Photo: Infrastructure development fuels deforestation, affecting these ecosystems and the diversity of species that dwell within them, including human communities. © Jabruson (www.jabruson.photoshelter.com)

CHAPTER 2

Impacts of Infrastructure on Apes, Indigenous Peoples and Other Local Communities

Introduction

Infrastructure is a common and expanding feature of the anthropocene, with human-altered landscapes across every part of the world (Laurance, Goosem and Laurance, 2009). Roads, bridges and railways, as well as hydroelectric dams, mining and processing plants, and electrification projects cover much of the earth's surface and infringe on even the most remote landscapes. Collectively, roads cover a distance of more than 83 round trips between the earth and the moon (van der Ree, Smith and Grilo, 2015, p. 3).

Fifteen years ago, an assessment of infrastructure using the GLOBIO tool—which models human impacts on biodiversity—revealed that up to 70% of tropical

forest habitat in Africa and in Asia had been affected by infrastructure development and the associated human exploitation of the forests around it. Projections based on the GLOBIO tool and more recent assessments indicate that less than 10% of the habitat in African great ape ranges and probably closer to 1% of the habitat in orangutan ranges in Asia will be left untouched by 2030, as a result of infrastructure development and the associated habitat disturbance (Junker *et al.*, 2012; Nellemann and Newton, 2002). For apes and the majority of other animal and plant species, infrastructure development represents a major conservation threat.

> "Strategies to mitigate damage to forest ecosystems are most effective when they consider both the potential social impacts of proposed infrastructure projects and forest peoples' capacity to help mitigate such damage."

Infrastructure also affects human populations living in or near tropical forest habitats, and not only in the intended positive manner. Infrastructure development fuels deforestation, affecting the complex dynamic of these ever-changing ecosystems and the diversity of species that dwell within them. Human communities are among those that depend on the forests and their resources. Forest peoples are part of the dynamic ecosystems of forests, living in them, adapted to them and shaping them—in stark constrast to the forces that are destroying forests. Strategies to mitigate damage to these ecosystems are most effective when they take into consideration both the potential social impacts of proposed infrastructure projects and forest peoples' capacity to help mitigate such damage. This approach serves not only to ensure the well-being of forest-dwelling and other local communities, but also to garner their support for proposed conservation measures, which are likely to fail without local backing.[1]

This chapter explores the ecological and behavioral impacts of infrastructure on apes in the forest, as well as social impacts of infrastructure development on forest peoples and communities dependent on forest resources. The first section considers the ecological impacts on apes and other species of fauna and flora across a range of infrastructure types; the second section explores the social impacts of infrastructure via examples from Cameroon. The chapter then offers some lessons learned and steps that can be taken to minimize the deleterious effects of infrastructure development.

With respect to the ecological impact of infrastructure, this chapter's key findings are:

- Infrastructure development is a major conservation threat for apes and for the majority of other animal and plant species.
- The major negative direct impacts of infrastructure development are habitat loss, road kills, and noise pollution and disturbance; indirect impacts include increased human access to previously remote areas, poaching, and the introduction of disease and invasive species. Some of these impacts are immediate, such as road kills, while others can have pernicious long-term and far-reaching consequences for wildlife populations.
- The anticipation of project implementation alone can exacerbate habitat loss and disturbance to wildlife in a locality, particularly through the development of roads to prospect areas and small-scale encroachment by local people, even if the project is not taken to completion.
- Industry-specific certification bodies already exist, such as the Forest Stewardship Council (FSC) and the Roundtable on Sustainable Palm Oil (RSPO), which require standards to be met for certification to take place, including those relating to associated infrastructure. There is thus scope to develop and implement standards for other large scale infrastructure development in relation to both the ecological and social impacts of such developments; and to monitor, maintain

and promote the uptake of these standards through the development of additional certification requirements.

- In designing appropriate responses to infrastructure development, it is important to factor in direct and indirect impacts at both the local and landscape levels for all projects, be they expansive, such as roads, railways and transmission lines, or characterized by relatively small footprints.

With respect to the social impact of infrastructure, the chapter's key findings are:

- Infrastructure development in the traditional lands of indigenous peoples has a negative impact on their livelihoods, cultural practices and norms.
- Indigenous peoples traditionally manage and utilize natural resources from forests sustainably, but they can also become part of the cycle of destruction that is exacerbated by infrastructure development.
- Conservation efforts designed to mitigate and offset the impact of infrastructure development on biodiversity can further exacerbate negative impacts on indigenous peoples.

Ecological Impacts of Infrastructure on Apes

Impacts of different types of infrastructure can vary in intensity on several scales. Impacts can be direct or indirect; they can occur during the construction, utilization, production or decommissioning phases; they can be felt in the short or long term. The main direct impacts of infrastructure include habitat loss and fragmentation, behavioral disturbance and the creation of artificial barriers, which in turn disrupt movement patterns and affect habitat use, increase mortality rates, and hamper gene flow. Indirect impacts and threats, such as hunting or the risk of disease transmission, are often linked to the presence of people (see Table 2.1).

This section outlines the impacts of different types of infrastructure on apes. It covers transportation-related projects, such as roads, railways and ports; broader development infrastructure, such as dams, power lines, processing plants and human settlements (including temporary or permanent housing developments for workers); and other types of infrastructure, such as tourist lodges.[2]

Compared to industrial-scale agriculture and logging, which typically result in the conversion of thousands of hectares of forest or more, infrastructure such as roads or tourist lodges may be expected to have a relatively small impact on apes. Indeed, such linear and localized projects may pose a less significant immediate threat of habitat loss. Nevertheless, as forests are opened up for infrastructure development, people increasingly disturb previously intact ranges by hunting, capturing live animals, degrading and destroying the forest, producing noise, transmitting disease and polluting. In connection with infrastructure development, such human disturbance can have significant negative impacts on apes, affecting the landscape's structural connectivity (habitat type and composition) as well as its functional connectivity, which involves both the structure of the landscape and the ways in which animals interact with their environment (Kindlmann and Burel, 2008).

Various mitigating measures can be developed and implemented to prevent and respond to the negative impacts of infrastructure-related human disturbance in and around wildlife habitat. Designed to integrate conservation into infrastructure development, such measures can usefully be adapted to the characteristics of each

"When designing appropriate responses to infrastructure development, it is important to factor in direct and indirect impacts at both the local and landscape levels for all projects."

Photo: A common impact of all infrastructure development is the destruction or degradation of habitat wherever construction is taking place. Highway construction between Port-Gentil and Omboué, Gabon. © Julie Sherman

individual plan, be it managed exclusively by private companies, by a government or by a combination of stakeholders.[3]

Impacts of Infrastructure Development

Each type of infrastructure project can be expected to have a number of direct or indirect impacts on the local landscape. These impacts may differ in terms of their duration and extent, as well as in relation to the timescales required for the construction phase and the longevity of the infrastructure (see Table 2.1).

Three phases can be distinguished for infrastructure projects: their construction, their use and, in some cases, their decommissioning (as for dams, logging concessions and mines). These phases require separate consideration when it comes to assessing their impact on wildlife in general, and apes in particular.

Construction Phase

The overall impacts of infrastructure construction on apes are similar across development projects, but the scale of any impact depends primarily on the type of infrastructure being built. For example, setting up infrastructure that affects small areas of land, such as a power line or a pipeline, and that is mostly left alone after being established in the middle of a rainforest is likely to cause less disturbance than erecting a major structure, such as a dam, power plant or highway, in a similar area.

A common impact of the construction of any type of infrastructure is the human presence and the influx of workers to the construction site. The arrival of people increases indirect threats to wildlife, such as hunting, physical and noise pollution, risks of disease transmission and an influx of invasive species (Burgess *et al.*, 2007). The noise of heavy machinery during construction is also likely to affect and possibly displace animals (see Box 2.1). In Uganda,

for instance, mountain gorillas in Bwindi National Park reportedly shifted their range when the park service was building new office premises. In general, apes move away and shift their range in response to human disturbance.[4]

BOX 2.1

Impacts of Roads on Chimpanzees

Chimpanzees show flexible behavior that enables them to exploit anthropogenic landscapes; they may use human-made paths and cross large roads to access different areas of their home range (Cibot *et al.*, 2015; Hockings, Anderson and Matsuzawa, 2006; Hockings and Sousa, 2013). At the same time, roads and paths can provide hunters with access to previously unreachable areas, where they can set traps and hunt chimpanzees and other animals for local consumption or for commercial trade (Blake *et al.*, 2007; Poulsen *et al*., 2009; Robinson *et al.*, 1999). When hunters use indiscriminate devices, such as snares or traps, they are also likely to capture non-target species.

Roads are generally risky areas for wildlife due to the increased human presence and the danger of collisions with vehicles (Jaeger *et al.*, 2005). Research has shed some light on the risks associated with road development and utilization and how chimpanzees in particular manage road crossings.[5]

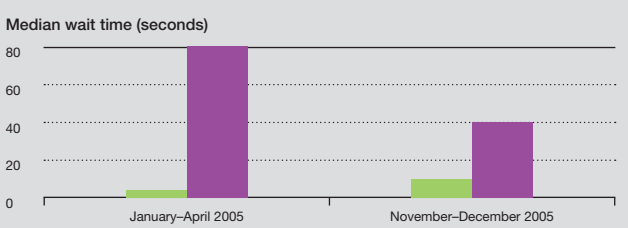
There is growing evidence that road crossing can cause injury or the death of individual chimpanzees (Krief *et al.*, 2008; McLennan and Asiimwe, 2016). The danger is high although chimpanzees appear to assess the risks by looking left and right before and during road crossings, and despite the fact that they check on and wait for group members, especially more vulnerable ones (Cibot *et al.*, 2015). Adult males are particularly at risk because they often take up the more dangerous positions at the front or rear of a group progression when crossing (Hockings, 2011). As shown in Figure 2.1, Bossou chimpanzees in Guinea spend more time waiting before crossing a large road than a small road. The large road had been widened prior to the period under review; between early 2005 and the end of that year, the chimpanzees reduced their waiting time at the road, most likely because they became habituated to its greater width.

Interestingly, Sebitoli chimpanzees in Uganda appear to maintain the old pathways they used prior to road construction, regardless of risk (Cibot *et al*., 2015). This finding highlights the need for road developers to identify chimpanzee paths and trails and to integrate such knowledge into road design and development plans.

FIGURE 2.1

Chimpanzee Waiting Time before Road Crossing, Bossou, Guinea, 2005

Key: Small road (3 m width) Large road (12 m width)



Source: Hockings (2011)

Another common impact of all infrastructure development is the destruction or degradation of habitat wherever construction is taking place. More often than not, these impacts result in habitat and population fragmentation and isolation, with possible long-term consequences (see Table 2.1).

Utilization or Production Phase

Apes generally prefer areas with lower levels of human disturbance.[6] The overall response of apes—and other mammals—to established infrastructure is avoidance of the built area, which results in reduced densities of the animals (Benitez-Lopez, Alkemade and Verwej, 2010). Several types of infrastructure can kill apes directly, such as through electrocution or collisions with vehicles on roads (McLennan and Asiimwe, 2016; see Box 2.1). Asian apes and other arboreal mammals are regularly electrocuted in the Kinabatangan region of Malaysian Borneo when they use power lines to move across the landscape. Apes and other animals sometimes recover from electric shock, but many die of electrocution; they may also drown near dams or in drains (see Annex I).

