient Ecosystems	Current Economic System	New Resilient Economies	Transition Network
Self-regulating networks, positive & negative feedback	Linear system (take, make, dump) that generates negative externalities that are not automatically self-regulated within the system	Circular economies that incorporate feedback and resource efficiency into production methods that mimic ecosystems	Developing local economies based on closed loop and ecological production systems (e.g. organic and forest farming food systems)
Diverse, appropriate scale, context specific	Standardised global economic rules; economies of scale and homogeneity	Economies of scope; re-localised economies; diversification; building on local context and strengths	Strengthening local economies through community participation with a focus on basic needs sectors ; context specific solutions
Catalytic – facilitating transformation	Money as a store of value and wealth	Money as a catalyst to facilitate flows in economic systems	Local currencies to facilitate local trade; principle of demurrage wherein money loses value if stored
Competition and cooperation as evolutionary forces	Market system based on competition	Encourages cooperation to create value	Collaborative processes and cooperative enterprises
Emergence, creativity and novelty	Planned, regulated, risk management, emphasis on technological innovation	Experimental, multiple solutions, social and technological innovation	Experimental approaches across communities to find patterns of production and exchange appropriate to local regions
Ecological limits, efficiency and sufficiency	Optimistic about technological solutions to overcome ecological constraints	Economic system is dependent upon and operates within ecological and social boundaries	Low carbon solutions beyond oil dependency; broader concept of well-being beyond growth

Transition and Food Resilience in the UK

The issue of food security is not explicitly part of the UK government agenda in the food sector. However, it is acknowledged that the current system is not able to cope with the current challenges of climate change and peak oil. A recent UK government policy paper concludes that, “existing patterns of food production are not fit for a low carbon, more resource-constrained future” (Cabinet Office 2008). How to respond to these challenges differs between the UK government and the solutions offered by the Transition Network. Government policy focuses on promoting food resilience by diversifying the range of countries that the UK sources its food from. The argument is that the broader the base the less risky any significant disruption to supply. The Transition Network endorses the ecological principle of diversity, but promotes an approach that reduces reliance on oil, both in its production and distribution mechanism. In simple terms, this means transforming production systems away from dependence on fossil fuels towards low carbon production methods, and reducing food transport miles towards more local economy solutions. At the policy level, such a move will need to be supported by changes in the rules of world trade that prioritise international competitiveness over national food security.

Promoting Food Resilience in Transition Towns

The Food Standards Agency in the UK report that “imported foods make up an increasingly large part of the UK diet and about 50% of food consumed in the UK comes from countries outside the UK” (Food Standards Agency 2010; 2). The Transition ambition is to convert this to 20% imported and 80% self-sufficiency. Small scale food initiatives in the domestic, urban and peri-urban areas, could potentially contribute up to 60% of our food needs (Pinkerton and Hopkins 2009; 16-17). The Transition vision for a post carbon resilient food economy in the UK is summarised in Table 2.

Table 2: Principles for a Post Carbon Resilient Food Economy

- 80% cut in carbon emissions by 2050
- Resilience in food supply system to adapt rapidly to rising energy costs and climate change
- Improved access to nutritious and affordable food
- Diversity in terms of species, ecosystems, produce and occupations
- Prioritise establishment of substantial carbon sinks – through perennial tree based systems, good soil management and return to soils of organic matter
- Provide more employment
- Phase out of dependence on fertilizers and other agrochemicals
- Increase in food produces from back gardens, allotments and urban areas
- Lower food miles at all stages – growing, processing and delivering

Rob Hopkins, Mark Thurstain-Goodwin and Simon Fairlie (2009; 3)

Examples of Transition Related Food Projects in the UK

The Transition movement has spawned a wide diversity of local food projects and resources (<http://www.transitionnetwork.org/food>). Examples of Transition Towns

and related projects are illustrated below according to the following schema - access to land, low carbon production methods, food distribution systems, health and community gardens and orchards, and collaborative ownership models.

Access

Garden Shares

The UK is famous for its flower gardens. But the potential for growing food on garden land is surprising. Up to 400,000 hectares of garden and community land could potentially be used to grow food to feed over a million people (Pinkerton and Hopkins 2009; 71). Garden share schemes have been blossoming in the UK, both inside and beyond the transition movement. The idea is simple. The schemes expand access to productive food growing land by match-making available private land (and its owners) with those seeking land for growing food. The benefits are not only more local food production, but reduced food miles and strengthening the local community.

Garden share schemes provide a practical solution to land-access problems which are particularly relevant in densely populated countries. Good examples of UK based schemes include the Transition Town Totnes Garden Share Project (<http://www.totnes.transitionnetwork.org/gardenshare>); the Tavistock Garden Share Alliance, the Isle of Wight's Adopt a Garden Scheme and the Landshare project which has inspired many initiatives worldwide. Landshare addresses genuine concern among policy makers about future food security and greenhouse gases from industrial farming and food miles. It has been cited by the House of Lords, New Local Government Network, the international Wikinomics team and most recently – the Food Ethics Council – as changing the landscape in food accessibility and security (<http://www.landshare.net/>)

