Photo: By 2050, an additional *25 million kilometers* of paved roads are expected to crisscross the earth—enough to encircle the planet more than 600 times. © Waldo Swiegers/Bloomberg via Getty Images

CHAPTER 1

Towards More Sustainable Infrastructure: Challenges and Opportunities in Ape Range States of Africa and Asia

Introduction

We are living in one of the most dramatic eras of infrastructure expansion in human history. By 2050, an additional *25 million kilometers* of paved roads are expected to crisscross the earth—enough to encircle the planet more than 600 times. In addition to the growth in road networks, work on other infrastructure projects—such as railroads, hydroelectric dams, power lines, gas lines and industrial mines—is expected to increase sharply over the next few decades (Laurance and Balmford, 2013; Laurance and Peres, 2006).

Roads and other infrastructure have strong and intimate links with economic growth, frontier expansion, globalization, land colonization, agriculture and economic

and social integration (Hettige, 2006; Weinhold and Reis, 2008; Weng *et al.*, 2013). Unfortunately, such projects can also have severe impacts on many ecosystems and species (Adeney, Christensen and Pimm, 2009; Blake *et al.*, 2007; Fearnside and Graça, 2006; Forman and Alexander, 1998; Laurance, Goosem and Laurance, 2009; Laurance *et al.*, 2001; see Chapter 2). Roads that penetrate into wilderness areas, for example, often have profound and proliferating environmental effects—such as promoting habitat loss and fragmentation, poaching, illegal mining and wildfires (Adeney *et al.*, 2009; Laurance *et al.*, 2001, 2009; see Chapter 3). Even relatively narrow (10–100-m wide) clearings associated with forest roads can hinder or completely halt the movements of some ecologically specialized fauna, such as forest-interior or strictly arboreal species that require a continuous canopy (Laurance, Stouffer and Laurance, 2004; Laurance *et al.*, 2009).

The remarkable pace of infrastructure expansion in developing nations—and its very real potential to provoke profound environmental harm—underscores an urgent need for better planning and management of new infrastructure projects to allow for the mitigatation of their adverse effects (Laurance and Balmford, 2013). This chapter identifies key issues revolving around the proliferation of large-scale infrastructure, focusing in particular on their potential effects on critical ape habitats in equatorial Africa and Asia.

Key Findings

- The contemporary pace of infrastructure expansion is unprecedented. A majority of the projects are planned or underway in biodiversity-rich developing nations, including all ape range states in the African and Asian tropics.
- Roads and other infrastructure often open up remote areas to a range of human pressures, such as deforestation, poaching, illegal mining and land speculation.
- Rising demands for natural resources and energy, as well as the rapid growth of multinational transportation networks, are providing a key impetus for building new infrastructure.
- The explosive pace of infrastructure development is partly the result of ambitious schemes to promote economic growth via increased access to land and natural resources, and partly an indirect symptom of more fundamental drivers, such as rising population growth, increased per capita consumption, economic disparity and the heavy national-level focus on extractive industries.
- Via its ambitious international policies, China is having a dramatic impact on infrastructure expansion in developing nations. This expansion is designed to gain access to natural resources.
- Environmental assessment and mitigation efforts for many infrastructure projects are inadequate, often seriously so.
- Alarmingly, major multilateral lenders are loosening some environmental and social safeguards. In target nations, large influxes of foreign capital for infrastructure projects and extractive industries often provoke a variety of negative economic and social consequences, unless managed carefully.
- Innovative solutions, such as an increased emphasis on "green" energy sources and natural capital, could lessen the negative impacts of some infrastructure.
- In view of the rapid pace of infrastructure expansion, two urgent priorities emerge: the need for (1) strategic regional planning, and (2) efforts to prevent infrastructure from expanding into remaining wilderness and protected areas.

Infrastructure: A Game Changer

Global Infrastructure

The contemporary scale of global infrastructure expansion is unprecedented. From 2010 to 2050, the total length of paved roads worldwide is expected to increase by more than 60% (Dulac, 2013). In Asia, scores of hydroelectric dams and associated energy and transportation projects are planned for the Mekong River and its tributaries (Grumbine, Dore and Xu, 2012). Meanwhile, several mega-dams are planned for Africa's Congo Basin (Laurance *et al.*, 2015a). In fact, Africa is currently experiencing unprecedented foreign investment for mineral exploitation, with China alone investing more than US$100 billion annually (Edwards *et al.*, 2014). Such investments are a key economic impetus for 35 planned or ongoing "development corridors" that would exceed 53,000 km in length and crisscross sub-Saharan Africa, opening up vast areas for economic exploitation (Laurance *et al.*, 2015b; Weng *et al.*, 2013; see Figure 1.1).

Environmental Impacts

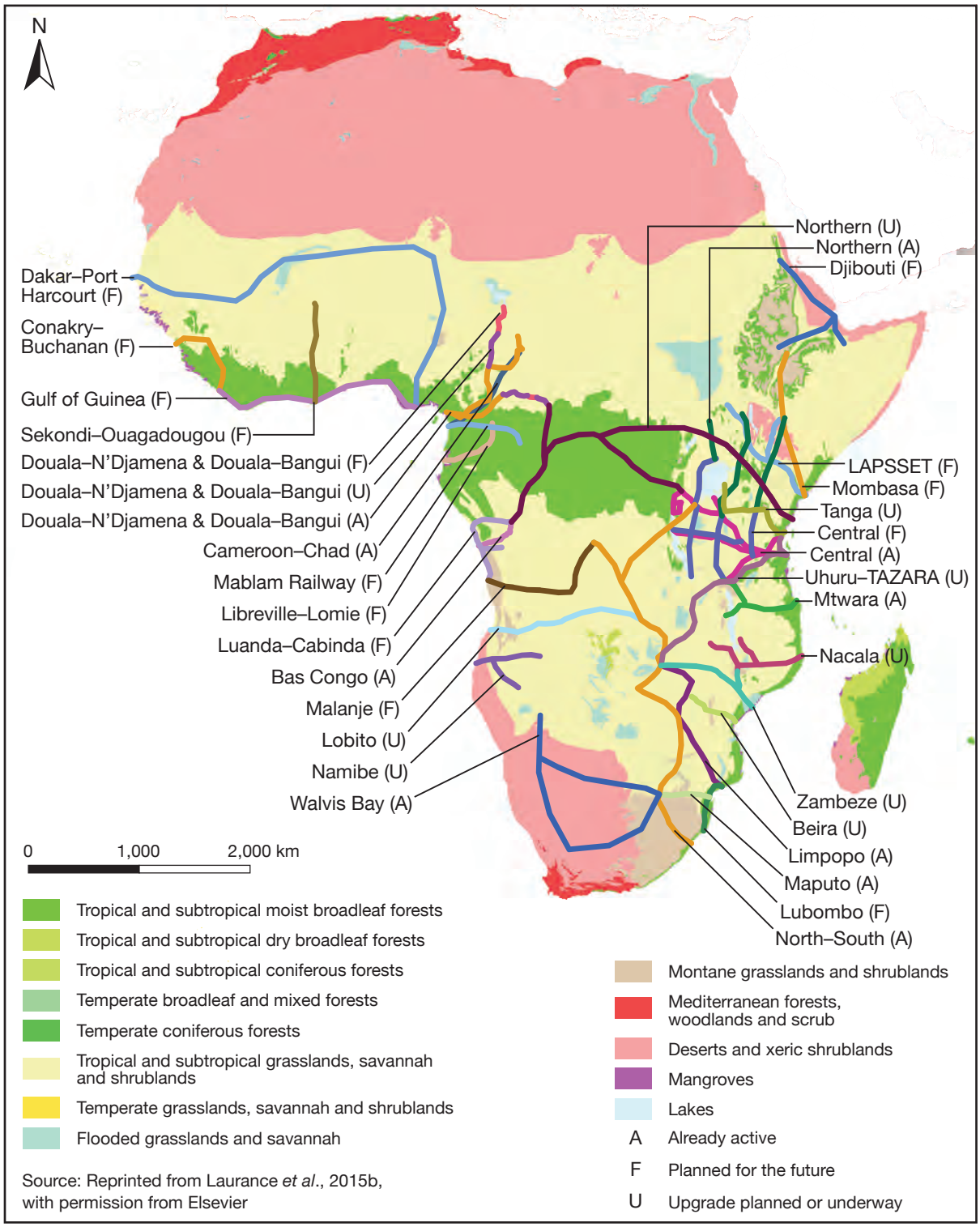
The rapid proliferation of infrastructure is having substantial and often irreversible impacts on many ecosystems and species (Adeney *et al.*, 2009; Blake *et al.*, 2007; Clements *et al.*, 2014; Fearnside and Graça, 2006; Laurance *et al.*, 2001, 2009). In the Brazilian Amazon, the construction of new roads, hydroelectric dams, power lines and gas lines is projected to cause major increases in the rates of forest loss, fragmentation and degradation (Laurance *et al.*, 2001). In the Congo Basin, more than 50,000 km of logging and other roads have been built since 2000, greatly increasing access to forests for poachers and hunters armed with modern rifles and cable snares (Kleinschroth *et al.*, 2015; Laporte *et al.*, 2007).

