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Restorative Land Use as Appropriate Technology: a System Account

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Restorative Land Use as Appropriate Technology: a System Account[1]

Jenneth Parker

Living Economy Contributes to Climate Solutions

We are in a state of climate emergency with increasing carbon dioxide from industrial development and methane releases from damaged natural systems. Existing viable alternatives in land use need political will and policy innovation to be protected, joined-up and scaled up.
The living Earth system is being change by human activity across the whole range – including food production, ecosystems and soils. This ***living economy*** *is currently in a serious decline but the good news is that we already know the basics of how to restore it for people and planet.*
Current climate negotiations are concentrating on emissions from the industrial economy. This is important but not sufficient. The purpose of this paper is to highlight solutions based in the living economy. The evidence shows that without this essential aspect we cannot hope for the stabilised climate essential to the future of life on Earth.

Convergence Alliance et al (2015)

[1] **This is a draft version. Please do not cite without permission.**

Contents

- **Introduction**
- **Section 1: Assessing appropriate technology-a global systems approach** proposes a second-generation Schumacherian formulation for 'appropriate technology' based in systems and process approaches.
- **Section 2: The context - Earth system science** provides an outline of the systems approaches to be used in providing the basis for: the arguments linking land use, social justice and mitigation of climate change; underpinning the recommendations for specific policy areas; and strategic proposals for different actors to work together more closely.
- **Section 3: Focus on climate and land use** will make the links between systems approaches to climate issues, land use and livelihoods. This will explore the current state of policy development on land use and climate.
- **Section 4: Social Justice: the price of global ecological restoration** will concentrate on the topic of Soil Cultures and Human Rights – including the right to food.
- **Section 5: Conclusions – Restorative land use in the Anthropocene** applies the appropriate technology formula to land use in the context of Earth system science and social justice.
- **Section 6: New Alliances for Living Economy** looks at the prospects for social movement, policy and scientific liaison and co-creation in this new and complex terrain.

Acknowledgements

This paper builds from a policy discussion paper (here cited as 'Convergence et al') supported by the following: Greenhouse UK www.greenhousethinktank.org; Convergence Alliance – Schumacher Institute www.schumacherinstitute.org.uk, SCAD Tamil Naduwww.scad.org.in, Greendependent Hungary www.greendependent.org; Water 21 UK www.water21.org.uk; ECOLISE EU www.ecolise.eu; colleagues from the University of Iceland contributed the systems diagram and expertise. Thanks to Ashley Ward of the Schumacher Institute for 'intelligent design'.

The paper works from existing knowledge at the forefront of a number of key areas and generates new knowledge by bringing them into more dynamic relation to each other. This chapter will draw from the following range of research and dialogue:

- Managing the transdisciplinary synthesis phase of the UK National Environment Research Council (NERC) QUEST project to add in global biotic feedbacks to climate models, highlighting land use questions for climate change
- Perspectives developed as a lead researcher in the EU funded FP7 CONVERGE project focussed on re-thinking globalisation in the light of planetary limits and equality, particularly the contribution of our Indian NGO partners Social Change and Development (SCAD) and our Hungarian NGO partners Green Dependent; Stakeholder modelling of the food system in Bristol, Iceland and Tamil Nadu, with colleagues from the University of Iceland.
- Work with the international Society for Ecological Restoration (SER) exploring the potential of major restoration for climate mitigation, livelihoods and biodiversity
- Ongoing discussions about the value of soil – Political Economy or Political Ecology approaches with SoilTreC scientist Vala Ragnarsdottir
- Philosophical and methodological reflections on interdisciplinary research and local/indigenous knowledge informed by masters research of students from different African Commonwealth countries in Education for Sustainability[2]
- Ongoing participation in AdaptEcon Marie Curie project involving systems modelling for transforming the economy in the light of planetary limits and resource depletion http://jardvis.hi.is/adaptecon.

[2] Education for Sustainability Masters programme by Distance Learning, London South Bank University lsbu.ac.uk

Introduction

> *Experience shows that whenever you can achieve smallness, simplicity, capital cheapness, and nonviolence, […] new possibilities are created for people, singly or collectively to help themselves, and that the patterns that result from such technologies are more humane, more ecological, less dependent on fossil fuels, and closer to real human needs than the patterns (or lifestyles) created by technologies that go for giantism, complexity, capital intensity and violence.* (Schumacher, 1979, p57)

This paper aims to articulate the systems basis and underlying rationale for bringing together many different kinds of knowledge and actors connected with land use to collaborate for our global future. The paper proposes a second-generation Schumacher-inspired formulation that defines 'appropriate technology' using a systems approach in the context of the complex interdependencies of the Earth system. This applied systemic approach can also support normative political developments of solidarity based on the interdependent relationships that systems approaches reveal. The role of small scale agricultural producers has now been shown to be primarily benign and it is in the interests of all global citizens that this is strengthened and supported. This paper also proposes some new policy alliances based on this systems analysis and outlines the potential of systems tools for these alliances to work with.

The development of informed collective agency lies at the heart of the complex challenges of global 'Earth System Governance' and the need for joined-up responses to climate change. Strategically, this will involve joining together in agreements for changing a wide range of linked human activities, including land-use, farming and diet. We have to try to change in ways that can continue to meet immediate and short-term human needs whilst at the same time maximising routes to complementary, joined-up system change- this is what **transition** means. There are also challenges of scales of activity which means re-thinking and re-designing agency at different scales. We need complementary actions across scales - not just across our global regions but at national, city-regional and local to community levels [3]. We also should not underestimate the extent of the challenge involved in defending **the living economy** from the financialised economic 'realities'[4] still embedded in the current structure of global power.

'Waking up in the Anthropocene' is one way to describe the dawning awareness of the extent to which human action will now be decisive for the fate of the planet, of future generations of humans and of evolved life. The sciences that have revealed the Anthropocene to us most starkly are the Earth system sciences. Global satellite technology has also shown us our effects on the macro scale of the planet in dramatic visual form, along with the beauty of our planetary home. The results of our individual and collective actions are adding up to a massive system change raising fundamental questions about the trajectory of modernity over the last two centuries and the speed with which we continue to consume the planet's resources. Analysis of complex problems of land use can help us see the complex ways forward in terms of the kind of joined-up changes that are needed for us to make a 'fruitful Anthropocene'. This paper argues that we should be designing a range of complementary actions establishing benign positive feedbacks across different parts of the system.

1 Assessing Appropriate Technology – a Global Systems Approach

What is technology? Although theorists of technology give somewhat different answers, they all share an account of technological artefacts and processes of production as chains of relationships. Very few thinkers now separate technology from these human activities, and this is an indication of how deeply technology is now linked in with our human future. It is often supposed that 'technology' only refers to things that have been produced by machines, are complex and resource-intensive. When discussing

[3] This has been called 'polycentric climate governance' ref the EU workshop in Florence May 2016

[4] Economic instruments and concepts have a 'reality' as they are applied in the world – however many of these instruments totally ignore the reality of the biophysical and social bases of the economy. Financialised 'products' involve the selling of futures that do not yet exist – but then form a powerful channel helping to determine the future should feed the present.

management of soil, land, biodiversity and water and in the context of food production it is important to be very clear that there exist powerful and efficient technologies that are still used in agrarian systems. The power of these technologies lies in the benign feedback relationships that they work with and support (see diagram page X). Whilst these are often informed by centuries of practice, these technologies can still adapt and are not necessarily static.

