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Guest Editorial

Resilience: what it *is* and is *not*

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"Resilience" is becoming a buzzword. Sometimes it is open to interpretation and sometimes it is simply wrong. This misuse is detracting from an important and much-needed basis for managing agricultural regions, rivers, fisheries, natural ecosystems, cities, communities, people—all of which are complex systems. To help overcome the misunderstandings the following is a brief outline of what resilience is and what it is not, based on research over the past 50 years.

The simplest definition of resilience is the ability to cope with shocks and to keep functioning in much the same kind of way. It is a measure of how much an ecosystem, a business, a society can change before it crosses a tipping point into some other kind of state that it then tends to stay in.

There are two key parts to resilience: first, learning how to identify and stay away from (or where necessary cross) such tipping points/thresholds and second, to avoid crossing as yet unknown and unsuspected thresholds, learning about the attributes of a system that confer resilience, in general.

To begin with what it is not, resilience is not always good and desirable. Evil dictatorships, salinized landscapes, and psychotic states in people can be very resilient. The problem in such cases is to know how to reduce their resilience.

Possibly the most common misinterpretation of resilience is "bouncing back." Resilience is in fact the ability to adapt and change, to reorganize, while coping with disturbance. It is all about changing in order not to be changed. A resilient system responds to a disturbance by changing the relative amounts of its different parts and how they interact, thereby changing the way it functions. It stays the same *kind* of system by learning from a disturbance, to be able to better cope with a similar disturbance in the future. It does not bounce back to look and behave exactly like it did before. Resilient systems are learning systems.

There is confusion in regard to the terms robustness and resilience. Robustness is generally taken to mean the ability to resist a disturbance by not changing, sometimes referred to as "engineering resilience" (Holling 1996), which is quite different from the idea of resilience as changing and adapting in response to a disturbance. Some, however, see little difference and equate the two (Levin and Lubchenco 2008). But amongst nonscientist policy makers there is a tendency to assume that building resilience means making it "robust," resistant to change, able to stay the same despite stress or a disturbance. And in general this will reduce resilience.

It is important not only to build resilience to particular threats but also, as stated earlier, in general, in all parts of the system to any and all kinds of disturbance. Becoming very resilient in one way can cause a loss of resilience in other ways. In the growing concern around disaster resilience, for example, building resilience of forests to fires by widespread fuel reduction burns can reduce the resilience of small fauna species during times of drought. A forest with high spatial variability in terms of different successional states after fire is generally more resilient to a variety of disturbances than one focused only on making the forest layer resilient to fires.

We are learning more about a growing list of attributes that promote general resilience and the following are some of the more important ones that are commonly overlooked or misunderstood.

1. Response diversity. Probably top of the list is to acknowledge the need for different ways for doing the same thing, with different capacities to respond to different kinds of disturbance. For example, some of an ecosystem's plants (legumes) fix nitrogen from the air, which is a vital function for the health and productivity of the whole ecosystem. In a resilient ecosystem this function is performed by several different species, with different abilities to respond to drought, frost, fire, disease, etc. Whatever happens in the environment, this resilient ecosystem can continue fixing nitrogen. Corporations, government departments, in fact all elements of society today are driven by the need for "efficiency," getting rid of "redundancies." But what is considered "redundant" is often in fact response diversity. There must be an investment to maintain the benefits of resilience, and efficiency drives invariably do not consider (do not understand) this.

2. Exposure to disturbances. An ecosystem that is always protected from fire gradually loses its species able to tolerate fire; some species require fire (to set seed, for example). Where fires are a natural part of the environment the only way to keep an ecosystem resilient to fire is for it to be burned every now and then. There are limits that should not be crossed; too much or too strong a fire can cause severe damage and loss of other species. Similarly, children who are prevented from playing in dirt grow up with compromised immune systems and suffer allergies later in life. Trying to prevent one disturbance completely, in the name of keeping a system safe, actually reduces its resilience. Allowing exposure to the full range of environmental (natural and social) conditions is necessary for maintaining resilience to those environments. You can think of it as probing but not crossing the boundaries of stresses and disturbances.

