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Strange bedfellows? Techno-fixes to solve the big conservation issues in southern Asia

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ABSTRACT

The conservation challenges facing mega-biodiverse South and Southeast Asia in the 21st century are enormous. For millennia, much of the habitat of these regions was only lightly modified by human endeavour, yet now it is experiencing rampant deforestation, logging, biofuel cropping, invasive species expansion, and the synergies of climate change, drought, fire and sea-level rise. Although small-scale conservation management might assist some species and habitats, the broader sweep of problems requires big thinking and some radical solutions. Given the long expected lead times between progressive economic development and stabilization of human population size and consumption rates, we argue that 'technological fixes' cannot be ignored if we are to address social and fiscal drivers of environmental degradation and associated species extinctions in rapidly developing regions like southern Asia. The pursuit of cheap and abundant 'clean' energy from an economically rational mix of nuclear power, geothermal, solar, wind, and hydrogen-derivative 'synfuels', is fundamental to this goal. This will permit pathways of high-tech economic development that include intensified (high energy-input) agriculture over small land areas, full recycling of material goods, a transition from fossil-fuel use for transport and electricity generation, a rejection of tropical biofuels that require vast areas of arable land for production, and a viable alternative to the damming of major waterways like the Mekong, Murum and northern tributaries of the Ganges and Brahmaputra Rivers for hydroelectricity. Rational approaches that work at large scales must be used to deal with the ultimate, rather than just proximate, drivers of biodiversity loss in the rapidly developing regions of southern Asia.

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1. The big picture for southern Asia

The conservation challenges facing modern South and Southeast Asia are enormous (Sodhi et al., 2010). This is among the most mega-biodiverse regions of Earth, dominated by wet tropical rain forests, punctuated by spectacular topography, and supporting many unique, insular biotas within seven major Biodiversity Hotspots (East Melanesian Islands, Wallacea, Philippines, Indo-Burma, Sundaland, Himalaya, Western Ghats and Sri Lanka; www.biodiversityhotspots.org). Although the region was only lightly modified by human influence for many millennia, human population density and their rate of natural resource extraction have grown massively over the past century, leading to rampant human encroachment (Sodhi and Brook, 2006; Peh and Lewis, this volume). South and Southeast Asia (henceforth 'southern Asia') is therefore urgently in need of practical conservation initiatives,

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underpinned by robust science. The question is how to achieve meaningful biodiversity protection outcomes at a sufficient scale to make a real difference. In this essay, we argue that whilst many key elements are required, some important strategies are not being actively researched, discussed or even contemplated by conservation scientists.

Scientific knowledge is obviously essential. If we do not understand the composition, habitat requirements, population dynamics and evolutionary history of biota, management actions will lack a scientific basis and it will be difficult to weigh up the costs and benefits of various alternatives. There must also be a socio-political willingness to conserve and protect – if local people do not feel invested in the issue, or view conservation as peripheral or even antagonistic to other aspirations, then on-ground actions are doomed to fail due to self-interest, corruption and the lure of profit (Ehrlich and Ornstein, 2010). The third pillar of change is technological; this is among the most vexed requirements for sustainability, especially among traditional conservationists.

2. Science and social change are important, but not enough

Scientific knowledge and socio-political barriers are the two big problems usually addressed in the multidisciplinary work undertaken by conservation scientists and supporting environmental groups (Sodhi and Ehrlich, 2010). Our colleague and friend, Navjot S. Sodhi, to whom this special issue of *Biological Conservation* is dedicated, was well aware of the need to tackle the major conservation problems from multiple fronts. He was a dedicated and scientifically focused biologist and a talented field researcher. That is, he was a generator and analyst of primary data – one of the pillars of robust knowledge. Yet he was also unwilling to be a mere passive witness to the biodiversity crisis. His recognition that the bigger picture could not be ignored led Sodhi to work with local collaborators in developing regions (scientific-, agency- and government-based) to influence both public attitudes and government policy on controversial issues like poverty alleviation, governance and regulation, women's rights, and access to critical resources – to the point where he almost lost his job over research on environmental rankings that revealed how badly Singapore fared (Bradshaw et al., 2010). We clearly need people willing to carry on Sodhi's bold legacy in interdisciplinary research and advocacy if conservation management and biodiversity protection in regions like southern Asia are to be effective.