Low Carbon & Ecological Production Methods

A range of growers are working with Transition communities to supply local, low carbon and organic food to its members. In a recent report, Soil Not Oil, the ***Soil Association***, make the link between peak oil and food insecurity. “Intensive, industrial agriculture is totally dependent on oil, for fuels, fertilisers and other agrochemicals. But the world's oil supplies will soon be running down, leaving farmers and our food supply vulnerable to volatile and rising oil prices” (Soil Association 2008; 12). The ***Soil Association*** traditionally promotes conversion to organic principles – both for large scale producers as well as small scale mixed plots and gardens. Organic food growing reduces dependence on fossil fuels largely through replacing carbon based pesticides and fertilizers with natural alternatives as well as incorporating a traditional system of crop rotation across the seasons. No dig organic horticulture systems take another step, by conserving the carbon store in the soil through the no dig method. ***School Farm***, provides an example of a mixed market garden that supplies organic fruit and vegetables to the nearby Transition Town Totnes as well as providing vocational training in sustainable horticulture.

Perhaps one of the most ecological forms of food growing is ***forest farming***. Rob Hopkins, one of the founders of the Transition movement, is inspired by the experiment in agroforestry that has been taking place near Totnes by Martin Crawford. Forest farming reflects the structure of a forest with trees, shrubs and

plants. The key is to work with the ecosystem and plant perennial tree crops that require much less energy to cultivate than traditional annual crops.

“A forest garden is a kind of under-planted orchard – you start with fruit and nut trees, and with careful design and placement, shrub crops and perennials are grown beneath – all can be useful edible plants, though you cannot really grow the ‘normal’ annual vegetables in shade”. (Tamzin Pinkerton and Rob Hopkins (2009; 99)

Distribution

Growing Communities is an excellent example of an urban scheme to supply communities with affordable, sustainable food produced by small scale growers. It has been an inspiration to many Transition and other local food distribution projects across the UK – including the planned Food Hub in Transition Town Totnes (<http://www.transitiontowntotnes.org/groups/food-group/food-link-project/>).

Growing Communities is a social enterprise set up to provide greater resilience in the food sector as an alternative to the large scale, centralised food businesses that can exacerbate food insecurity. The scheme runs a number of community led trading projects including a weekly organic vegetable box scheme delivered by bike or electric vehicles to drop off points in the city; urban food production through a network of market gardens and community orchards in the London metropolis; and outreach community work and training in sustainable business skills and models.

Health and Community Gardens and Orchards

Gardening for Health

This project forges a link between individual, community and food resilience by working with health professional and the medical referral system to provide practical food growing and gardening placements as a therapeutic opportunity for a range of physical and mental health problems. The Faculty of Health at the University of Plymouth is working with the project to develop a replicable model for integrating food production and individual resilience with measurable physical, mental and emotional health benefits.

<http://www.totnesdevelopmenttrust.org.uk/totneshealthyfut.html>

Community Orchards

Many areas in the UK have been traditionally known for their orchards – whether it be cider apples in Devon or the ‘Beauty of Bath’ apples in Somerset. Since the 1960’s, the UK has been witnessing a loss of its traditional orchards by up to 95% in some areas. This decline in home grown fruit has meant an increased reliance on imported varieties, largely from New Zealand and South Africa, to the tune of 90%.

Transition Towns in the UK have been working with other organisations, such as Common Ground, to reverse this trend. There are now a number of community orchards emerging across the country both in rural and urban areas. The Broadlands Community Orchards scheme near Bath started up in 2006 and operates a share harvest scheme with the land owner. In contrast, the Transition group in Portobello in

Edinburgh operate a community orchard in an urban setting. The community are planting a range of fruit trees, willow plantation and medicinal herbs to demonstrate the range of uses of trees and shrubs as part of its outreach educational programme.

Collaborative Ownership Models

Community Supported Agriculture

Community Supported Agriculture (CSA) is a growing movement in the UK based on the notion of mutual support between farmers and the local community. CSA is a model of collaboration based on sharing the responsibilities, risks and rewards of food growing. The model for collaboration varies across CSA's. Often they are farms (set up as limited company) in which the community members buy shares, contribute to decision making and often help in harvesting. Farmers receive a more stable and secure income whereas consumers benefit from eating locally grown fresh produce and learning new skills. The range of produce grown in this collaborative way is expanding and now includes vegetables, eggs, poultry, bread, fruit, meat, dairy, fish and firewood.

The Stroud CSA scheme is one of the first in England and has inspired many Transition Towns to set up their own schemes, with over 100 CSA's now operating in the UK (Pinkerton and Hopkins 2009; 103). The Stroud CSA set up as industrial and provident society with democratic decision making and cooperation built into the core of the organisation. The scheme operates from a 50 acre site with around 200 community shareholders growing a range of fruit and vegetables that are distributed to share owners.

Food Cooperatives

Food coops demonstrate economic resilience as they address the linked threats of community breakdown and food insecurity. Shared ownership and decision-making of food cooperatives, "emphasise the importance not only of what we eat but also how we organise ourselves around access to it" (Pinkerton and Hopkins 2009; 123). An excellent example of a successful food cooperative is the Food for All cooperative in Bristol (<http://www.foodforallbristol.org.uk>). The objective is to make food accessible to all, in a seriously deprived area where access to affordable and nutritious food is a critical issue. Membership is restricted to local residents with over 200 households paying a small annual membership entitling them to 10 per cent discount on all co-op produce.

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