Causes of ape mortality that are indirectly linked to infrastructure typically involve hunting, most of which takes place fewer than 10 km from any roads (Laurance *et al.*, 2009). Mortality rates are also affected by the transmission of emerging diseases due to close proximity to people or domestic animals, as well as reduced food availability due to habitat loss (see Table 2.1).

A primary concern associated with all types of infrastructure is the increased mortality rate among apes whose habitat has been destroyed and who are thus pushed away from their original home range or concentrated in small patches of forest. Mining and dam development have particularly significant effects on apes, especially if human

settlements, be they temporary or permanent, are established alongside the infrastructure.

Habitat fragmentation results primarily from linear infrastructure with a pronounced edge effect, such as roads, railways, power lines, drains and canals. In the long term, fragmented and isolated ape populations become more prone to extinction due to genetic isolation, stochastic events (such as fire, flooding or the outbreak of disease) and reduced resilience to the impact of climate change (Gillespie and Chapman, 2008).

The impact of roads also depends on their size and the frequency with which they are used. Dirt and gravel roads that receive relatively little use may not be much of a barrier for apes, even for some arboreal species, such as orangutans. As their level of use increases, such roads can become a greater barrier and may ultimately prevent passage by apes.

The longevity of infrastructure is also of importance. For example, a dirt road that is not well maintained or is closed after the cessation of activities (such as a logging road) may be recolonized by the forest over time, unless it continues to be used. In contrast, the decommissioning of a dam is not likely to result in the full reversion of the dam site and associated flooded forest to their previous natural, functional state, even if the local river system recovers in part (see Annex VII).

Decommissioning Infrastructure

The decommissioning process involves the rehabilitation of areas after infrastructure is no longer in use. At that stage, mitigating the impacts of infrastructure can include the following steps:

- *A clean-up of the exploitation site*: removing machinery and equipment; destroying buildings and other infrastructure that is no longer used and cannot be recycled; removing chemicals and other toxic waste.
- *Habitat rehabilitation*: replanting trees; reforesting degraded areas; filling in a landfill or a mine. In areas that are known to harbor important gorilla populations, it should be noted that gorillas consume large quantities of terrestrial herbaceous vegetation (THV)—particularly *Marantaceae* and *Zingiberaceae*—and are likely to be attracted to these resources in areas with an open canopy. Rehabilitation in such habitats requires careful planning, as focusing on tree planting alone can be detrimental to the establishment of THV (Morgan and Sanz, 2007).
- *Habitat protection*: closing or monitoring of paths, roads and bridges to decrease the opportunities for access, illegal hunting and other encroachment. The costs of effective control of access can be prohibitive (Elkan *et al.*, 2006). If successfully applied, however, habitat protection can help to promote the natural regeneration of vegetation, which can complement habitat rehabilitation efforts.

General Impacts on Apes

Apes vary in their socioecological traits, such that infrastructure affects each species differently (see the Socioecology section, p. xvii). Nevertheless, all apes share social and behavioral characteristics that limit their ability to adapt to infrastructure development. Most notably, these include:

- No ape species can swim: a dam, canal or a wide drain without any natural bridge (such as overarching tree branches) represents an impassable barrier to any individual or group.
- All ape species have low reproductive rates; due to their long period of maturation, individuals do not begin to reproduce until they are at least ten years

Photo: No ape species can swim: a dam, canal or a wide drain without any natural bridge (such as overarching tree branches) represents an impassable barrier to any individual or group. Grand Poubara Dam, Gabon. © Steve Jordan/AFP/GettyImages

old. They typically have one offspring every 4–9 years depending on the species. As a result, apes characteristically experience very slow population growth rates. Increased mortality rates can thus have severely detrimental effects on population size. Populations may take a very long time to recover to their original size, if they ever do.

- Apes are susceptible to many diseases that affect humans. As apes come into increasingly close contact with people, the risk of disease transmission is heightened, along with the risk of infection and subsequent death among apes (Carne *et al.*, 2014; Köndgen *et al.*, 2008; Muehlenbein and Ancrenaz, 2009).
- All apes are highly adaptable: many of them will use new food resources planted by people. Crop owners may identify such apes as "pests" (Humle, 2015; Seiler and Robbins, 2016); in this scenario, it is not only difficult to harness these people's support for conservation initiatives, but the likelihood of retaliation and killing of apes also increases (Ancrenaz, Dabek and O'Neil, 2007; Humle, 2015).
- All ape species depend on forests for all or a significant part of their behavioral ecology. Even chimpanzees and some bonobo populations that occur in savannah-dominated landscapes need forest for nesting sites and food. Gibbons are exclusively arboreal and cannot cross large distances on the ground. While chimpanzees and gorillas typically travel on the ground, and orangutans may also do so to a certain extent (Ancrenaz *et al.*, 2014), any barriers in their habitat may restrict their ranging patterns, depending on the size and the level of disturbance.
- Except for orangutans, most apes live in social groups and are either territorial or have overlapping home ranges, so that multiple groups occur in the same area. Therefore, as the construction of infrastructure leads to a loss of habitat and apes are compressed into smaller

areas, it becomes difficult or impossible for them to establish new territories or shift their range. Greater density leads to increased intergroup aggression and possible death owing to attacks between individuals (especially among chimpanzees), increased social stress, as well as a reduction in food resources (Mitani, Watts and Amsler, 2010; Watts *et al.*, 2006).

Table 2.1 presents information about impacts of different types of infrastructure on apes. The list is not exhaustive; several impacts are not included due to a lack of data (for example, dust and airborne pollutants, and invasive species). The table also identifies to what extent apes tend to be able to adapt to such impacts.

The Consequences of Infrastructure Development

Increased Access, Immigration and Human Settlement

Infrastructure development nearly always leads to increased access, human influx and human settlement in areas that previously were not easily reached. Of all the types of infrastructure, new roads are the ones that result in the largest increase in access (Clements *et al.*, 2014). Access roads are almost always needed for other types of infrastructure, which in turn open up areas to human settlement.

Research shows that the distance to roads, villages and cities is a strong predictor of the presence of apes; indeed, ape densities decrease as human presence increases, largely because of hunting pressure.[7] One study that compares the abundance of large mammals at varying distances from roads inside an oil concession (a non-hunted area that received extensive protection) and

TABLE 2.1

Impacts of Infrastructure on Apes and the Likelihood of Ape Adaptability

Impact of infrastructure	Impact type	Duration of impact	Roads and railways	Ports and dams	Power cables	Human settlements
Increased access, immigration and human settlement (villages; tour lodges; and buildings of any sort)	Indirect	Short to long term	Moderate	Limited	Unknown	Moderate
	Indirect	Long term	Moderate	Limited	*	Good
Hunting (commercial and personal)	Direct	Short to long term	Limited	Limited	Limited	Limited
Habitat loss, degradation and fragmentation	Direct	Short to long term	Moderate	Limited	Moderate	Moderate
Creation of artificial barriers (which disturb movement patterns and affect habitat use, increasing mortality and/or hampering gene flow)	Direct	Short to long term	Moderate	Limited	Moderate	Moderate
Behavioral change	Direct	Short to long term	Unknown	Unknown	Unknown	Unknown
Disease (or pathogen) transmission	Direct	Short to long term	Moderate	Limited	Good	Moderate
Mortality and injury associated with vehicle and equipment collisions	Direct	Short term	Moderate	Limited	Limited	Limited
Disturbance associated with noise and vibration (including blasting), project lighting, and presence of workers	Direct	Short to long term	Good	Limited	Good	Good
Hydrological impacts, including flooding and fragmentation	Direct	Long term	Moderate	Limited	Limited	Limited

Note: * Chances of ape adaptability are good if local settlements do not have access to electricity, limited or moderate if they do.

Likelihood of ape adaptability

Limited Moderate Good Unknown

in the hunted territory beyond the concession demonstrates that *hunting*—rather than the roads themselves—leads to a decline in gorillas (Laurence *et al.*, 2006). Similarly, a recent study reveals that the distance from roads is the best predictor of bonobo nest occurrence; distance is an indicator of hunting of apes, rather than of the displacement of bonobos, as hunting intensity is greatest closer to roads (Hickey *et al.*, 2013; Laurance *et al.*, 2009).

As people settle into an area, land use practices change and subsistence agriculture generally expands, as does the extent of land under cultivation. These shifts can cause apes to forage on cultivars with greater frequency and can lead to an increase in encounters between apes and people, which may result in increased conflict and aggression (Bryson-Morrison *et al.*, 2017; Campbell-Smith *et al.*, 2011b; McLennan and Hill, 2012; McLennan and Hockings, 2016). Crop foraging may be driven either by necessity, due to the loss of natural foods, or by opportunities linked to agricultural expansion of palatable crops.[8] It leads to a loss of income for local community members, stoking negative reactions and behavior towards apes (Ancrenaz *et al.*, 2007; Naughton-Treves, 1997).

Close cohabitation may be particularly problematic if the people in question have no previous experience of living near apes. They may be afraid of the apes—due to their lack of experience or based on urban myths about apes—and may therefore be more antagonistic towards apes. Even among people who have traditionally lived near apes, increased encounters with them may erode traditional or religious taboos and beliefs that favor local ape conservation or tolerance of apes (Humle and Hill, 2016).

In addition, employment insecurity associated with a significant influx of people into an area can exacerbate people's engagement in alternative revenue-generating enterprises that can have significant negative impacts on apes. Such activities include artisanal mining, small-scale logging and subsistence or commercial hunting, which can be facilitated by increased access to ape habitat.

Habitat Loss, Degradation and Fragmentation

All types of infrastructure development lead to some level of habitat loss, degradation and fragmentation. While infrastructure itself can be relatively "small" compared to large tracts of forest, some types, especially roads, can transect extensive areas, and all types will have impacts at both the local and the landscape level. In some cases, roads can limit apes' access to food and nesting trees (Bortolamiol *et al.*, 2016). Such infrastructure may lead apes to shift their range or territory, thereby increasing intra- or interspecific competition for food and nesting, which causes social disruption and stress, as well as a heightened risk of intergroup aggression. This kind of aggression can significantly raise the mortality rate, especially among chimpanzees (Mitani *et al.*, 2010; Watts *et al.*, 2006).

For the more arboreal Asian ape species, disruption to canopy connectivity can compel apes to travel on the ground and thus heighten their exposure to pathogenic agents, including viruses, bacteria and parasites, which may be transmitted from humans and domestic animals, such as via attacks by dogs (Das *et al.*, 2009). In addition to limiting the spatial distribution of apes, the loss of canopy connectivity also increases the risk of predation and food shortage, particularly among gibbons (Channa and Gray, 2009; Cheyne *et al.*, 2013, 2016; Hamard, Cheyne and Nijman, 2010; Turvey *et al.*, 2015).

While more terrestrial apes are less constrained by the presence of railways and

Photo: Chimpanzees show flexible behaviour that enables them to exploit anthropogenic landscapes, which puts them at risk of injury or death when crossing roads. © Matt McLennan

roads, the latter may nevertheless act as barriers, depending on the intensity of traffic, road or rail width, travel speed and visibility (see Box 2.1). In Uganda's Bwindi Impenetrable National Park, three groups of gorillas tend to cross a 15-km-long gravel road a few times per year. There are plans to pave the road, which is expected to increase vehicular traffic and, in turn, heighten the risk of vehicle collisions. If the gorillas stop crossing the road once it is paved, their habitat will be fragmented, as about 10% of the 330 km² (33,000-ha) park would effectively be eliminated as suitable habitat. Plans to pave a road through the already fragmented habitat of Cross River gorillas in Nigeria would have similar detrimental effects (see Case Study 5.1).