The threats to wildlife from humans entering into their habitats are indisputable. From 2002 to 2011 alone, nearly two-thirds of Africa's forest elephants were slaughtered (Maisels *et al.*, 2013). Ape populations are particularly vulnerable to hunting because they are highly desirable as wild meat in some areas, are diurnal and conspicuous, have delayed maturation and slow rates of reproduction, and have restricted geographic distributions (Chapman, Lawes and Eeley, 2006; Cowlishaw and Dunbar, 2000; Robinson, Redford and Bennett, 1999; Struhsaker, 1999; see Chapter 2).

Photo: A researcher examines the skull of a western lowland gorilla found in Nouabalé-Ndoki National Park, Republic of Congo, November 2016. The cause of the ape's death is unknown, although poachers are increasingly detected inside the park near upgraded roads that skirt its boundaries. © William Laurance

FIGURE 1.1

Status of Major Development Corridors in Sub-Saharan Africa, 2015



Source: Reprinted from Laurance *et al*., 2015b, with permission from Elsevier

Infrastructure projects related to natural resource exploitation, such as mining, fossil fuel and hydroelectric projects, have direct environmental impacts and also provide a key economic impetus for road building (Edwards *et al.*, 2014; Laurance *et al.*, 2009; WWF, 2006; see Box 1.1). Consequently, such projects and roads cannot be planned or studied independently of one another. In the Amazon–Andes region, for instance, proposals currently envision more than 330 hydroelectric dams (with a total capacity of more than 1 megawatt); these projects would require extensive road networks for both the dams and associated power line construction (Fearnside, 2016b; Laurance *et al.*, 2015a). In the southeastern Amazon, new dams planned for the Tapajós River alone are projected to increase deforestation by nearly 10,000 km² (1 million hectares (ha)), predominantly by increasing access to remote forests for colonists and land speculators (Barreto *et al.*, 2014). Scores of new dams planned for Southeast Asia might have comparably serious impacts on great ape and gibbon habitats (Grumbine *et al.*, 2012).

Inferring Long-Term Impacts of Infrastructure

In the wet and humid tropical forests that serve as ape habitat, rivers are a conspicuous feature. Used as natural "highways" for

BOX 1.1

Infrastructure for Extractive Industries

Escalating Demand

Starting in 2003, sharply rising prices for oil, gas and minerals—spurred in particular by growing demand from China and other developing Asian nations—made it economically feasible to exploit ever more remote regions of the world. Such conditions can create a powerful economic impetus for building new roads, railroads and waterways, especially to ferry low-value, high-volume commodities such as iron ore, copper and coal over long distances to ports, refineries and smelters. Conflicts with nature conservation can easily arise because many natural resources are located in remote regions with high conservation value—including, in some cases, critical habitats for apes (Nellemann and Newton, 2002).

Since 2014, declines in commodity prices have slowed the expansion of new mining ventures, but this is probably just a temporary respite.[1] As demand and prices are likely to rise again in the future, the current economic slowdown may be seen as a "window of opportunity" in which to implement direly needed environmental and social safeguards wherever possible (Hobbs and Kumah, 2015).

Development Corridors

The construction of large-scale infrastructure, such as roads, railroads, power lines and gas lines, is increasingly being planned and concentrated along so-called "development corridors" (Hobbs and Butkovic, 2016). Political support for such corridors revolves around their potential to catalyze economic growth and trade, unlock private sector and development finance, encourage regional integration, improve logistical efficiency and increase frontier security (AgDevCo, 2013; Weng *et al.*, 2013). Development corridors can also be the legacy of investment in extractives long after closure of the initial resource extraction project.

In Africa, the 35 planned and initiatied development corridors are sure to be transformational (Laurance *et al.*, 2015b; WWF, 2015b). In East Africa, for example, the Lamu Port, South Sudan, Ethiopia Transport (LAPSSET) corridor is to comprise port facilities, airports, cities, tourist resorts, highways, railways, pipelines and fossil fuel, hydropower and water-reticulation schemes. In 2013, projected costs for this venture were estimated at more than US$29 billion (Warigi, 2015).

In Asia, the massive "Belt and Road" initiative, launched in 2013, is a prominent feature of China's current Five-Year Plan (2016–20). This scheme aims to reinvent ancient silk trade routes between China and Europe and to expand Beijing's political, economic and cultural influence. It also extends to Africa, via a "21st-Century Maritime Silk Road." Fueled by massive investments from both China (US$40 billion) and the Asian Infrastructure Investment Bank (AIIB), this landmark venture will involve more than 70 nations. To date, the AIIB has been authorized to disburse US$100 billion to promote new global infrastructure (Honjiang, 2016).

Similarly, the Initiative for the Integration of Regional Infrastructure of South America is etching new highways and other transportation and energy infrastructure across South America (Killeen, 2007; Laurance *et al.*, 2001). Many of the initiatives' projects are penetrating into remote regions of the Amazon, Andes and beyond, where they are likely to provoke sharp increases in rates of forest loss, fragmentation, hunting and illegal gold mining. In the Brazilian Amazon, for instance, 95% of all deforestation occurs within 5.5 km of a legal or illegal road (Barber *et al.*, 2014).

Photo: Illegal dwellings along a river in the interior of the Leuser Ecosystem in northern Sumatra, Indonesia—critical habitat for the Sumatran orangutan (*Pongo abelii*) and two gibbon species, 2016. © Suprayudi

millennia, rivers facilitate human movement, settlement, trade and hunting. They also form long-term biogeographic barriers for apes and other species, promoting genetic isolation and the evolution of distinctive new species or subspecies (Gascon *et al.*, 2000; Harcourt and Wood, 2012).

Rivers can thus be considered ecological analogs to roads—but ones that have existed for many millennia. Rivers might provide long-term insight into road impacts, just as land-bridge islands have been used to provide long-term perspectives on rates of population extinction in fragmented habitats, since

they were once linked to mainland areas—during past ice ages, when sea levels were lower—but have been isolated for millennia since (MacArthur and Wilson, 1967; Wilcox, 1978). Although rivers differ from roads in several respects, they might yield insight that is otherwise very difficult to infer (see Box 1.2).

BOX 1.2

Can Rivers Teach Us About Infrastructure?

As human activities penetrate ever deeper into ape habitats, maintaining ecological connectivity within intact forest blocks—particularly across linear infrastructures such as roads, railways, pipelines and power lines—is vital to prevent the fragmentation of larger wildlife populations into many smaller, isolated ones. Rivers have been used as human transportation corridors for millennia and can also halt or hinder animal movements; in that sense, they may share certain characteristics with roads.

Given the explosive rate of infrastructure expansion, linear infrastructure will increasingly allow for human access to remote areas, facilitating hunting and wildlife trafficking, and hindering animal movements (Blake *et al.*, 2008; Laurance *et al.*, 2004, 2008, 2009; Van Der Hoeven, De Boer and Prins, 2010; Vanthomme *et al.*, 2013, 2015). Navigable rivers play comparable roles as natural arteries for human movements. In the rainforests of Central Africa, for example, many human settlements are located along navigable rivers or their estuaries, including major cities such as Bangui, Brazzaville, Douala, Libreville, Kinshasa and Kisangani. In addition to being corridors, however, rivers can also hinder human movement, as crossing them requires bridges, rafts or boats.

In biogeographic terms, larger rivers have more profound impacts on the distribution of wildlife than do smaller rivers. This "river-width effect" was first noted in the 19th century in Amazonian monkeys and has since been studied in detail (Ayres and Clutton-Brock, 1992; Wallace, 1849). Ape distributions have been strongly influenced by river barriers. While the Oubangui River marks the eastern limit of the western gorilla (*Gorilla gorilla*), other rivers divide up genetically distinct subpopulations of this species (Anthony *et al.*, 2007; Fünfstück *et al.*, 2014; Mitchell *et al.*, 2015; Williamson and Butynski, 2013b). Similarly, the Congo River has separated bonobos (*Pan paniscus*) from other African ape populations for around two million years (Prüfer *et al.*, 2012; Reinartz, Ingmanson and Vervaecke, 2013).

In terms of their effects on wildlife, rivers and roads appear functionally similar in many respects. Wildlife responses to rivers are species-specific; while gorillas are unwilling to cross deep rivers, elephants will readily swim across them. Regardless of such distinctions, however, bonobos, chimpanzees, elephants and a number of other wildlife species all show consistent trends in terms of declines in population density near roads and rivers used by poachers (Blake *et al.*, 2007; Hickey *et al.*, 2013; Laurance *et al.*, 2008; Maisels *et al.*, 2013; Stokes *et al.*, 2010; WCS, 2015c). In a positive sense, the barrier effects of roads and rivers can slow the spread of infectious diseases such as Ebola in apes (Cameron *et al.*, 2016; Walsh, Biek and Real, 2005). Such barriers may be linked to the inability of apes or a disease-reservoir species to traverse rivers or roads efficiently (Cameron *et al.*, 2016).

Rivers can offer important analogs for roads, particularly as avenues that are readily used by poachers. For non-swimming species, rivers are likely to be stronger barriers than roads of comparable width, whereas the two may be roughly similar for swimming species. Wildlife managers could potentially learn much from studying river systems and how they have affected the distributions of apes and other fauna over large time periods.