Yet we are also convinced that such good work will ultimately be insufficient. Our current pathway has led to far more failures than successes, with habitats in southern Asia (and other tropical regions) continuing to be cleared and fragmented at a steady or accelerating rate (Brook et al., 2006; Bradshaw et al., 2009), coupled to the tropical consequences of climate change (e.g., heat waves and extreme cumulative degree days, sea level rise, droughts and associated feedbacks such as increased fire frequency; Corlett, this volume) and direct use of forest products (e.g., rare timber, bush meat) (Rands et al., 2010). As we have argued elsewhere (Brook et al., 2008), a combination of historical momentum and continually evolving circumstances are driving us towards a mass extinction. The result of these systematic threats are macro-ecological impacts that reach far beyond the circumstances that typically imperil individual species, and are driven by both top-down and bottom-up imperatives for the countries in southern Asia to seek expanded economic development, urbanization and globalization.

3. Technology as a driver of environmental degradation

A long-standing and well-respected argument in the sustainability literature is that increasing technological sophistication is a driver (or at least a correlate) of environmental damage. This concept is captured mathematically in the Gini coefficient (Barro, 2000) and the IPAT equation (Human Impact [I] on the environment equals the product of P = Population, A = Affluence, T = Technology; Ehrlich and Holdren, 1971). It is a logical outcome that a higher population density of people will require a more intense use of natural resources and a greater sequestering of landscapes for agricultural production, dwellings and other human infrastructure (Edwards and Laurance, this volume). Similarly, affluence in economically developed nations induces an enormous demand for goods and services, such that per capita resource use can greatly exceed essential living requirements (food, shelter). Empirical work has shown a strong correlation between national wealth and relative environmental degradation, with some countries in southern Asia, such as the city state of Singapore, being among the worst offenders (Bradshaw et al., 2010). When population density and resource demands are considered, this makes intuitive sense.

Technological development is clearly coupled to economic success, material wealth and high standards of living (as typically quantified by measures such as essential and luxury foods, life expectancy, leisure time, educational benchmarks and women's fertility; Simon, 1995). Energy supply is similarly positively correlated with both affluence and environmental damage (Ehrlich and Holdren, 1971; Bradshaw et al., 2010). The rapidly growing appetite for energy in the developing world, which includes most countries in southern Asia, is increasing the pressure on countries like Brunei and Malaysia to extract ever more oil, on India, Indonesia and Thailand to open new coal mines and to harvest peat for thermal power stations (Ewart, 2003), a push throughout the region to open vast areas of former lowland tropical rain forest to palm oil and other biofuel production (Koh and Ghazoul, 2008), and proposals to dam large numbers of rivers in the Himalayas (Pandit et al., 2007) and elsewhere (Kang et al., 2009). The thesis seems clear – technology demands energy and resources, the hunger for technology and material prosperity promotes affluence, and together, these factors drive an accelerating damage to natural systems. But can such trends be reversed, and indeed, are such apparently logical inferences necessarily always correct?

4. Social change or techno-fixes? The crucial matter of time and human nature

The challenges to achieving global-scale environmental protection are massive, being social, political, and economic in scope (Ehrlich and Pringle, 2008). One idea, proposed in the early 1970s by economist E.F. Schumacher is to adopt a 'small is beautiful' philosophy and deploy 'appropriate technologies' that are relatively simple and work only at local scales, but might eventually achieve a large 'bottom-up' shift towards sustainability (Schumacher, 1973). Another approach is to advocate for substantive behavioural change in society (Ehrlich and Ornstein, 2010; Koh and Lee, this volume). Some obvious questions are, how does one initiate such change fast enough and at sufficient scale whilst still upholding democratic and liberal freedoms, or are there short-cuts that can be used to drive a more rapid transformation (Etzioni and Remp, 1972)?

The alternative to trying to initiate large-scale social change (often against human nature) is to seek major policy interventions on infrastructure, investment, and promotion of *technological* advances that result in broad-scale benefits to biodiversity. Yet this requires a very different way of thinking about solutions to macro-ecological crises. The concept of the 'techno-fix' is alien or anathema to most environmentalists. After all, the idea – that social problems are more quickly and efficiently solved via application of technology rather than relying on a multitude of people to act rationally (Weinberg and Young, 1967) – involves engagement with the neo-classical economic ideas of Julian Simon (Simon, 1995) and similarly controversial environmental commentators (e.g. Bjorn Lomborg; Lomborg, 2004). Further, techno-fixes are often looked on disparagingly by ecologists as 'band-aid' solutions that fail to address the root cause of problems (Fazey and Fischer, 2009). It really all depends on scale and context.

