

# Chapter 11

## Relating sustainability, resilience, permaculture, agroecology, organic agriculture, and vulnerability

*I fear that we may be clever enough to create a world that is grievously biologically impoverished, but nevertheless sustainable.<sup>338</sup>*

*Nature has no compassion. Nature accepts no excuses and the only punishment it knows is death.<sup>339</sup>*

You may be an ardent permaculturalist, sustainable agriculture advocate, organic farmer or just someone who likes good, healthy food. The purpose of this book is not to convert you to resilience. In fact, a basic quality of resilient systems is that all innovations must fit within the tried and true systems of the past. No matter what system you follow, we are sure you want to learn more about how to make your system last. We are here to increase your understanding of how Earth's ecosystems adapt and transform to sustain the web of life. Thousands of studies in ecological resilience indicate that a few basic changes in perspective can and will reinvigorate sustainability, permaculture, organic agriculture and agroecology. The following discusses what ecological resilience research can bring to each of these approaches.

### **A fresh perspective on sustainability.**

For almost three decades, sustainability has been the goal of people focused on the world's "wicked problems"<sup>340</sup> (interconnected issues on which people are polarized —e.g. environmental degradation, overpopulation, endangered species, poverty, food security and climate change). The right mix of incentives, technology substitutions and social change were assumed to eventually lead to a lasting equilibrium with our planet and each other. Those working in sustainability have noticed instead that the world is increasingly out of balance, the wicked problems becoming more intractable.

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<sup>338</sup> May, R., 2002. The future of biological diversity in a crowded world. *Current Science*, 82:10.

<sup>339</sup> Hoffer, E. 1973. Reflections on the human condition.

<sup>340</sup> Rittel, H. and M. Webber, 1973. Dilemmas in a General Theory of Planning, *Policy Sciences* 4:155-169; Tackling Wicked Problems: A Public Policy Perspective, <http://www.enablingchange.com.au/wickedproblems.pdf>

Sustainability engendered worldwide enthusiasm with Gro Bruntland's Our Common Future<sup>341</sup> in 1987 and then became embedded throughout the US government in the early 1990s with the President's Council on Sustainable Development<sup>342</sup> and the Sustainable Agriculture Research and Education program<sup>343</sup>.

However, the concept of sustainability has often been stretched, distorted, co-opted, and even trivialized by being used without the ecological context that anchors it to natural systems.

**Resilience arising from sustainability.** The mass media has chronicled the growing number of scientists, social innovators, community leaders, nongovernmental organizations, philanthropies, governments and corporations who contend that resilience may provide a useful perspective on resilience. As is the wont of journalists, some pit sustainability against resilience.<sup>344</sup>

"Resilience holds the key to our future. It is a deceptively simple idea," according the Administrator of NOAA, Jane Lubchenco. The Federal Reserve promotes resilience.<sup>345</sup> USAID seems to be changing its focus to have resilience at the core of everything it does.<sup>346</sup> The Soil and Water Conservation Society's 2013 annual conference theme was Resilient Landscapes. The 2012 USDA Publication "Climate Change and Agriculture in the United States" uses the term resilience 46 times and sustainability only 10 times. One excellent summary of sustainable agriculture in the US<sup>347</sup> points out that a primary quality of systems that move toward greater sustainability is resilience. For example, the study's discussion of case study farms notes that resilience and similar overlapping concepts are the primary qualities of sustainable systems. "[C]ase study farms still in operation appear to exhibit qualities that are associated with movement toward greater sustainability (for example, robustness, resistance, and resilience)".<sup>348</sup> Resilience is the route to achieve the goals sustainability, according to industry trade groups,<sup>349</sup> design firms,<sup>350</sup> and think tanks such as Living Future Institute<sup>351</sup> and World Resources Institute.<sup>352</sup>

Several research centers devoted to resilience have arisen lately at Universities including Ohio State University, University of Stockholm, throughout the Australian national agricultural

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<sup>341</sup> Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" <http://www.earthsummit2012.org/about-us/historical-documents/92-our-common-future>

<sup>342</sup> <http://clinton2.nara.gov/PCSD/Overview/index.html>

<sup>343</sup> <http://www.sare.org/>

<sup>344</sup> See the five part series in the Guardian (<http://www.theguardian.com/sustainable-business/sustainability-movement-faces-extinction>) and many articles in the New York Times, e.g., <http://www.nytimes.com/2012/11/03/opinion/forget-sustainability-its-about-resilience.html?pagewanted=all&r=0>

<sup>345</sup> <http://www.federalreserve.gov/newsevents/speech/bernanke20130412a.htm>

<sup>346</sup> <https://www.devex.com/en/news/blogs/usaids-new-way-of-doing-business>

<sup>347</sup> c.f., National Research Council, 2011. Toward Sustainable Agricultural Systems in the 21st Century.

