# Back from the brink

The idea that Earth is approaching an irreversible tipping point is well known. But it's probably untrue and almost certainly unhelpful, says **Erle C. Ellis**

HOW much can our poor Earth take? We've already transformed most of the biosphere beyond anything our early ancestors could have imagined, clearing, ploughing, burning, building, damming, domesticating, driving to extinction, dousing with chemicals and even changing the climate. Surely at some point, the biosphere will simply collapse in the face of such a massive and unrelenting onslaught.

Or will it? This is a question that inspires intense debate among ecologists and global change scientists. Some say that we are heading rapidly for a global tipping point – a threshold beyond which the entire biosphere will shift into a new and mostly undesired state. Others, like me, are convinced that no theoretical or empirical evidence exists for such a claim, and that a widespread belief in the existence of such a point of no return threatens to push ecological science and its application in the wrong direction.

Let us examine the evidence. Ecologists have long been aware that tipping points exist in local and regional ecosystems. For example, when nutrients are added to a lake, its ecological properties tend to continue as before until the lake suddenly shifts to a new state. The water changes from clear to turbid; communities of plants, fish and other species change almost completely. Shifting the lake back into its previous state is possible, but requires massive efforts.

Among other examples of local and regional tipping points are the rapid collapse of coral reefs in the face of rising ocean acidity and the transformation of ecosystems by the extinction of a dominant species, or the introduction of a new one.

With such strong evidence of tipping points in regional ecosystems, why wouldn't we expect such tipping points to exist in the biosphere as a whole? Examine the mechanisms that produce tipping points, and the answer becomes clear.

Tipping points happen when the components of a system respond gradually to an external force until a level of change is reached at which the response becomes non-linear and synergistic. This amplifies the effect of the force and rapidly drives the system into a new state.

To respond in this way, systems must meet certain requirements. Either external forces are applied uniformly and each part of the system responds in the same way, or the system must be highly interconnected to allow synergistic responses to emerge. Or both.

Do these criteria apply to the biosphere as a whole? I think not. For planetary tipping points to exist, the forces of humanity would need to act uniformly across the planet, all ecosystems would need to respond to them in the same way, and the response would need to be transmitted rapidly across Earth's many ecosystems and continents.

**"To deny a global tipping point is not to deny that we are profoundly changing the biosphere"**

Even the force of human-induced climate change, so evident across the planet, does not meet these requirements. For example, it warms and dries some regions while cooling and moistening others. Even if it did uniformly heat Earth's ecosystems, this would not produce a coherent global shift in ecology because local ecosystems respond so differently, often in opposing ways.

Finally, organisms and ecosystems in different biomes and on different continents are not strongly connected. Animals, plants and microorganisms are limited in their interactions by distance and barriers such as oceans and mountain ranges. Even with human-induced species invasions, there is no species capable of colonising all of Earth's biomes – not even the mighty cockroach.

So there is little chance of anthropogenic climate change leading to a global tipping point in the biosphere. When it comes to other changes, including land use, habitat fragmentation and extinction, the case for a global tipping point is even weaker.

How, then, does the biosphere as a whole respond to human pressures? To put it simply: every ecosystem changes in its own way. We are driving massive long-term

changes in the ecology of our planet, one ecosystem, one community, one species at a time. The biosphere's response to human pressures is merely the sum of all of the changes.

Viewing things this way puts the emphasis back where it belongs: on understanding and managing ecosystems at the local and regional level. While we must continue to think and act globally, it is the local and regional levels that are the key for conservation and management.

To deny the likelihood of an impending global tipping point is not to deny that we are transforming the biosphere profoundly and permanently in ways that are likely to disgrace us in the eyes of future generations. Much of our planet's ecology can and will be lost unless we focus much greater effort on conserving and restoring it.

With this in mind, the concept of a global tipping point has major policy implications. It suggests that below some threshold nothing serious will happen, but after that all will be lost. Holding such a view risks breeding complacency on one side and hopelessness on the other. Both are misplaced: to lose even one species is more than we should accept lightly. The same holds for our local ecosystems. To conserve them is to conserve the biosphere.

The claim that the biosphere is approaching a global tipping point remains no more than a contested and untested hypothesis. As we strive towards more sustainable stewardship of our planet, we must think globally – but let us not lose track of problems on smaller scales. The fate of the entire biosphere depends on it. ■

**Erle C. Ellis** is associate professor of geography and environmental systems at the University of Maryland, Baltimore County. A more detailed version of this argument is published in *Trends in Ecology and Evolution* (DOI: 10.1016/j.tree.2013.01.016)

## One minute with...

# Malcolm Duthie

To eradicate a disease you first have to find it, says the immunologist who created a blood test for leprosy

**Most people think of leprosy as a problem of the past. How common is it today?**
There are about 250,000 new cases reported each year. But that's probably about 5 to 6-fold lower than actually occur. In one study in Bangladesh, for example, they detected a rate sixfold higher than what was reported.

**Why is leprosy so under-reported?**
It is very easily misdiagnosed. In the mid-1980s there were about 12 million cases globally. Then the World Health Organization led a drive to reduce cases to less than 1 per 10,000 people by 2000. Since then levels have plateaued. But an unfortunate consequence of that success is there are now fewer clinicians who can diagnose leprosy – and the front line is clinical recognition.

**How is a leprosy infection confirmed?**
You need to collect lymph fluid, or take a biopsy and look for evidence of *Mycobacterium leprae*. But none of this is rapid, and it requires significant expertise. People are commonly treated for fungal infections or other skin conditions. It is often a last resort, after multiple wrong diagnoses, that they end up at leprosy reference centres. That delay is critical; the longer the infection goes on, the greater the chance that person is going to have lasting nerve damage.

**Your team has developed a new blood test for leprosy. How early can it detect infection?**
In a lab-based study, we were able to identify most cases about 9 to 12 months in advance of clinical symptoms. That is probably conservative.

**How easy is it to use the test?**
It is like a home pregnancy test, but with blood. You take a finger prick, collect a drop of blood, add it to a window in the test, and it causes a colour change. It doesn't have to be done by a specialist.

**The test was developed as an offshoot of your leprosy vaccine programme. How close are you to a vaccine?**
Our timeline, if everything goes to plan, is to have a phase 1 clinical trial at the end of this year or the start of next year. Actual implementation of the vaccine is probably several years down the track.


**PROFILE**
**Malcolm Duthie** is a senior scientist at the Infectious Disease Research Institute in Seattle. He led a team that developed a blood test for leprosy, which can provide results in 10 minutes

**Do you think we can eradicate leprosy?**
Yes, there is the potential. About 65 per cent of cases are reported in India. The one significant hurdle is that, with a population of 1.2 billion and a disease that officially affects about 150,000, there's probably not going to be widespread implementation of the vaccine. That is why we want our blood test, so we can target regions to implement the vaccine. The WHO mantra is early detection, early treatment. Well, early detection based on clinical symptoms is often too late.

**So would the strategy be like that used to eradicate smallpox – by targeting hotspots?**
Exactly. An infection with a clinical onset of seven years is not going to advance as rapidly as smallpox, but that's the model. Identify the hotspot, treat the hotspot, knock the disease down in a particular region and then keep an eye on that region.
**Interview by Tiffany O'Callaghan**

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