The small-scale conservation and environmental education work undertaken by field biologists and on-ground conservation managers is excellent and needed (e.g., single-species research and policy-associated recommendations; Sekercioglu, this volume), but it will equally prove grossly insufficient at preventing a mass-extinction event if that is all we try to do. That is why we, as committed and well-established conservation scientists, argue the need for techno-fixes – at least until society has a chance, if ever, to realize a long-term goal of sociological change sufficient to reach an equilibrium of human–ecosystem interactions (Ehrlich and Ornstein, 2010). Some examples include adoption of new energy-dense fission technology based on the full recycling of spent nuclear fuel (Hannum, 1997), and plasma-arch torches to treat municipal garbage, proving a syngas fuel and recovering metals from the waste stream (Mountouris et al., 2006). Obviously we must proceed with caution, but as Weinberg (1980) said: "Technological fixes have unforeseen and deleterious side effects – but so do social fixes, especially revolutions".

5. Sustainable alternatives to large-scale problems

There are real opportunities for techno-fixes in the southern Asia region: the challenge of local problems that, if addressed, will have global ramifications. For instance, can major river systems like the Mekong, Murum and Himalayan mountain valleys avoid major damming projects that would otherwise drastically alter their hydrological regime, fish spawning pathways and floodplain sedimentation and destroy the surrounding unique terrestrial biotas (Dudgeon, 2005)? Can genetically modified crops and new forms of energy-intensive, but tightly controlled food production (e.g., vertical farming and building-integrated agriculture: The Economist, 2010; Despommier, 2011 and 'land sparing': Phalan et al., 2011) be deployed to provide resilience in the face of potential monsoon failures, increased typhoon intensities and inundation of lowland fields due to sea level rise? Are there large-scale alternatives to hydropower and water supply (such as nuclear- and solar-thermal electricity with associated multi-stage flash distillation for desalination; Tian et al., 2003; Shannon et al., 2008)? Beyond the worthy goal of providing reliable electricity to millions of people who currently rely on dirty wood- or dung-fired cooking stoves, such deployments would also obviate the need for large dams. Likewise, are there alternative routes to sustainable prosperity for the indigenous land owners of Indonesia, which leave most of the forests intact, provide viable alternatives to swidden farming, and avoid the need for widespread and destructive biofuel plantations (Koh and Ghazoul, 2008), timber production for exports (Edwards et al., this volume), and flooding associated with forest clearance (Bradshaw et al., 2007)? Once again, energy supply is at the core of these problems – and potentially of their large-scale solutions.

Although the idea of techno-fixes was not necessarily among Sodhi's advocated views, the themes we explore in this essay are very much in keeping with his philosophy – an appreciation of the need to think outside of the box, and be willing to tackle big problems by getting to the root cause of them, rather than tinkering around the edges on just the collection of biological data, addressing interesting but narrow conservation issues. Science must play a crucial role in allowing decision makers to achieve a balance of the various priorities within each society, if sustainability is to be achieved (Koh, 2011). This includes recognition that embracing apparently economically viable and biodiversity-friendly techno-fixes might still face intractable impediments, such as entrenched corruption and vested business interests (Smith et al., 2003); techno-fixes will not necessarily be applied just because they are a good idea! Conservation biologists can only play a small part in overcoming these problems, but they still have a duty to expose unethical and scientifically unsound practices. Examples include analyses to overturn the oil-palm industry's claim that plantations are sufficient for biodiversity maintenance (Koh et al., 2010), and providing data for identifying occurrences of illegal wildlife or timber trade (Laurance, 2008).

We can also contribute directly to evaluating the environmental costs and benefits of different technological options. For instance, three alternative energy proposals might be to build a wind farm, a nuclear reactor, or a coal-fired power station at a site. We can evaluate systematically, using theory and experiments, the evidence for biodiversity detriment (e.g., bird strike from wind turbines or addition of cooling water to aquatic systems) relative to environmental benefits (e.g., elimination of aerosol pollution and carbon emissions from fossil fuel combustion). Collaborating with economists to put market values on ensuing policy recommendations would ultimately strengthen the potential for positive biodiversity outcomes. Of course, such conclusions must be tempered by acknowledgement of the political stability of a region and the need for international safeguards and standards – we have a role in ensuring that these standards incorporate evidence-based conservation and adaptive management principles, are monitored for long-term impacts, and have contingencies for future change.

6. Conclusion

We know what the macro-scale problems in conservation are, and we know that species are going extinct at an alarming rate (Pimm and Raven, 2000; Ehrlich and Pringle, 2008; Bradshaw et al., 2009). Additional biological information, though obviously useful, will only serve to refine our estimates of extinction rate if we fail to act regionally and globally to prevent the worst ravages of ecosystem collapse. What we need now are the pragmatic, real-world fixes – implemented in time, and at sufficient scale, to make a meaningful difference.

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