<sup>348</sup> Ibid, p. 355.

<sup>349</sup> [http://www.nrmca.org/resilience/downloads/Resilience\\_Article.pdf](http://www.nrmca.org/resilience/downloads/Resilience_Article.pdf)

<sup>350</sup> <http://inhabitat.com/resilient-design-is-resilience-the-new-sustainability/>

<sup>351</sup> <http://living-future.org/resilience-new-driver-sustainability/>

<sup>352</sup> <http://www.wri.org/blog/new-language-sustainability-risk-and-resilience>

research organization and the European Union and, most broadly, the International Resilience Alliance.<sup>353</sup>

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### **Man-made laws and natural laws: a personal epiphany**

Every blue moon or so, I realize I have been pretty blind to an obvious truth. These epiphanies usually come when we succeed in reconciling seemingly contradictory ideas. One epiphany began when I learned that Alabama, Kansas, Tennessee and Missouri legislatures had all passed bills opposing sustainability. In 2013, 15 bills in seven states were introduced to oppose sustainability (specifically the Agenda 21—a United Nations document written 20 years ago.

Many who advocate for sustainability were surprised, amazed and nonplussed. For many, sustainability ranks right up there with Mom and apple pie as absolute goods and with gravity as an absolute truth. Yet these bills have been overwhelmingly adopted in many instances by our elected officials. Presuming that both sides are well-meaning, why is sustainability raising such vociferous emotion?

Then I stumbled onto research on ecological resilience and slapped my forehead with my palm saying, how could I have missed this all these years? This research area studies how systems grow and transform themselves in adaptive cycles. Resilient systems are those which last, just as sustainable systems are those which last. I realized that the mainstream approach defined sustainability normatively and legally and not based on natural, empirical evidence. In fact, nearly all those involved in sustainability research have focused on achieving practical and applied goals—such as achieving an environmentally sound and socially just agriculture—rather than understanding sustainability as a natural phenomenon. These practical and applied goals can be fine and good, but they are normative, not scientific, goals. That is, we have decided that environmentally sound and social just systems are better. These are values, not testable hypotheses. When you pursue a particular value, you can't logically object when others promulgate goals based on other values such as maximizing profit or favoring one ethnic group over another.

Ecological resilience research gives us more than a set of values we are trying to push systems toward. It gives us a working model of the cycle of adaptation and transformation that explains and predicts which systems survive and which don't. Sustainability is a term which carries some of the meaning of resilience to some people, but has never been defined in testable, scientific terms. Ecological resilience research seeks a well-defined model which will enable sustainability to be based on natural law instead of man-made law.

Advocates of sustainability who discover the adaptive cycles of ecological resilience can marshal arguments which transcend values. Eventually, naysayers realized the earth is not flat and the sun does not revolve around it because a spherical earth revolving around the sun results in better predictions. As people begin to see how the adaptive cycle and resilience explain and

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<sup>353</sup> <http://resilience.osu.edu/CFR-site/concepts.htm>; <http://www.stockholmresilience.org/>; <http://www.resalliance.org/>

predict behavior of systems, those who attack it will disappear just as all non-resilient systems do.

When presented as a natural property of systems, rather than a set of values we want to impose on others, sustainability as a concept will have more resilience. Popular values are fads. They inevitably rise and fall in popularity. Meanwhile the natural systems just keep rolling along. The resilient systems survive and transform into even more successful systems. Values which are consistent with natural laws survive. They will be tested and contradicted by popular values but they will survive. Societies, businesses and farms which don't operate consistent with those natural laws may seem successful, but they will perish. A concept of sustainability will likewise perish unless it is derived from empirical evidence of systems which adapt and transform in the face of adversity.

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### **Assumptions which can lead sustainability astray**

Why all this movement toward a resilience perspective on sustainability? A few unchallenged assumptions have led sustainability astray. The first will be the toughest for some.

#### **1. Sustainability is a societal norm not natural law.**

Many contend that this trend toward resilience provides a scientific foundation which sustainability desperately needs. Resilience arose not as a normative goal for society, but as an observation of nature. As long as sustainability is based on social values it will be limited to those who share those values and remains susceptible to change as those values change. Unfortunately, some who work in resilience are also taking a normative, political stance.