As a founder of the western 'Appropriate Technology' movement (AT), Schumacher attempted a philosophy of appropriate technology that included a view of human being particularly concerned with technology and human flourishing. Along with many others, including Marx, Schumacher was concerned with the impact of technological development on the nature of work and on patterns of human settlement. However, **Schumacher's account of appropriate technology was a radical one that sought to combine a degree of technological conservatism with a cultural radicalism that supported equality**[5]. Schumacher was also concerned with technology and human freedom and innovation as part of the freedom of human beings. He identified that high energy cost and high capital cost requirements for modern technological development means that power is concentrated in even fewer hands and deprives society of the innovative capacity held by the majority of people. This is why Schumacher's thought includes the promotion of 'human scale' social technologies of production, part of the thinking behind 'Small is Beautiful'. What does Schumacher's thought look like today if we update it and apply it in the context of the developing system sciences?

Appropriate Technology

Appropriate Technology (AT) does look at the human/technology/'nature' relationships which other approaches have not often considered. The Appropriate Technology concept was taken up by those who criticised the one-size-fits-all approach to development which consisted in exporting western technologies without regard to context. Thus the AT movement[6] challenged **both** the liberal economic school of 'laissez-faire' development through globalisation **and** the (western) Marxist approach. AT has helped to clarify the extent to which the emancipatory thesis of Marxism depended in some aspects upon a kind of technological determinism (Dusek, 2006, p93-95) applied to all countries and contexts. The following analysis by Trotsky makes clear the ideological links between 'big technology' and human liberation:

> *The real possibilities of collectivisation are determined, not by the depth of the impasse in the villages and not by the administrative energy of the government, but primarily by the existing productive resources - that is, the ability of the industries to furnish large-scale agriculture with the requisite machinery. These material conditions were lacking. The collective farms were set up with an equipment suitable in the main only for small-scale farming. In these conditions an exaggeratedly swift collectivisation took the character of an economic adventure".* (Trotsky, 1937, p. 38.)

Whilst Trotsky is critiquing the way that collectivisation of farming took place, he has no doubts that when it comes to agriculture 'bigger is better'. The local knowledge of the farmers was ignored by the regime and the centralised ideology of 'modern scientific'[7] farming resulting in appalling famine. This now looks like 'technological adventurism' i.e. high risk taking and low evidential support for actions due to being over-impressed with modern technology. The view that rural society was inevitably conservative and anti-change was held to justify some of the purges of Stalin and Mao[8]. The violence that is done to the rural populations in the name of development – of any kind – has been a constant theme in the post-development and sustainability movement[9]. This is worth emphasising as a major

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[5] Although as a man of his time Schumacher does not seem to have been particularly gender-aware.

[6] Sometimes also called 'intermediate technology' to indicate its place between 'hightech' and 'lowtech'.

[7] In this case Lysenko's science which conformed to ideology was a disaster leading to terrible famine.

[8] See http://necrometrics.com/20c5m.htm for sobering facts that tend to make one doubt Stephen Pinker's thesis that humanity is becoming less violent (2012) and to keep at the front of the mind when considering sustainability politics.

[9] Peasant revolts in Europe have historically been put down with the utmost cruelty as elsewhere in the world. One of the most iconic actions at the start of agricultural capitalism was the enclosures of the common lands that

continuing point of difference between some aspects of the sustainability movement and the left in industrialised countries. We need to recognise these issues openly if we are really going to build effective alliances for sustainable global change that can cross over the agrarian producers and the industrial producers of the world[10].

As MacLurcan (2012) argues,

> *Schumacher's proposal was for 'appropriate technology'. Grounded in hope for greater human equity, what Schumacher proposes could also be considered "…democratic or people's technology" …..Such technology, he claimed, would address the 'law of the disappearing middle' by proposing an 'in-between' technology that would be: "…vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the super-technology of the rich"….. In doing so, Schumacher considered the potential to draw from both the best of the North's modern knowledge and experience as well and the South's traditional, local wisdom. pp. 65-66*[11]

Considerations of the disempowering effects of some technologies are crucial in conceiving of 'Green Technology' and what that might mean. Vandana Shiva has been one of the most powerful voices protesting that industrial agriculture de-skills farmers and deprives the world of their essential knowledge. The workers' cooperative movement in industrial countries also makes some similar arguments for workers' control and/or involvement in management decisions. With regard to industrial systems Reinhard Loske[12] recently claimed (2013) that the development of renewable energy in Germany had been constructed so as to diminish the control of the big two energy companies who were dominating policy. A more distributed model has been developed and it is argued that this is also a better way forward for **resilience** – that is because a linked system of robust parts can survive shocks and impacts better and adapt quicker than cumbersome large systems (Blewitt & Tilbury, 20012; Roderick, 2014).

An Updated Global Appropriate Technology Concept

In wider terms, the issues of Appropriate Technology are often missing from the 'IPAT' 'equation' (Impact = Population x Affluence x Technology). In sustainability we want to maximise Human Well Being[13] , rather than just 'affluence' and to minimise Impact on our life support systems. It is also vital to consider infrastructure and its likely sustainability – will existing infrastructure continue to be available in the light of current trends or are more resilient options needed? In addition to impact minimisation, Appropriate Technology assesses resource availability and its sustainability over time and the context in which technology is to be used and repaired. In addition these approaches to AT need to take on board many of the lessons from Transition approaches. There is much to be said here – but for now AT defines the goal of the technology that we would like to end up with and transition helps us think about how to get there starting from where we are now. This may mean initial compromises[14] provided the strategy is going in the right direction and is open to adaptation as changing circumstances and unexpected system shocks may manifest.

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peasant communities used for their own subsistence. http://www.permanentculturenow.com/history-of-enclosure/

[10] The Left should embrace degrowth says Georgios Kallis http://www.resilience.org/stories/2015-11-10/the-left-should-embrace-degrowth

[11] This also represents a fault line between Ghandians and Marxists. Ghandi's concept of swaraj did not call for people to overthrow the state but to become capable of running their own affairs and sustaining themselves, *Independence begins at the bottom... A society must be built in which every village has to be self-sustained and capable of managing its own affairs... It will be trained and prepared to perish in the attempt to defend itself against any onslaught from without... This does not exclude dependence on and willing help from neighbours or from the world. It will be a free and voluntary play of mutual forces...* ' (Bhattacharyya, 1969, p 479)

[12] Professor of Politics, Sustainability and Transformation Dynamics, Witten/Herdecke

[13] Arguably in the Anthropocene we need to re-assess the minimal factors for Human Well Being

[14] For example at the 'Small Is…' festival in Bristol 2014 Rich Pancost of the University of Bristol Cabot Centre argued that we need to take a transitional approach to moving towards renewable energy. He argued that as we have an existing investment in nuclear infrastructure, and it is not contributing to greenhouse gases, it would be

An Appropriate Technology 'Equation': HuMiTRaC

Human Well Being x Minimal Impact (low risk) x Resource Availability x Context = Appropriate Technology
One example provided by Ravi Kumar (2012)[15] is that of localised hydro-electric systems.[16] Minimal impact is recognised by using naturally occurring hydro energy. Engineers' current tendency is to maximise the efficiency of the machine forgetting to account for other factors. However a less efficient machine that can be repaired and serviced by locals is the best appropriate technology option with regard to resource availability and context.

'Minimal Impact' has to include the 'low risk' proviso and one key implication of Earth system science is the change in the ways we need to asses 'risk' (Beck, 2013). We now have to assess risk globally as well as more locally. For example, since James Lovelock pointed out the key role of micro-organisms in creating and sustaining our global atmosphere[17], any potential threat to the safe operation of these organisms should be taken very seriously indeed. We rely on microorganisms in every sphere of life and this is one completely valid source of concern regarding genetic modification – even for allegedly benign purposes.

Whereas in the context of rural development infrastructure and resource availability are generally only assessed on a local level, increasingly they will be looked at in terms of their effects on the global system (Biermann, 2010). Arguably **these AT criteria provide the basis for technology assessment for sustainability more generally and should also be applied to macro-level technology decisions**[18]. They might form part of a globally applicable philosophy of technology for sustainability and thus contribute greatly to global public reasoning about these essential topics.