Photo: Increasingly, China is linking infrastructure investments with policies that promote overseas trade, economic and political influence, and the acquisition of large stocks of minerals, fossil fuels, timber and other natural resources. Kaleta, Guinea © Waldo Swiegers/Bloomberg via Getty Images

Drivers of Infrastructure Expansion

Rapid Economic Growth in Asia

Contemporary investment in infrastructure is unprecedented in terms of its scale and pace. Since just after 2000, rapid economic growth in Asia—and especially in China (see Box 1.3)—has been a major driver of new infrastructure projects both within and outside the continent. In recent decades, China's gross domestic product has grown at an average rate of 10% annually, from just over US$200 billion in 1980 to US$8.6 trillion in 2013 (*The Guardian*, n.d.).

China is now the world's second-largest economy, having contributed one-quarter of all global economic growth over the period 2011–15 (NBS of China, n.d.). Increasingly, China is linking infrastructure investments from its corporations and multilateral lenders with policies that promote overseas trade, economic and political influence, and the acquisition of large stocks of minerals, fossil fuels, timber and other natural resources.

Multilateral Financial Institutions

China is far from the only driver of infrastructure expansion around the globe. During their 2014 global summit, the heads of state of the G20 nations—comprising the world's largest economies—committed to invest US$60–US$70 trillion in new infrastructure

BOX 1.3

China's Growth and Global Infrastructure

Economic Expansion

China's remarkable economic growth, together with its ambitious development and international outreach policies, has had major impacts on global infrastructure expansion. The nation's growth rate began to accelerate in 1978 with the government's landmark "reform and opening up" policy, which planted the seeds of private enterprise. Growth was further promoted in the 1980s and 1990s by rapid internal infrastructure expansion, and in the following decade by international expansion under the country's "going global" policy. The latter was prompted in part by China's huge trade surpluses and accumulation of foreign reserves, which it decided to use to invest abroad and to obtain overseas assets (GEI, 2013).

China's push to expand and improve its internal infrastructure began when the government, realizing that weak infrastructure was hindering its socioeconomic development, began investing heavily in its energy, telecommunications and transportation sectors. The slogan "building roads is the first step to becoming rich" became popular across China's villages and cities. The length of the country's roads nearly doubled from 1987 (0.89 million km) to 2000 (1.68 million km), giving China the second-highest national road mileage in the world (Liu, 2003; NBS of China, n.d.). Chinese hydropower, bridge, rail and telecommunications industries underwent similarly rapid expansion and upgrades (Liu, 2003).

China's "going global" strategy subsequently liberalized investment policies and provided financial incentives to encourage Chinese overseas investments and contracts. As a result, China's direct international investment multiplied rapidly, from US$2.7 billion in 2002 to US$118 billion in 2015 (MoC, 2016b). During this period, the country became the second-largest foreign investor worldwide, after the United States (MoC, 2014, 2016a).

The national government of Xi Jinpeng is continuing to promote the Chinese model of infrastructure development as the first step to development internationally. Starting in 2013, Xi announced three major initiatives: (1) domestic supply-side reform, (2) an acceleration of strategic adjustment of China's economic structure, and (3) the "Belt and Road" initiative, named after the Chinese term for "one belt, one road." The government also established two major financial institutions to support these initiatives, the Silk Road Fund and the Asian Infrastructure Investment Bank (Knowledge@Wharton, 2017).

On the strength of such ambitious efforts, the Chinese role in developing international infrastructure has expanded rapidly. In 2014, for example, Chinese "build–operate–transfer projects"—in which the private sector *builds* an infrastructure project, *operates* it and eventually *transfers its* ownership to the host government—generated 70% of Cambodia's hydropower electricity (GEI, 2016). In 2015, Chinese companies signed US$210 billion in new foreign-project contracts; transportation, electrical engineering and telecommunications are the top three sectors, accounting for 60% of the contracted value for the year (MoC, 2016c).

Addressing Social and Environmental Concerns

Many Chinese firms invest in Southeast Asia and Africa, regions rich in biodiversity but weak in environmental governance.

These investments have generated widespread environmental and social concerns (Edwards *et al.*, 2014; Grumbine *et al.*, 2012; Laurance *et al.*, 2015b). A case in point is the Myitsone Dam, a US$3.6 billion project in Myanmar that was halted because local communities believed the project would destroy natural landscapes and their livelihoods (Chan, 2016). In response to this fiasco, the Chinese government developed guidelines on environmental and social responsibility, including:

- *A Guide for Chinese Enterprises on Sustainable Silviculture Overseas* (2007). This manual was developed by the Chinese Ministry of Commerce and the State Forestry Administration (MoC, 2007).
- *Green Credit Guidelines* (2012). Published by the China Banking Regulatory Commission, this document stipulates that operational practices of financial institutions must be consistent with international good practice standards, including environmental protection, land, and health and safety laws and regulations. Financial institutions are also required to establish green credit strategies and policies, abide by local laws requiring disclosure of significant environmental and social impact risks, and accept market and stakeholder supervision (GEI, 2015).
- *Guidelines for Environmental Protection in Foreign Investment and Cooperation* (2013). Published by the Ministries of Commerce and of Environmental Protection, these guidelines require companies that invest overseas to comply with the relevant local laws and regulations. The guidance relates specifically to environmental impact assessments, pollutant discharge standards, emergency management and other accepted environmental obligations. Companies are also encouraged to implement practices such as "clean production, circular economy and green procurement" (GEI, 2015, p. 18).
- *Measures for Overseas Investment Management* (2014). Published by the Ministry of Commerce, this guidance stipulates that foreign-funded enterprises must abide by local laws, respect local customs, and perform social responsibility and effect measures for environmental and labor protection and corporate-culture development (GEI, 2015).

Challenges and Limitations

While these guidelines demonstrate the Chinese government's commitment to promoting sustainable foreign investment, the policies remain weak at the implementation level, with poor policy promotion and a lack of compliance by Chinese industries (GEI, 2015). Environmental organizations and researchers have begun to address these problems by conducting policy field studies and training Chinese companies and local communities to strengthen their capacity for effective policy action.

Another challenge is the inoperability of some of China's current policies. Policy effectiveness depends on the framework and implementation of environmental safeguarding policies in host countries, as well as information disclosure, transparency and public participation. To achieve these goals, Chinese and host-country governments, civil society organizations, Chinese financiers and local communities must work together more effectively (GEI, 2015).

Photo: The presence of apes, such as Sumatran orangutans, should trigger extra environmental safeguards for multinational lenders. © Perry van Duijnhoven, 2013

by the year 2030 (Alexander, 2014). This would not only be the single largest financial transaction in human history, but would more than double the current value of global infrastructure (Laurance *et al.*, 2015a).

Large infrastructure investments are often disbursed via multilateral lenders. These lenders are playing a major role in infrastructure projects in ape range states in Africa and the Asia–Pacific region (ICA, 2014; Ray, 2015).

Meanwhile, the landscape of infrastructure investment is changing. Large infrastructure investments were traditionally disbursed via multilateral lenders such as the African, Asian and Inter-American Development Banks, the European Investment Bank and the World Bank Group. While these lenders continue to play a major role in infrastructure projects, including in ape range states in Africa and the Asia–Pacific region, their strongholds are being challenged (ICA, 2014; Ray, 2015). The Asian Infrastructure Investment Bank (AIIB), which opened for business in 2016, the Chinese Import–Export Bank and the expanding Brazilian Development Bank are all poised to become major international lenders.

As a consequence, the nature of infrastructure funding is undergoing worrying changes. After drawing criticism for years, the big traditional lenders had elaborated and implemented a number of environmental and social safeguards. Since the emerging banks generally consider environmental and social constraints a lower priority, however, they represent a formidable challenge to the traditional lenders (Laurance *et al.*, 2015a; Wade, 2011; Withanage *et al.*, 2006). In 2015 the World Bank decided to "streamline" its environmental and social safeguards in order to remain competitive with the emerging lenders, especially the AIIB (see Box 1.4).

BOX 1.4

Multilateral Lenders and Ape Conservation

Safeguards

To improve the sustainability outcomes of their investments, multilateral lenders such as the World Bank and regional development banks have developed environmental and social safeguards that identify standards and procedures for project screening. These frameworks determine the level of assessment and mitigation or management the lenders and their clients should apply.[2] High-risk projects or initiatives are subject to environmental and social impact assessments or strategic environmental assessments.

Critical Habitats

Environmental and social safeguards specify habitat value classifications that are determined through assessments of the critical nature of biodiversity and ecosystems. "Critical habitat"[3] is the most sensitive criterion and demands the most stringent avoidance or mitigation measures (EIB, 2013; IFC, 2012a, 2012c). Habitat that is important for apes would typically be classed as critical habitat because of the imperiled status of ape species and their keystone role in supporting ecosystem functioning. Ecological processes that support ape populations are also considered critical habitat by many multilateral lenders "where feasible."

In some project applications, the presence of apes represents a fatal flaw—one that can cause a bank to decline investment or withdraw. Alternatively, the bank could require demonstration that the project will produce no adverse effects (AfDB, 2013); no reduction in the ape population (ADB, 2012); a positive conservation outcome (EIB, 2013); or a net-gain outcome (IFC, 2012a, 2012c; World Bank, 2017). Such outcomes demand a comprehensive assessment of the direct, indirect and cumulative impacts of the project and rigorous application of impact reduction measures (see the discussion of the mitigation hierarchy in Chapter 4, p. 119). For ape landscapes, such assessments call for an appreciation of the complex

socio-ecology of affected apes, their role in maintaining ecosystem integrity and the potential of habitats to support viable populations in the future; in practice, however, these factors are often addressed poorly (see Box 1.6 and the Apes Overview, p. xii).

