THE CONVERSATION

Setting priorities for environmental research is daunting when the questions are so huge

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Gamba Grass is altering fire regimes in the Top End, threatening human life and property, natural assets including Kakadu and Litchfield National Parks, and compromising savanna burning programs. Samantha Setterfield, Author provided

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This article is part of our series on the Science and Research Priorities recently announced by the Federal Government. You can read the introduction to the series by Australia's Chief Scientist, Ian Chubb, here.

Ian Lowe

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A few years ago I was part of an exercise to identify the important knowledge gaps that prevent effective environmental management in Australia. The study was motivated by a recognition that our future well-being depends critically on the health of the natural systems we rely on for clean air, water and the resources for food production, as well as indirect benefits derived from a healthy environment.

We published a paper which identified areas of environmental management that are profoundly hindered by a lack of basic scientific knowledge, rather than just by a lack of policy development and management.

Of the 22 big questions we identified, more than half are directly related to climate change, while several concern our limited understanding of marine systems. These are still the top priorities today.

We identified four global issues that are important for Australia: integrating environmental management with other human needs; tackling climate change; ocean acification; and coastal flooding (note that most Australians live near the coast).

As well as those global issues, we have a particular local problem: the continuing loss of our unique biodiversity.

There is some overlap here with the main areas identified by the government's new research priorities, which in the area of environmental change call for attention to be directed towards: better prediction of climate impacts; making our urban, rural and regional infrastructure more resilient; and helping our biological systems, communities and industries adapt to environmental change.

Our paper went on to pose a series of questions that need answers if we are to overcome the current lack of knowledge that is holding back our environmental management.

To integrate environmental management with other human needs, we need to know how to value natural ecosystems so that financial incentives can be used to help preserve them, and the environmental costs of production can be incorporated into the prices of goods and services.

We also need well-defined sustainability goals, a knowledge of how much change different ecosystems can tolerate, and an understanding of what management policies will work best in each situation.

With relation to climate change, we need to know how to downscale global climate models to give us useful predictions at the landscape scale for Australia. More specifically, we need to know how fire regimes are likely to be influenced by climate change and how best to manage them; how marine systems such as coral reefs are likely to respond to changes such as increased ocean acification; how agriculture might change (or even physically move location) in the future; and how coastal systems such as freshwater aquifers will respond to sea-level rise.

We also need to devise and implement an early detection system for potential invasive species such as new weeds, pests, pathogens, and diseases.

And a big question about our loss of biodiversity is whether we can reverse and restore the loss of species in degraded landscapes, and in particular how we can preserve them to prevent further loss?

While there are many areas where we know what needs to be done and are still failing to respond because of ideology or short-term political expediency, the areas identified here require basic research if we are to make informed decisions. This is far from a comprehensive list.

As much of the environmental damage done in the past has been the result of ignorance, improving our knowledge should be a top priority.

We urgently need to know how fire regimes will respond to changing climates. Ian Dixon, Author provided

Andrew Campbell

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Others in this series will rightly focus on research priorities in terms of the “what?” questions: identifying the topics most deserving of attention. Important, of course, but I prefer to focus on the “how?” questions. How should we go about understanding an issue as complex and contentious as environmental change?

Let’s take at face value the term “environmental change” as being broader than just “climate change”, rather than the former being simply euphemistic code for the latter.

Fair enough – there are lots of drivers of environmental change besides global warming: human consumption and pollution; invasive species; agriculture and land clearing; changing fire regimes; and mining, to name a few. Of course, many of these intersect with, and are worsened by, climate change.

In broad terms, we know what we need to do. Over the next century or so, we have some deceptively simple objectives:

Decouple economic growth from greenhouse gas emissions

Increase food production while using less land, water and nutrients

Increase water and energy productivity

Adapt to an increasingly difficult climate

Each of these is a herculean scientific and policy challenge. Yet we need to do them all at once — walking, chewing gum, patting our heads and rubbing our bellies at the same time.

Figuring out how to tackle so-called wicked problems demands a rethink of the process of scientific inquiry, going beyond the traditional reductionist approach by which we test single-issue hypotheses. Earlier this year my colleagues and I published a paper discussing how to design more effective interdisciplinary research.

However, understanding environmental change in ways that help society to stay within planetary boundaries requires more than new research methods. It also means rethinking the interface between education, science, society and policy.