**Assessment tools based on internal qualities, not external goals.** All sustainability assessment tools define external goals or principles which systems must meet in order to be called sustainable. By focusing on goals or principles, such tools are conceptually similar to an assessment tool which measures the ability of a system to achieve goals set externally, such as profit maximization. Ecological researchers focus on emergent qualities of the system which make it resilient, rather than externally imposed criteria.<sup>354</sup>

**Sustainability needs a testable theoretical structure.** Sustainability simply leaves too much room for doubt, manipulation and distortion in terms of exactly what is sustainable and inescapably why that item or practice is sustainable. Sustainability has legal meaning and moral meaning, but scant testable theoretical structure. The normative aspects of sustainability have attracted both widespread support and recent antipathy. The lack of a rigorous empirical definition of sustainability enables a polarizing debate since sustainability can be whatever an interest group projects onto it. As long as sustainability research focuses on societal goals instead of understanding existing empirical systems, it will continue to be a concept easily hijacked by those uninterested in creating more ecologically resilient systems.

Sustainability is conceived in three different ways: as a science, a movement or a set of practices. As a science, it is wholly synonymous with ecological resilience. A particular set of

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<sup>354</sup> Some resilience researchers, however, have introduced external criteria as we discuss in Chapter 10.

defined practices or a social movement, sustainability becomes a plethora of conflicting approaches.<sup>355</sup>

## **2. Sustaining an unsustainable system versus transforming the system.**

The goal of sustainability, for some, is to maintain and sustain our present system. Societies throughout human history have sought to sustain unsustainable systems.<sup>356</sup> A resilience perspective on sustainability beckons us to reshape, reform and adapt. It welcomes the ingenuity that emerges based on the local capacities within a system.

Throughout history, many have focused on eliminating the vagaries of Nature and creating what today we might call a well-engineered mall.<sup>357</sup> Some hope to sustain the same kind of consumption that generates cheap, low quality, environmentally degrading items that are now turning China and India into ecological nightmares.<sup>358</sup> If we think that our civilization can consume the fossil fuels required to produce all our hearts' desire and ship them to us, while casting toxic waste willy-nilly into our air and water, we're going to fall short and never create resilient systems. Sustainability can too easily suggest that we continue on by making a few changes to alter our energy sources, create more efficient engines, use "98% biodegradable materials", while ignoring the life cycle assessment which shows the toxic effect of most of our agricultural and manufacturing systems on our ecosystems.<sup>359</sup>

## **3. Belief in "Balance of nature" has led sustainability astray**

Popular conceptions of ecological systems usually operate on the assumption that the normal condition of nature is a state of equilibrium, in which organisms compete and coexist in an ecological system whose workings are essentially stable. It led to the doctrine, popular among conservationists, that nature does best and involving human intervention is bad by definition.

Simultaneous with the emergence of an "environmental crisis" and attendant widespread environmental consciousness and conscience in the 1960s, Eugene Odum, then dean of the field, announced the advent of the "New Ecology." Odum's new ecology was based on the ecosystem concept as its organizing idea and reiterated the classic notion of nature, unperturbed by human disturbance, as in a steady state of dynamic equilibrium.<sup>360</sup> Many

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<sup>355</sup> Agroecology, which many see as the foundation of sustainable agriculture, is likewise torn between being a science, a social movement and a set of practices as explicated by Wezel et al., 2009. Agroecology as a science, a movement and a practice. A review. *Agron. Sustain. Dev.* [http://www.ensser.org/fileadmin/files/2009\\_Wezel-et-al.pdf](http://www.ensser.org/fileadmin/files/2009_Wezel-et-al.pdf). Organic agriculture is also torn between the three.

<sup>356</sup> See discussion in the Working with Nature: ecological integration chapter.

<sup>357</sup> See discussion in the Embracing disturbance for periodic transformation chapter.

<sup>358</sup> <http://www.theguardian.com/world/2014/may/08/india-admits-delhi-matches-beijing-air-pollution-world-health-organisation-cities>; <http://www.economist.com/news/leaders/21642172-narendra-modi-should-learn-chinas-mistakes-its-too-late-indian-winter>

<sup>359</sup> <http://www.epa.gov/sustainability/analytics/life-cycle.htm>

<sup>360</sup> Odum, H., 1974. Energy, Ecology, & Economics, <http://www.sustainabletucson.org/2007/01/energy-ecology-economics-by-howard-t-odum-intro-by-bob-cook/>

modern agroecologists seem to also see the most sustainable system as a well-developed, stable, mature system which recovers from disturbance and adapts to change.<sup>361</sup>

This traditional wisdom, first voiced by the ancient Greeks, assumed that nature undisturbed by human influence is characterized by a certain kind of harmony, balance and order. Wilderness is presumed to have three attributes: (1) It remains in a constant state; (2) when disturbed and then left to its own devices, wild nature returns to that original state and (3) finally, an ethic is attached to this natural state which is assumed to be preferable to all others.<sup>362</sup>

This view of nature is espoused in popular environmental literature throughout the world. It is the basis of twentieth century scientific theory about populations and ecosystems. It is the basis of our Federal and state laws and international agreements that control our use of wild lands and wild creatures.