The timing and duration of a lender's engagement, as well as its commitment and capacity to uphold environmental and social safeguards, can strongly affect its influence on a project. In some cases, lenders take more of a lead by requiring cumulative and strategic environmental assessments to reduce landscape-scale impacts and better inform project design or location (ADB, 2008).

Limitations and Risks

Multilateral lenders acknowledge major deficiencies in data and capacity. While a precautionary approach supported by long-term monitoring is considered ideal, it is not always applied. Time pressures coupled with sparse data can result in inadequate baselines, which, in turn, constrain management responses (see Box 1.6). Stakeholder engagement and expert input are highly valued by many lenders, but may be inadequate. The conservation community and species specialists have a vital role to play in ensuring that assessments of critical habitats and environmental impacts are based on sound ecological principles and the best available information. It is vital that civil society helps lenders to uphold their environmental and social impact requirements and holds them to account should they fail to do so.

The rapid rise of the Asian Infrastructure Investment Bank (AIIB) as a more streamlined and borrower-friendly lender, and the release of its environmental and social framework—soon followed by the announcement of simplified safeguards from the World Bank—have generated concerns about a potential "race to the bottom" in environmental and social protections (AIIB, 2016; CEE Bankwatch Network, 2015; Humphrey *et al.*, 2015; World Bank, 2016c, 2017). Some consider the World Bank's anticipated transition from a rules-based compliance system towards one of "unprecedented flexibility that favors using a borrower's own laws and policies" in lieu of the Bank's traditional safeguards as especially worrying (BIC, 2016). However, others believe that the World Bank's new Environmental and Social Standard (ESS) 6[4], and the International Finance Corporation's (IFC) Performance Standard (PS) 6, continue to represent best practice in the protection of biodiversity and habitats (TBC, n.d.).

There is deep concern about the impacts of the weakening of some lenders' environmental safeguards. In ape range states, this relaxed approach is of particular concern when combined with borrowers' limited commitment and capacity, as well as weak national regulatory frameworks, and enforcement, which tend to be unable to prevent or mitigate the complex social and environmental impacts of high-risk infrastructure projects (BIC, 2016). Under these circumstances, approving a mega-infrastructure project seems analogous to pressing a car's accelerator to the floor while unbuckling the seatbelt.

The World Bank's shift in approach reflects deep internal conflicts within all multilateral lenders, as they seek to reconcile their primary business as profit-driven financial institutions with the fundamentals of long-term sustainability. Lenders have the ability to improve their environmental and social frameworks by developing detailed guidance notes, proper tools and well-resourced support for the critical implementation process (BIC, 2016). A great deal is going to depend on how their environmental and social frameworks are implemented in the future.

Photo: Forest clearing for a Chinese-operated road construction camp in the northern Republic of Congo. © William Laurance

Emerging Threats to Ape Habitats

Impacts on African Ape Habitats

In broad terms, there are many reasons to be concerned about Africa's environment. Indeed, nearly one-third of Africa's protected areas could face degradation if the entire suite of proposed and ongoing development corridors proceeds (Sloan, Bertzky and Laurance, 2016). The specific threats posed to apes by infrastructure projects and the further developments they catalyze are less certain, but one modeling study suggests that fewer than one-tenth of African ape habitats would remain free from infrastructure impacts by 2030 (Nellemann and Newton, 2002).

As currently being constructed, the Lamu Port, South Sudan, Ethiopia Transport (LAPSSET) project in East Africa will not directly threaten ape range states, but it will affect Kenya's imperiled Tana River Primate Reserve, which harbors the highly endangered Tana River red colobus (*Procolobus rufomitratus*) and Tana River crested mangabey (*Cercocebus galeritus*) (Kabukuru, 2016; see Figure 1.1). But LAPSSET is nothing if not ambitious. The long-term plan is to provide a "great equatorial land bridge" that would traverse Africa, linking Kenya on the east coast with Cameroon on the west coast (LAPSSET, 2017). If realized, this great bridge would slice through the Congo Basin and have substantial impacts on a number of ape range states.

Several other development corridors aim to access the mineral-rich region of the eastern Democratic Republic of Congo, Rwanda and Uganda, as well as the goldfields of western Tanzania (see Figure 1.1). The results could increase human pressures on bonobos (*Pan paniscus*), eastern chimpanzees (*Pan troglodytes schweinfurthii*), Grauer's gorillas


KOMATSU

(*Gorilla beringei graueri*) and mountain gorillas (*Gorilla beringei beringei*).

In Africa, corridors that penetrate into equatorial forests are the greatest concern for ape conservation (see Box 1.5). Chief among these is the Central African Iron Ore Corridor. The backbone of this project is the M'Balam railway, which will stretch for more than 500 km and traverse the equatorial rainforests of Cameroon, Gabon and the Republic of Congo. The corridor will also include a new highway linking Brazzaville in the Republic of Congo with Yaoundé in Cameroon. Key components of this project include the Chollet Hydropower Dam near the Dja Biosphere Reserve, the Mekin Dam inside the Dja Reserve and the Memve'ele Dam near the Campo Ma'an Reserve, all of which are located in southern Cameroon (Halleson, 2016).

The greater Congo Basin harbors the second-largest expanse of rainforest on earth. It includes the vast (146,000 km², or 14.6 million ha) Tri-National Dja–Odzala–Minkébé (TRIDOM) landscape, which is jointly managed under an agreement by Cameroon, Gabon and the Republic of Congo. TRIDOM contains a complex of

BOX 1.5

Africa's Integrated Resource Corridors

Development corridors are not new concepts in Africa. In fact, corridors such as the Maputo Development Corridor, the Walvis Bay Development Corridor and TRIDOM have been promoted to varying degrees in different regions for many years. The potential for such multinational infrastructure projects to support sustainable development has been widely discussed and debated (ASI, 2015).

Many organizations tout development corridors as transformative vehicles through which to ensure equitable distribution of benefits from sector-specific operations. Corridor proponents include: the New Partnership for Africa's Development; the mining policy framework developed for the United Nations by the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development; and, more recently, the Africa Mining Vision (AU, 2009; IGF, 2013; NEPAD, n.d.). Development corridors are also on the agendas of regional entities such as the African Development Bank, the Asian Development Bank, and the East African and Southern African Development Communities (AfDB, OECD and UNDP, 2015).

Opportunities

Ideally, development corridors should be able to leverage large extractive industry investment in infrastructure, goods and services to bring about sustainable, inclusive economic development and diversification for a specific geographic area. Potential opportunities include:

- Increasing prospects for governments and the private sector to work together.
- Developing supply chains that encircle the extractive industry, such as a major mine at the heart of a corridor. The direct procurement of local supplies can have a multiplier effect on the local economy, increasing local demand and employment. The use of local resources can also stimulate industrialization and domestic value-adding, which can promote transformational economic growth.
- Bringing together stakeholders from the government, private and community sectors, aligning their incentives and improving coordination. Such synergies can provide opportunities to embed robust environmental standards and practices into the project.
- Benefiting landlocked countries and their neighbors, enabling both to gain from resources in the landlocked country and their export via coastal states.
- Spreading benefits away from the anchor project to provide opportunities, such as shared-cost infrastructure, for isolated towns and villages. Such infrastructure is vital for remote communities, which can find themselves cut off from economic opportunities and political processes or dominated by local patronage systems that inhibit development.
- Allowing affected communities to have a seat at the negotiating table. Large-scale extractives and infrastructure projects can generate high expectations around jobs and the role of companies to provide services that should be the mandate of the state. Inclusion can improve understanding and help to manage the expectations of local communities.
- Allowing planners to concentrate linear infrastructure (such as roads, railroads, pipelines and power lines) along shared corridors, thereby reducing the overall impact by leaving other areas intact (ASI, 2015).

Challenges

While the potential benefits of Africa's development corridors may be considerable, they are far from fully realized. Key challenges include:

seven protected areas and harbors critically endangered western lowland gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes*) (Ngano, 2010). The corridor is adding to stresses that the estimated 40,000 gorillas and chimpanzees in the region already face from industrial logging, agro-industrial concessions and poaching. A combination of threats—including ongoing forest loss and fragmentation, the increasing isolation of protected areas, expanding human settlements and now large-scale infrastructure projects—suggest that the TRIDOM region may be facing imminent demise as a contiguous forest landscape (Halleson, 2016).

In the imperiled forests of West Africa, a global biodiversity hotspot, a major concern is the massive Simandou iron ore project. Rights to explore the Simandou deposit were first granted in 1997 and following a number of issues and disputes, mining rights have been held by the Aluminum Corporation of China Limited (Chinalco), Beny Steinmetz Group Resources (BSGR), Rio Tinto Corporation and Vale. The largest integrated mining and infrastructure project in Africa, it is situated at the southern end of a biologically

- Poor planning and inadequate community engagement often plague corridor projects. Most active and planned corridors are currently unlikely to achieve sustainable development outcomes, particularly in relation to local economic benefits and environmental and social impacts.
- Government agencies are often ill equipped, ill informed and unable to apply an integrated approach to planning. They fail to consider the cumulative impacts of numerous ad hoc developments or synergies that could be created among them. They do not or evidently cannot take advantage of resource efficiencies that would result from economies of scale.
- Cross-national corridors are bedeviled by a lack of coordination when key agencies work in relative isolation. Limited dialog among government agencies, donors, civil society, the private sector and communities results in conflicts and inefficiencies.
- Corridors are often planned without adequate assessments of their potential social and environmental impacts, such as:
  - demographic shifts and the subsequent demand for additional services and infrastructure;
  - resilience considerations in relation to climate change;
  - protection of areas with high conservation value; and
  - effects on water supplies.

