The thin green line: Scientists must do more to limit the toll of burgeoning infrastructure on nature and society

Given its wide-ranging and transformative impacts, the global explosion of built infrastructure is arguably the most urgent environmental threat today (Laurance *et al.*, 2014; Laurance and Arrea, 2017; Laurance, 2018b). This tsunami of infrastructure has many contributing factors, including human overpopulation and the short-term thinking that arises from consumptive growth-oriented economies. The consequences will be many, from massive loss and degradation of wildlife habitat to increasing pressures on the global climate, and they will reverberate across nearly every sector of society.

China's Belt & Road Initiative, Africa's 'development corridors' and other world-changing ventures are unleashing a tidal wave of new transportation and energy projects, extractive industries and land-use change. More and improved infrastructure is unquestionably a vital component of humanity's pursuit of economic and social development – with estimates for needed investments of US$3–5 trillion per year (Zarfl *et al.*, 2015) – but ongoing ventures vary greatly in their risks and rewards. Here, I argue that many proposed projects have such striking hazards that they should never have left the drawing board.

My approach is pragmatic. Some level of development is inevitable and urgently needed, especially in poorer nations. But there is still a dire need to challenge many proposed infrastructure projects from environmental, economic, social, financial, political and other perspectives. One need not invoke ecological ethics (*e.g.* Curry, 2018) or reverence for the Earth and biodiversity to arrive at such conclusions. Hard numbers and rational cost–benefit arguments reveal that many proposed projects are foolhardy. Our immediate goal should be halting projects that will have the greatest costs for nature and marginal benefits for humanity.

The effort to advance smart, sustainable infrastructure transcends scientific disciplines – linking engineering and environmental sciences to governance and economics. However, for many reasons, scientists have struggled to provide urgently needed guidance and leadership. Some scientists are swayed by promises of sweeping socio-economic benefits for host nations, or assume that environmental impact assessments or promised mitigation measures provide reasonable safeguards against project risks. Others are daunted by complex environmental, economic and socio-political elements of large developments, or are being pressured or drowned out by project proponents. Some find it all too depressing, and essentially give up (Laurance, 2018b).

The perils of poor decisions are underscored by the stunning pace of infrastructure expansion. Globally, paved roads are expected to increase by 25 million km in length by 2050 – enough to encircle the Earth more than 600 times (Laurance *et al.*, 2014; see Figure 1). At least 3700 major hydropower projects are planned or underway (Zarfl *et al.*, 2015). Mining, fossil-fuel and other extractive projects currently threaten nearly 1 million km^2 of intact tropical forest (Grantham and Tibaldeschi, 2018). China's Belt & Road is projected to cost US$8 trillion and will include over 7000 infrastructure and extractive-industry projects that will span much of the world (Ascensão *et al.*, 2018). If completed as planned, Africa's massive development corridors (Laurance *et al.*, 2015) and South America's Initiative for the Integration

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Figure 1. Rainforest in the Congo Basin being destroyed for a Chinese-funded road construction project (photo by William Laurance).

of Regional Infrastructure will criss-cross entire continents while slicing through remaining wilderness and hundreds of protected areas. In addition to their many direct impacts, such schemes also indirectly intensify illegal or unplanned road-building, deforestation, mining, poaching and land speculation (Laurance *et al.*, 2014; Alamgir *et al.*, 2017).

Why are we failing?

After decades of work in this realm, I believe the general failure of scientists to provide coherent views on infrastructure can be linked to several factors. One is ambivalence around the notion that 'development is good'. In fact, much development is 'bad' – in the sense of being wasteful, inefficient, financially risky, inequitable or environmentally destructive (Flyvbjerg, 2009; Laurance, 2018a).

The repercussions of ill-advised developments can be astonishing. In Malaysia, for example, escalating national debt, soaring project costs and corruption have forced the cancellation of over US$40 billion in ongoing Belt & Road projects financed by Chinese loans (Laurance, 2018c). If completed, these projects would have led to staggering environmental degradation. The scale of alleged bribery and misappropriation – including the arrest of Malaysia's former Prime Minister, Najib Razak – beggars belief. Comparable scandals have led to the collapse of dozens of planned mega-dams in Brazilian Amazonia, spurred economic disarray in Pakistan and Sri

Lanka, and provoked open warfare in Papua New Guinea (Laurance, 2018c).

The reluctance of many scientists to engage in development controversies – which can be complex, time-consuming and personally confronting – also promotes poor decisions on infrastructure. It might be tempting for researchers to assume that environmental and social non-governmental organizations (NGOs) provide an adequate safety net for decision-making. In fact, most NGOs are overwhelmed, especially in the technically complex realm of major infrastructure ventures (Laurance, 2018b).

Scientists can also be plagued by anxieties around political appropriateness. For instance, in seven years of co-chairing the Conservation Committee of the Association for Tropical Biology and Conservation, I found a recurring impediment was agonized doubts by certain members as to whether a scientific organization should take public positions on environmental issues, often involving new infrastructure, in developing nations. Some argued that only researchers from the affected countries were in a morally defensible position to voice their reservations. With nine-tenths of all infrastructure slated for developing nations – which harbour most of the world's mega-biodiverse tropical and subtropical ecosystems – such arguments, though clearly well intentioned, seem naive and disempowering.