In estimating or assessing the impact of infrastructure on great apes and other wildlife, it is crucial to consider the anticipated or sustained disruption of habitat connectivity and relationships among patches across the affected landscape. A study that compared the amount of structural and functional connectivity for the critically endangered Cross River gorilla showed that the decline in functional connectivity was double that in structural connectivity over a 23-year period (Imong *et al.*, 2014).

Disease and Pathogen Transmission

Apes are susceptible to many human diseases. Disease epidemics or parasitic infections can negatively affect reproduction and kill apes, thereby changing demographic patterns (Gilardi *et al.*, 2015). An increased risk of disease and pathogen transmission is likely in areas where there is garbage, such as tourist lodges, villages and roadsides. Artisanal mines, camps used by construction workers, and satellite communities typically have unsanitary conditions that pose a large health risk to apes (Plumptre *et al.*, 2016b). Habituated chimpanzees, gorillas and orangutans may range very close to tourist lodges and may even come into very close contact with humans in unregulated settings, such as those not monitored by park staff, which can lead to an increased risk of transmission

of respiratory and other diseases (Gilardi *et al.*, 2015; Macfie and Williamson 2010; Matsuzawa, Humle and Sugiyama, 2011). Such contact puts both the apes and people, including tourists and staff, at risk of injury and pathogen infection in case of attack.

Injury and Death Due to Vehicle and Equipment Collisions

Terrestrial apes are at risk of injury or death when crossing roads. There are reports of chimpanzees being injured or killed in vehicle collisions (McLennan and Asiimwe, 2016; see Box 2.1). Encounters with infrastructure can also be life-threatening for arboreal apes, and poorly insulated and bare power lines pose a risk of electrocution for all species (see Annex I). In Kinabatangan, Malaysia, and in Assam, India, several cases of gibbons and orangutans being electrocuted have been recorded, some of them fatal. In 2011 and 2014, two adult orangutans were electrocuted when they used a power line to access a fruiting durian tree in the village of Sukau, Kinabatangan. In both cases, the orangutan fell to the ground and was unconscious for several minutes before recovering from the electrical shock and fleeing to a nearby tree. The hands of the animals showed marks of burning. Although neither orangutan died at the time, it is unknown whether they survived in the longer term. Local villagers have reported that gibbons and monkeys have died after similar shocks (Das *et al.*, 2009).

Disturbance Associated with Noise and Vibration (including Blasting), Project Lighting and the Presence of Workers

The construction phase of all types of infrastructure is accompanied by noise and human activity, both of which tend to be reduced once the infrastructure is built. This additional noise and disruption can cause apes to avoid affected areas, leading to temporary displacement that can affect individual and group ranging, access to food and shelter, and dispersal. The disturbances can also cause heightened stress levels, with possible impacts on health and reproduction.

Rabanal *et al.* (2010) measured the impact of dynamite blasts for oil exploration on gorillas and chimpanzees and found that both avoided the area where the explosions had occurred for months after the exploration work, even though there were strict regulations in place to minimize disturbance (for example, chainsaws and mechanized vehicles were not allowed, and transects were very narrow). The dynamite blasts and increased human presence presumably caused the apes to keep their distance. In Borneo, noise linked to timber extraction—such as from the use of machinery and chainsaws—drives orangutans away from disturbance areas, although animals may recolonize the same areas after the disturbance is over (Ancrenaz *et al.*, 2010; MacKinnon, 1974).

Hydrological Impacts

In both intact and degraded landscapes, gallery, riparian and swamp forests often represent critical habitats for apes, be it for food or nesting (McLennan, 2008; Mulavwa *et al.*, 2010). Riparian habitats are also vital to healthy freshwater ecosystems, fisheries, clean water and other essential functions that support local people and agricultural productivity (Chase *et al.*, 2016). It is therefore crucial to preserve these habitat types.

Chimpanzee and bonobo populations that occur in more arid landscapes dominated by savannah can be severely constrained by water availability (McGrew, Baldwin and Tutin, 1981; Ogawa, Yoshikawa and Idani, 2014). In such water-stressed

Photo: Strategic road planning can reduce the number of roads that apes must cross in their home range, decreasing stress and risks. Road construction in Guinea. © Morgan and Sanz, Goualougo Triangle Ape Project, Nouabale Ndoki National Park

landscapes, it is particularly critical that infrastructure development not prevent access to or otherwise affect water sources.

Infrastructure such as roads and dams typically affects hydrological systems, for instance by changing water levels and flow. Infrastructure development can also cause erosion or indirect impacts on the local or regional climate, which can modify vegetation composition. How such changes affect apes largely depends on the impact of infrastructure on three main factors:

- land use patterns, such as agricultural activities (whose expansion may cause additional habitat loss for apes);
- the degree to which water acts as a constraint on local apes; and
- local vegetation species, some of which may be critical to apes for shelter (nesting) and food.

Steps Forward

Learning from Environmental Impact Assessments

Environmental impact assessments (EIAs) are designed to identify measures to prevent or reduce the negative impacts of infrastructure development on biodiversity. Appraisals that also consider impacts on people are known as environmental and social impact assessments (ESIAs). Chapter 1 discusses best practice in impact assessments (see Box 1.6, p. 36).

Unfortunately, not all infrastructure development projects require EIAs or ESIAs. Whether an assessment is obligatory depends primarily on a country's laws and policies; which, if any, lending or investment agencies are involved (such as the International Finance Corporation, the World Bank and development banks); and what type of infrastructure is being considered. In many

countries, assessments are not required for road or bridge construction. When they are requested, EIAs and ESIAs often consider only the impact that infrastructure is likely to have on the immediate vicinity of the specific project, although the impact typically extends far beyond the area under review and may contribute to cumulative impacts, depending on surrounding land use and the proximity of other projects. Furthermore, EIAs and ESIAs are often carried out too late to influence the decision-making process; in such cases, they become tools for mitigating—as opposed to preventing—environmental degradation (see Box 1.6).

> "Integrated, well-informed land use planning is the most effective way to minimize the negative impact of infrastructure development while enabling social and economic development."

In addition to being undertaken late in the process, the vast majority of EIAs and ESIAs are conducted over extremely short periods of time. A short time frame precludes a surveyor's ability to establish a proper understanding of the distribution and conservation status of impacted ape populations, as well as the potential seasonal or long-term impacts of any infrastructure development on these animals. Indeed, surveying apes properly is time-consuming and requires significant effort and resources, both of which are often lacking (Kühl *et al.*, 2008). Companies have to secure resources in advance to be able to hire qualified experts in ape population surveys to carry out thorough assessments. To capture seasonal variations, such assessments require data collection periods of at least one full year, as well as sufficient time to analyze and report on the findings (see Box 1.6). In practice, these vital conditions are rarely met.

To avoid adverse effects on local people and to help to manage their expectations, ESIAs for any infrastructure project need to consider the expected impact on their lives and estimate how many external people are likely to be attracted to the area prior to and during implementation. The process is most effective when such aspects are considered early on in the planning stages. Activities associated with infrastructure projects can otherwise have aggravating consequences, as was recently the case with the Bumbuna dam expansion project in Sierra Leone. Small-scale logging activities increased in the dam's potential inundation zone as local people sought to exploit timber resources that they anticipated would be lost (R. Garriga, personal communication, 2016). Such activities, which are generally based on the assumption that a project will go ahead, thus have a negative impact on local wildlife even if a project is not taken forward. If such a project is indeed abandoned, the prospect of its implementation alone will have exacerbated habitat loss and disturbance to wildlife in the locality. By providing an accurate assessment of anticipated social impacts in the early phases of a project, an ESIA can highlight these risks and inform the development of effective mitigating measures, typically more comprehensively than an EIA.

Mitigation Measures That Can Reduce Negative Impacts on Apes

The following approaches can serve to mitigate the impact of infrastructure development on apes. While some are not applicable in all circumstances, others are used by several certification bodies, including the FSC and the RSPO.

- **Applying strategic land use planning**. Integrated, well-informed land use planning is the most effective way to minimize the negative impact of infrastructure development while enabling social and economic development. There is an urgent need for conservationists to identify key priority ape ranges on maps and

to use these maps in efforts to prevent infrastructure development in those areas. Just as development takes place at the international, national and local levels, so too does effective land use planning. Such planning considers the different stakeholders involved in various types of infrastructure development: local private industry may support planning for a tourist lodge, while governments may drive efforts to develop road networks, and multinational corporations may back bids for hydropower projects, mining concessions, processing mills and industrial agricultural activities.

- **Minimizing the length of road networks**. Efforts to restrict the growth of road networks help to limit impacts on habitat and wildlife populations overall, even if restrictions are only applied on a temporary basis (Wilkie *et al.*, 2000). Strategic road planning can also reduce the number of roads that apes must cross in their home range, decreasing stress and risks. To minimize the impact of road development on apes, stakeholders can apply best-practice measures, such as by:
  - undertaking road construction at least 5 km from protected areas, and ideally 10–20 km (Morgan and Sanz, 2007);
  - avoiding the construction of roads in areas that are important to apes, such as the core of their habitat or areas with high densities of fruiting trees, bearing in mind that construction in open or monodominant forest will cause less disturbance and minimize the loss of tree species that are important to apes for food and nesting (Morgan and Sanz, 2007);
  - reusing old logging and similar road networks instead of opening up new road networks, as long as such "recycling" does not lead to increased damage to forest canopy (Morgan and Sanz, 2007);
  - constructing well-designed and -located wildlife crossing sites, speed bumps and other structures (whether arboreal or terrestrial) to allow safer passage for animals (Cibot *et al.*, 2015; McLennan and Asiimwe, 2016; see Box 2.2);
  - keeping road width to a minimum since apes perceive wider roads as posing higher crossing-related risks (Hockings *et al.*, 2006; see Box 2.1); and
  - installing signs to alert drivers to the presence of apes.
- **Avoiding fragmentation**. In landscapes that are already fragmented and deforested, infrastructure—such as roads and power lines—may become additional filters or barriers to wildlife movements. The construction of wildlife passages as linear corridors can serve to minimize mortality rates and restore connectivity.
- **Controlling domestic animals and invasive species**. In areas adjacent to infrastructure and ape habitat, strict controls and policies can be effective in preventing the introduction of domestic animals and invasive species, and associated risks of disease transmission to apes.
- **Dismantling temporary infrastructure**. The dismantling and destruction of temporary infrastructure—such as access roads, provisional camps and bridges—prevents its further use by people after a project has been completed. The FSC and other certification bodies already encourage such dismantling as best practice (FSC, 2015; Rainer, 2014). Any relocation of people from temporary camps requires careful assessment

"Just as development takes place at the international, national and local levels, so too does effective land use planning."