3. Being modular, that is, not over- or underconnected. Overconnected systems are vulnerable to rapid spread of diseases (coronavirus), cascading failures (like the global financial crisis), faulty ways of doing things, bad ideas, etc. Underconnected systems have reduced learning ability, can suffer unnecessary duplication, react too slowly to a crisis, and other drawbacks.

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Both conditions are apparent in the ways various natural regions, societies, and organizations are structured. How much connectivity is right? It's one of those tricky Goldilocks questions that is best addressed (if possible) by deliberately making small changes in the kinds and numbers of connections, predicting what will happen, and monitoring what actually happens to fine-tune the system. It's a learning process and being aware of the fact that modularity is an important resilience attribute is the first step.

4. Being able to respond quickly to shocks and changes in the system. This ability has evolved naturally over time in ecological systems but can fail to emerge or is even suppressed in some social systems. For example, having too many steps in a reporting and approval procedure significantly slows down response time. The widespread trend of more and more checks and approval processes to promote safe operating procedures (including legal safety) does not promote resilience, it reduces it.

5. Being ready to transform if necessary. A particular area of confusion in trying to apply resilience is that sometimes there is a need to undertake fundamental change. When a catastrophic change into a "bad" state is looming under existing use, or due to a changing environment, continuing to try to adapt simply amounts to digging the hole deeper. There are many coastal towns in the world suffering increasing frequencies of flooding due to sea level rise. Continuing to raise the height of sea walls amounts to digging the hole deeper. Resilience includes knowing when an unwanted transformation is inevitable and instead deliberately transforming all or parts of the system such that the new system delivers what is valued and wanted. Because of the changed environment the exact nature of this may not be the same as that delivered by the old system. An obvious global manifestation of this is the need for transformational changes to reduce greenhouse gas emissions as opposed to continuing to try to adapt to global warming.

Resilience and transformation are not opposites. They can be complementary. Maintaining resilience at one scale can require transformational changes at other scales. For example, there isn't enough water in Australia's Murray Darling Basin for all the existing irrigation schemes to continue as viable systems. For the basin to continue as a resilient productive, irrigated agricultural region, some of its component irrigated farms need to transform into some other kind of land use. Maintaining all the irrigation systems is reducing the resilience of all of them, and therefore of the basin as a whole.

6. Thinking, planning, and managing across scales. One of the most common causes of unwanted outcomes in planning and management is focusing only at the scale of a perceived problem. You cannot understand or manage the resilience of a complex system at one scale. All complex systems function at multiple scales and the interactions between the scales are critical to resilience. In some cases the cross-scale effects reduce resilience at the focal scale, in others it enhances it. It is hard to get organizations or agencies that are defined at a single scale to accept this, or even consider the consequences for development of multiscale programs. Those familiar with the interactions of local, state, and federal/national agencies will be familiar with this.

7. Guiding not steering. Future environments and the future states of all complex systems are inherently uncertain. Trying to design and steer them toward some preferred state is bound to fail. Resilience is about keeping options open, learning how to guide, to shepherd, a system within a set of "good" states and avoid crossing into "bad" states. It's about learning where not to go rather than perfectly controlling where to go.

There is a growing list of attributes deemed to confer resilience. Carpenter et al. (2012) described nine, Walker and Salt (2012) identified 11. Psychologists identify many more for determining a person's ability to cope with adversity. The 100 Resilience Cities program (http://www.100resilientcities.org/resources/) identifies seven critical resilience attributes of cities. More are being proposed and shown to be relevant as work in many areas proceeds. Importantly, not all are always critical in all situations. A key part of a resilience assessment, therefore, should be considering all the attributes likely to be relevant at the time and determining which of them most need attention. Such an assessment is all too often lacking, and the proposed interventions then reflect the limited knowledge, sometimes selective "pet" theories, perhaps budgetary implications, and may well be deficient and ineffective.

In conclusion, I offer a few key points:

- Resilience is largely about learning *how* to change in order not to *be* changed.
- It is necessary to consider both the resilience of particular parts of a system to particular threats, as well as resilience in general, of all parts of the system to all kinds of disturbance.
- Trying to protect a system by keeping it in a constant state reduces its resilience. Exposure to the full range of social and environmental variation is necessary for maintaining and building resilience.
- Deliberate transformation of a system is sometimes necessary for it to continue delivering what is fundamentally of value to society.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/11647

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