We know what to do. Why don't we do it?

The time has come to mitigate and adapt

An invited comment by Bob Freitag

The warming world presents the primary risk and opportunity for our generation and our children's generation. It is time we accept our responsibility to do what emergency managers do best—mitigate the causes and adapt to those impacts for which we cannot mitigate.

After six years of silence on the subject, President Barack Obama proposed a plan to address climate change. Notably, Speaker of the House John Boehner (R-Ohio), in his June 20, 2013 response to the president, did not question the science. Rather he said the administration proposal is "absolutely crazy" because it will kill jobs. But he didn't argue—and this is critical—that the plan is based on faulty science. More about jobs later.

In the mid-2000s, when we were researching material for our book *Floodplain Management: A New Approach to a New Era*, climate change was our driving theme. Today, we know climate change brings unique challenges. They can only be understood if global warming is profiled as a primary hazard, not merely as "extreme events" that are only an amplification of known hazards like flooding, landslides, winter storms, hurricanes, tornadoes, and even earthquakes. Recent research suggests reduced polar ice may trigger earthquakes.

To understand the advantages of addressing climate change directly, it is important to review a little physics, some ecology, and their contribution to resilience. But, in doing so, please excuse my limiting the profiling of climate change frequency, magnitude, timing, and location mostly to examples from the Pacific Northwest.

First, a little physics ...

The first law of thermodynamics says when you add energy to a system you get work (something happens). For example, when you heat a kettle of water you make steam. Then you can convert the steam to mechanical energy by routing it through a steam engine. If the engine is connected to an electric generator, you can then remove some heat to power, say, a refrigerator.

Greenhouse gasses in the atmosphere trap energy from the sun. This energy creates work, but in this case, work is weather. More energy, more weather. Weather can take many forms. The energy can be used immediately (kinetic energy) as rain or wind, or water stored in upland lakes or trees (potential energy).

In the Northwest, west of the Cascades, we enjoy a marine environment resulting from moist sea air blocked by the mountains. There is a lot of precipitation here, but historically it has been more mist than rain. Global warming is adding energy, and our weather systems and lives are changing.

In the Northwest:

- More rain is falling in the winter and it is more intense.
- Less snow is being stored in the Cascades and this contributes to greater winter discharges in our developed coastal areas.
- Summer flows are decreasing.
- Higher discharges are increasing channel erosion.
- Higher temperatures are melting glaciers and historically frozen soils, increasing sediment mobilization.
- Higher flows and more sediment in the river are causing more flooding to our low-lying cities.

It is not helpful to say this change in energy will create more flooding where there is current flooding, more drought where there is now drought, more heat where it is currently hot, or ultimately, describe the phenomenon as just anomalous "extreme weather" without connecting the dots. Climate change-induced impacts, such as flooding, are different. The impacts are unique. Evaluating these unique climate change attributes will direct us to developing better adaptive actions.

Second, some ecology ...

Ecology is the study of relationships between physical and biological processes. This can be viewed as the study of how everything is connected to everything else. Understanding interdependences is crucial to understanding how our world is changing and how we can adapt. Northwest ecology is mainly a reflection of our slowly evolving post-continental glacier landscape beginning some 13,000 years ago. Climate change is ramping up the speed of ecological and evolutionary successional processes. For instance:

- The Cascades are warming and forests are drying out, resulting in more fuel for forest fires.
- With the loss of spring and summer snow packs, more trees are drying, increasing the risk of forest fires.

- These new successional systems often store less water than the established forests being replaced, contributing to even greater wildland fire risks.
- Invasive species are moving north as the climate warms. The pine bark beetle is destroying forests, reducing the forest's ability to store water and resulting in more frequent and severe downstream flooding.
- Forest fires clear vegetation, decrease storage, reduce water absorption, increase sediment mobilization, and cause more flooding.
- Burnt forests retain less runoff, increasing downstream flooding.

It is not sufficient to address these impacts within the isolated context of flooding, drought, landslides or winter storms. The interdependent nature of these ecological changes would be lost if climate change were a footnote to other hazards, limiting the discovery of viable solutions to reducing risk.

Third, resilience ...

If we are to adapt to a changing climate, we must be resilient. There are many definitions of resilience. Here I will borrow from the field of social ecology, defining resilience as the ability of an individual or community to adapt or transform in response to stress and shocks—rather than just "bouncing back," undergoing undesirable change, or collapsing.

Important to this definition is that resilience demands a focal point. What is resilient to one stressor may not be resilient to others. One's resilience may depend on another's collapse. Any change may bring benefits to some, hardships to others. Climate change will make some rich and others poor. For instance, global warming demands that we reduce carbon emissions. This change will hurt the fossil fuel industry, help the alternative fuel sector. But we know from basic physics that energy and work are related. With more energy in the atmosphere, there is more energy to exploit. Technologies are emerging to harvest atmospheric energy such as windmills, solar cells, and bio-carbon approaches.

Change brings both adversity and benefit. Climate change mitigation will reduce some jobs and increase others. It may seem counterintuitive to think of change as a job creator, but after we bombed the daylights out of Germany and Japan during World War II, we watched their economies surpass others, in part because we removed encumbrances associated with older infrastructures. Think Pony Express to telegraph to telephone to internet. Opportunity can accompany change.

Social ecologists discuss resilience science within the context of five variables: remembering, revolt, feedback, thresholds, and transformability. The terms may seem a little awkward at first but you will quickly see their value in both reducing risk and identifying opportunities.

Remembering. This occurs when the potential for recovery is accumulated and stored. A fire burns a forest but seed stocks remain, allowing for the forest to regenerate. Global warming is changing ecology. The forests remembered are not necessarily the ones emerging. Stressed forests are not storing adequate seed stocks. A great example, although not one involving climate change, is the recovery of Santa Cruz, California following the Loma Prieta earthquake. Here this tightly knit community exploited their social and intellectual capital and reconstructed a new and more vibrant commercial center. East Coast barrier island communities may not be afforded the same opportunity.