BOX 2.2

Apes and Wildlife Bridges: Examples from Asia

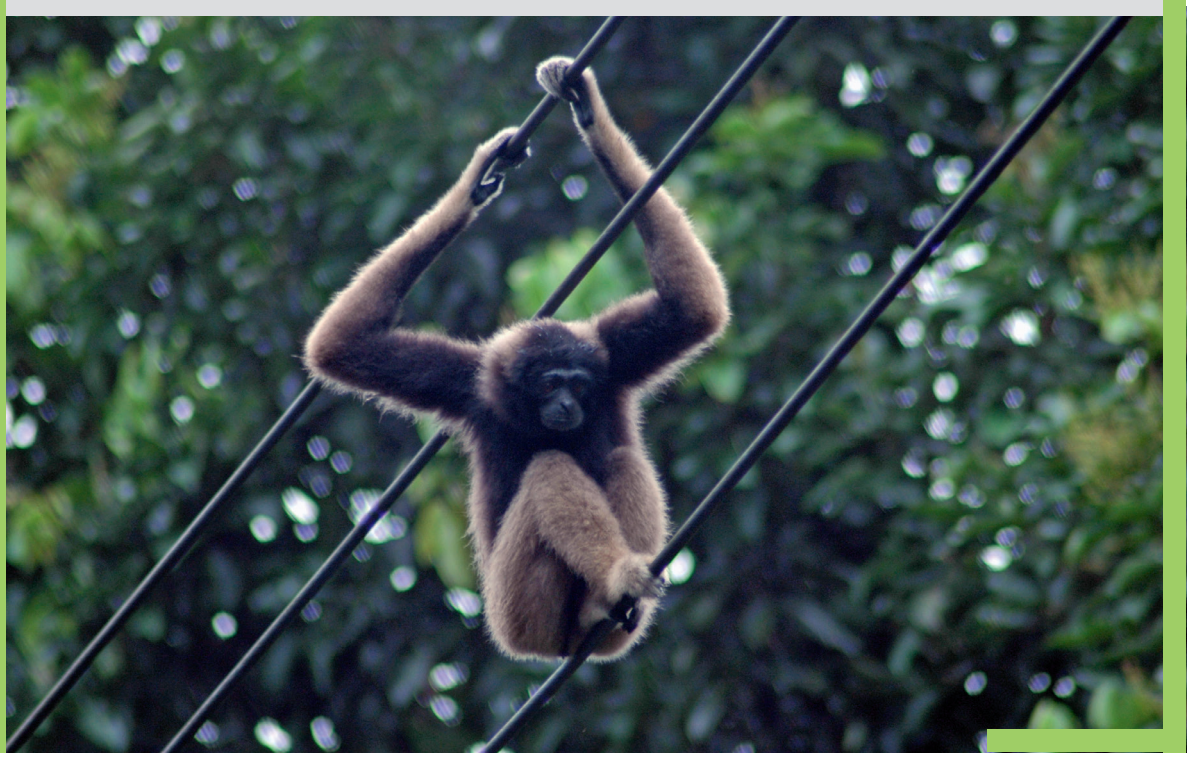
Infrastructure can act as an artificial barrier, preventing apes from moving freely within their habitat. No apes can swim; even small rivers or drains can become impassable barriers to them. Gibbons rarely come to the ground, so the construction of a road dissects their habitat and results in intense fragmentation.

Wildlife bridges allow animals to cross artificial barriers. Bridges that have multiple access points at various heights can provide different routes across a gap; by allowing several animals to cross at different points at the same time, they help to avoid bottlenecks in which conflict can occur between family groups or individuals. In the absence of such bridges, single-strand rope bridges can also be effective. Canopy bridges are an inexpensive, minimally disruptive way of manipulating the habitat to provide primates (and other animals) with access to a larger area of habitat and food sources while minimizing the need for the animals to behave in stress-inducing or dangerous ways, such as descending to the ground to cross gaps (Das *et al.*, 2009).

In Sabah, the removal of large riparian trees along major tributaries of the Kinabatangan River resulted in the destruction of all natural bridges that were used by orangutans (and probably gibbons) to move across the landscape. As a result, these populations experienced further fragmentation (Jalil *et al*., 2008). The HUTAN–Kinabatangan Orang-utan Conservation Programme in Sabah decided to erect bridges that would enable these species to cross small tributaries or drains. The first bridges were built with used fire hoses, but these ropes degraded after a few years and needed regular monitoring and maintenance to prevent any fatal falls. The second bridge generation used weather-resistant ropes that do not decay under tropical weather conditions. Several types of bridges were erected: from single lines to a web-like design using up to five different intertwined lines. The widest gap between the two riverbanks was about 30 m and the height of the bridges was about 10 m above water level.

A major challenge was identifying suitable trees on both sides of the river that would be tall and strong enough to sustain the weight of these bridges. A total of eight bridges were erected and are now constantly monitored via direct observation and camera trapping. Monkeys and other small mammals started to use these bridges in a matter of hours or days, sometimes even before a bridge was fully established. It took several years for gibbons and orangutans to start using the bridges, however. Once they did, the frequency of passage by these two species increased steadily.

These bridges have proved to be effective ways to alleviate artificial travel bottlenecks for apes. They have also become a major attraction for tourists, who come to watch macaques (*Macaca* spp.) and proboscis monkeys (*Nasalis larvatus*) cross them. Regular monitoring is needed for maintenance purposes and to make sure that poachers do not ambush wildlife on or near the bridges.



of relocation areas to minimize the potential impact on apes. Following dismantling and destruction, rehabilitation activities to promote natural regeneration help to support repopulation by apes and other wildlife.

- **Developing and implementing ecological and social standards for large-scale infrastructure development and establishing certification criteria**. Certification can boost credibility, not only by satisfying legal or contractual requirements, but also by enhancing transparency and maintaining high standards. The infrastructure sector could take the lead from other industry-specific certification bodies, such as the FSC and the RSPO, which require adherance to sustainable practices to mitigate threats posed by industry and associated infrastructure. Other certification bodies—including future ones that might be focused on the large-scale infrastructure sector—could adopt similar ecological and social standards as part of their certification processes. By requiring such certification for large-scale infrastructure projects, lenders and donors would contribute to sustainable development.

Systematic monitoring of ape populations and people is a valuable means of assessing and demonstrating the usefulness of applied mitigation measures; it is also a reliable method for gathering evidence to inform management decisions. For details on the mitigation hierarchy, see Chapter 4 (pp. 119–128).

Reducing Knowledge Gaps

To date, there is a paucity of longitudinal data that could allow for a more comprehensive evaluation of the impacts of infrastructure on ape survival. At best, snap-shot data are available, but they are rarely published or easily accessible. Even when baseline data have been collected, they often become available only after the infrastructure has been put in place. The lack of data is an impediment to informing infrastructure development.

There is a clear need to undertake more longitudinal research into the impacts of infrastructure development on apes. Studies will be possible and relevant only if there is collaboration among those who are involved in the development, financing and use of infrastructure, namely private companies, governments and all other stakeholders. A first step in the promotion of studies that assess clear, scientific data gathered before, during and after infrastructure development is dialog between those who plan, finance and develop infrastructure and ape conservationists. Such collaboration can benefit both sides (see Box 2.3).

Some information is available about the correlation between roads on the one hand, and poaching and the decline of ape density in the vicinity of large-scale infrastructure on the other. Overall, however, there is a dearth of monitoring data on the short- and long-term impact of infrastructure development on ape survival. In view of such knowledge gaps and the issues highlighted in Table 2.1, urgent research questions include the following:

- How are apes using roads in relation to traffic intensity and road width?
- What are the best road and rail crossing mitigation strategies?
- At what point does traffic density on roads turn them into impermeable barriers for African and Asian great apes and gibbons?
- Are canopy and rope bridges effective tools for ape conservation? How many individuals or groups use them and for how long? What would be the ideal design for these bridges (see Box 2.2)?

Photo: Gibbons rarely come to the ground, so the construction of a road dissects their habitat and results in intense fragmentation. Wildlife bridges allow animals to cross artificial barriers. © Marc Ancrenaz/HUTAN–Kinabatangan Orang-utan Conservation Project

- What patterns emerge from short- and long-term monitoring data on road kills and injuries; health patterns (including human sanitary conditions); dust and airborne pollutants; and noise levels?
- What is the impact of power-line electrocution on gibbons and other apes? What devices could be effective in the prevention of electrocution (see Annex I)?
- How are great apes and gibbons affected by water-dependent infrastructure projects, such as hydropower dams and geothermal plants, given that rivers and large bodies of water can be significant natural barriers?
- To what extent do satellite communities that develop in proximity to infrastructure projects affect the local environment and biodiversity?

In the absence of data needed to evaluate the possible impact of infrastructure on ape survival, a cautious and preventive approach is necessary. It is difficult to predict the impact of some types of infrastructure due to the limited occurrence of certain structures, such as cable cars, in ape habitat. In the Virunga Volcanoes in East Africa, a proposed cable car would run through an area that was only recently re-inhabited by gorillas, members of one of the few ape populations that are currently increasing in size (Gray *et al*., 2013). With such a small population living in such a small habitat—about 500 gorillas in 450 km² (45,000 ha)—it seems too risky to assume that the impacts will not be great, in the absence of firm data to the contrary.

BOX 2.3

Private Industry and Ape Conservation

In 2006 a private company, the China Petroleum & Chemical Corporation, or SINOPEC, began an oil exploration concession in Loango National Park, Gabon. Initially, the company was conducting exploration work (using dynamite explosions along a grid of transects cut through the forest) without any environmental regulations, even though work was being carried out in a national park. Following discussions with the Gabonese Ministry of the Environment, non-governmental organizations (NGOs) and researchers, an environmental impact assessment was conducted to inform the second phase of exploration in 2007. The assessment resulted in guidelines that:

- forbade the use of chainsaws and mechanized vehicles;
- called for narrow transects and allowed only trees with a diameter of less than 10 cm at breast height to be cut down;
- forbade hunting; and
- stipulated that a bridge providing access to a large area of the park had to be destroyed after the exploration work was finished (Rabanal *et al*., 2010).

With the help of routine monitoring of the area, SINOPEC followed these guidelines. Nevertheless, the disturbance caused by the noise of dynamite explosions resulted in displacement of chimpanzees and gorillas from the area for several months after the work. The exploration did not result in further exploitation of the area for petroleum extraction and, ten years after the exploration, the main access road is greatly reduced in width as the forest is slowly regenerating.

In some cases, a company's interest in maintaining infrastructure may be compatible with conservation goals. One example involves the oil giant Shell, which, until mid-2017, operated one of the highest-producing onshore oilfields in sub-Saharan Africa—Rabi, located between two national parks in Gabon. The company strictly limited access to this area; it also forbade hunting and implemented other regulations that reduced incentives for staff to hunt. These rules were in place largely to protect the infrastructure of the petroleum concession, but they resulted in higher densities of large mammals in this area, as compared to nearby landscapes that do not receive such high levels of protection (Laurance *et al*., 2006).

Social Impacts of Infrastructure

Introduction

Wildlife conservation and human welfare cannot be considered in isolation from each other; both rely on the well-being of tropical forests as dynamic, ever-changing ecosystems. Such systems include human communities that depend on and are part of forests. To be fully effective, wildlife conservation initiatives also rely on the support of local communities. The consideration of potential social impacts of infrastructure development and the formulation of associated mitigation measures are key steps in

designing more effective strategies to prevent and minimize damage to these communities. At the same time, these steps can help to secure local support for efforts to protect wildlife and the environment.

Rather than attempting to cover the vast range of human societies affected by infrastructure development within ape range states, this section focuses on some forest-dwelling communities that retain an intimate knowledge of, and interaction with, complex tropical forests. By drawing on examples of oil pipelines, roads and railways in southern Cameroon, it examines the way industrial infrastructure development fuels deforestation. Analysing the impacts not only of infrastructure, but also of conservation-oriented attempts to offset the adverse effects such infrastructure has on indigenous peoples is critical to developing strategies to protect the forests on which both apes and such peoples depend.

Photo: Wildlife conservation and human welfare cannot be considered in isolation from each other; both rely on the well-being of tropical forests as dynamic, ever-changing ecosystems. © Jabruson (www.jabruson.photoshelter.com)

> "Wildlife conservation and human welfare cannot be considered in isolation from each other; both rely on the well-being of tropical forests as dynamic, ever-changing ecosystems."