A fuller discussion of Appropriate Technology in the wider sustainability movement is long overdue. There are ideological positions involving concepts of 'Environmental technology' that are in need of critical review – exactly what are technologies that 'work with nature' (Soper, 2007) and where is the borderline? If it is the case that all the factors above should be considered before we can call a technology 'appropriate', then this opens up the need for wider assessment and public deliberation about all technologies. Certainly we need a lot more arguments than simply the fact that a powerful corporation has invested large sums in research for which shareholders want a return – especially when the future of the life-support systems of the planet is at stake.

How would the above approach look if it was applied to crucial questions of agricultural technologies? On the existing evidence we should aim for radical change but we might support a basket of options on a strategic path to get us there. First, more easily obtainable successes through supporting and defending forms of agricultural production that simultaneously provided livelihoods or immediate human benefits would be a priority. But we might also want to support the ongoing research programme of more technical forms of agricultural production such as aquaponics in order to have a range of options for the future. The 'basket of options' approach is more suited to a systems and process understanding which allows for learning and deliberation in the light of changed knowledge and options. This would argue against demonising any technologies out of hand. However, the Appropriate Technology concept does presume a strong orientation towards overall public benefit and technology development in the service of civil society (Steinhaus, 2013; WGBU, 2011) The more participatory model needed for vital discussions of technology and sustainability requires expert and

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wise to accept this as part of the current 'basket' of options, but to work to phase it out. This is a reasonable transition argument.

[15] Convergence conference held at SCAD, Spring, 2013.

[16] Kumar recognised that villagers want the national and global cultural connections that TV and internet can provide. It is very important to recognise the cultural needs of agricultural producers are not simply those of being left in peace to pursue their 'Soil Culture'.

[17] Micro-organisms in the ocean are responsible for over half the air we breathe http://oceanexplorer.noaa.gov/facts/oceanproduction.html

[18] See the complex approach to the development of UK Energy and emissions policy as described in *2050 Pathways Analysis* (DECC, 2010) , and the participatory calculator at https://www.gov.uk/2050-pathways-analysis

stakeholder input and real discussions in the public arena to take place[19]. Indeed, this is one way to view this colloquium itself.

Feenberg (2013) argues in relation to Critical Theory of Technology, that technologies are tied to social orders of power and that scrutiny of technologies has to be part of democracy:

> *Technological design and development is shaped by this pattern as the material basis of a distinctive social order.....Releasing technology from this project is a democratic political task.'* 148 (my emphasis)

Modern forms of technology as embodying power relationships between people has been one basis for the critique springing from the appropriate technology movement. Technologies that have been forcibly applied to 'developing countries' are the target of vociferous critique from many proponents of sustainability. How can the various proposed criteria for ecological efficiency and issues of justice and empowerment be reconciled? Could 'appropriate technology' become a normative philosophy of technology for sustainability? One key change since Schumacher's time is that global corporate actors are no longer content to let the rural poor get on with their low-tech lives, they are determined to gain access to the land and livelihoods and to create new markets. We know that capitalism must always expand in order to keep servicing interest and shareholders (and increasingly financiers and the super-rich) and it has become greatly more predatory in its inroads into agricultural systems worldwide. This is bad news for the Earth system as most corporate in the food business are still heavily committed to technologies that are very inappropriate for our living global system as well as generating inequality and loss of livelihood. So can an Earth system science perspective help us to develop our arguments and strategies to support the living economy?

2 The Context – Earth System Science

> *According to systems science the "environment" is a mega-system comprising ecosystems and man-made systems which share complex relationships of dynamic interaction. The ecosystems are organised wholes of living and natural systems (biotopes), while man-made systems are systems converting matter/energy and information, which are designed, created and managed by man during his dynamic interaction with the ecosystems.* (Decleris, 2000)

Introducing systems approaches always makes more sense when they are applied to a topic of mutual interest – and what could be of more mutual interest to humanity than understanding our Earth system? Most importantly this paper claims that a basic understanding of this system gives us strong new arguments and perspectives from which to defend restorative land-use practices for the sake of the planetary system as a whole and all those who depend upon it.

Earth System Science

Over the last 30-40 years, the idea of the "Earth System" has been a very fruitful conceptualisation. This relatively new field of study aims to develop dynamic studies of the living integrated and predictive understanding of global environmental change. Research into the Earth system has exploited the rapid technological developments since the 1960s in technologies for Earth observation from space and modelling and data handling. Through the 1980s and 1990s, a series of international collaborative global change programmes were established to address different dimensions of Earth system research (see www.essp.org for more information).

Earth System Science (ESS) has relied upon developments in the areas of computing technology and global satellite data collection. Global data gathering has yet to be standardised in various key areas – such as data on plant types. In addition there are many areas of the world where data-gathering

[19] Involving philosophers of public reason in sustainability is crucial for the degree of transparency and clarity that such kinds of governance now require. This will involve a change in the public profile and accessibility of philosophical reasoning consistent with a higher level of informed public engagement.

capacity needs support and development, for the science of our Earth to develop every region is equally important[20].

Modelling Complex Adaptive Systems

The study of the complex adaptive system of Earth has led to the development of new methods and methods adapted from other areas. The key method of ESS has been **modelling.** The reason for modelling the Earth system (apart from pure scientific curiosity) has been that we cannot develop hypotheses about the causes of climate change or perturbations without first developing a model of the system. If the problem focus is climate then we need to understand how it interacts with everything else in order to work out why climate change is happening and what to do about it. So in the process of 'hunting down' climate change we have learnt a great deal about the system as a whole – knowledge that throws a bright and different light on many other areas and can also be pretty decisive in settling some controversies for which the science was not originally developed. This spread of unintended applications is normal in the process of scientific discovery.

A key question for Earth system science is common to systems sciences dealing with structure and process - what does 'change' mean in a system that is changing all the time anyway? With regard to climate change one key aim has been to work out what elements of the current condition of the system **are** caused by humans and what elements are 'natural perturbations'. One way to do this is by looking at different historical states of the system for which we do have data in order to try to establish the main features of the system before large scale human impacts. Much effort has been expended doing just this, proving[21] in the process that current climate change is being forced by the scale and impact of human activities.

We can identify some key systems elements essential for understanding ESS. These elements could be grouped under the heading of **structural features of complex adaptive systems** and farmers know them well.

Key elements are:

- Time delays in effects through the system (the growing process takes time)
- Feedbacks between parts of the system (healthy soil is necessary for healthy plants which in turn feed the system when composted)
- 'tipping points' key thresholds where the system may 'tip' into another state (there is a big system difference between a dead plant and a live plant)

Another key conceptual tool is **scenario methodology**. In 2011 the then UK chief scientist convened a discussion of how to research potential tipping points for the Earth system. This meeting concluded that the only method could be scenarios. Notably these can only provide **decision support** in terms of outlining possible futures for the Earth, for humanity and the rest of life. Scenarios depend upon the background assumptions about how the system works (taken from modelling) being more or less correct and the scenario input conditions being plausible [22]. If a reasonably realistic set of scenario inputs predictions show a possible set of tipping points for the Earth system then the Precautionary Principle should come into play and we should take urgent evasive action.

The development of ESS has progressively incorporated more elements of the Earth System into modelling (Scholze et al, 2012, p130). This means that ESS needs to become hugely interdisciplinary

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[20] This is a very hard mindset to encompass for those who see the 'developed' industrialised world as the most important

[21] 'proof' is a relative term. Here we can invoke Aristotle's dictum that we should look for ' that degree of certainty that is suited to the subject'. Human induced climate change has been proved to the satisfaction of 98% of the world science community (that are not funded by the fossil fuel companies to produce misinformation). In addition however, the predictions of ESS about climate are coming true at a disconcertingly fast rate for all to see.