  This suite of factors can ultimately undermine the value of a corridor, particularly for the poor and vulnerable.
- Where they are carried out, assessments are usually restricted to site-specific environmental and social impact assessments of individual projects and therefore miss opportunities for key strategic decision-making through the integration of environmental and social considerations (ASI, 2015, p. 12).

A Success Story?

Despite such challenges, some corridors appear promising. The Maputo Development Corridor in southern Mozambique is often highlighted as a positive example (AfDB *et al.*, 2015). Providing a 500 km-long link between Maputo and the landlocked provinces of Gauteng, Limpopo and Mpumalanga in South Africa, it will provide Swaziland with an alternative to the port of Durban, South Africa, for international trade. The corridor's anchor is the Mozal aluminum smelter, on the outskirts of Maputo (Byiers and Vanheukelom, 2014).

Arguably, the reported success of the Maputo Corridor is attributable in part to an alignment of national and cross-border interests. "From the perspective of the Mozambican government, the MDC was as an important signal to the outside world of stability and viability of carrying out major foreign investments" (Byiers and Vanheukelom, 2014, p. 18). Challenges remain, however. Operational inefficiency—including deficient rail infrastructure and capacity, high prices and unequal trade flows within the corridor (given that the volume of goods South Africa exports to Mozambique is 120 times greater than the volume it imports from its trade partner)—highlights the importance of effective planning and political will at all levels (Bowland and Otto, 2012).

As illustrated by the Maputo Development Corridor, five factors stand out as being most critical to the goals of development corridors to achieve sustainable economic progress and reduce poverty:

1. government support up to and including the highest level;
2. private sector involvement from the outset;
3. community engagement and capacity building throughout the project;
4. access to geospatial data; and
5. good governance.

Photo: Plans for large-scale highway expansion across Borneo could degrade some of the last virgin and unhunted forests on the island, such as these in eastern Sabah, Malaysia. © William Laurance

critical region—the Simandou Mountains in southeastern Guinea. Transportation infrastructure needed to link the mine to the coast for shipping ore overseas would span about 700 km and would bisect and fragment the habitat of the western chimpanzee (*Pan troglodytes verus*). Although it is not yet at the production phase, the Simandou project demonstrates how large-scale infrastructure associated with industrial mines can have considerably greater environmental impacts than mines themselves.

Impacts on Asian Ape Habitats

Mapping the impacts of large-scale infrastructure on great ape and gibbon range states in Asia, as well as the array of ancillary developments such projects can catalyze, is a daunting challenge. If all of the proposed projects proceed, then the overall impacts are sure to be substantial.

China's scheme to construct an Asian "Belt and Road"—including a "21st-Century Maritime Silk Road" that is to traverse Asia, Europe and Africa—is certain to be world-changing (see Box 1.1). This spate of projects would have an impact on the habitats of orangutans, in parts of Borneo and Sumatra, and gibbons, whose ranges extend from the islands of Southeast Asia northward to Indochina, southern China and northeastern South Asia. Projects such as the planned high-speed railway linking southern China (Kunming) to Singapore would cut across Thailand and Peninsular Malaysia, affecting important ecosystems for gibbons, including parts of Malaysia's critical Central Forest Spine (Wu, 2016).

Ambitious plans for infrastructure expansion are also afoot in insular Southeast Asia. Indonesia's large-scale development is being structured around a "six-corridor" scheme that would traverse large swaths of Sumatra, Java, Indonesian Borneo (Kalimantan), Sulawesi, the island chain from Bali to West Timor and Indonesian Papua (Indonesia Investments, 2011). The forests of Malaysian Borneo will be further reduced and fragmented by the "Pan-Borneo Highway" plan, which is expanding highway networks across much of Sarawak and Sabah (Property Hunter, 2016).

Expanding infrastructure could affect Asian apes and other wildlife in a diversity of ways, such as by promoting extractive industries. Mining concessions already overlap with 15% of the current distribution

of Borneo's orangutans (*Pongo pygmaeus*) and 9% of Sumatra's (*P. abelii*) (Lanjouw, 2014, p. 155; Meijaard and Wich, 2014, pp. 18–19). Case studies illustrating the impacts of infrastructure projects on Asian ape habitats are provided in chapters 3, 5 and 6.

Social and Political Concerns

Inequitable Social and Economic Benefits

Large-scale foreign investment is driving much of the ongoing expansion in infrastructure and extractive industries in developing nations (see Boxes 1.3–1.5). A common assumption is that these types of investment typically yield broad societal benefits for developing nations; in practice, such benefits rarely materialize, for five main reasons.

First, influxes of foreign capital, such as the major investments in infrastructure and extractive industries in African nations, typically elevate the value of the nation's currency relative to other currencies (Ebrahimzadeh, 2003). By increasing costs for foreign consumers, higher currency values reduce the competitiveness of agricultural and manufacturing exports, tourism, higher education and some other economic sectors. The economy then becomes less diversified and more reliant on a few extractive industries or large projects, and therefore more vulnerable to shocks from commodity price fluctuations or boom-and-bust cycles when key natural resources are depleted (Venables, 2016).

Second, the benefits of foreign capital are rarely distributed equitably. A few individuals, such as those in politically powerful positions, can benefit dramatically, whereas many others see little benefit (Edwards *et al.*, 2014; Venables, 2016). Even nations with strong governance, taxation and resource rent-capture mechanisms, such as Australia, have had much difficulty in distributing benefits from large foreign investments equitably. As a result, many people and sectors of the economy have struggled. Developing nations with weaker institutions and governance can be greatly challenged and even destabilized under such conditions (Venables, 2016). The catchphrases "blood diamonds" and "blood gold" vividly illustrate this concept.

Third, inflation typically increases in the developing nation because demand for goods and services rises. Wealthy elites are troubled little by such inflation but those struggling to meet their daily rent and food costs can suffer greatly. As a result, economic and social disparity can increase, rather than decline (Auty, 2002).

Fourth, corruption is a serious problem in many developing nations, including virtually all ape range states (Laurance, 2004). Even projects that are socially and environmentally ill advised may be approved by decision-makers who stand to reap large personal rewards from bribery or other illicit benefits. Decision-makers may also borrow from international lenders to advance projects for personal or political gain, knowing that future governments and taxpayers will have to bear the burden of servicing and repaying the loan. Documented examples of such corruption-driven environmental mismanagement are far too numerous to detail here (Collier, Kirchberger and Söderbom, 2015; Shearman, Bryan and Laurance, 2012; Smith *et al.*, 2003).

Finally, environmental damage resulting from large-scale developments is typically an economic externality borne by the entire population and domestic economy. Even in the most advanced nations, mechanisms to compensate the public for deforestation, water and air pollution, and mining damage are often far from adequate (Daily and Ellison, 2012). In turn, the absence of effective compensation measures creates perverse incentives in favor of polluting industries,

as they do not bear the full costs of their activities (Myers, 1998).

Risks to Project Proponents and Investors

Risks from large-scale infrastructure and extractive projects are not confined only to the target nations. Multilateral lenders, corporations and investors are also exposed to considerable financial and reputational risks when projects go awry. For example, the reputation of Asia Pulp and Paper, an Indonesia-based corporation that caused massive forest loss in Borneo and Sumatra, became so toxic that it lost a considerable share of the market and suffered widespread international condemnation. Along with a number of major oil palm and wood pulp corporations operating in Southeast Asia, Asia Pulp and Paper has since made a "no deforestation" pledge to limit public criticism and avoid threatened boycotts (Arcus Foundation, 2015, p. 159; Laurance, 2014).

Large infrastructure and extractive projects also face other risks. These can arise from political instability, project cost overruns, labor disputes, liability for environmental disasters and an almost infinite variety of "unknown unknowns" that can bedevil major projects (Garcia *et al.*, 2016; Laurance, 2008). The failure of a large project can lead to "stranded assets," whereby major investments are lost or offset by unanticipated costs that outweigh the project's benefits. In Aceh, Indonesia, for example, deforestation associated with road expansion has increased downstream flooding that is estimated to cost landowners US$15 million per year (Cochard, 2017). Similarly, oil palm and wood pulp plantations on tropical peatlands are likely to incur long-term ecological restoration costs that could exceed the value of the plantations (Bonn *et al.*, 2016).

Advocates of major infrastructure projects often downplay the risks to investors and host nations while overstating their potential to yield large profits and societal benefits. The University of Oxford economist Bent Flyvberg describes how deceptions and an incessant "optimism bias" by proponents create a dynamic in which megaprojects continually proceed despite being "over budget, over time, over and over again" (Ansar *et al.*, 2014; Flyvberg, 2009).

"Advocates of major infrastructure projects often downplay the risks to investors and host nations while overstating their potential to yield large profits and societal benefits."

