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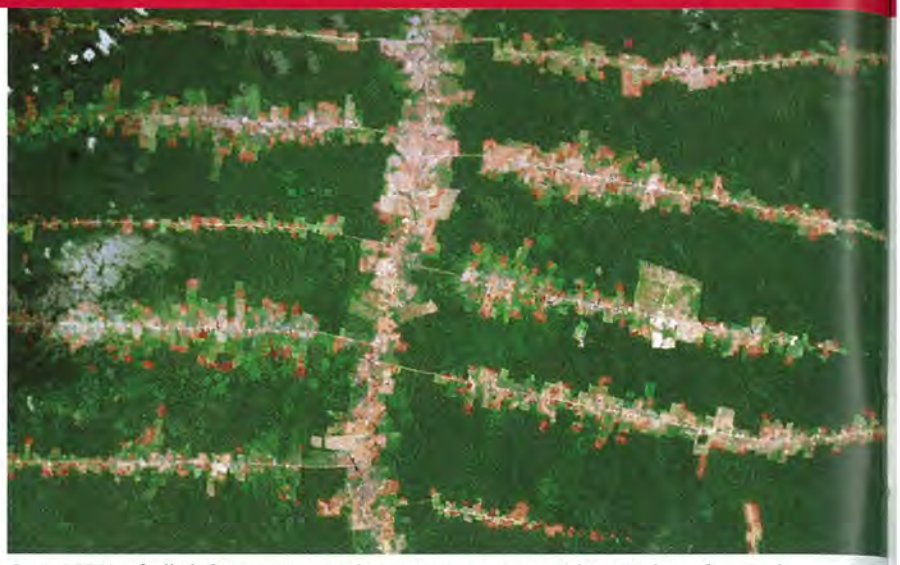
Roads to Ruin

Can we build roads that benefit people while not destroying nature?



Some 95% of all deforestation in the Amazon occurs within 5.5 km of a road, while for every kilometre of legal road there are nearly 3 km of illegal roads.
Credit: Google Earth

We are living in the most aggressive era of road-building in human history. The International Energy Agency projects that by 2050 we will have another 25 million kilometres of paved roads on Earth – enough to encircle the globe more than 600 times. Nine-tenths of these roads will be built in developing nations, mostly in the tropics and subtropics, which sustain the planet's most biologically rich and environmentally important ecosystems.

This modern road-building spree is terrifying ecologists like us, because we know that new roads often open a Pandora's box of environmental ills – exposing vulnerable ecosystems to an influx of human colonists, hunters, miners and land speculators. In the Amazon, for instance, our research shows that 95% of all deforestation occurs within 5.5 km of a legal or illegal road. In Africa, roads bulldozed by loggers are crisscrossing the Congo Basin, allowing waves of poachers armed with modern rifles and snares to penetrate deep into forests. In just the last decade, two-thirds of Africa's forest elephants have been slaughtered for their valuable ivory tusks.

Almost everywhere we look we see roads causing one environmental crisis after another. The same things are happening on Australia's northern doorstep in Indonesia, Malaysia and Papua New Guinea. All three of these nations have ambitious plans to open up their last frontier areas to exploit timber, construct new mines and hydropower dams, and expand farming. Can they achieve this while not destroying their remarkable biodiversity or sacrificing their forests and the critical services they play in regulating our climate, limiting destructive floods and sustaining indigenous peoples?

That is the great challenge our research team at James Cook University is attempting to confront. We are working with dozens of decision-makers, scientists and conservationists in the Asia–Pacific to devise strategies to promote human welfare while simultaneously saving some of the most critical vestiges of nature.

Roads don't just bring poachers: shown here is a road-killed Malayan tapir in Peninsular Malaysia. © WWF-Malaysia/Lau Ching Fong

The Benefits of Roads

Despite their potentially severe environmental impacts, economists will tell you that we need roads. These are an indispensable part of our modern societies, providing a cost-effective way to promote economic growth, encourage regional trade and provide access to natural resources and land suitable for agriculture. They also have more dubious political uses, such as shoring-up the claims of nations to disputed geopolitical boundaries.

One of the most pressing reasons to build new roads is to increase agricultural production and food security. The tropics currently have 40% of the world's population and 55% of its young children (under the age of five). By 2050 it's expected that more than half the world's population and two-thirds of its young children will reside there. Nearly all tropical nations will see major increases in population size, with global food demand expected to double as a result.

