

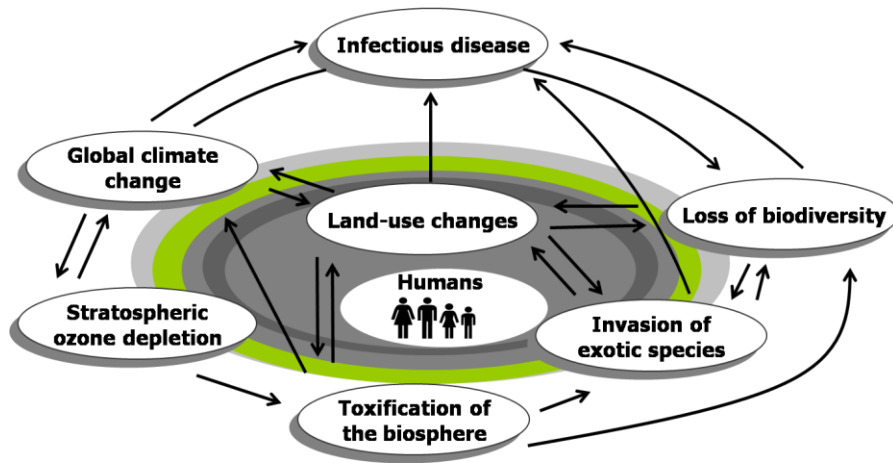
## Change and the Hudson River

Paddling a kayak through the Hudson's marshes, watching a bald eagle preening its feathers or pulling in a net filled with immature white perch and tessellated darters, you would be tempted to say 'Ahh, this is the way nature is meant to be'. Quiet, and yet full of life. And then you hear the rumble of a train, and you notice the sea of purple loosestrife, or you watch a fisherman catch a largemouth bass. Humans have dramatically altered the Hudson's ecosystem, but it is difficult to describe what its natural state should be, since for all ecosystems, change is normal. However, we also know that we are putting tremendous pressure on the natural world, and it cannot withstand multiple stressors forever. In order to understand more about the Hudson River, and whether it is changing normally or experiencing unusual disruptions, scientists monitor how the river changes over months, years and decades. This critical information tells us how much we are changing the ecosystems we depend on, and provides information to policy-makers and planners who are concerned about human impacts.

Scientists often define change in two ways: a *bend* or a *break*. A bend refers to a change that alters the ecosystem for a short period of time, but from which the ecosystem can ultimately recover (given enough time). A break, on the other hand, creates a permanent change in the ecosystem. These bends and breaks can be due to humans or to natural processes, or a combination of both. Defining whether a change is a bend or a break helps scientists decide what research to focus on, and it helps inform public land managers and local governments about what problem solving strategies to put into place. For instance, every time there is a heavy rain and a stream floods, there is often a change in the pathway of the stream or erosion along the stream's banks. Does this mean that we should restore the stream to its pre-storm 'path'? Generally, this type of a bend in a stream ecosystem is allowed to persist, because it is part of the natural changes that take place.

However, there are changes that represent breaks in the ecosystem from which it will not recover, and sometimes those breaks have unintended consequences for humans. Many scientists and policy makers point to the deadly Indian Ocean tsunami or Hurricane Katrina as examples of breaks in an ecosystem that caused incredible devastation. Mangroves and other wetlands provide a number of ecosystem services, including shoreline stabilization and reducing the impact of coastal storms. These coastal areas act as buffers against the wrath of the ocean, but both regions have seen huge wetland losses. Had they been left intact, the damage caused by the tsunami and Hurricane Katrina could have been significantly reduced.

Scientists are concerned that we are slowly building towards other breaks in the global ecosystem, as the interactions between climate change, species extinction, human development, pollution, invasive species, and habitat loss intensifies.



The diagram at the left, created by Dr. Gene Likens, is one way of thinking of the interrelated nature of the changes that are occurring due to human activities. Each change is linked to other changes, making it difficult to attribute a species extinction or an extreme flood to just one factor. Regardless of the

complexity of our impact on the planet, it is clear that humans are altering the earth on an unprecedented scale, at an unprecedented rate.

Some historians argue that human impact on the Hudson River ecosystem began with the Native Americans who burned areas for farming, building villages, and hunting. However, the most dramatic changes occurred after the arrival of Europeans. While population growth was slow during the first two hundred years of colonization, tanneries, timber companies, and the paper industry contributed to the swift decimation of old-growth forests, while rampant hunting created local extinctions for many animals, including the panther, wolf, and the oyster, whose fishery collapsed in the late 1700s. Along the Hudson, the railroads were built and the river channel was dredged to allow easier passage for ships. It is estimated that over 50% of the shoreline has been modified, and many wetlands within the watershed have been lost. Hundreds of dams were built along the Hudson's tributaries, which, along with the dam at Troy, have devastated the native fish populations due to impaired migration routes and lack of spawning habitat. Shipping, the railroads, and the opening of the Erie Canal allowed fast transport, which made life and commerce easier along the river, but also enabled the arrival of numerous invasive species. The Hudson River is now home to over 113 non-native species, many of which continue to cause significant economic damage. Lastly, the region became a center for industry, producing toxic chemicals which still persist in the waterways.

Which of these changes was a bend for the Hudson, and which was a break? How long do we have to wait until we decide? What can humans do to mitigate some of these changes? We know that improvements are possible, especially since the Hudson's water quality has dramatically improved, but we need to understand which changes are important and permanent. Answering these questions will help us make decisions about restoring some of the natural functions of the Hudson River.

**Reference:** Likens, G. 2004. Biogeochemistry: Some opportunities and challenges for the future. *Water, Air, & Soil Pollution*, vol. 4(2-3), p5-24.

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