A Dire Need for Better Infrastructure Planning

Optimizing Infrastructure Costs and Benefits

Not all infrastructure is inherently "bad" for the environment. In appropriate contexts, new infrastructure can yield sizeable social and economic benefits with only limited environmental costs. For instance, road improvements in already settled areas can facilitate increases in agricultural production and improve rural livelihoods, as they give farmers better access to urban markets, fertilizers and new agricultural technologies (Laurance and Balmford, 2013; Laurance *et al.*, 2014a; Weinhold and Reis, 2008). Such roads can also provide rural residents with better access to health care, schools and employment opportunities, while encouraging private investment (Laurance *et al.*, 2014a).

In developing regions, those areas with improved roads might actually function like "magnets," attracting settlers away from vulnerable forests and frontiers (Laurance and Balmford, 2013; Rudel *et al.*, 2009). In this way, improving transportation in suitable areas could help to concentrate and improve agricultural production, raising farm yields while potentially promoting land "sparing" for nature conservation (Hettige, 2006; Laurance and Balmford, 2013; Laurance *et al.*, 2014a; Phalan *et al.*, 2011; Weinhold and Reis, 2008).

However, efforts to plan roads strategically to optimize their benefits and limit their costs face practical challenges. First, environmental impact assessments (EIAs) often place the burden of proof on road opponents, who rarely have sufficient information on rare species, biological resources and ecosystem services to determine the actual environmental costs of roads (Gullett, 1998; Laurance, 2007; Wood, 2003). Second, many road assessments are limited in scope, focusing only on the direct effects of road building while ignoring their critical indirect effects, such as the promotion of deforestation, fires, poaching and land speculation (Laurance *et al.*, 2014a, 2015a). Finally, until recently, there was no strategic system for zoning roads regionally, and thus road projects had to be assessed with little information on their broader context. As the pace of contemporary road expansion intensified, road planners and evaluators thus carried a growing burden (Laurance and Balmford, 2013).

For these reasons, a *strategic* scheme for prioritizing road building was recently devised (Laurance *et al.*, 2014a). This approach has two components:

- an environmental values layer that estimates the natural importance of ecosystems, and
- a road benefits layer that estimates the potential for increased agricultural production, in part via new or improved roads.

The environmental values layer integrates data sets on species richness and endemism, threatened species, key habitats for wildlife, wilderness attributes, ecosystem representativeness and important ecosystem services.

The road benefits layer focuses on the role of new or improved roads for enhancing agricultural production—which is a crucial priority due to four main reasons:

- First, agriculture is by far the dominant form of human land use globally (Foley *et al.*, 2005).
- Second, global food demand is expected to increase by 60%–100% from 2005 to 2050 (Alexandratos and Bruinsma, 2012; Tilman *et al.*, 2001).
- Third, vast areas of land, especially in developing nations, have already been settled but support relatively unproductive agriculture (Mueller *et al.*, 2012).
- Fourth, the amount of additional farmland needed to meet global food demand by 2050 is projected to reach up to 1 billion hectares—an area the size of Canada—unless production on under-yielding agricultural lands can be improved (Tilman *et al.*, 2001).

In this context, strategic road improvements are a key prerequisite for achieving the needed increase in agricultural production (Laurance and Balmford, 2013; Laurance *et al.*, 2014a; Weng *et al.*, 2013). With concerted improvements in transportation, farming technologies and crop varieties, global food demand this century could be met with a far smaller amount of new farmland than if a "business-as-usual" approach were employed (Alexandratos and Bruinsma, 2012).

Combining the environmental values and road benefits layers allows areas to be grouped into three categories:

- areas where roads or road upgrades could have large benefits;
- areas where road building should be avoided; and
- "conflict areas," where the potential costs and benefits of roads are both sizeable.

An example of this analysis at the global scale demonstrates its potential for strategic road zoning, although planning of roads in

> "Many road assessments focus only on the direct effects of road building while ignoring their critical indirect effects, such as the promotion of deforestation, fires, poaching and land speculation."

real-world contexts would be undertaken at a smaller scale, be it regional, national or local (Laurance *et al.*, 2014a; see Figure 1.2).

Promoting Green Energy

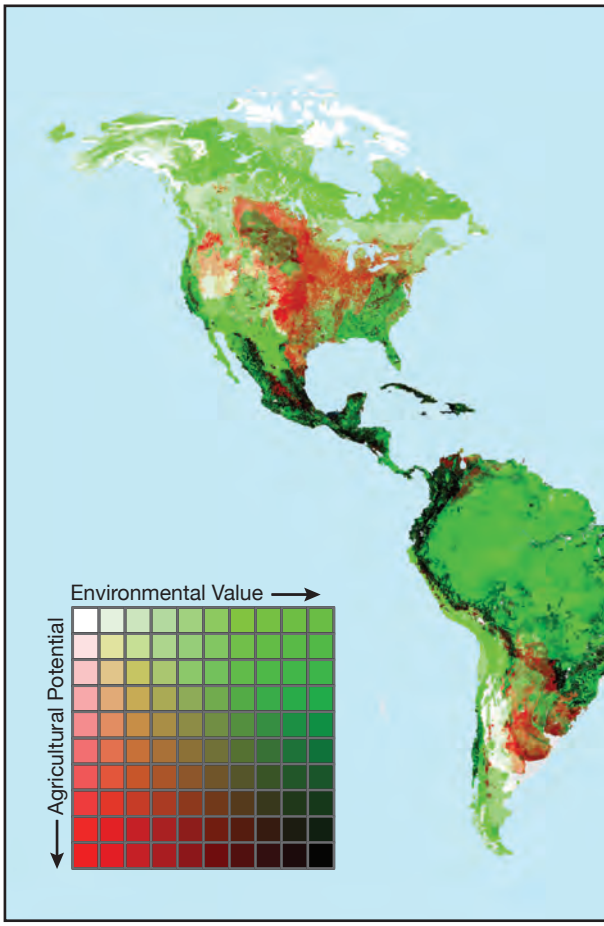
Developing tropical nations such as those that sustain great apes and gibbons often have considerable potential to develop solar, wind and other smaller-scale energy sources. Sustainable energy sources could help to meet their growing energy demands, reducing the need for expensive, large-scale energy infrastructure such as hydropower or gas- or coal-fired electricity plants, which also require extensive road and power line networks. Decentralized solar and wind technologies could be particularly suitable for remote villages and settlements (McCarthy, 2017).

Thanks to its proximity to the equator, the tropical Asia–Pacific region has high solar-energy intensity, indicating a large potential for solar energy expansion. In 2010, the Asia Solar Energy Initiative of the Asian Development Bank announced plans to install 3,000 megawatts of solar capacity in the region, reflecting robust confidence and employment potential in this sector (ADB, 2011; McCarthy, 2017). By 2015, total wind power capacity had reached 175,000 megawatts in Asia, showcasing faster growth than in any other region except the Middle East (Global Wind Report, 2015). In addition, geothermal energy is being proposed or developed in a number of locales, although several proposed plants would be in remote regions, such as forested areas of Sumatra that are prime habitats for Sumatran orangutans (see Case Study 6.4). Since such installations require road networks for plant and power line construction, they are far less desirable than decentralized solar and wind energy in areas of high conservation significance.

Equatorial Africa also has strong potential for solar, wind, geothermal and biomass power (ESI Africa, 2016; IRENA, 2015). As Africa's energy demand is expected to double or even triple between 2015 and 2030, renewable energy advocates are urging African nations to "leapfrog" large-scale energy infrastructure in favor of solar, wind, geothermal and biomass energy sources (IRENA, 2015). At present, however, such technologies have limitations in terms of energy storage and meeting base-load demand, and it is likely that hydropower, coal-fired energy and other large-scale projects will also expand rapidly. Nonetheless, there is much potential for growth in solar, wind, biomass and other small-scale energy technologies, especially in