[22] Not all useful scenarios have to be realistic as noted by Cornell & Prentice 'there is an important place for thought experiments in climate science.' (2012, p251) the uncertainty of scenarios challenges current conceptions of 'evidence based policy' and the communication of science to the wider public.

– but often struggles to achieve this – especially as it is still embedded in, and supported by, an academic knowledge system that is traditionally organised into specialist areas (Cornell & Prentice, 2012). The necessary complexity of the system that this science has revealed shows that strategies to deal with climate change have to be equally multi-dimensional. This paper will argue that we cannot develop strategies for sustainability of any sector without understanding its role in the bigger system. In this context though, we must note that ESS has struggled to work with social science, often failing to understand the difference in an area that deals with people's beliefs, attitudes and power relations as part of the reality it seeks to analyse (Cornell, 2010). Why cannot people simply recognise the science and change their behaviour? This question can only be answered by engagement with a whole other range of social sciences including political economy that can address questions of power (see quote from Latin American scientists px). However, many people have become frustrated with the inability of classical political economy (PE) to take seriously the biophysical basis of life, and also the apparent blindness to rural and agrarian struggles in the focus of PE on industrially developed countries. Political ecology approaches are thus being developed which include a much richer diversity of elements – but is still very much in development.

From its inception, but increasingly more so in recent decades, ESS has had major implications for humanity and has thus been to some extent 'politicised' throughout its history. Most importantly it is one of the major challenges to the cosy relationship between science and the old model of technological and economic development. The implications of ESS are profound in revealing the destruction caused by this old model and its basic ecological inefficiency. In fact ESS has many implications for every kind of human engagement with our living systems and the maintenance of life support systems generally – including soil, water, oceans and climate. **Every single kind of human livelihood is implicated in the findings of ESS.**

Here the focus is on the land 'sector' and as a major piece of research looking at implication of land use the QUEST programme is particularly relevant[23].

QUEST: key questions (Colin Prentice)

- How important are biotic feedback for 21st Century climate change?
- How are climate and atmospheric composition naturally regulated on time scales of up to a million years?
- How much climate change is caused by human activity
    - Dangerous representing risk to humans/economy
    - Can be avoided by managing the biosphere

The popular conception or public face of ESS has been climate change and this has had some impact on how the area has been funded and developed. It is worth considering that QUEST was considered by the UK NERC as 'policy-relevant' science as it was aiming to help to answer questions about climate in ways that would make sense to policy-makers. One of the scientists raised the question: 'why don't we get funded to work out forms of mitigation that will maximally deliver on human rights?' One answer is that climate research funding is still mostly nationally (or regionally) funded and thus corresponds to what are considered to be national interest questions. In this respect **the funding architecture has not caught up with the global significance of this science.**

Another way to put this issue is to say that scales can be essential to consider in sustainability. The scale of the problem for climate and for other systemic forms of global change is global. Many real causal relations may appear most powerfully at the macro-level, you cannot find a lever/trigger internal to a system if the main determining factors are at a more macro level. However it then becomes questionable if any more local phenomena can be understood without the global level being at least a part of the calculation and vice-versa. Unless we have a fairly good idea of what is happening

[23] Oceans are an essential part of the climate system and no measures can succeed without complementary action on oceans (means solidarity with fishing issues etc.) (World Oceans, 2015).

on the ground (and this mostly means what people are doing) we cannot make global policy for climate mitigation that will work. Arguably we need some understanding of scalar system relations in order to understand the 'dependency' of the local on the global for example – and vice versa. Although it is primarily a global science, ESS reminds us powerfully that **the living Earth is composed of localities which are the real embodied sites of practices that can heal or destroy its bio-capacity or life-support systems.** It is taking us some time to work out the relations between local and global that make sense in terms of governance, responsibility and appropriate agency. In the meantime those pursuing a path of short-term self-interest can use this confusion to push through their own projects, avoid responsibility and blame others.

The example of climate change in Kenya 2011

In 2011 Kenya had already been suffering from a prolonged and terrible drought that had lasted for more than 3 years. This was causing great suffering, loss of livelihood and death.
Some prominent Kenyan politicians blamed global climate change – and developed countries for this national disaster. However, there was also a story to be told about rapid deforestation in key water catchment areas of the country which are/were known to be part of the local climatic system. Politicians were implicated in this deforestation as parts of the forest had been declared as owned by the government allegedly for protection purposes but then clandestinely felled and 'developed' by some of the politicians and their friends.
It seems likely that the drought would be a combination of local and global factors (and some natural climate variability) – but in what proportion would be difficult to assess.
This story also brings home the issue that without good governance and enforcement, measures for sustainability will fail.
It should also be remembered that this took place in a country where national consciousness of the importance of trees for life has been highlighted by the 'Green Belt Movement' started by Wangaari Matthai

Parker, 2013

The complexities of the situation in countries such as Kenya and the problems of governance and corruption in many poorer countries are not an excuse for avoiding redress for climate change on the part of nations who have benefitted from fossil fuel driven development. However this is not the whole story. Many of these industrial nations benefitted and continue to benefit from forms of corporate agriculture that displace the true costs of production onto the host countries' people, soils, biodiversity **and** climate – which now affects us all.

3 Climate Science and Policy Land Use

This section summarises the scientific and policy developments that seem most potentially fruitful in providing ways forward for joined-up action in the complex realities of the 'land sector'. The evidence regarding benefits of small-scale farming is assumed to be decisive for the purposes of this argument and is not examined in detail in order to concentrate on innovative aspects. This section includes information on the rapidly developing area of ecological restoration – both grassroots and expert forms – and the potential for this to contribute to climate mitigation, adaptation and social justice. This section proposes a form of system-based 'wedges' for climate mitigation based on land use that complements that envisaged for the industrial economy based on reduction in emissions.

Key System facts on Climate: State of the Art

Land is both a source and a sink for carbon (Prentice et al, 2012). There are estimates of the extent to which tree cover and other vegetation have helped in taking up additional carbon from the atmosphere. The concern is that under warming conditions these sinks could turn to sources of carbon in the atmosphere. Current estimates are that 24% of C02 is from deforestation. BUT protecting forest without addressing the whole system could displace the problem (Popp et al, 2014; SER, 2012?). The burning of forest that takes place due to human activity has a direct relationship to the extent to which agricultural land is sought by people. This in turn has a relationship to how fertile and productive is the land currently under cultivation and how well it can support growing populations. The availability of water for agriculture and the existence of regional and micro-climates supporting agriculture are

other key factors. The intentional human destruction of forest linked to agriculture includes the historical destruction of forest in developed countries such as the UK for example where forest cover is down to 16%.[24] The increasing risk of wildfire in warming climates is also of great concern. Fire not only results in loss of livelihood and local amenity, but also has political implications as areas begin to take approaches to 'managing carbon budgets'[25].

Globally there are now rough guides on greenhouse gases and sinks of different land-use types in different global zones (House, 2015). There are many different research efforts underway to estimate the impact of different kinds of agriculture on the climate but not all these include an holistic assessment of the impacts in relation to human benefit. It is in regard of these more holistic assessments that the comparisons between industrial agriculture and small scale farming is of most interest. The comparisons that take into account other key systemic factors such as nutrient availability in soils, the maintenance and regulation of productive soil activity including moisture retention and drainage are now shown to favour traditional and small scale farming. This is not surprising from a systems perspective as **the extent to which the local resources of soil are managed productively has a direct positive feedback loop to the continued well-being of the people who depend upon it over their life span and for future generations**. In industrial and highly capitalised agriculture this link is broken and decisions are made on the basis of financial returns over a short time frame that can set up a dynamic of soil and fertility destruction and destruction of hydrological systems supporting agriculture.