Climate change is rendering remembering inexact for many communities damaged by Hurricane Sandy. Reconstructing as they remember it is not sustainable. As Yogi Berra is reputed to have said, "The future ain't what it used to be." Remembering helps with traditional flooding. False remembering may represent the greatest climate change detriment to resilience.

Elevating homes on a coastal floodplain might make perfect sense when addressing traditional flooding. Building on the "remembered" seeds would increase resilience. But this approach would prove expensive and decrease community resilience where global warming is causing increased sea levels, storms, and greater losses in protective natural capital.

Revolt. This occurs when forces or events overwhelm recovery. Burnt forest attempting to reestablish itself may be overtaken by more resilient competitors such as Scotch broom or Himalayan blackberry, preventing the establishment of the pre-change ecology. For East Coast barrier island communities, "revolt" could come in the form of a changing landscape. Global warming is increasing storm magnitude and frequency. Protective offshore buffers like reefs and gradually slopping bathymetry are disappearing. Migrating sands that created these islands are relocating. Revolt, or any of these variables for that matter, has a focal point and can be positive or negative. We have destroyed countless forests in order to build houses and plant orchards. Our resiliency depended on the lack of resiliency of a forest.

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Prescribed burning along with rehabilitation of native plants will reduce wild fire risks increasing resilience if climate change is not a factor. But for stressed forests, spending money to reestablish native species may prove futile.

Feedback. Resilient communities have self-organizing feedback mechanisms. The commercial market offers many examples of self-correcting feedback. A flood damages a home in Snoqualmie, Washington. Most homes are elevated and the owner sees a lifestyle and market advantage of elevating the home above future flood levels even without the incentives of the National Flood Insurance Program. However, along the east coast of a New Jersey barrier island, using limited resources to elevate your home may create a destructive feedback if the grounds wash away from under your home and you have exhausted your financial resources. The market does not respond well to "false remembering."

Depending on market driven incentives to re-establish an ecologically dependent resort would waste resources where the ecology and natural capital incentives are changing.

It has been estimated that there is $527 billion dollars of coast property at risk from sea level rise and coastal storms. We do not have the resources to continually "bounce back," rebuilding pre-event communities following each disaster.

Tipping Point. This is a point at which a relatively small change in external conditions causes a rapid change. Change is seldom linear. A one-degree change in temperature can melt a protective ice shelf, removing a vital buffer for an Alaskan community.

Acknowledging thresholds and tipping points can provide support for profitable interim uses. For instance, ski resorts located in the lower Cascades may prove extremely profitable over the next few years as warmer air absorbs more moisture and falls as snow. However, as the mountain snow line rises above these resorts, skiing will no longer be profitable. To continue they will have to exploit other natural capital.

Climate change is forcing many systems across thresholds. Little ones, such as our traditionally cool northwest system, are becoming warmer and more attractive to mosquitoes. Big ones are altering coastal currents.

James Hanson of the Goddard Institute of Space Studies has identified 350 parts-per-million of CO_2 in the atmosphere as a safe upper limit if we are to avoid a variety of climate-related tipping points. We are currently at 400 ppm, and if all the current oil drilling leases were exercised and the stored CO_2 was emitted in the atmosphere, we may well exceed 500 ppm.

Reinforcing levees would remove risks associated with coastal agriculture. However, with increasing sea levels, the salinity of these areas will reach a threshold where traditional crops will not survive. Farms will have to plant salt tolerant crops and universities will have to push evolutionary processes to create new salt tolerant varieties.

Transformability: This is the capacity to create a fundamentally new system when conditions make the existing system untenable—where organizations are capable of exploiting new opportunities. *New York Times* economic pundit Paul Krugman, writing at the end of June this year, said, "Environmental action could actually have a positive effect [in creating jobs]. Suppose that electric utilities, in order to meet the new rules, decide to close some existing power plants and invest in new, lower-emission capacity. Well, that's an increase in spending, and more spending is exactly what our economy needs." Transformability may also come in the form of interim strategies. Think of our ski resort example. Will they be able to attract visitors to pay for a different experience?

Rebuilding better is a popular risk reduction mantra, but "better" may mean building temporary transitional structures and land uses that have small economic footprints, generating fast lifecycle returns on investment.

And, finally …

We must address climate change directly if we are to be resilient and develop sustainable risk reduction solutions. The discovery of sound adaptation measures is only possible if we discuss global warming as the focus of our concern—the primary hazard in our mitigation, response, recovery, and preparedness planning. When writing hazard mitigation plans, coastal area plans, comprehensive land use plans, or conducting "discovery" meetings, doing benefit-cost analyses or environmental assessments, we need to address global warming as the driver of change and not some ancillary effect of another hazard. Only then will sound sustainable adaptation measures emerge.

This will support climate change policies that are opportunistic and positioned to exploit market and disaster recovery forces. Policy and funds must be in place to buy valuable floodplain capital when made available by willing sellers or as the result of changes provided by disaster events. It has been estimated that there is $527 billion dollars of coast property at risk from sea level rise and coastal storms. We do not have the resources to continually "bounce back," rebuilding pre-event communities following each disaster.

And lastly, we don't know how our culture will survive high levels of carbon in the atmosphere. If we are to avoid extreme tipping points, we must reduce our emission of greenhouse gasses. This must begin immediately. We can begin now at the local level by reexamining our development patterns, land uses and transportation systems, and restoring our natural capital.

Addressing global warming as a secondary hazard will prove ineffective, if not futile, as will restricting our energy to adaptation alone.

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