The accumulation of evidence has led many ecologists to abandon the concept or declare it irrelevant, and others to alter drastically. They say that nature is actually in a continuing state of disturbance and fluctuation. Change and turmoil, more than constancy and balance, is the rule. As a consequence, say many leaders in the field, strategies of conservation and resource management will have to be rethought. The classic "balance-of-nature" paradigm has been replaced by a paradigm in which ecosystems are open, human influence has been ubiquitous and long-standing, and natural disturbance is multifaceted, widespread, and frequent. Everything is subject to periodic disturbance, of which fire is so common an instance as to be symbolic. Every organism in an ecosystem is a unique point of unpredictability striving to manage its environment to make it more comfortable for its self and its offspring.

However, most laypersons are unaware of this paradigm shift in ecology, which was consolidated over the last forty years.

**First order and second order equilibrium.** In short, first-order equilibrium -- a return of a disturbed ecosystem to the prior structure, and species population and inventory -- is at worst a myth, and at best an "ideal type" (like a "frictionless machine" in physics), never exemplified in nature.

Few ecologists have believed otherwise in the past, and none believe this today. Unfortunately, this understanding has not been universally acknowledged by environmental activists, popular writers, educators, and even some policy-makers.

In some systems the return frequency of disturbance is so long that the impression of equilibrium conditions develops. This is what underlies the traditional idea of climax communities. However, careful observation reveals that disturbance is ubiquitous and frequent relative to the life spans of the dominant taxa.

Populations do balance each other by their competition. Wolf numbers will decline when they eat too many caribou, because after caribou numbers get low enough, wolves starve. But

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<sup>361</sup> Gliessman, S., 2004. Agroecology and Agroecosystems. In *Agroecosystems Analysis*, <http://www.canunite.org/sites/default/files/agroecology%20and%20agroecosystems2004.pdf>

<sup>362</sup> <http://gadfly.igc.org/papers/much-ado.htm>

neither the wolves nor the caribou populations are striving for equilibrium, but to expand their numbers.

Consider the chaparral biome of evergreen scrub oak. The system requires fire to release the chaparral seeds from their pods. No fire means no regeneration, and the chaparral community will be succeeded by a different community. So if the chaparral community is to persist through time, it must "walk" through a sequence of inflammable maturity, fire, regeneration, maturity, etc . Clearly there is no equilibrium at the first level, but there is equilibrium at the second level: a constant, repeated sequence. In this sense, it is like the "equilibrium" of the furnace thermometer: constant change (first order) according to a constant pattern (second order).

Second-order equilibrium -- the return of an ecosystem to a state of "health" and "integrity," though with an altered structure and component species -- remains a tenable ecological concept, with the constant caveat that even this (higher order) sense of "equilibrium" is also never completely exemplified in nature.<sup>363</sup>

#### **4. Order is not always our friend, nor chaos our enemy.**

In our introductory chapter and the transformation chapter, we have briefly discussed the chaos theory and complex adaptive systems. Sustainability (and allied systems in agroecology and organic agriculture) often focuses on creating very orderly systems with very well-defined rules. Resilience establishes systems which use disturbance to maximize evolution, adaptive reorganization and quick reassembly after adversity. Continuous improvement is the goal of any successful system and this means responding to competing systems, but sustainability often looks only at current drivers. Any agricultural or other business enterprise which commits all resources to maximizing external sustainability goals or efficiency or profits will often die when system drivers change and they can't change quickly enough.<sup>364</sup>

The basic conflict between seeking order in sustainability and embracing chaos in resilience warrants a deeper look at complex adaptive systems.

**Complex adaptive systems.** Complex Adaptive System (or CAS) theory recognizes that most systems have a capacity for self-organization and adaptation. This conceptual framework recognizes the complexity of systems (ecological, economic, and social) in the hierarchical structures, the interactions and energy flows between these hierarchies and the systems and subsystems self-organization and adaptation which form all systems.