Soil itself sequesters carbon and it is now known that industrial fertilisers greatly reduce the ability of soil to take up carbon (Grain, 2015). Natural systems re-cycle key nutrients - traditional and small-scale farming also does this (ips news, 2009; de Schutter, 2015; Jones, 2015). Industrial agriculture relies on inputs of fertilisers which cost energy to produce and transport. Furthermore these fertilisers are used with heavy technology which destroys soil structure and its ability to take up carbon and causes pollution run-off into water systems destroying the life in streams, wetlands and rivers. Healthy soil is alive with micro-organisms which process decaying matter into nutrients for plant growth this has been the historical basis of the food system which works with natural systems.

Industrial farming is not confined to the production of green crops – often these are now used to feed the world's growing industrial livestock industries. Methane is a very potent greenhouse gas associated with livestock (Prentice et al, 2012) and reducing methane from industrial farming is quick gain for climate mitigation. Industrial livestock farming hoovers up large amounts of the world's plant-based food capacity meaning that the poorest go hungry whilst others eat more meat and dairy. This situation has led for calls to change diet in response to climate change but industries with heavy investments in livestock areas will not change unless incentives or disincentives are applied.

Ecological Restoration and Agrarian Livelihoods

Restorative land-use can contribute to climate mitigation through restoration of soils and ecologies, taking up carbon and providing livelihoods (SER, 2015; Jones, 2015). A key task identified by the restoration community is how to ensure that ecological restoration is seen as a key strategic goal for climate agreements, with some success. Ecological restoration sits most easily in the wider context of the global Earth System crisis of which climate change is one major symptom.

[24] The alleviation of flooding due to climate change would indicate changes in policy and land use to reforest many of the uplands to help with uptake of moisture. However these kinds of changes are inhibited by patterns of land ownership and profitable use.

[25] Fires in America blow carbon budgets: http://www.nsf.gov/news/news_summ.jsp?cntn_id=110580

The overwhelming scientific consensus is that global climate change is a real and immediate threat that requires action. Defined as an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its functions, integrity, and sustainability, ecological restoration is one of many tools that can help mitigate climate change.[…]

SER strongly urges local, regional, and national governments, international development banks and non-governmental organizations, as well as private institutions to work to maintain ecosystems and to plan, finance and coordinate ecological restoration projects and programs as part of a comprehensive global strategy for mitigating climate change and its effects.

Developed nations should actively support restoration programs throughout the world by providing financial support, sharing technology and committing expertise.

The Society for Ecological Restoration International (SER) is a non-profit organization of about 2,000 members – individuals and organizations who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets and cultural perspectives. The mission of SER is to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture.

(SER, 2015)

There is increasing work estimating the global potential for restoration as both climate mitigation and in providing or renewing livelihoods. This work should be more consistently linked to Earth system science. We are getting close here to answering the question 'what forms of climate mitigation can maximally deliver on both ecological and human benefits?' At the SER international conference in 2015 there were a number of detailed papers estimating global scale restoration possibilities. One study produced initial estimates that restoring 50% of available global sites could achieve mitigation gains of .6°. Other studies looked at ways to identify priority sites for restoration that could maximise ecological and human benefits.

Policy and Politics

This is the point at which the biophysical science of the Earth system must be supplemented by understandings from political science. Although restoration can be complex, given the obvious potential for win-win scenarios with restoration it is initially a bit puzzling why this option has not been more fully considered. Arguably there are two key reasons and both boil down to economic ideology and structures. Firstly, it is important to consider that the policy options for responding to climate change were constructed in the context of the ascendancy of neo-liberal market ideology at the international level before the financial crisis. Carbon market discourse and strategies captured the policy space to a very great extent. There was very little imaginative and creative thinking taking place in terms of a mixed basket of complementary strategies and there were certainly no links made to the Millennium Development Goals for example in terms of seeking ecologically valid strategies that could deliver on human benefits. The research work around measuring the goal on 'environmental sustainability' led to the work on the Millennium Ecosystem Assessment which did go on to make links with humans via biodiversity and access to 'ecosystem services'. This work has been slow to integrate into climate change policy. The verdict on carbon markets is that they have not delivered, yet such is the policy trap of market 'solutions' that extensions are still being planned:

> *Carbon markets have lost us more than 15 years in the battle against climate change yet we continue to plough forward with scaling them up. Why?.....There is an urgent need for alternatives to be considered, as the world is running out of time to curb the most serious impacts of run-away climate change.……...The principles of carbon markets were established in the 1997 Kyoto Protocol, but to date there have been few, if any, measurable reductions in greenhouse gas (GHG) emissions that can be attributed to these measures. The two most important carbon markets so far – the* EU Emissions Trading System *(EU-ETS) and the UN's carbon offsetting scheme,* Clean Development Mechanism *(CDM) – are failures, yet, new carbon markets based on these schemes are being planned in both developed and developing nations.* (Bohm, 2013)

This is typical of the reaction of the neoliberal and market theorists to the financial crisis. Far from reassessing their approaches and failed models they dug in and demanded more of the same (Sheffield Political Economy Research Institute conference 2013). This has led to a student revolt demanding to be taught other varieties of economics that is opening up this subject in vital ways.

Payment for (global) ecosystem services to poor communities who are regarded as stewards through international schemes could be part of a basket of linked options (Milder, J. C., S. J. Scherr, and C. Bracer, 2010). Generally these are geared to protect that which still exists rather than to act as part of restoration programmes. At the SER 2015 conference there was broad agreement that private finance for restoration programmes of the type that benefit farmers was very difficult to come by. This is one area where perhaps civil society forms of finance could be leveraged for global restoration projects. The potential of the not-for-profit and social business sector to innovate for public good is huge (McLurcan, 2015) we should aim to grow this sector so that it can replace the corporate donors that seek to tie the poor into corporate forms of development.

Notwithstanding the general difficulties of carbon markets in damping restoration potential, there have been policy developments in support of restoration. The EU Aichi targets of 15% sound good but it has been pointed out that these are capable of multiple interpretations (Kotiaho, 2015). Without a more rigorous specification these targets begin to lose their value. It seems that perhaps policy makers want to gain the commitment and iron out the details later – sometimes this can be a productive strategy. Equally the question of finance is key: if these are to be funded from public money then is this a tax on developed countries for the benefit of the planet? If so it should probably be cautiously welcomed – but we will need to engage with the process in order to be sure that expenditure can be made efficient in achieving its ends and that money does not end up in corporate bank accounts rather than results on the ground, for people and in the atmosphere.

In global governance arenas[26] 'managing the biosphere' is now beginning to be seen as an alternative to trashing the biosphere and hoping that it is robust enough to regenerate. Climate agreements are simply the very first areas to come into general recognition based on the obvious capacity of climate change to do major harm to human interests – even to those of the rich and powerful who can usually avoid disasters. In whose interests will the biosphere be managed and according to what structures of governance? These key political questions cannot be left to be arranged by default by the most powerful. This means that those of us in progressive movements have to up our game and form new and effective alliances across many frontiers. There are pressing reasons why we cannot rely on governments, or putting it another way, why governments need strong support from civil society for change.