Scientists must avoid a dangerous perception that environmental impact assessments and recommended mitigation measures provide adequate safeguards. They rarely do (Laurance and Salt, 2018). Most assessments are short-term and myopic in nature and systematically biased toward project approval – partly because the project proponent must pay for the assessment and thereby has manifold means to influence its outcome. For example, the environmental impact assessment for Brazil's 900-km-long BR-319 Highway, which is slicing into the heart of Amazonia, concluded that the project would cause *no net increase* in deforestation. Independent analyses suggest it will provoke a dramatic acceleration of forest loss – by an additional 5-39 million hectares by mid-century (Ritter *et al.*, 2017). Similarly, the provincial government of North Sumatra, Indonesia, formally approved the environmental impact assessment for a hydropower project that would cut across the scarce remaining habitat of the critically endangered Tapanuli orangutan (*Pongo tapanuliensis*), a species which numbers only 800 living individuals (see Figure 2). My colleagues and I found the assessment to be rife with inaccuracies and misrepresentations, which ALERT reported to Indonesian President Joko Widodo (ALERT, 2018), and has been vigorously challenged by an NGO lawsuit.

Finally, some scientists who attempt to engage in development issues are pressured, paid off or attacked by project advocates. Project proponents long ago learned the strategy of hiring leading experts to force their silence or complicity. Principles of financial and professional transparency that help govern the behaviour of researchers must appear quaint to some project proponents. In 2001, a research team I led (Laurance *et al.*, 2001) was so stridently criticized by advocates of the dramatic expansion of Amazonian roads and dams that one of Brazil's leading newspapers ultimately slammed the campaign for 'attacking the messenger'. Some suffer a far worse fate. Globally, around 200 environmental advocates and park guards are murdered each year (Global Witness, 2018).

Strategies and solutions

The global infrastructure tsunami is advancing so rapidly that there is no time for pie-in-the-sky solutions. The most urgent priority is to halt, or at least delay, ill-advised infrastructure projects, ideally before they gain political and financial momentum. This can be a fraught goal as most infrastructure proponents strive to do the opposite, railroading projects through the approvals process before their risks can be fully exposed and publicly

"Scientists can also be plagued by anxieties around political appropriateness."

Figure 2. The Tapanuli orangutan is the world's rarest great ape and is being imperilled by a Chinese-funded hydropower project in Sumatra, Indonesia (photos by Sumatran Orangutan Conservation Programme).

debated. One must realize, however, that large-scale projects have relatively high rates of attrition. Delaying tactics can be effective because corporate and government advocates of projects operate under tight time constraints – such as annual profit statements and limited terms of political office (Laurance, 2018a).

Opposing ill-advised projects is not at all 'anti-development' but rather pro-smart development (Alamgir *et al.*, 2017; Laurance, 2018c). All nations have finite assets available for construction and maintenance of infrastructure. Monies that are borrowed for new projects must be repaid with interest; natural resources that are squandered might not be recuperable; and failed projects typically have heavily intertwined financial, social, political and environmental costs. For instance, a project that increases wildfires and air pollution, or landslides and flood risk, has – alongside environmental liability – major financial, political and reputational burdens.

Actively working to halt risky or ill-planned infrastructure projects differs strikingly from the status quo (Laurance, 2018b). Prevailing strategies for 'greening' planned infrastructure are varied, but they rarely involve halting projects entirely. The emphasis, typically, is on adjusting projects to make them more benign and publicly palatable (Alamgir *et al.*, 2017). Examples of such measures include construction of fish-ladders for hydro-dams and of wildlife underpasses, overpasses and rope-bridges for highways, to help maintain vestiges of animal movement. But such measures are often expensive and of uncertain benefit (Corlatti *et al.*, 2009), especially for species of high conservation concern. They also fail to counter the many indirect impacts of projects – such as illegal deforestation, encroachment and poaching (see Figure 3) – which are frequently their most dangerous consequences (Alamgir *et al.*, 2017; Laurance and Arrea, 2017).

Thus, I argue, the most essential element of greening is screening out bad projects. But how does one decide which projects to eye most critically? In fact, we know enough now to identify broad

categories of projects whose rewards can be swamped by their risks. A good example is infrastructure planned for high-rainfall or steep environments, typical of many areas in the tropics. Here, engineering and long-term maintenance costs can be prohibitively high, as are risks of disasters such as flooding, fires and broad-scale erosion (Alamgir *et al.*, 2017). A second category includes projects in remote locales (Laurance *et al.*, 2014), such as those intended to integrate frontier communities into cash economies or expand large-scale electrification. Such projects generally have modest *per capita* benefits and arrays of important environmental, social and economic hazards. Globally, trillions of dollars are currently being invested in projects in steep, remote or rain-drenched environments (Laurance *et al.*, 2015; Alamgir *et al.*, 2017; Ascensão *et al.*, 2018; Laurance, 2018c).