Africa and Asia are home to relatively few indigenous hunter-gatherer populations that depend completely on forest resources, yet these continents are the most affected by activities that impact forests, including infrastructure. The prospecting, developing and operating of infrastructure have more extreme impacts on forest-dwelling peoples than on other communities that live near forest boundaries.

Forest peoples themselves have analyzed the dynamics involved in infrastructure development. In the Palangka Raya Declaration on Deforestation and the Rights of Forest Peoples of 2014, representatives of forest peoples from Asia, Africa and Latin America describe the situation as follows:

> Global efforts to curb deforestation are failing as forests are cleared faster than ever for agribusiness, timber and other land development schemes. We, forest peoples, are being pushed to the limits of our endurance just to survive. [. . .] Deforestation is unleashed when our rights are not protected and our lands and forests are taken over by industrial interests without our consent. The evidence is compelling that when our peoples' rights are secured then deforestation can be halted and even reversed (FPP, Pusaka and Pokker SHK, 2014, p. 117).

The Declaration goes on to highlight how the international bodies that are charged with halting deforestation are very often the same ones that are driving it:

> Global efforts promoted by agencies like the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) and the World Bank to address deforestation through market mechanisms are failing, not just because viable markets have not emerged, but because these efforts fail to take account of the multiple values of forests and, despite standards to the contrary, in practice are failing to respect our internationally recognised human rights. Contradictorily, many of these same agencies are promoting the take-over of our peoples' land and territories through their support for imposed development schemes, thereby further undermining national and global initiatives aimed at protecting forests (FPP *et al.*, 2014, pp. 117–18).

Numerous examples from around the world, along with multiple studies that highlight the role of indigenous peoples and other local communities in forest conservation, indicate that conservation can succeed if it is based on securing forest peoples' rights to their lands and supporting them in conserving their lands. The opposite approach to forest conservation—one that destroys indigenous peoples' forests for "development" or evicts them from their forest for "conservation"—has been shown to fail (Seymour, La Vina and Hite, 2014). A survey undertaken by the Center for International Forestry Research compared 40 protected areas and 33 community-managed forests in 16 countries and found that community-managed forests were more than 6 times better at avoiding deforestation than protected areas (Porter-Bolland *et al.*, 2012).[9]

Drivers and Impacts of Infrastructure in Cameroon

In relation to Cameroon, the Palangka Raya Declaration highlights that:

> logging, oil palm plantations and new infrastructure schemes are causing galloping deforestation, aided by colonial laws which deny our rights to our lands and forests and corrupt government officials who allocate our lands to other interests without regard for our welfare. Evictions are common and impoverishment results. Even protected areas set

> aside to compensate for forest loss restrict our livelihoods and deny our rights (FPP *et al.*, 2014, p. 118).

The major direct causes of deforestation and forest degradation in Cameroon are commercial logging, cultivation of cash crops (mainly cacao and coffee), agro-industrial plantations (rubber and oil palm) and the exploitation of minerals (FPP *et al.*, 2014, p. 42). More recently, forests have been opened up and destroyed by infrastructure projects such as roads, railways and oil pipelines, and hydroelectric power, including the aluminum smelter at Edéa (Dkamela, 2011, pp. 32–5). This section identifies the overall drivers and consequences of such infrastructure development and presents specific examples from the rainforest areas of southern Cameroon.

Southern Cameroon is dominated by equatorial rainforest and is relatively sparsely inhabited by indigenous Bagyeli and Baka forest hunter-gatherer communities (the minority) and Bantu farming communities (the majority) (Kidd and Kenrick, 2009, p. 17; Nguiffo, Kenfack and Mballa, 2009; Owono, 2001, p. 249). Although many Bantu are also long-term inhabitants of the forest, they nevertheless acknowledge the Bagyeli and Baka hunter-gatherers as the first inhabitants of the forest (Dkamela, 2011, p. 27; Kidd and Kenrick, 2009, p. 16; van den Berg and Biesbrouck, 2000).

Between 1990 and 2010, Cameroon lost close to 20% of its forest cover, largely as a result of commercial logging, the expansion of medium- and large-scale commercial agriculture, and a major infrastructure project, the Chad–Cameroon pipeline (de Wasseige *et al.*, 2013; Freudenthal, Nnah and Kenrick, 2011; Ndobe and Mantzel, 2014, p. 5).

In 2009, the government of Cameroon set out its ambitious "Vision 2035" for becoming an emerging economy within 25 years through major growth in export agribusiness, mining, commercial logging and infrastructure development. Much of this economic activity is geared to export-led growth, which entails the supply of international markets with timber, rubber, palm oil, minerals and commodities (Dkamela, 2011, pp. 32–6; Republic of Cameroon, 2009a). To date, the resulting impacts on forests, wildlife and forest-dependent communities have often been exacerbated by poor governance and corruption, as well as by smaller companies and local elites who use the infrastucture opened up by export-led economic activity to encroach on forests and generate income on domestic markets, often at the expense of customary communities.[10]

The government's development plans do not make provisions for legal reform of outdated land laws, nor for addressing governance and corruption issues. As stipulated in ordinances issued in 1974, land that is not registered as private property (including any non-registered forest land) is under the administration of the state, a continuation of the colonial *terra nullius* principle, under which lands owned by local communities were appropriated by colonial administrations (Alden Wily, 2011b, pp. 50–51).[11] In practice, this means that communities are denied any collective property rights to forests and lands that they have customarily occupied and used for their livelihoods.

Cameroonian government officials generally grant forest concessions to private interests without consulting or compensating impacted communities (Alden Wily, 2011b; Perram, 2015). Based on the 1994 Forestry Law, which allows for community forests of up to 50 km² (5,000 ha), some groups have been granted community forests, or temporary access or use rights in protected areas and logging concessions. Community forests can be granted to and managed by customary communities, but, counterintuitively, they can also be granted

> "Numerous examples and studies indicate that conservation can succeed if it is based on securing forest peoples' rights to their lands and supporting them in conserving their lands."

to and controlled by elite interests. Either way, communities generally gain little from these processes, since they are granted management but not tenure or property rights, and because they typically encounter widespread corruption and administrative barriers (Alden Wily, 2011b, pp. 66–83; Cuny, 2011).

At the international level, the principle of free, prior and informed consent (FPIC) is enshrined in the UN Declaration on the Rights of Indigenous Peoples (2007) and in International Labour Organization (ILO) Convention 169 (1989),[12] among other treaties. FPIC is embedded in the universal right to self-determination, which is itself embodied in legally binding instruments to which Cameroon is a party, such as the International Covenant on Economic, Social and Cultural Rights; the International Covenant on Civil and Political Rights; and the African Charter on Human and Peoples' Rights. Moreover, under Article 45 of its constitution, Cameroon is required to let its international law obligations take precedence over its national legislation (FAO *et al.*, 2016, pp. 12–13; Franco, 2014, p. 5; Perram, 2016, pp. 6–7).

Although the government is thus legally required to consult communities about any project that may affect their customary lands, indigenous peoples typically learn that their forest has been allocated to a concession or infrastructure project via the sudden arrival of survey teams. Such teams may proceed to install concrete waymarkers to delimit a concession boundary, cut trails to make a new roadline, or dig pits and remove cores for mineral exploration.

Regulatory and administrative ambiguities and challenges currently prevent local people from accessing adequate, reliable information about development projects on customary land and from asserting their rights with developers or the government (Perram, 2016). The Mining Code, for example, makes provision for mining companies to pay compensation to customary land rights holders, but it does not identify how these rights should be determined (Nguiffo, 2016; Republic of Cameroon, 2001, art. 89).

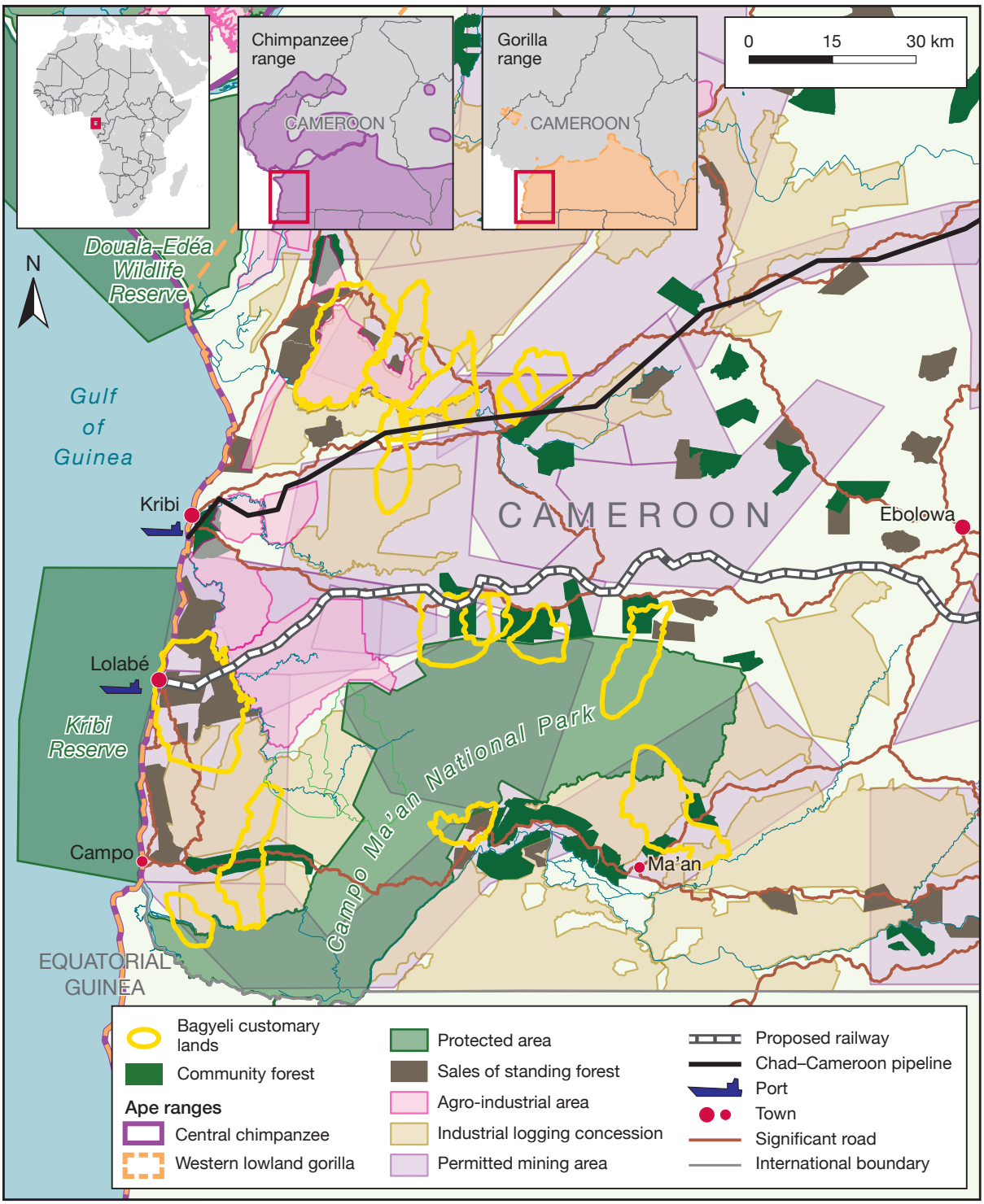
Meanwhile, permits for mineral exploration frequently overlap with protected land and established logging or commercial agriculture concessions (principally oil palm and rubber), reflecting not only disregard for legally binding conservation commitments and community rights to FPIC,[13] but also a lack of coordination between the ministries responsible for issuing different permits. Mining permits now reportedly cover almost 100,000 km² (10 million ha), or about 20% of the country's total land area (Nguiffo, 2016); many overlap with forested areas and designated permanent forest estates, and 20% coincide with protected areas, including national parks (Dkamela, 2011; Mitchard, 2012; see Figure 2.2). Mining companies that have begun extracting or that are currently prospecting include:

- Caminex, a former Cameroonian subsidiary of Afferro Mining, which was taken over by the UK-based International Mining and Infrastructure Corporation;
- Cam Iron S.A., a Cameroonian subsidiary 90% owned by the Australian company Sundance Resources Ltd.;
- Civil Mining & Construction Pty Ltd. of Australia;
- Geovic Cameroon PLC (GeoCam), based in the United States; and
- G-Stones Resources S.A. of Canada (KPMG, 2014; Meehan, 2013; Profundo, 2016; Sundance, 2016).