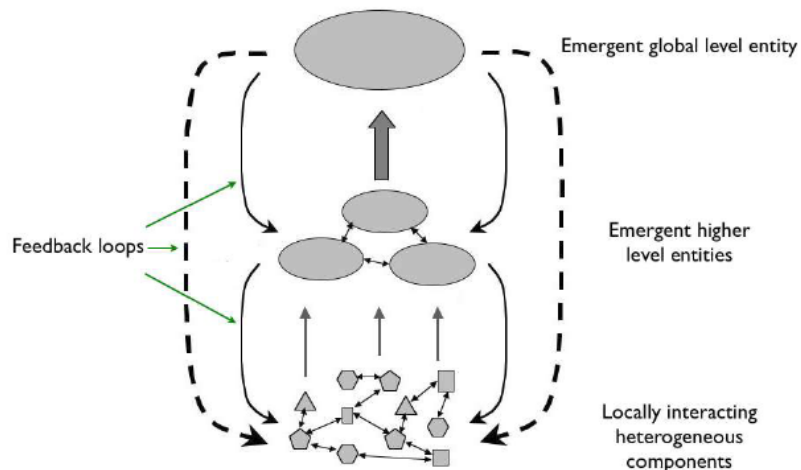
A complex adaptive system is a system that has a diversity of "agents" which are connected, with certain behaviors and actions which are interdependent and which exhibit adaptation and self-organization. Each CAS is composed of multiple CAS which must be redundant, flexible, modular, diverse and prone toward reassembly. An economy composed of businesses, composed of people, composed of selves. Society is composed of communities, composed of

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<sup>363</sup> First and second order equilibrium ref.

<sup>364</sup> Though beyond the scope of this book, competition which destroys other systems to create a monopoly destroys the diversity necessary for resilience. Adaptive governance for resilience insures that a business, farm or other component system does not use momentary advantage to drive all other players out of a market or even out of existence.

families, composed of individuals, composed of selves, composed of cells, composed of proteins and lipids, composed of molecules, composed of atoms, composed of quarks, etc.



The resilient system has multiple states, multiple ways of dealing with adversity, disturbance or just changes in the external environment. Take a resilient college student for example. He can deal with sitting in school, actively playing sports, solitary study, socializing with friends, interacting in formal meetings with peers or formal meetings with his boss, children, elderly, his girlfriend and with platonic friends, and on and on.

When a CAS becomes less redundant, less flexible, less modular, less diverse, less ready for reassembly, it becomes more vulnerable to destruction when outside drivers change.

Transformation and change are inevitable. Trying to maintain a particular system means continually fighting the natural inclination to change. Finally the changes will build and you will be overwhelmed if you are not willing to adapt and transform your system.

Any effort to create a permanent agriculture or perpetually stable and constant system has a basic problem in this area. This we shall see as we explore another powerful and influential perspective: permaculture.

## Uniting ecological resilience and permaculture

Any discussion of permanence in agriculture must discuss permaculture<sup>365</sup>. This is especially true for the purpose of comparing different approaches to resilience since the guiding principles of permaculture are nearly entirely consistent with the findings of ecological resilience research.

Permaculture exemplifies a basic quality of ecological resilience: ecological integration. Permaculture is a design philosophy which imitates and amplifies naturally occurring patterns, as do ecologically resilient systems. Below, the twelve permaculture design principles

<sup>365</sup> <http://permaculturenews.org/>



articulated by permaculture co-founder David Holmgren in his Permaculture: Principles and Pathways Beyond Sustainability<sup>366</sup> are explored to see the consistency with research on the adaptive cycles and ecological resilience.

**Principle 1: Observe and interact:** *By taking time to engage with nature we can design solutions that suit our particular situation.*

The concept of ecological resilience has arisen from observation of adaptive cycles in thousands of ecosystems. These observations, however, contrast with permaculture beliefs by embracing disturbance and change. No agricultural system is or can be permanent. All components are constantly adapting to each other and changing the system. Ecological resilience is not resilience in the materials science sense, where a material bounces back to its original form. Ecological communities naturally encounter disturbances which seem to destroy them. The oak-hickory forest where I live can be destroyed when a beaver family comes in, downs trees, builds dam. Organic matter gradually accumulates in the pond, eventually becomes a bog. Then a meadow. Then invaded by shrubs. Then forest. Multiple climax communities are possible depending on external drivers. Destruction of the climax community always occurs now and then, permitting the expression and renewal of other communities contributing to the resilience of the system. The ubiquity of disturbance has led to the concept of adaptive cycles.–

Ecological communities are always in resilience and transformation cycles with four stages: rapid growth (r), conservation (K), release ( $\Omega$ ) and reorganization ( $\alpha$ ). Observance of any ecosystem over time reveals a succession of communities following these stages. A system which seeks to make one stage permanent runs afoul of this natural cycle.

Observation of nature also shows that the most successful systems have a host of potential tools which are deployed exactly when needed. These include the propagules of a multitude of organisms which respond to disturbance by creating new systems, not by cementing an established system.

**Principle 2: Catch and store energy:** *By developing systems that collect resources at peak abundance, we can use them in times of need.*

We suggest that by building assets with ample built in backups we can build resilient systems, reflecting the principle to catch and store energy very clearly.