Proactive approaches for environmental and social planning, such as 'global road mapping' (Laurance *et al.*, 2014), can further identify high-danger zones for new infrastructure. One such area is the Leuser Ecosystem in northern Sumatra, Indonesia, the last place on Earth where Asia's megafauna (rhinos, tigers, orangutans and elephants) still persists. Here, the need for large, unbroken areas of high-quality habitat cannot be overstated. Other examples include geopolitically sensitive areas, such as segments of the India–China, Peru–Brazil and Indonesia–Papua New Guinea borders (Laurance, 2019), where infrastructure is being driven by territorial or nationalistic ambitions rather than plausible cost–benefit arguments. Other factors – such as unstable governments, land-ownership conflicts and fluctuating prices for export commodities at the heart of big projects – can create major risks for infrastructure (Laurance, 2018c). In sub-Saharan Africa, a quantitative comparison of the potential agricultural benefits and environmental costs of 33 massive development corridors suggested that all but six were marginal or inadvisable (Laurance *et al.*, 2015; see Figure 4).

In promoting ecologically non-destructive infrastructure, tactics and messaging are crucial (Laurance, 2018a). The most effective strategies will incorporate many angles, focusing as much on the financial, social, economic and political risks of projects as on their environmental impacts. Above all, scientists must accept and embrace the view that each nation has a fully sovereign right to determine its own development priorities and trajectories.

An upshot of sovereignty, however, is that few decision-makers are adequately trained to see the many shoals of risk on which infrastructure ventures can easily founder (Laurance, 2018c). Compounding

Figure 3. The author examining a forest elephant slaughtered by poachers in the Congo Basin. The elephant's face had been hacked off to extract its valuable ivory tusks (photo by Mahmoud Mahmoud).

"In the many arenas where infrastructure projects are debated, experts ready to grapple with real-world challenges could play a pivotally important role."

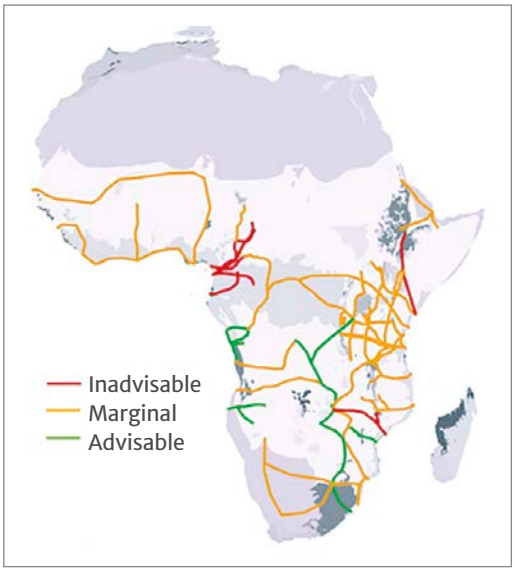

Figure 4. Most of the 33 massive 'development corridors' proposed or underway in sub-Saharan Africa are poorly justified when evaluated using transparent cost–benefit criteria (after Laurance *et al.*, 2015).

this is an absence of self-regulation by project advocates, who often stand to gain financially from major ventures, and behave accordingly. In the People's Republic of China – overwhelmingly the biggest driver of new infrastructure – the public almost never sees reports critical of the Belt & Road because of overt or tacit media censorship (Laurance, 2018c). Beyond this, China has no history of corporate transparency and no political will to halt corrupt overseas business practices. According to Transparency International, "There have been no investigations or charges *ever* laid in China against its companies, citizens, or residents for foreign corrupt practices" (Dell, 2018; emphasis added). Despite its incessant greenwashing to obscure reality, China's prevailing approaches are a formula for promoting bad business practices, social abuses, environmental crimes and predatory development.

Thus, efforts to green and screen the tsunami of China-funded projects appear especially challenging, although some Chinese enterprises, facing growing scrutiny, are showing interest in social and environmental safeguards (Ascensão *et al.*, 2018). For the Belt & Road, the most urgent opportunities are to influence its many financiers outside China, as well as the roughly 130 host nations worldwide where new projects will be located.

Given their magnitude and myriad risks, it is in the best interests of nations, financiers and the public to view investments for infrastructure both conservatively and critically. In my view, an ideal conceptual model for evaluating infrastructure proposals is a Darwinian struggle, with projects that survive transparent cost–benefit assessments prevailing, whereas those with weaker prospects are delayed, diminished or driven extinct. Beyond all else, smart, sustainable infrastructure will require convincing and credible arguments – from scientists, economists and technical experts. In the many arenas where infrastructure projects are debated, experts ready to grapple with real-world challenges could play a pivotally important role.

How you can help

Please follow ALERT's efforts to promote smart infrastructure and development (www.facebook.com/ALERTconserv) and receive free updates to become involved (www.alert-conservation.org). We need your help. Bad projects thrive in the shadows, and it makes an enormous difference if we can shine a bright light on ill-advised development. ■

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