Where social trends are shown to be socially harmful, democratically elected government does have some leeway for policy support for change. However in situations where 'free market' ideology (or fundamentalism) holds sway this kind of social marketing of change to populations for becomes very difficult. This is the context in which we see the continued global efforts made by corporations to restrict civil society or political controls of the economy through such arrangements as TTIP. Such treaties would undermine our capacity to respond to climate change and to establish forms of Earth system governance for the future. TTIP would allow corporations to sue countries that try to protect their citizens and the environment from harmful practices or challenge existing technologies on this basis. This and other similar treaties has been described as against international law by the UN Human Rights expert de Zoyas:

> *"Experience shows that many of the 608 arbitration awards that have become known, have overridden national law and hindered States in the sovereign determination of fiscal and budgetary policy, labour, health and environmental regulation, and have had adverse human rights impacts, also on third parties, including a "chilling effect" with regard to the exercise of democratic governance."*

[26] But let us be clear that there are severe deficits in global governance of many kinds.

We have got to keep reminding governments desperate to provide jobs for their voters, that there is a duty beyond the electoral cycle. Equally we need to convince those who are protesting against austerity and see growth as the way forward that this can be self-defeating:

'There will be no jobs on a dead planet.'

Guy Rider, Director of the International Labour Organisation (ILO)

Joined up policy? It would be nice…

For systems thinkers, taking a complex approach is the only way we will really begin to steer our human project in a different direction. One reason for this is that unless we take account of the whole system we run the risk of simply displacing the problem. A well-known dramatic recent example has been the bio-fuels disaster. Good intentions were to reduce the dependency on fossil fuels and reduce pollution from transport. However, this has contributed to deforestation and to food crises – especially in poorer countries. A further ongoing example could be the protection of forests under the REDD scheme. This seems like a great idea to provide funds to protect forests from inappropriate development so that they can continue to be 'the lungs of the Earth system'. However, there is growing evidence that unless the political and socio-economic contexts of these measures are considered along with the consequent impact on other forms of land use, this spending may be either neutral in its effects or worse, even counter-productive (Popp et al, 2014). We do not have to throw up our hands in despair at this complexity. The good news is that we have the conceptual technology. Systems mapping, strategic planning and scenario applications are easy to use and effective ways to work in collaborative contexts. In addition they are good at combining more local and vernacular knowledge embedded in practice, with more abstract and universalised knowledge. The concluding section of this paper looks briefly at some of the ways that these tools can be used in the context of restorative land-use.

The Convergence policy paper called for joined-up policy on **land use in the following terms:**

Green shoots of policy development: we can grow living solutions

Aichi Biodiversity targets include restoration of 15% - needs to be further defined and extended (Kotiaho, 2015).

Difficulties of gaining market investment in restoration must be bypassed (Soils, 2014?). Civil society can start funds for the future based on restoration, livelihoods and equality (Greendependent, 2013).

Restoration targets in Sustainable Development Goal 15 – connected with land use. Target 15.3 requires countries to stop land degradation by 2030 (IISD, 2015). Bring it forward now by rewarding countries for policies in support of sustainable agriculture and stopping land grabs.

Reviews are being done of how to change diet through policies and advocacy (FCRN, 2014?). These should be extended as a matter of urgency, working with social movements for rapid change. Countries' efforts should be rewarded in negotiations.

Policies supporting sustainable agriculture can be extended worldwide. The FAO has identified a policy framework (FAO, 2014?) and there are some excellent national and regional examples (SoilTrec, 2014?). These policies should be further developed in conjunction with social movements (Henfrey & Penha-Lopes, 2015; Greendependent, 2013; O'Hara, 2013).

We cannot eat money! Climate research funding priorities are heavily influenced by policy communities still in the grip of outdated neoliberal economic models(???; Greenhouse, 2013). We should join with those scientists who believe that global science should work with and for global civil society to lobby for more climate research investment in living solutions.

With regard to the policy landscape in the Paris commitments there have been some attempts to include land use. In agreements it is mandatory to account for forestry – voluntary re agriculture. Land-use, landuse change and forestry protection can be counted as part of countries commitments but

it is accepted that these are difficult to verify. Forms of Measurement, Reporting and Verification (MRV) are extremely important in global agreements as transparency about actions is the foundation of international confidence. However MRV need to be suited to socio-ecological systems and restoration/ degradation as complex social processes/trajectories (O'Hara, 2013;) with social, political and economic dimensions.

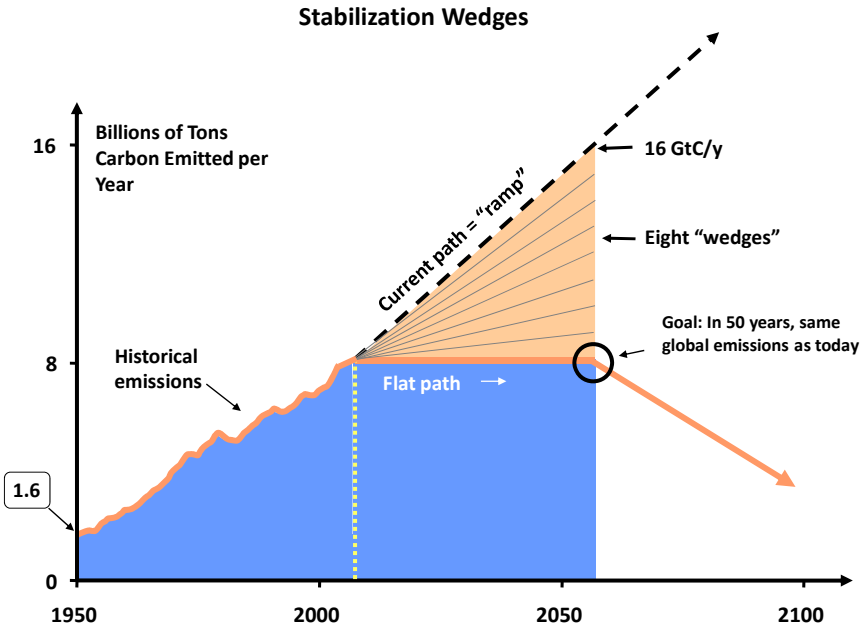
The following insightful comments appeared in a feature headed 'Latin American Scientists call for more Human Climate Science':

> *Meeting at the public National Autonomous University of Mexico (UNAM), in the capital, leading Latin American scientists called for the incorporation of more human climate science in research on global warming."The solution to climate change is not in the hands of natural scientists. The solution will be in the hands of social scientists: politicians, political scientists, psychologists, sociologists or economists,"* astro-geophysicist Carlos Gay, *the head of UNAM's Climate Change Research Programme, told IPS.…*

> *"The financial crisis and the climate crisis have the same origin: systems and markets and our vision of what progress is," said Gay, who added that he would like to see more UNAM social scientists carrying out research in this field, which is so crucial to humanity.* (ips news,2015).

In international climate governance and policy the links have not been fully made with the climate benefits of preserving and protecting forms of beneficial agriculture. To date there are no credits given for protection of climate neutral/beneficial livelihoods. Links have not been fully made to food and social justice – this would probably have been a battle too far for the negotiators at Paris who were hard pressed to keep the fossil fuel lobby at bay. To take on the organised might of the industrial agriculture lobby would have probably been counter-productive at this point. However this is a battle that will have to be joined. It would be preferable to be able to agree on transitional programmes that can allow for phased disinvestment in harmful agricultural technologies. In other ways land-use tends to be even more politically contentious than carbon emissions from industry, touching on land-rights, ethnic minorities, and basic inequality between rural food-producers, the city-dwellers they feed, and the elites who police policy developments from a position of power – often linked to corruption. These are inescapably political, legal and ethical issues that speak to the need for international solidarity for more democratic governance linked to land issues.Small farmers are increasingly organised, inputting into policy and research, but development policy remains biased in favour of powerful corporations (IISD, 2015). Time for a change! The proposal below envisages one way that different groups concerned with the Living Economy to come together to lobby for their contribution to be taken seriously, researched and supported.

The concept developed for bringing down emissions from the industrial economy in manageable 'wedges' was developed by Socolow and Pacala (2004) below.