A detailed approach to “peak abundance” is shown in the ecological resilience literature. American Indians learned to use regular burning to maintain grassland and attract and increase buffalo and other ungulates. Manure from grazing animals helps soils deepen and become more fertile, capturing more carbon and nitrogen and building communities of microorganisms, and soil flora and fauna so grassland is even more productive.

In the late 1900s farmers began using management intensive grazing to mimic natural systems. In management intensive grazing owners are always rotating to pastures in the r phase when the pasture has the highest nutrient content. Managers do not wait till the K phase, but induce the release phase ( $\Omega$ ) by grazing to induce the reorganization phase ( $\alpha$ ) of the adaptive cycle.

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<sup>366</sup> <http://permacultureprinciples.com/product/principles/>

**Principle 3: Obtain a yield:** *Ensure that you are getting truly useful rewards as part of the work that you are doing.*

A resilient system gives positive feedback to the complex adaptive systems which contribute to its resilience. If you are contributing to the resilience, the permanence, of your system, you will receive the positive feedback which is continued yield (a more benign synonym for profit). This profit is extracted from the system for the use of you, the manager. If that yield is invested in useful tools, new skills or other inputs, yield can again contribute to resilience of the system.

However, profit can be stealing when you're mining the soil. Stealing is extraction of yield without providing any contribution to improving the resilience of the system. Using this definition, taxes and insurance are other types of stealing.

**Principle 4: Apply self-regulation and accept feedback:** *We need to discourage inappropriate activity to ensure that systems can continue to function well.*

All living organisms adapt. Those who respond to feedback the best are the most resilient. The conservative innovation of ecologically resilient systems insures that innovation also learns from and preserves valuable practices of the past. The end goal is to weed out "inappropriate" activities that are corrosive, ineffective or outdated. Also in our application of periodic transformation we encourage renewal based on self-regulation and the feedback received within and outside the system.

**Principle 5: Use and value [renewable](#) resources and services:** *Make the best use of nature's abundance to reduce our consumptive behavior and dependence on non-renewable resources.*

In the chapter on working with nature we explore how ecological resilience requires us to utilize the abundant resources and abilities of nature. Moreover, by working with those natural processes we can achieve equal or greater results by leveraging the complementary diversity ever present in nature.

Ecological resilience research wholly supports this principle by noting the lack of non-renewable inputs in ecological systems. We advocate local value-added processing to keep as many local resources as possible available in the local system. For example, producing herbal remedies from herbs you grow. Valuable herbal medicines are organic compounds made primarily of nitrogen, carbon and oxygen from the air and minerals from local rock. If these are removed, they are replaced by natural processes and enable the purchase of new tools which can decrease need for future inputs from outside.

**Principle 6: Produce no waste:** *By valuing and making use of all the resources that are available to us, nothing goes to waste.*

Viewed as an adaptive cycle, no living system has either resources or wastes. What some call resources, others might call wastes. Producing too much yield by extracting nutrients from the soil is wasteful. Often what we call resources are waste (or wasteful overproduction) from another system. All resources and wastes are inputs to other systems.

Within the working with nature and building assets chapters we assess the value and potential of channeling these resources into opportunities for growth.

**Principle 7: Design from patterns to details:** *By stepping back, we can observe patterns in nature and society. These can form the backbone of our designs, with the details filled in as we go.*

Complex adaptive systems (CAS) can only be made useful if we can see patterns in the chaos. In working with CAS going through the adaptive cycle it is important to find those regularities and make detailed decisions with them. Ecological resilience research has shown the overarching patterns (modular connectivity, complementary diversity, conservative innovation and flexibility, redundancy, etc.) which a permaculturalist can use to maximize resilience on their lands.

**Principle 8: Integrate rather than segregate:** *By putting the right things in the right place, relationships develop between those things and they work together to support each other.*

Optimizing connectivity is crucial to resilience. By bonding between units and bridging to other units, but remaining modular (not integrating too much with external systems), failure of one unit does not lead to failure of others. Ecological resilience further supports this with the principle of complementary diversity which aims to pair complementary components, placing the right plants, people or infrastructure in the right places with each other to create the results we're looking for.

Integration also means feedback is insured and all outputs are turned into inputs for others within the system.

**Principle 9: Use small and slow solutions:** *Small and slow systems are easier to maintain than big ones, making better use of local resources and producing more sustainable outcomes.*

Ecological resilience research has expanded upon this basic principle. A basic observation of resilience research is: anything which can be done quickly can be undone quickly. The most valuable changes just take a while.