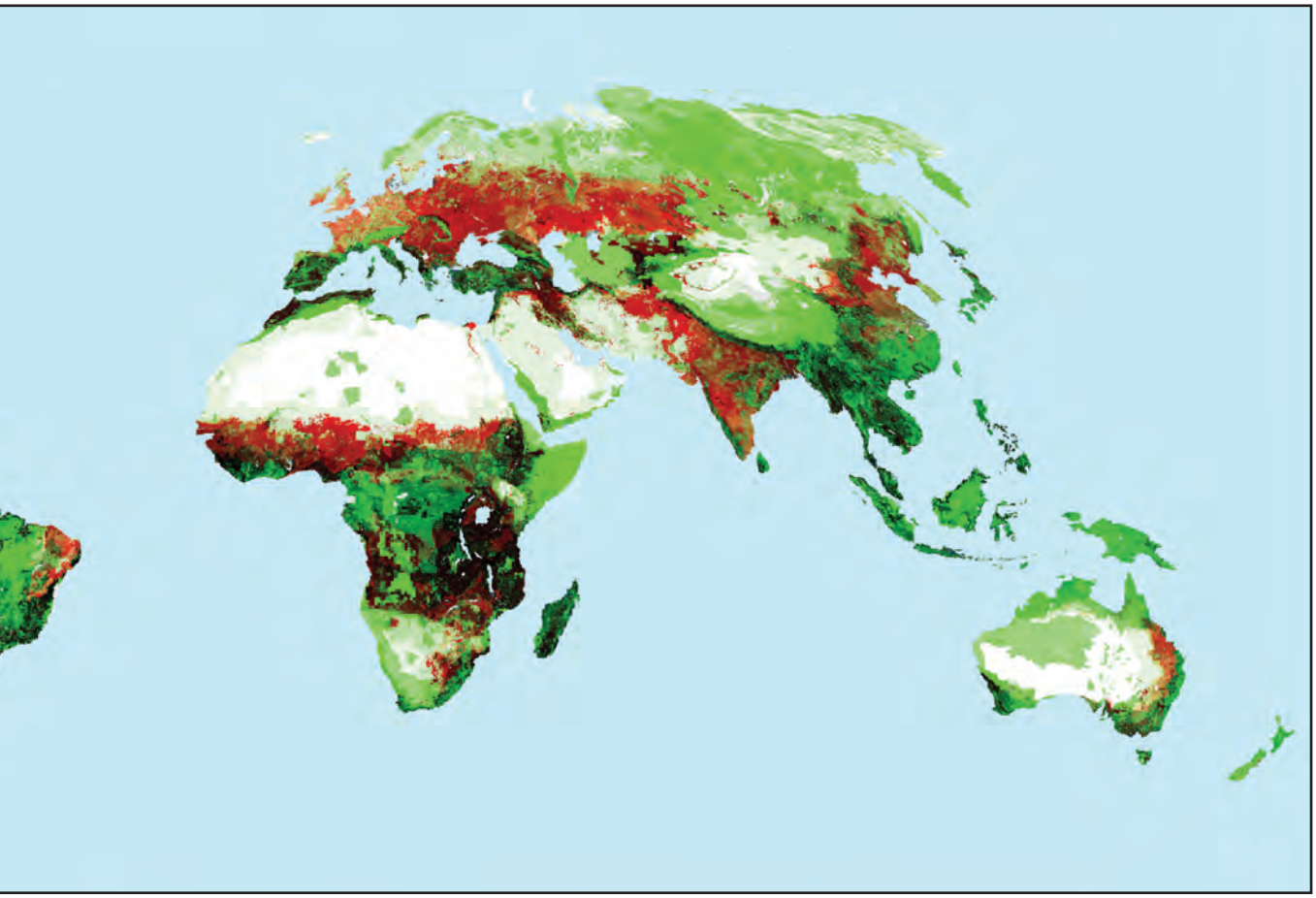
FIGURE 1.2

A Global Map for Prioritizing Road Building



Notes: Green areas have high conservation values. In red areas, transportation improvements have a high potential to improve agriculture. Dark areas are "conflict zones," where environmental and agricultural values are both high.

Source: Laurance *et al*. (2014a, p. 231)



the rural areas of Central and West Africa, which harbor vital ape habitats (IRENA, 2015).

Priorities for Change

This final section highlights six urgent priorities for improving infrastructure finance, planning and environmental sustainability.

1. Avoiding new infrastructure construction in and near critical habitat. From a nature conservation perspective, infrastructure is going many places it should not. Infrastructure expansion is promoting large increases in the human footprint worldwide, intensifying human pressures on protected areas and driving rapid declines in the extent of remaining wilderness, especially in the tropics (Laurance *et al*., 2012; Venter *et al*., 2016; Watson *et al*., 2016).

A key priority is "avoiding the first cut" into remaining wilderness areas by keeping them road-free wherever possible. This goal recognizes that deforestation is highly contagious spatially, in that forest loss tends to expand along new roads and then spread farther afield as the initial road spawns secondary and tertiary roads (Boakes *et al*., 2010). Once the first road goes in, forest loss

Photo: Oil palms spread to the horizon in central Sumatra, Indonesia. © William Laurance

will typically increase exponentially unless robust safeguards are in place to halt it. Such safeguards require long-term expenditures for forest monitoring and protection.

The environmental impacts of new roads and other infrastructure are often amplified in developing nations where land use zoning and the rule of law are limited, especially in the remote frontier regions that are crucial for wildlife. In the Brazilian Amazon, for instance, there are nearly three kilometers of illegal roads for every kilometer of legal road (Barber *et al.*, 2014). Such roads can facilitate a range of illegal activities, including timber theft, poaching, illicit drug production and illegal gold mining, all of which can defraud governments of needed revenues while provoking serious environmental harm (Asner *et al.*, 2013; McSweeny *et al.*, 2014).

2. Addressing the drivers of unsustainable infrastructure expansion. Unsustainable infrastructure expansion reflects deeper challenges. We desire sustainability and environmental quality—yet the average per capita consumption of the human population, which could exceed 11 billion people this century, continues to rise (UN Population Division, 2015). Ultimately, life on earth is a zero-sum game: when humanity consumes land, water and other natural resources, the planet's health is typically degraded to a similar extent.

While infrastructure expansion is among the most important impacts of humankind on nature, it is a proximate rather than an ultimate driver—a symptom of a broader malady revolving around a rapidly growing human population and extractive economies, including in the developing nations that harbor apes. Failing to confront the broader drivers of unsustainable behavior is nonsensical and dangerous.

3. Requiring strategic environmental and social impact assessments. Too many impact assessments are rubber-stamping exercises.

All too frequently, environmental and social assessments for large infrastructure projects rely on inadequate data on ecosystems and biodiversity. They often fail to examine indirect, secondary or cumulative impacts of a project, and they do not assess the "bigger picture" because the project is evaluated in isolation from other human influences that affect the same ecosystem. Indeed, most major infrastructure corridors develop incrementally on a project-by-project basis, with little regional-scale planning (Laurance *et al.*, 2014a, 2015a). Many such assessments fail to anticipate potential cumulative and secondary impacts of projects; they may also be subordinated to the priorities of different government agencies with inconsistent or even opposing interests.

Experts in financial institutions that fund large projects argue that civil society and expert knowledge can play a vital role in the EIA process (see Boxes 1.3 and 1.4 and Case Study 5.1). Yet many EIAs are conducted too late in the project approval process to allow for fundamental changes or to lead to the cancellation of a project, even if they reflect sound expert knowledge. Furthermore, EIAs are often not made widely available to interested parties outside of the project area (Laurance *et al.*, 2015a). When combined with limited time frames for public comment, such measures increase the likelihood that a proposed project is effectively a *fait accompli*—with modest "tweaking" of the project and limited mitigation the only alternatives. The weakening of environmental and social safeguards by major multilateral lenders will only exacerbate this problem (see Box 1.4).

Some EIAs are essentially boilerplate documents that are written in dense bureaucratic language and lack key information. In a striking example, an EIA that was carried out for a large housing estate in Panama claimed that 12 bird species were present in the project area. Two experienced bird-

Photo: Today's infrastructure projects must not become tomorrow's environmental disasters. Nam Ou Cascade Hydropower Project, Lao PDR. © In Pictures Ltd/Corbis via Getty Images

watchers surveyed the same area for two hours and documented 121 bird species, including several rare and threatened species (Laurance, 2007). EIAs for some major equatorial African and Amazonian highway projects have been similarly inadequate (Fearnside, 2006; Laurance, Mahmoud and Kleinschroth, 2017b; see Case Study 5.1). Not all EIAs are as weakly implemented as these, but only a minority are truly robust (Laurance, 2007; Laurance *et al.*, 2015a).

One way to address the broader suite of impacts that are often missed in localized EIAs is to carry out strategic environmental assessments at an appropriate landscape scale (see Box 1.4). Box 1.6 provides a checklist of best practice in impact assessments to enable developers to minimize adverse impacts and to avert a *net* loss of biodiversity, given that infrastructure development in ape ranges, by its very nature, degrades landscapes and habitats. As illustrated above and throughout this publication, these best practice actions are seldom fully or even partially implemented; and sometimes, EIAs are rather used as tools to greenwash destructive projects. Effective implementation of EIA best practice can contribute to the conservation of biodiversity, including apes and ape habitat, while also ensuring that financing is effectively allocated to preventive action, rather than costly mitigation expenses.

4. Carrying out strategic land use planning for agriculture. Many observers call for an increase in the productivity of agriculture in developing nations in order to "spare" land for nature (Laurance *et al.*, 2014a; Mueller *et al.*, 2012; Phalan *et al.*, 2011). Yet more productive agriculture is also more profitable, and highly profitable agriculture is likely to spread widely unless constrained in some manner. An apt example is the dramatic expansion of oil palm across the humid tropics, where the crop is promoting forest destruction both directly and


ຍິນດີຕ້ອນຮັບມາຮອດເຂື່ອນໄຟຟ້າ ນ້ຳອູ່5ຢ່າງຈິງໃຈ!
南欧江五级全体员工欢迎您！
Nam ou 5 all the staff welcome you!

BOX 1.6

Best Practice in Impact Assessment: A Checklist for Developers

An infrastructure project may have significant adverse impacts on biodiversity and local communities throughout its lifetime—from its planning phase through to the construction and operation periods, and, if it ceases to operate, during its decommissioning. Impact assessments can serve to identify, evaluate and mitigate such negative effects. More often than not, carrying out such assessments is a statutory requirement or a condition for disbursements from financial lenders.