Following the same basic concept we suggest a combination of 'wedges' from the living economy. The added twist here is that each of these can help to support the others and work in complementary ways. There is a strong case for combining quantitative research results on each of these areas to gain an idea of the overall climate mitigation that could be achieved. These proposals have considerably more chance of success than pouring more effort into carbon markets.

Mitigation 'Wedges' from the living economy: the potential

Support small-scale farming:
The FAO and the UN Ombudsman 16,2 have concluded that small-scale, closed loop farming is better for the soil, for food security and for sustainable food production with beneficial effects on biodiversity, water harvesting and conservation. (Jones, 2015; Water 21, 2015)

Change Diet:
Reducing the 'meatification' and 'dairyfication' of the global diet can greatly reduce greenhouse gases and help provide food for billions more people. (Guardian, 2010)

Support Ecological Restoration for Biodiversity and Livelihoods:
This provides local-global benefits for soil, biodiversity and communities (SER, 2013?; Henfrey & Penha-Lopes, 2015) – linking local and indigenous knowledge and technical expertise 24. Initial estimates are that restoring 50% of possible sites globally could achieve 0.6 of a degree climate mitigation and provide support for local livelihoods (Soils, 2014).

Transition to localised economies/food systems:
This reduces emissions from transportation, wasteful use of water (Jones, 2015; Water 21, 2015?) and high processing of food and reduces food waste (Scott-Cato, 2013).

Climate Research and Earth System Governance

It has been noted above that climate research finance is out of step with the global significance of the science. This seems to be a case in point. Currently large sums are being invested in investigating technical interventionist forms of geoengineering options (Royal Society, 2009). Technical

geoengineering options are run through climate models to demonstrate potential. Why not do this for ecologically-based options? In terms of risks these forms of 'ecogeoengineering' are practically risk free except that they require a greater degree of attention to be paid to social justice. The communities of interest linked to the above 'wedges' could lobby together for research and development funding at the global level to assess the potential and develop collaboration mechanisms. We should not let the corporate mind-set rule out by default fuller investigations of options for humanity at this crucial point in our history (Lacey & Lacey, 2010).

4 Social Justice is the Price of Global Restoration

> *'A new paradigm focused on well-being, resilience and sustainability must be designed to replace the productivist paradigm and thus better support the full realization of the right to adequate food.'* (De Schutter, 2014)

This section will summarise of Soil Cultures and Human Rights – including the right to food.

Taking on challenge of justice in land use essential for climate

Global civil society can mobilise support for protection and restoration of soils, ecologies and sustainable livelihoods, investing in food security and biodiversity. This will mean lobbying for policies supporting greater equality and human rights for food, land and livelihood. We need to re-design the industrial economy to support living processes and to share the benefits of development within and between countries.

Convergence Alliance et al (2015)

'Gardening the Planet': Global Ecological Citizenship and Food Security

The UK Royal Society international event on the Economics of Biodiversity (2010) raised many concerns about the need for access to 'ecosystem services', particularly for the poor and vulnerable. There was not one speaker who had not realised the implications of the TEEB (2010) report statement 'ecosystems are the GDP of the poor'. One speaker proposed that humanity collectively needs to think about 'gardening the planet'. However, there were sharp lines of division at this event between those who could only see industrialised farming, including GM as the key to feeding increasing global populations and those who argued for the systemic benefits of small scale farming. Crucial points that were perhaps overlooked at this event included:

- **The patchwork of local access to the means of life, of productive land, the tools to work it and the means for distributing food is the basis for global food security.** Where these are combined with long-term strategies to protect and develop soils, to minimise impacts on biodiversity (and in many cases help to reintroduce a richer mix of plants and animals) these strategies are good citizens contributing to the continued regeneration of Earth's living systems.
- The interlinked nature of planet Earth's systems means that gardening the planet involves re-designing the industrial economy to support rather than stress living processes as recognised by those supporting the 'circular economy' for example.
- This 're-design' is not simply as a technical challenge of re-designed agricultural and industrial systems, but also as a political and economic challenge that involves many kinds of redistributive power.
- Perspectives from global justice also remind us that to have any chance of global sustainability we must urgently address the need to share the benefits of development both within and between countries.

Effective climate mitigation and adaptation strategies must be linked to sustainable human livelihoods for joined-up solutions. We cannot deliver on the new Sustainable Development Goals without these

developments.[27]In order for globally restorative land use to be protected, to spread and to improve productivity, the price that has to be paid in developed countries is to understand and support social justice movements in agrarian communities worldwide. This will mean respecting and valuing food, soils and the people who grow food. Many of the world's small farmers and grassroots ecological restoration activists are women. Empowerment of rural women and recognition of soil culture mesh with human rights (TEEB, 2010; de Schutter, 2015).

These commitments to social justice are a growing part of the sustainability movement in industrial countries. For example in Bristol (the European Green Capital for 2015) there have been very successful events organised by the Bristol group of Global Justice Now focussed on the global food system. Another linked way forward is celebrating soil cultures and re-building them in countries that have neglected their growing resources and come to rely on artificially cheap food. In Bristol there were plans to build roads on the very best quality agricultural soil in the region. This has been the subject of a campaign that has now ensured some future protection for this area. There are also very active local food movements focussing on seeding urban agriculture and resilience. The Soil Saturdays curated at the Bristol CREATE Environment Centre were a showcase for soil issues that linked science, growers and the arts in celebration of Soil Cultures. It is important to educate those who are urban and have no experience of growing, that Soil Cultures reflect embodied knowledge and often, at their best, relations of mutual support as seen in the UK allotment movement. It is also crucial to introduce people to growing. However this raised deep historical issues of land ownership in the UK – of which more could be said.

Restoration, soils and social justice in Tamil Nadu, India

Social Change and Development (SCAD) restored a barren site with tree and seed planting 30 years ago. They transformed the area microclimate, soils and biodiversity creating a congenial site for their work and college campuses. SCAD works both on re-introducing traditional methods and investigating and trialling new primarily organic based soil improvement methods. SCAD helps 600 villages in the form of seeds and equipment, advice and women's leadership development.

New methods include algae based soil improvers and bio-char added to soils (SCAD, 2015). Continuing forms of restoration involve tree planting to provide shade, micro-climate, food, medicine and fodder for poor villages. SCAD is one of the National Government Agricultural Research Centres, and benefits from sustainable agriculture policies in the Tamil Nadu region.

This example demonstrates a mixture of appropriate technology and social change that provides inspiration for a sustainable future – there are many other similar initiatives around the world. This is not to claim that such projects solve all the political questions[28] for a sustainable future but the crucial role of appropriate technology in sustainable development is highlighted in such examples.

5 Conclusions – Restorative Land Use is Appropriate technology for the Anthropocene

> *What makes ecological restoration uniquely valuable is its inherent capacity to provide people with the opportunity not only to repair ecological damage, but also to improve the human condition. The conservation benefits of restoration are obvious. What is less apparent, but which is at least as important, is that in many instances, ecological restoration has also been able to renew economic opportunities, rejuvenate traditional cultural practices and refocus the aspirations of local communities* (Gann, G.D., & D. Lamb, eds. 2006).

[27] Bringing about the new Sustainable Development Goals, dealing with climate change and its systemic drivers means that we must have a new social contract for sustainability. This has to be and economic and social justice contract; a knowledge contract between citizens and science; and a new understanding of local to global relations and dependencies.

[28] SCAD's work comes up against the limits of ownership and inequality in India constantly – in addition to the questions of the widespread corruption in the Indian system

Using the framework outlined above we can summarise the results of the inquiry into appropriate technology across the dimensions - adding in the element of resilience or ability to withstand and recover from shocks.