The fast, efficient system can often be most vulnerable to disruptions, less resilient. A just-in-time supply chain can cause the downfall of a business system if it is interrupted. Continuous improvement is the goal of any successful enterprise but only looks at current drivers.

Resilience assumes enterprises will do their best to compete with each other and those who commit all resources to maximizing efficiency and profits will often die when system driver's change and they can't change quickly enough. The goal of adaptive governance for resilience is not to insure that all enterprises survive, only that their focus on efficiency does not include driving all other players out of the market.

Fast, unchecked coordination between units can speed a wave of failure throughout the system.

The slow variables, such as amount of soil organic matter, shape how a fast variable, such as crop production, responds to variation in an external driver, such as variation in rainfall during the growing season.

The fast-moving variables in the system fluctuate more in response to environmental and other shocks; and these shocks or directional change in the drivers can push the system across a threshold into an alternate stability regime.

“Fast” variables are typically those that are of primary concern to ecosystem users, for example a pest species or (often) ecosystem goods and services, such as crop production, clean water, and favored species. The dynamics of these fast variables are strongly shaped by other system variables that generally change much more slowly, and hence have been referred to as “slow”, or (because they are not always slow) “controlling” variables. They are not the same as the control variables used in other contexts, and to avoid confusion, ecosystem resilience researchers suggest it is best to simply refer to them as “slow” variables, recognizing that “fast” and “slow” are relative terms.

Resilient systems do respond quickly to minimize the impact of disturbance and to reassemble after disturbance. However, direct response to adversity is not the usual activity of any resilient systems. The usual focus is establishing a system which maximizes evolution, adaptive reorganization and the foundation for reassembly after adversity.

**Principle 10: Use and value diversity:** *Diversity reduces vulnerability to a variety of threats and takes advantage of the unique nature of the environment in which it resides.*

Resilient systems optimize diversity by making sure that diversity is complementary. Complementary units generate outputs which are needed inputs to other systems. Complementary units also engage the principle of backups, performing different functions and enabling the system to respond to multitudes of sudden problems.

If a unit is fulfilling the same function, producing the same outputs as other units, then it is not increasing complementary diversity. If not needed to optimize redundancy, then it is not contributing to resilience.

Some increases in diversity can destroy resilience. This include invasive plants or man-made systems which accumulate resources instead of feeding them back into the adaptive cycle.

**Principle 11: Use edges and value the marginal:** *The interface between things is where the most interesting events take place. These are often the most valuable, diverse and productive elements in the system.*

Adaptive cycles, with their  $r$ ,  $K$ ,  $\Omega$  and  $\alpha$  stages are most apparent on the edges of systems. On the edges, one system is transitioning from  $\Omega$  into  $\alpha$  and its successor is in  $\alpha$  reassembling into  $r$  phase. The  $\Omega$  is where resources are released and made available as profit (or taxes or other forms of stealing) or as inputs to the new system in  $\alpha$  phase.  $\Omega$  exists at margins where one system is dissolving and creating another system.

**Principle 12: Creatively use and respond to change:** *We can have a positive impact on inevitable change by carefully observing, and then intervening at the right time.*

Ecological resilience requires change. Periodic transformation is the quality of ecological resilience that most readily reflects this permaculture value. We explore in that chapter the value of creatively using times of disturbance. The  $\Omega$  phase inherent to every adaptive system is not destruction or an end, but a necessary part of reorganization to a more productive system.  $\Omega$  is precursor to  $\alpha$ , reassembly, reorganization creation of new system with emergent qualities.

Change and adaptation are at the foundation of ecological resilience, which views all living systems as complex adaptive systems (CAS) composed of other complex adaptive systems. Each CAS is composed of multiple CAS which must be connected, redundant, flexible, modular, diverse and prone toward reassembly. Each CAS is continuously changing in response to feedback from other CAS. An economy is composed of businesses which are composed of people which are all changing and adapting to each other. Society is composed of communities, composed of families, composed of individuals, composed of cells, composed of proteins and lipids, composed of molecules, composed of atoms, composed of quarks, etc.

Since each CAS is composed of CAS adapting to each other, every living system is constantly in flux. For example, the resilient person has multiple ways of dealing with the external environment and adversity. Sitting in school, actively playing sports, solitary study, socializing with friends, interacting in formal meetings with peers or formal meetings with bosses, with children, with elderly, are all useful responses demonstrating the flexibility needed for resilience.

When a CAS becomes less redundant, less flexible, less modular, less diverse, less ready for reassembly, it becomes more vulnerable to destruction when outside drivers change.

To assume that a system should remain stable, consistent and effectively stagnant is short sighted and destructive. A foundation of ecological resilience is a system's ability to both anticipate disturbance and to absorb it constructively.