Given these realities, our goal is to encourage road building in places that will maximise food production. Agriculture in many developing nations performs far more poorly than it could because farmers lack access to affordable fertilisers, modern crop varieties and farming methods, as well as urban markets where their crops will bring the highest prices. With

better roads in lands that have already been largely settled by farmers, there is enormous potential to improve farming – doubling or even tripling the amount of food produced on each hectare of arable land.

Improving roads in already-settled areas can bring further benefits. It will encourage more rural investment and give local residents better access to health care and schools. As farming in such areas becomes more profitable, they can also begin to act as "magnets" that attract colonists away from forested frontiers. In this way, better roads can amp up farming in settled areas while helping to spare shrinking wilderness areas for nature conservation.

Avoiding the First Cut

While part of our research focuses on where to locate and improve roads to benefit people, we are also concerned with benefiting nature. One lesson we have learned is that deforestation behaves very much like a cancer. Across the world, forest clearing is highly "contagious" spatially, as new clearings tend to spread out from existing clearings.

So when someone cuts the first road into a pristine forest, deforestation begins to grow along the road, much like how cancerous tumours will grow. The road then spawns secondary and tertiary roads, and the cancer seeds and spreads. The key lesson is that there is no such thing as having a little bit of cancer. If you have a bit of cancer you'll soon have a lot more cancer. The best solution is to avoid getting cancer in the first place.

For forest conservation, then, the message is to avoid the first cut. Don't put roads into places you want to conserve, at least not unless you're willing to bear the long-term costs of monitoring those roads and stopping forest colonisation and deforestation. A second key lesson is to, wherever possible, close existing roads in high-risk places such as prime wilderness, much as you would surgically cut out a cancer before it grows and spreads.

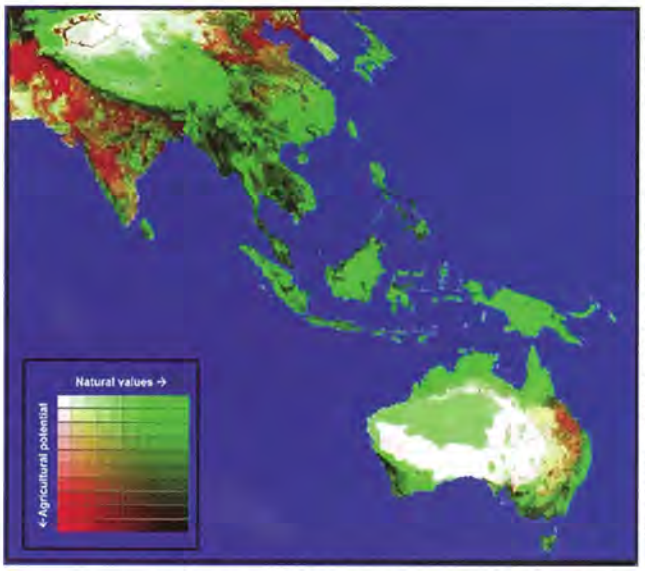
Turning Theory into Action

These ideas sound simple in theory, but in practice it gets more complicated. We use field observations, satellite data, mapped datasets and sophisticated computer models to generate our road-prioritisation schemes. Our very first model, published in *Nature*, was highly ambitious: we devised a road-mapping scheme for the Earth's entire land surface.

However, global-scale datasets are too coarse for road planning at national and regional scales, so now we are focusing on a series of environmentally critical regions. We're beginning with northern Sumatra in Indonesia: the very last place on Earth where orang-utans, tigers, elephants and rhinos still survive together. After that we will be moving to Indonesian

Credit: William Laurance

For farmers in already-settled lands, such as this woman growing cassava in the Solomon Islands, new or improved roads can increase farm production and improve rural livelihoods.



From Laurance et al. 2014. A global strategy for road building. *Nature* 513:229–232).

Our first attempt at a strategy for prioritising road building in the Asia–Pacific region. Green areas in this image have high environmental values and relatively low agricultural potential; red areas have high agricultural potential and lower environmental values; and black areas are "conflict" zones where environmental and agricultural values are both high.

Papua, and after that probably to Borneo. There is no shortage of urgent places to work; in fact, we could increase the size of our team by tenfold and we'd still be flat-out trying to develop road-mapping schemes for ecosystems under urgent threat.

The bottom line is that we desperately need to plan infrastructure, especially proliferating roads, much better than we're doing at present. If we don't, we are going to see many of the Earth's last wild places vanishing before our eyes.

A famous Brazilian scientist once said: "The best thing you could do for the Amazon is to blow up all the roads". He was probably right, but in the real world that just isn't an option. We have to learn to live with roads, and do everything we can to ensure that nature can live with them as well.

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