In an era where every smartphone has GPS, we can combine outputs from sophisticated research facilities like TERN with the observations of hundreds of thousands of people, through citizen science initiatives like the Atlas of Living Australia and e-Bird.

We have as yet made only baby steps with the integration of citizen science, the internet of things, social media, school and adult education, and the voluntary community sector (landcare, field naturalists, renewable energy and the arts).

The closer we draw these groups together, the more difficult it will be for governments, corporations or industries to get away with promoting or subsidising environmental destruction, delegitimising environmental concerns, or weakening environmental protection.

One of our biggest challenges in an era of wicked problems, big data and knowledge economies is how to analyse, synthesise and make sense of the disparate data we generate.

Along with big-ticket projects like synchrotrons and square kilometre arrays, we also need research infrastructure designed to do this kind of analysis.

A dozen or so scientific synthesis centres have emerged around the world in the earth and environmental sciences over the past 20 years, for instance in Santa Barbara, Stockholm and Leipzig. Compared with radiotelescopes and research ships, these synthesis centres are dirt-cheap, but the emerging evidence that they are scientifically very valuable, especially from a policy perspective.

Unfortunately we have been unable to sustain funding for our short-lived Australian synthesis centre, ACEAS. So at the top of my personal wish list would be for Australia to invest in its own national environmental synthesis centre. Team Australia needs an environmental dashboard.

Ideally, as many team members (citizens) as possible should be involved in generating the information that goes into it, in tracking progress on the various dials (water, energy, food, land, biodiversity, atmosphere, oceans, climate), and in working out how we can do better.

Figuring out how we can achieve that is as important as deciding which research questions to explore.

The Northern Territory's Daly River is one place that is still in a relatively natural state - but is threatened by development pressures. Michael Douglas, Author provided

Bill Laurance

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One of the first things a boxer learns is “throw punches in bunches”. It’s not a single blow that will fell most opponents, but a devastating flurry of jabs, hooks, crosses and uppercuts.

Scientists are increasingly drawing similar conclusions about biodiversity and the environmental stresses that imperil it. Most species aren’t being endangered by a single hazard, but by combinations of different threats acting in concert.

For example, in many parts of the tropics, an alarming synergism arises between selective logging and hunting. In the Congo Basin, for instance, loggers have bulldozed more than 50,000 km of new roads since 2000. Following in their footsteps are hordes of hunters armed with deadly rifles and cable snares. The result? An epic slaughter of wildlife, with two-thirds of the world’s forest elephants killed off in the past decade.

Many human disturbances also increase wildfires. Habitat fragmentation and logging create piles of flammable slash in the forest while disrupting the canopy, allowing light and wind to dry out the forest floor. From the Amazon to Australia, human-disturbed forests have suffered catastrophic fires that have destroyed or degraded vast expanses of native growth.

Climate change is also making ecosystems more fire-prone. El Niño droughts are known to affect many forests, but in 2005 and 2010 researchers saw a completely new kind of drought in the Amazon, caused not by El Niño but by exceptionally warm Atlantic sea-surface temperatures, which drove the rain-bearing “intertropical convergence zone” northwards. As a result, vast expanses of the Amazon that were formerly thought to be drought-proof suffered catastrophic tree death, resulting in hundreds of millions of tonnes of greenhouse gas emissions.

The remarkable mobility of modern human societies is a subtle but nonetheless critical form of disturbance, because we are spreading foreign species all across the planet. Some exotics are complete game-changers. The chytrid fungus spreading around the world has caused at least 200 species of frogs and other amphibians to disappear. And elephant grass and Gamba grass in northern Australia are utterly destroying native forests. These African grasses grow up to 4 m tall and burn so savagely that even fire-adapted woodlands are being wiped out.

I sometimes challenge my students to name a single place on Earth where only one environmental change is occurring. They can’t do it because no such place exists – and Australia is certainly no exception. Air and water pollution, climate change, overhunting, widespread habitat loss and fragmentation, foreign species, altered ecosystems and food chains. There are no refuges from these external, infernal threats.

That’s the most alarming thing we are doing to the world — changing it in myriad ways all at once. Species aren’t enduring just a single menace, but are running a gauntlet of perils as they struggle desperately for survival.

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