For some forest-dependent individuals, the impact of Cameroon's development trajectory is not entirely negative in the short term, even if the longer-term consequences for families, communities and the forest

FIGURE 2.2

Bagyeli Customary Land, Forests, and the Chad–Cameroon Oil Pipeline and Proposed Railway in Southwestern Cameroon, as of November 2016



itself often far outweigh immediate individual benefits. Those benefits can involve paid (but often short-term) employment opportunities, improved access to services and markets (as forest roads are often maintained by logging companies) and the arrival of mobile telephone masts in remote areas of rainforest. In some instances, developers promise to provide communities with healthcare facilities or school buildings on the basis of a "social contract" and, in principle, logging companies pay forest taxes. As observed by a Bagyeli man in 2014, however, such promises do not always materialize:

> We were promised 3 million CFA francs [US$5,000] as compensation for our land but so far we have received nothing. They told us this is development, yet we have no schools, no hospital and no transportation. The government did not respect its promise (FPP *et al.*, 2014, p. 44).

Cameroon's forest communities depend on the forest to provide them with food, clean water, shelter and medicinal plants. Forests are also the basis of the social and cultural identity and spirituality of the Bagyeli and Baka. Their customary practices are based on low-intensity hunting, freshwater fishing, gathering of wild honey and other forest products, and small-scale cultivation. For these communities, the negative consequences of large-scale deforestation and infrastructure development are varied and far-reaching (see Table 2.2).

The Chad–Cameroon Oil Pipeline

The Chad–Cameroon oil pipeline was constructed to transport crude oil from the oilfields of Doba in southern Chad, through Cameroon, and on to the coast at Kribi. On

TABLE 2.2

Infrastructure Developments and Impacts in Cameroon as of June 2017

Development	Impacts	Examples
Roads	In-migration, construction camps, poaching, artisanal logging, displacement	Djoum–Mbalam international road
Railway and port	Construction camps, displacement	Mbalam–Kribi proposed railway; Kribi deepwater port
Pipeline	In-migration, construction camps, commercial poaching, artisanal logging, displacement	Chad–Cameroon pipeline
Mining	Pollution and siltation of watercourses, loss of customary forests, destruction of sacred sites and medicinal trees, displacement, in-migration, commercial poaching, mining camps	G-Stones/BOCOM/MME Inc. mining Tsia sacred hill; Cam Iron mining sacred hill for iron ore at Mbalam
Commercial agriculture	Loss of customary forests, displacement, destruction of sacred sites and medicinal trees, extreme poverty	Oil palm and rubber by companies such as BioPalm Energy; Herakles Farms oil palm plantations; SOCAPALM; Sud-Cameroun Hévéa
Logging concession	Road construction facilitating poaching, loss of customary forests, destruction of sacred sites and medicinal trees, siltation of watercourses, in-migration, commercial poaching, mining camps	Logging concessions and standing sales such as 625,253 ha attributed to French timber group Rougier and 388,949 ha to Pallisco from the Pasquet group

Sources: Corridor Partnership (n.d.); Environmental Justice Atlas (n.d.); FPP *et al*. (2014); MME (n.d.)

the coast, the pipeline enters the ocean and, since 2003, the oil has been pumped to a stationary floating storage unit, from where it is offloaded onto tankers bound for the United States and Europe (IFC, n.d.).

Estimated at US$6.5 billion, the cost of construction was covered by the U.S. multinationals Exxon-Mobil and Chevron Texaco, Petronas of Malaysia and the International Finance Corporation of the World Bank. The southern portion of the pipeline, between Lolodorf and Kribi, traverses more than 100 km of rich biodiverse forest lands used by indigenous Bagyeli hunter-gatherer communities as well as local Bantu farming communities (Nelson, 2007, p. 2).

An 890-km stretch of the pipeline's total length of 1,070 km is on Cameroonian territory, where the route is 30 m wide. Its final 100 km have had a particularly destructive impact, especially on the Bagyeli hunter-gatherers and on the forest itself, including apes (Planet Survey/CED, 2003). Research has documented the adverse effects on the Bagyeli:

> Hunting is the most important Bagyeli activity, although they are also gatherers and increasingly farmers […]. Construction of the pipeline brought large numbers of trucks, heavy equipment, workers, and work camp followers, including poachers, into the region, negatively impacting this form of livelihood. The pipeline has resulted in making hunting increasingly difficult for the Bagyeli. They say they now need to walk for at least three days in the forest before finding animals. Before the pipeline, they say, the animals were right next door and easy to hunt. Poachers are one of the problems, increasing competition for game, while not respecting the traditional methods of hunting without irreparably damaging the balance of the ecosystem (Horta, 2012, p. 221).

While World Bank policy required the development of an indigenous peoples plan to counteract any adverse impact on the Bagyeli, a study conducted in 2001 found that the Bank itself had failed to provide adequate and culturally meaningful space to enable Bagyeli participation in the design of the indigenous peoples plan (Nelson, Kenrick and Jackson, 2001, p. 3). Specifically, the plan did not address the Bagyeli's main priorities, but instead focused solely on supporting Bagyeli agricultural, health and education programmes. These programmes rarely reached their intended beneficiaries and ignored the fundamental need the Bagyeli had expressed, namely the protection of customary rights to their forests, which would have helped to secure their access to the forest itself and to agricultural land (Nelson, 2007, p. 15).

For the Bagyeli, the destruction of the forest by the pipeline has had very direct and devastating consequences. As one Bagyeli healer explained:

> When the pipeline destroys the medicinal trees, it will destroy everything. I am a healer; I don't use the medicines of the hospital. I was born in the forest, I live in the forest, I will die in the forest. I live from the forest—the pipeline destroys the forest by which I live (Nelson *et al.*, 2001, p. 12).

Another Bagyeli described how the process of constructing the pipeline intensified the exploitation of the Bagyeli by their dominant Bantu neighbors (referred to as the Myi):

> The Bagyeli work on the pipeline and the Myi take the wages. The monkey travels on high, but the chimpanzee takes what the monkey finds. I don't want to talk of the pipeline, because the pipeline makes the Myi take from us (Nelson *et al.*, 2001, p. 12).

Meanwhile, the pipeline opened up the forest not only for poachers, but also for loggers. Together they combined to destroy the

rich biological diversity as well as the specific paths and places that made up the ecological and cultural richness that the Bagyeli always depended on and that had been sustained by their presence. A leading Bagyeli spokesperson, Madame Nouah, observed:

> The forest is very rich for us Pygmies, for us to nourish ourselves. Now we are afraid that things will be destroyed in the forest that are necessary and useful for us (Horta, 2012, p. 221).

Logging also removes non-timber products, such as honey and seeds, as well as other points of orientation. As a result of such losses, the Bagyeli are facing increasing poverty and "are now more frequently losing their orientation in the forest they used to know so well" (Horta, 2012, p. 221). In interviews, some Baka suggested that as the forest habitat became unrecognizable and filled with noise, humans, apes and other species most probably experienced disorientation and related disturbances in comparable ways.[14]

When "development" leads to the destruction of forests, the international community's standard response is to try to balance the damage with forest protection in the name of "conservation." This is exactly what happened in southern Cameroon:

> Since construction of the pipeline has led to the loss of important biodiversity in Cameroon's coastal forest, the World Bank's operational policy on Natural Habitats (OD 4.04) required the establishment of protected areas or national parks to compensate for these losses (Horta, 2012, p. 221).

The pipeline project gave the final justification and impetus for the establishment of Campo Ma'an National Park near Cameroon's coast (see Figure 2.2). The Campo Reserve had existed since 1932, but now funding for the national park came from the global fund managed by the World Bank's Global Environment Facility, which described the park "as part of the environmental compensation for the Chad–Cameroon pipeline project" (Owono, 2001, p. 248). As a result, hundreds of local Bagyeli communities were banned from hunting and gathering in many forest areas on which they had always relied, and so their livelihoods and ways of life became seriously threatened. The impact of this "green land grab" on the Bagyeli was severe:

> Previously, life within the Wildlife Reserve had been regulated, but with the creation of the park and the new funding which enabled the imposition of rules prohibiting access to the protected area and the use of any of the natural resources, the lives of the resident populations, especially the hunter-gathering Bagyeli Pygmies, have worsened. This is all the more paradoxical because the park was created as part of the environmental compensation for the Chad–Cameroon pipeline which, according to the World Bank, would help alleviate poverty. However, the establishment of the [park] will instead worsen the already precarious living conditions of the local hunter-gathering population (Owono, 2001, pp. 246–7).

As a case study on the implementation of the Chad–Cameroon pipeline notes, for peoples such as the Bagyeli, the forest is not so much a resource to be exploited or a wilderness to be protected; it is a place that is home, the source of livelihood and well-being. The Bagyeli have experienced the construction of the pipeline and the setting aside of land for conservation to compensate for the destruction of forests as a two-fold existential threat. First, the Bagyeli—along with the rest of their complex forest ecosystem—were severely impacted by the pipeline construction and concomitant disruption; second, the "compensation" for this disruption further marginalized the

community, impoverishing them and disrupting their lives (Planet Survey/CED, 2003, p. 12).