The following measures can assist developers as they seek to achieve the objective of causing no net loss of biodiversity:

- **Building and accessing expertise**. Although some developers have in-house expertise to undertake impact assessments, few, if any, have specialists to cover all relevant areas and most will be obliged to seek external support and advice, often through private-sector consultancies that specialize in ecological and related services. If a project is likely to have a significant impact on sensitive habitats and species, such as by causing the loss or fragmentation of areas that support ape populations, building early relationships and trust with experts is crucial. A developer organization that contracts external consultants needs dedicated internal support staff to provide a bridge to outside agencies and other departments. Such project managers can help to provide clear justifications for actions, as external stakeholders may not always understand or support the need for detailed studies or mitigation, often on financial or timescale grounds. Project managers also ensure continuity when contracted work is staggered or consultants are only engaged for limited periods.
- **Planning for impact assessments**. How much time is required to carry out an impact assessment is often dependent on the capacity of the developer organization, applicable legal requirements regarding the provision of independent, impartial advice, and technical needs associated with each stage of a project, from the planning through to the implementation phase. It is important to consider project-related impacts as early as possible to ensure favorable outcomes for biodiversity. Prompt action will reduce a developer's risk of incurring costly delays and constraints at later stages, such as construction stoppage if legally protected habitats or species are identified once a project is under way. Assessing the situation early also allows biodiversity specialists to implement the mitigation hierarchy to its full potential, by ensuring that the project design entails measures to avoid and minimize adverse impacts. These types of measures can prevent the need for expensive alternative mitigations, including changes to ongoing construction, such as the rerouting of roads, and complex, often less effective offset schemes.
- **Assessing baselines**. Initial baseline scoping studies are useful tools for identifying which key species may be affected by an infrastructure project. By covering both the immediate development zone as well as the surrounding area, they can reveal which parts of a landscape may be harmed during the various project stages. Baselines are always required with respect to ape populations; additional assessments are typically needed to fill any knowledge gaps regarding ape numbers, habitat use or distribution. Consultation with local conservation NGOs, academic institutions and state agencies can help to establish what type of data is available. Field surveys are usually necessary to assess the state of species in project areas if they have not been studied in detail.
- **Collecting data**. In the planning stages of impact assessments, the importance of gathering relevant baseline data that is robust and measurable, and allowing sufficient time for this collection and analysis, is essential. To capture seasonal variations in species behavior, surveyors require at least one calendar year to collect and analyze relevant data. If less time is allocated to the task or if inappropriate survey methods are employed, it will not be possible to determine the project's impact on target species with any degree of accuracy, with the result that all future stages of the impact assessment will be compromised. The chance to apply appropriate mitigation measures may therefore be missed, or measures may be applied on a speculative basis, which could lead to unpredicted detrimental impacts or costly—and potentially unnecessary—actions.
- **Collaborating**. Undertaking field surveys can provide a good opportunity for ecologists and sustainability and corporate social responsibility teams from private sector developers to collaborate with environmental consultancies, academic institutions, NGOs and state organizations (such as national park authorities). Collectively, these stakeholders can more readily establish, at an early stage, the likely impacts of a project, as well as appropriate mitigation measures. Private-sector environmental consultants usually have extensive experience drawing up ecological content for impact assessments and meeting financial lender requirements; academic institutions and NGOs can provide science-led research expertise; and state agencies generally contribute invaluable local knowledge and insight into what is achievable within regional and national legal frameworks. At the same time, the data collected can contribute to the ongoing study of habitats, biodiversity and the socioecology of particular species.
- **Mitigating effects**. Once baseline studies are complete and the impacts of an infrastructure project have been considered, developers and other stakeholders can begin to mitigate any subsequent effects—and to monitor the effectiveness of the mitigation measures. Ideally, such measures meet two requirements: they are tailored to address specific impacts, and their outcomes are measurable. If permanent habitat loss is a likely consequence

Photo: There is a pressing need to limit the expansion of new infrastructure into remaining wilderness, protected areas and biodiversity hotspots. Western lowland gorillas, Dzanga, Central African Republic. © David Greer, WWF

of an infrastructure project, habitat amelioration within the remaining range of affected ape communities may be able to preserve populations at pre-construction levels. In some cases, however, predicted or observed residual effects require offsite mitigation measures within the wider landscape. In these cases, measures can be applied following established protocols, such as the Business and Biodiversity Offsets Programme (BBOP, 2009–2012). For information on the mitigation hierarchy, a set of guidelines established in the IFC's Performance Standard 6, see Chapter 4, page 119.

- **Applying additional measures**. In addition to direct mitigation, supplementary measures may be employed, such as awareness raising and community engagement—to reduce hunting pressure, for example. These strategies can be effective in contributing to the overall objective of achieving no net loss; however, it is not appropriate to use to use them as primary forms of mitigation or as replacements for key mitigation measures, such as habitat reinstatement and creation.
- **Producing biodiversity action plans (BAPs)**. The process of implementing the above-mentioned steps and measures is commonly described in a BAP, a document that many lenders require. Under the IFC's PS6, for instance, a BAP is required if critical habitat may be affected by infrastructure development (IFC, 2012c). The standard covers habitat that supports endangered and critically endangered species, meaning that a BAP is required if a project threatens any great ape habitat and most gibbon habitats. Designed to help achieve the aims and objectives of a mitigation and monitoring program, a BAP serves as a single working reference of a given project, pulling together all related studies and reports. The document sets out clear guidance on how each action is to be carried out, by whom and in what time frame. Unlike other associated documents, such as the environmental statement, the BAP is a "living" report that is updated as actions are completed, and modified as new data come to light or if mitigation measures are not as effective as anticipated.

In practice, the environmental considerations and measures presented here are often overlooked or sidestepped, with potentially detrimental repurcussions for developers' finances as well as affected fauna and flora. By making a conscious effort to integrate these considerations into their planning, however, infrastructure developers can play an active role in seeking to avoid both going over budget and a net loss of biodiversity. It is as important for developers to factor social considerations into their activities to prevent harm to—and, ideally, to ensure benefits for—indigenous populations and local communities that may be affected by an infrastructure project (see Chapter 2). In so doing, they can seek to harness local support for a project and any related conservation actions and initiatives.

indirectly—by displacing other land uses, such as rice production, which then leads to further forest loss.

Only when coupled with strategic land use planning and backed by the rule of law will productive and profitable agriculture actually promote the "sparing" of land for nature. The most effective way to constrain the expansion of agriculture into environmentally sensitive areas is arguably by halting the spread of roads and other infrastructure into those areas.

> "We have rapidly shrinking opportunities to help steer infrastructure expansion in directions that meet human needs while promoting greater sustainability for critical ape habitats."

5. Encouraging China to require compliance with its established development guidelines. Of all nations, China is currently the most ambitious and aggressive in terms of advancing large-scale infrastructure projects, often in concert with schemes to exploit and access natural resources in developing nations. Such projects are funded by Chinese public–private partnerships, corporations and lenders. Compared to projects that are underwritten by industrialized nations in the Organisation for Economic Co-operation and Development, Chinese-funded initiatives are significantly more likely to create "pollution havens" (areas where pollution or environmental damage are concentrated) in developing nations (Dean, Lovely and Wang, 2009). In this way, China exports its environmental degradation and pollution to poorer countries.

Having acknowledged these problems, China has devised a series of "green" guidelines and operating principles for Chinese ventures operating internationally (see Box 1.3). Nevertheless, the Chinese government has failed to accept any responsibility for the lack of enforcement of its stated principles. Instead, the recurring problems are being blamed on intransigence by its corporations, a lack of general transparency and weaknesses in the governing frameworks of the host countries (see Box 1.3). Beijing could take a firmer hand in promoting environmental sustainability, notably by requiring that Chinese firms and ventures operating overseas increase compliance with China's development guidelines.

6. Taking advantage of the current window of opportunity. For those striving to promote better infrastructure, the current global economic slowdown offers a limited window of opportunity (Hobbs and Kumah, 2015). The stakes are high: today's infrastructure projects must not become tomorrow's environmental disasters. Advocates of sustainable infrastructure will find it effective to address a broad constituency of environmental, economic, civil society and political stakeholders—emphasizing, for instance, the enormous value of biodiversity, ecosystem services, natural capital and climate regulation, as well as the primacy of sustainability for human welfare (Meijaard *et al.*, 2013). They can also build on the infrastructure sector's aim to avoid financial and reputational risks.

Moreover, researchers and land use planners must respond to a growing demand from businesses and private investors for guidance in determining the best locations for new infrastructure (Green *et al.*, 2015; Laurance *et al.*, 2015b; Natural Capital Coalition, 2016; see Box 4.5). There is a pressing need, in particular, to limit the rapid expansion of new infrastructure into remaining wilderness, protected areas and biodiversity hotspots. As noted above, "avoid the first cut" into wild places should become a clarion call for biodiversity and sustainability advocates.

It is difficult to overstate the urgency of the task at hand. We have rapidly shrinking opportunities to help steer infrastructure expansion in directions that meet human needs while promoting greater sustainability for critical ape habitats. It is time for decisive action—for the protection of great apes and nature in general.

Acknowledgments

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Author acknowledgments: Mason Campbell and Mohammed Alamgir provided useful comments on the manuscript.

Reviewers: Stanley D. Brunn, Miriam Goosem, Matthew Hatchwell and Wijnand de Wit

Endnotes

1 As predicted, since this content was provided in 2017, commodity prices have generally recovered, resulting in increasing demand for infrastructure development (J. Hobbs, personal communication, 2018).

2 This generalized description is derived from a review of multilateral lender safeguard documents and author interviews with lender environmental staff, conducted in late 2016.

3 "Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes" (IFC, 2012c, p. 4).

4 IFC Performance Standard 6 has been reviewed and will be relaunched in 2018 (I. Bray, personal communication, 2018).

5 James Cook University – https://www.jcu.edu.au/