**Summarizing the relationship of ecological resilience and permaculture**, ecological resilience provides an empirical foundation for some aspects of permaculture, refines other principles and shows some permaculture pronouncements are too broad and sweeping. The value of a discipline such as permaculture is enhanced when it stays grounded in the natural patterns it seeks to emulate, manage, and improve.

This is the task of anyone seeking to create an ecologically resilient system, to mimic the inevitable ebb and flow of nature. Within the shifting qualities of nature we can build lasting and, relatively, permanent structures that can continue to serve populations long into the chaotic and unpredictable future of our planet.

**Let's finish this chapter by standing the concepts of vulnerability and resilience side by side.** . Vulnerability assessment is entrenched in international rural development circles.<sup>367</sup> People have built careers and reputations on the concept. Vulnerability assessment has even crept into some climate change circles.<sup>368</sup>

Vulnerability research has a long history in social psychological research. Vulnerability is an attractive characteristic, to some. The look of vulnerability is said to be 'the key to unlocking intimacy.' "The more vulnerable you look, the more men find you attractive." There's even a vast and growing body of psychological research on the topic: "Why do we find vulnerability

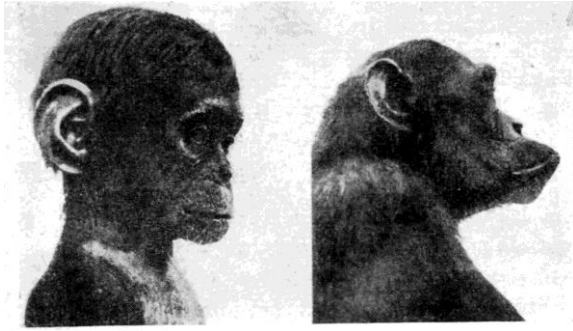
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<sup>367</sup> Moret, W., 2014. Vulnerability Assessment Methods. USAID.

<http://www.fhi360.org/sites/default/files/media/documents/Vulnerability%20Assessment%20Methods.pdf>

<sup>368</sup> Manangan AP, Uejio CK, Saha S, Schramm PJ, Marinucci GD, Brown CL, Hess JJ, and Luber G. Assessing health vulnerability to climate change: A guide for health departments. Climate and Health Technical Report Series, 2014. (<http://wwwdev.cdc.gov/climateandhealth/pubs/AssessingHealthVulnerabilitytoClimateChange.pdf>).

attractive?”<sup>369</sup> Vulnerability, as a set of signals used to stimulate attraction, does seem to have



some physical reality. Big eyes, small chin and other characteristics of infants do connote vulnerability and do induce protective instincts across many species.

Neoteny, in the field of developmental biology, is the retention, by adults, of traits seen only in babies of its progenitors. Baby chimpanzees look much more attractive to us than adult chimps.

In babies, vulnerability means dependency. We want to take care of a new baby. It's hardwired into us. But dependency in rural development is something to be avoided. It is the opposite of resilience.

Furthermore, vulnerability in famine mitigation, poverty reduction, disaster preparation, etc., refers to the lack of something. You can't measure the lack of something except by measuring the real thing which is lacking. You can't measure how much space is left in a glass without the water which is already in the glass. If the water is gone, so is the lack of water which once the water enabled you to see.

Empirical scientists usually feel that they can only study something when they can measure it. Other, more theoretical, scientists study with the hope of someday measuring it. In order to measure something, it must exist. A huge number of concepts in psychology and sociology do not exist in Nature. So they can't be measured, no matter how much some psychologists build their careers on them. In the long run, it's not wise to build your career on a nonexistent phenomenon. Just because it has a name does not mean it exists, except in the minds of the deluded. That's why psychologists need to get out in nature and away from people regularly. And not just psychologists, but all of us.

**Summarizing, vulnerability, from an ecological resilience perspective, is simply the lack of resilience.** Resilience is the real phenomenon of which vulnerability is just the lack. If you measure resilience on a 0-1 scale, vulnerability is 1 minus resilience.  $V=1-R$ .

## Conclusions

Sustainability, agroecology, organic agriculture and permaculture can each be improved by incorporating ecological resilience research. You can follow any of these approaches and still be consistent with the natural processes revealed by resilience research. What ecological resilience research adds to these approaches is a more specific method. One that is echoed through every old growth forest and developed prairie. The eight factors outlined in this book combined with ecological resilience research from around the world also adds a distinct dimension of change, shift and new beginnings. Where too-often systems aim to stay the same, resilient systems are waiting for change, poised to respond and recalibrate.

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<sup>369</sup><http://attractioninstitute.com/being-vulnerable-and-increasing-the-attraction/>