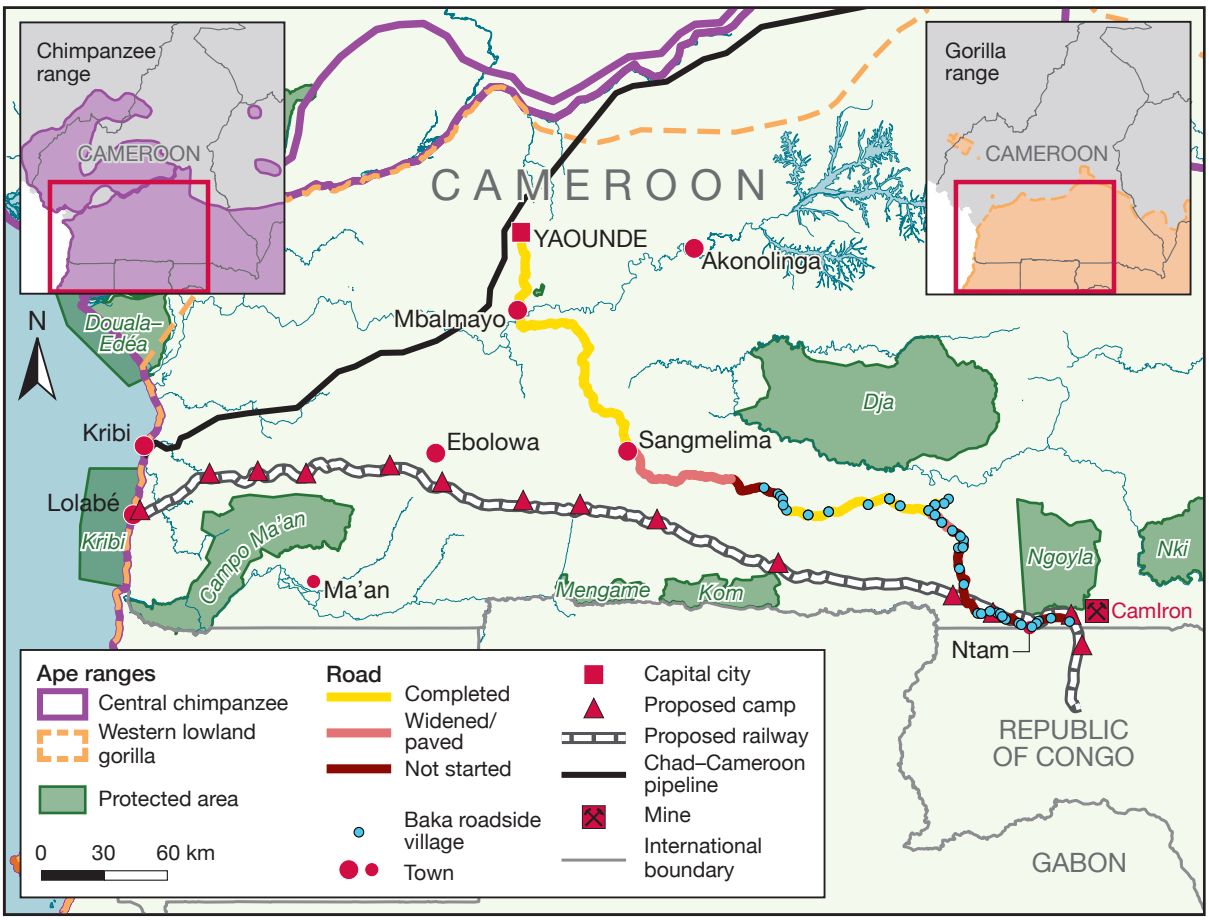
Like other forest peoples throughout the Congo Basin, the Bagyeli have been resilient despite centuries of discrimination by their more powerful neighbors and outsiders. As long as they have been able to move between the forests and the roadside Bantu villages, the Bagyeli have traded with their neighbors from a position of autonomy and resilience (Kenrick, 2006; Kenrick and Lewis, 2004; Kidd and Kenrick, 2011). Once they are no longer able to sustain their lives in the forest, however, the structural discrimination will become as permanent a feature of their lives as the poverty and sociocultural dislocation that resulted from having their forests destroyed by the pipeline. A conservation regime that excludes the Bagyeli from familiar places and from their hunting grounds effectively ignores their needs, their rights and their ability to sustain and be sustained by their forests (Kidd and Kenrick, 2011, pp. 16–21).

Road and Rail: Impacts of Extraction in South Cameroon

It has long been pointed out that Africa and Latin America are not intrinsically poor, but that so many of their inhabitants are poor

FIGURE 2.3

Ape Ranges and Road and Rail Impacts in Southern Cameroon, as of November 2016



because far more powerful outsiders, along with national elites, have sought to extract the plentiful resources of both continents (Cotula, 2016).

The map of road and rail infrastructure is a clear indicator of whether the wealth of a country is being used to benefit its inhabitants. Uruguayan writer Eduardo Galeano points out that his continent's infrastructure was developed in order to suck its wealth into the ports, and thence into the colonial and neo-colonial economy; that infrastructure, he argues, was designed to leave as little wealth behind as possible (Galeano, 2009).

Similarly, in southern Cameroon, the proposed and developing roads and railways—and the Chad–Cameroon oil pipeline discussed above—very clearly run to the coast at Kribi so as to facilitate the extraction of inland wealth, such as tropical timber and iron ore (see Figure 2.3). Meanwhile, key local transport roads within a radius of 100 km of Kribi remain unpaved and are unpassable without a four-wheel-drive vehicle for parts of the year.

The issue of impoverishment caused by wealth extraction cannot be considered simply in economic terms; it also needs to be assessed socioecologically. Can biodiversity and forest communities' traditional livelihood patterns survive such a process?

More specifically, it is an open question whether large-scale mining can coexist with forest conservation. Baka community members interviewed by the Forest Peoples Programme (FPP) said that preparations for iron ore mining in the south-eastern town of Mbalam had entailed the felling of large areas of forest. Meanwhile, Chinese-funded expansion of West Africa's first deepwater port at Kribi, the administrative capital of the Océan Department and the marine terminal for the Chad–Cameroon pipeline, has involved forest clearance to make way for roads, mineral terminals, a gas plant and other infrastructure (Smith, 2013). This activity has had a severe impact on the local Bagyeli, who were relocated and have since experienced reduced access to the forest, an increasing scarcity of forest products, and noise and pollution from nearby construction work (FPP *et al.*, 2014; Tucker, 2011).[15]

In the words of an older Bagyeli man named Bibera:

> The forest where we usually hunt and collect medicinal plants and non-timber forest products is disappearing, especially as the deep sea port, gas plant and roads are being constructed. The government has shown us a resettlement area, which has no forest, not even where you could find a tree to scratch the bark for medicine or hunt even a rat. We shall now be in the centre of the town; the railway line will be passing by us; roads are there; there is a gas plant. The calmness of the forest has been replaced by noise of vehicles and machines. Please tell the government to reserve us a place to go and collect medicines to heal our sick children. No one allows us to decide if we want to be resettled or not, and where. Everything is being imposed on us (FPP *et al.*, 2014, p. 45).

Two major infrastructure projects are designed to feed the ports at Kribi and Douala. The first, a transnational road from Yaoundé to the Republic of Congo, is intended to allow for the transport of finished goods to Yaoundé and Douala, and the outbound conveyance of primary commodities. International civil engineering firms are currently building the road (AfDB, 2015). The second is a proposed railway line that aims to link several mining projects throughout southern Cameroon and deliver their resources to Kribi on the coast. Although this project is currently on hold due to the low price of iron ore, Cameroonians and Australians are seeking funding to be able to resume work once the price has increased.

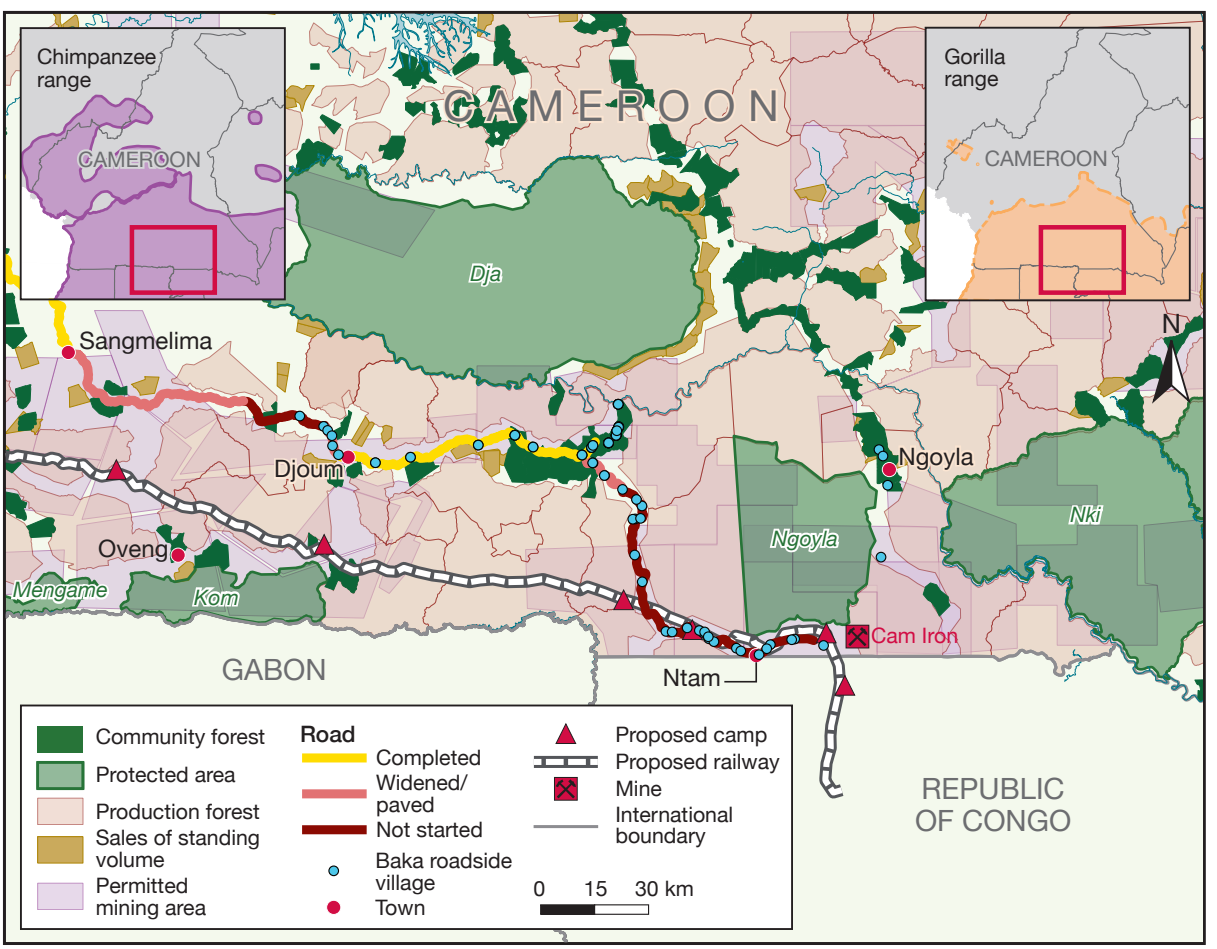
Sundance Resources continues to request support from China and other international financial markets (Mining Review Africa, 2016).

Figures 2.2, 2.4 and 2.5 highlight the impact—and the potential impact—of these two projects by overlaying the road and railway line onto the community forests and customary lands of the Bagyeli and Baka. Of particular concern is the area around Ntam in the far southeast, close to the Congolese border and the Cam Iron mine at Mbalam. In this part of Cameroon, the concentration of Baka roadside villages is high and the road and rerouted railway run alongside each other.