Appropriate Technology Criteria	Small Scale Agriculture with multiple diverse patterns
Human Well Being	Social justice and the right to food are better served.
Minimal Impact	Found to support biodiversity and be low impact on ecologies, supports stabilisation and maintenance of climate
Low Risk	Small scale localised risks minimised
Resource availability	Resources recycled in loops – possibility to process human waste
Infrastructure	Low tech and intermediate tech – assistance needed with IT and communications tech. Eg mobile phones and marketing of produce
Context	Suited to development that is sensitive to context
Resilience	Mosaic of diverse activity; wide genetic base of plant varieties; social exchange of knowledge and support provides resilience IF protected from global financial instability

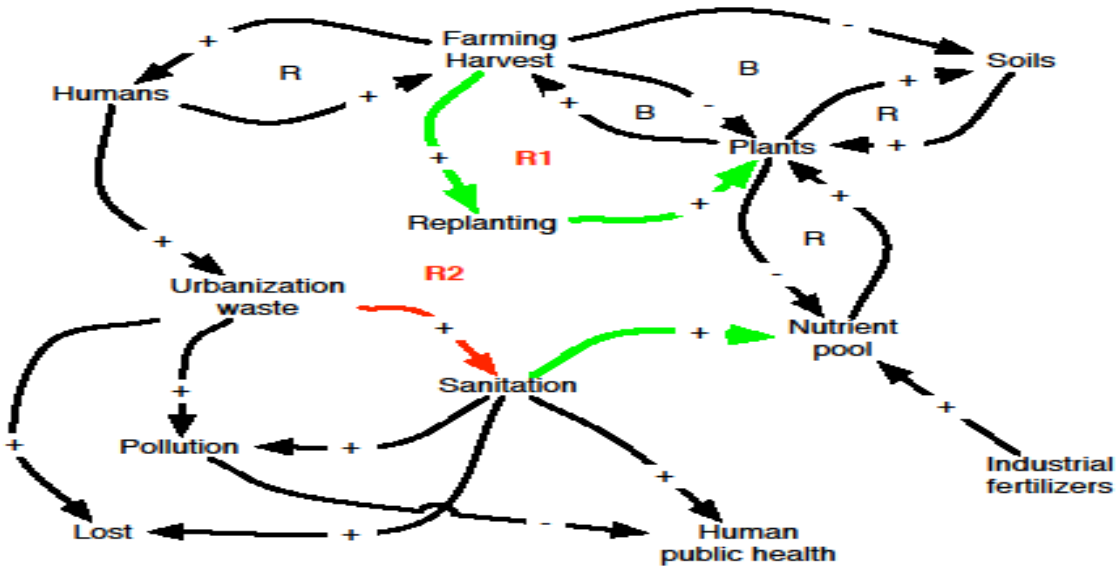
This summary demonstrates the importance of recognition of the knowledge embedded in indigenous and traditional living and working with ecosystems and soils and the prospects for a rapprochement between these kinds of knowledges and 'expert' more universalised knowledges. Locally embedded soil cultures are still the foundation of the global food system but are under threat from corruption, land grabs and policies supporting industrial agriculture (de Schutter, 2015). Industrial corporate agriculture has been shown to systemically undermine the life and structure of the soil and contributes to forms of pollution that degrade our water systems.

The analysis shows how the various different kinds of knowledge possessed by people working in different contexts in the global system can become complementary pieces of a mosaic of human understanding and practice. This is an approach to knowledge, its creation and development that can underpin solidarity and positive ways forward with full recognition of diversity, not just as a 'nice to have' but as essential for success.

We confront an Earth system crisis of which climate change is one symptom, and we are seeking to re-assess our technologies to determine how to go forward with mitigating impacts, restoring living systems and providing for human well-being. These corporate actions seek to undermine our ability to take action on the basis of assessments of technologies through democratic governance. In the field of agriculture and food security these battles are particularly severe. **The reluctance or refusal on the part of much of the corporate food sector to re-assess their technologies in the light of new information about their effects on planet and people prove them unfit for the Anthropocene.**

6 New Alliances for Living Solutions

This concluding section looks at the prospects for social movement, policy and scientific liaison and co-creation in this new and complex terrain. This section briefly proposes the increased use of system-based tools to link up sources of information and to facilitate productive dialogue and action.



In this diagram '+' shows positive feedbacks and '-' shows negative feedbacks. The line in red indicates the current disastrous waste of nutrients from human waste. Lines in green indicate gains to be made in closing loops. This is generic as it is not based on any one place.

Research has shown that small-scale farming is overall 'systems-informed technology' and current forms of industrial farming are not – in fact they are systems-destructive technology. New forms of systems-informed food production such as aquaponics and other technologies should be considered to supplement and/or work with existing farming systems. We must up our game in terms of getting to grips with the challenges that these approaches pose to the current dominant (but increasingly systemically unstable) financial and development systems. This means linking with those who are seeking new ways to 'do' economy and create new business models to develop forms of system-informed economy.

This kind of modelling of the system can help us do the following things:

- Develop and test causal hypotheses
- Identify key actions and mutual dependencies in the system linked to different groups of actors. This can help in mapping new potential alliances across the system.
- Identify quick system gains – that do not undermine but keep ways open for larger system change
- Identify the bottom line for necessary major system change

There are many ways that systems tools can be used in specific projects and applications and the Schumacher Institute invites suggestions and proposals for collaborative work.

The final policy discussion points that were generated by the organisations involved in the policy discussion document were as follows. They indicate the potential for step change if these measures can create synergies that are more than the sum of the parts.

We call for living solutions:

- Recognition in climate agreements for governments who both defend small scale forms of sustainable food production and enable/empower localised food producers.
- Allocation of equal global research funds for positive climate mitigation measures of land use. Research to include social science, anthropology and local knowledge in co-creation of strategies.
- Rapid policy development for dietary change as part of climate strategy. Assisting farmers in changing the food system in policy/practice.
- Enabling of localised economies/food systems. These systems need research and policy support at local, national, global regional and global levels to be resilient in the face of global change.
- Promotion of sustainable soil cultures as exemplary: A global awareness campaign is needed to support small producers and large scale ecological restoration linked to livelihoods.
- Civil society movement collaboration across the industrial and living economies for sustainability and social justice.

Convergence Alliance et al (2015)

Effective climate mitigation and adaptation strategies must be linked to sustainable human livelihoods for joined-up solutions. Many of the world's faith groups have recognised the need for stewardship of the soil and biodiversity and links to equality and human rights (UNDP, 2015) giving more impetus for change. Equally, many of us who identify with more secular values-based (or normative) traditions would also agree that, side by side with new tools for understanding, we need to rediscover or further develop forms of love and recognition that can help us share the planet (King, 1989). Let us hope that at this point in human history what unites us can be made stronger than those things that divide us.

> ***'There comes a time in human history when human beings have to reach for a new level of consciousness, a higher moral ground. That time is now.'***

Wangari Maathai - founder of the Green Belt (reforestation movement) in Kenya and winner of the Nobel Prize.

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'Climate, restoration, soils and social justice' Report of the Bristol Research Workshop, June, 2015 organised jointly with the Cabot Centre.

'Framing Earth System Governance' Convergence discussion document for the International Herrenhausen workshop on 'Cyber-systemic possibilities for global governance' Hannover, July, 2015

Research events contributing to this paper: 'Climate, restoration, soils and social justice' Report of the Bristol Research Workshop, June, 2015 organised jointly with the Cabot Institute; BISA Environment group panel on Convergence and Climate, international conference, London, July, 2015;'The Living Economy: climate mitigation and social justice' Convergence Alliance and Greenhouse workshop, Bristol, August , 2015; Soil Saturdays @CREATE, Bristol July-August 2015; Convergence Alliance workshop at the Society for Ecological Restoration (SER) conference, Manchester, 2015.