The settlement of Ntam is on a road that has yet to be upgraded, more than 100 km away from the part of the road that is being improved (see Figure 2.4). Nevertheless, in anticipation of the road's completion and arrival at Ntam, the settlement is gearing up to become a big trading post. A large customs building has already been constructed in the town; moreover, local sources indicate that significant tracts of nearby community forest land have already been "sold" to incoming state functionaries, their families

FIGURE 2.4

Community Forests, Protected Areas, and Road and Rail Impacts in Southern Cameroon, as of November 2016



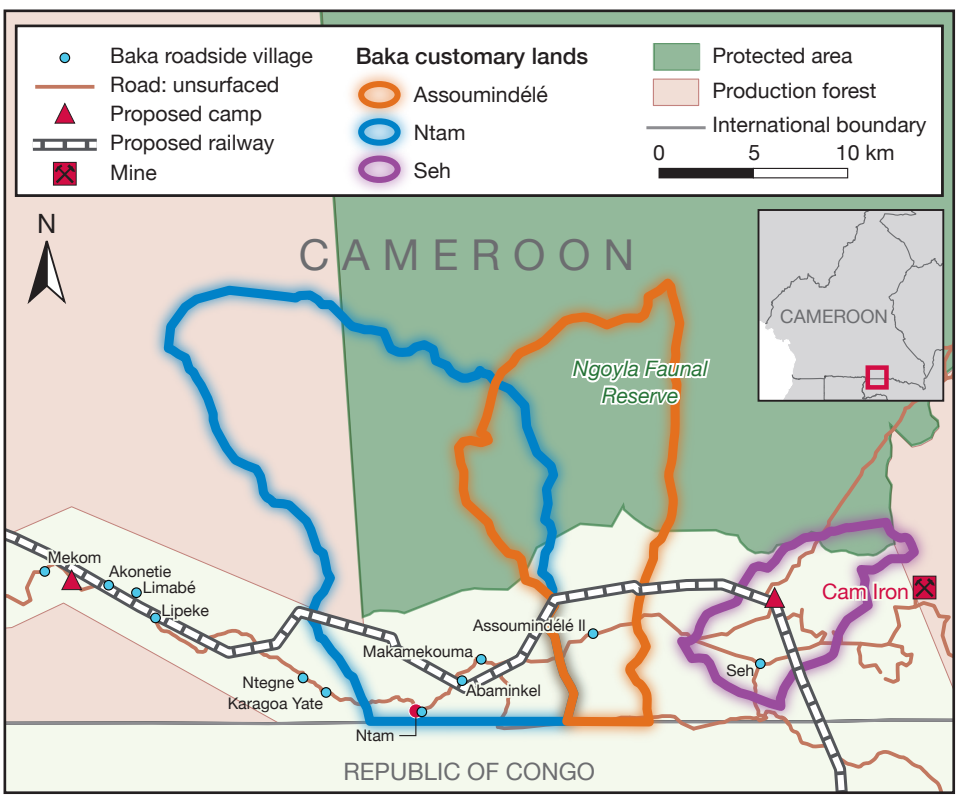
and others—not always lawfully (J. Willis, personal communication, 2016). Ntam's transformation shows that impacts of infrastructure projects also precede—rather than simply follow on from—development. Indeed, the mere anticipation of infrastructure development opens up the forest for exploitation by major players. Small traders, poachers, small-scale loggers and others also make their way into the area to start exploiting the forest in the expectation of an exponential increase in opportunities and in the demand for various services and products.

The dynamics involved in the railway are similar to those of the transnational road but even more destructive because the railway opens up swathes of forest far from the road. A key point to notice in the environmental and social impact assessment of the railway is the effect of the construction camps (Cam Iron and Rainbow Environment Consult, 2010). The space cleared to build such camps and the number of people expected to populate the sites are indicators of the likely impacts on the area, not least in terms of unsustainable wild meat extraction. While the proposed line of the railway was rerouted to avoid the forest ranges of gorillas and elephants, it was consequently positioned to run through a series of villages along the road corridor, which is certain to exacerbate disruptions to communities' livelihoods and increase conflict over resources (see Figure 2.5).

Both the local communities and the forest are extremely vulnerable in the face

FIGURE 2.5

Baka Customary Lands, Production Forests and Mining Permits near Ntam on the Road–Rail Corridor in Southern Cameroon, as of November 2016



of these developments. Affected communities are rarely consulted with respect to such projects; if they are informed, project proponents tend to focus exclusively on the positive aspects—substantially easier transport options, opportunities to sell forest products to those in transit, and reduced costs for goods coming from outside the community. Community members thus have a limited understanding of the negative impacts, including increases in criminal activity and significant pressures that development-related activities will place on the lands and forest in which they live.

During a recent meeting of Baka community representatives in Assoumindélé, 12 km from Ntam, a Baka NGO staff member raised the issue of Djoum, where the road had already been paved, noting:

> Djoum is already full—there is no land left, and now it is starting to cause disputes within families.[16]

The social impacts of the destruction of their socioecological context include growing rates of alcoholism and suicide among the Baka, increased conflict within and between communities, displacement of whole communities along development corridors and elite capture of community forest concessions by influential Bantu.[17]

The Baka communities along prime transport routes targeted for "improvement" are in an extremely precarious position, as are the Bantu. The Baka, and the Bagyeli in the west, still rely significantly on the forest for their livelihoods. They generally cannot claim possession of their forests under national law, and their customary use rights are frequently violated in practice, particularly if more powerful people stand to profit financially. For the Baka and Bagyeli, the loss of forest areas translates into a loss of livelihood. No suitable compensation can restore that livelihood, nor can they expect any economic benefits from the road, since its construction and associated activities lead to the disappearance of the habitat on which they depend.

Without the possibility of obtaining land titles, the Baka and Bagyeli recognize that moneyed and authoritative outsiders can put pressure on them that is hard to resist, especially if the benefits they are promised sound appealing.

Conclusions and Strategic Approaches

Forest communities in southern Cameroon, particularly indigenous Bagyeli and Baka communities, are unprepared for the radical changes that large-scale road and rail infrastructure projects impose on them. The direct impacts include a reduction in livelihood opportunities; an increase in commercial poaching; and restricted access to land that has been allocated to different concessions (including conservation offsets). The social impacts outlined above, including disorientation, displacement, depression and substance abuse, and intra-communal conflict, compound the situation.

In Cameroon, the meaningful and effective inclusion of indigenous communities in economic development planning is extremely rare. The country's ten-year Growth and Employment Strategy, the cornerstone of Vision 2035, is focused solely on building infrastructure for national and regional resource extraction. In the same vein, financial observers predict that "recent developments in Cameroon's road and rail networks are set to drive the region's economic growth" (Williams, 2015). Efforts to promote such infrastructure expansion—through economic policy and land use planning—are being shaped at the national level, among government and business elites, international development banks and international private capital.

> "The impacts of infrastructure development include a reduction in livelihood opportunities; an increase in commercial poaching; and restricted access to land that has been allocated to different concessions (including conservation offsets)."

These efforts aim to develop infrastructure networks that will facilitate national and regional resource extraction. Put differently, the infrastructure is not designed to enable farmers and forest communities to bring renewable resources to market, or to allow them to access social provisions. Such planning is arguably based on a model of economic growth that has failed to protect the environment, and that has been unable to create the conditions for secure and stable societies (Blaser, Feit and McRae, 2004; Edelman and Haugerud, 2005; Martinez-Alier, 2002; Mosse, 2005).

The need to support indigenous communities faced with such a bleak future is as urgent and challenging as the need to support non-human forest communities. Neither is likely to be supported by an approach that focuses on economic extraction alongside aggressive conservation tactics, rather than one focused on securing communities' ability first to retain their lands and then, on that basis, to pursue development that is compatible with their well-being.

Below are some current and potential strategies that can enable government, conservation organizations and industry to support communities to challenge and adapt to infrastructure development. More fundamentally, these steps can help them to reclaim their self-determination and an ability to sustain and be sustained by socio-ecologies on which all living beings ultimately depend:

- **Securing community tenure**: This step is critical to enabling recognition in the national legal system of indigenous peoples' and local communities' rights to self-determination, self-governance, FPIC and participation in decision-making processes that affect them. As mentioned above, Cameroon is party to a number of conventions that recognize such rights; enabling them to be recognized in national law and practice may also require an acknowledgment that such communities are the ones best placed to secure the forests. The Cameroon-based Centre pour l'Environnement et le Développement (Centre for Environment and Development), FPP, the Rights and Resources Initiative (RRI) and many other organizations support communities in the use of mapping, the identification of legal strategies and the development of the capacity needed to sustain community lands to advance their goals. Central among these goals is the inclusion of communities in infrastructure-related decision-making processes that are likely to affect them, particularly in view of the fact that indigenous peoples are rarely, if ever, consulted about infrastructure development.
- **Participatory mapping of customary territories**: In Cameroon and other countries that do not recognize customary land tenure as representing legal land title, presenting evidence of such tenure can help to persuade developers to recognize land rights. Participatory mapping is a tool developed by international NGOs and communities to provide georeferenced maps of customary land use boundaries and key resources and sites within those boundaries (using GPS and GIS tools). Maps and supporting information can be used by a community and its NGO allies to challenge a project (for example, to oppose a development or reroute a roadline); to protect key resources and sacred sites; and to make a case for compensation. In Cameroon, a project is under way to develop a common set of protocols for identifying and mapping community land use and tenure across the country's diverse social and ecological landscapes. The project, part of the RRI Tenure Facility, is starting to garner support for

the adoption of common mapping protocols by government agencies responsible for the application of relevant land laws and ordinances, as well as the potential support of the land holders themselves, key private sector operators, civil society actors and donor agencies.

- **Capacity building**: One way to support communities is to provide them with information about infrastructure projects and their human rights in relation to infrastructure projects, as defined in national and international laws.
- **Development of indigenous peoples' representative structures**: Combined with capacity building, support for the development of networks of forest communities (such as federations, local associations or advocacy platforms) enables indigenous community voices to reach the elites, government officials and company shareholders. In Cameroon, the development of Bagyeli and Baka associations and their convergence into the Gbabandi platform in 2016 is starting to open political space for their issues at the national and regional levels.
- **Safeguard monitoring and complaints procedures**: With training and appropriate legal support, communities and community-based organizations are monitoring safeguards that developers and funders, such as the World Bank and the African Development Bank, are obliged to observe. They are also lodging formal evidence-based complaints to their grievance procedures whenever systemic or repeated failures to implement safeguards are documented, including the right to FPIC.
- **Advocacy**: Opposition to large-scale infrastructure development can take many forms, from direct mediation between communities or community-based organizations and developers (using legal texts, participatory maps and monitoring evidence); coalitions of national and international NGOs with social and environmental agendas that place pressure on government agencies and donors; and Internet-based campaigns (such as Avaaz, Survival International and various rainforest action networks) that raise the profile of an issue and apply pressure through petitions and letter-writing campaigns.
- **Compensation**: It is important to monitor social agreements and other forms of compensation (such as logging taxes) that developers and concessionaires have agreed to pay to communities, as they often fail to deliver on their part of the bargain.
- **Adaptation**: Steps can be taken to support agriculture-based livelihoods in order to compensate for the loss of forest resources; to develop microcredit and savings schemes; and to encourage added-value processing and market development. These measures generally require partnerships between rights-based organizations that work on community self-determination and development NGOs and international agencies that are more focused on meeting the United Nations Sustainable Development Goals.

> "The protection of community land rights is often a prerequisite for the protection of the environment."

The protection of land rights is often a prerequisite for the protection of the environment, and community-based forest management works best when it is rooted in communities that are recognized as legitimate owners of forest ecosystems.

In contrast to Asia and Latin America, Africa provides limited evidence on how forest communities' customary tenure can slow and reverse the loss of indigenous forest. This poor performance reflects many African governments' reluctance to recognize such customary rights, as well as the fact that community forestry has largely been limited to co-management regimes (Blomley, 2013). As the international land

Photo: Cameroon is focused solely on building infrastructure for national and regional resource extraction; not to enable farmers and forest communities to bring renewable resources to market, or to allow them to access social provisions.
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tenure and resource governance specialist Liz Alden Wily has pointed out, however, "several states stand out as having purposely pursued democratic devolution of forest tenure, as well as management, in a bid to radically improve conservation" (Alden Wily, 2016, p. 11).

Alden Wily goes on to list Gambia, Liberia, Namibia and South Africa as countries in Africa that have advanced this process. She also notes: "Multiplication of community owned forests is especially advanced in Tanzania where, by 2012, 480 communities owned and managed their own forest reserves totaling 2.36 million hectares" (Alden Wily, 2016, p. 11).[18]

There is clear progress on community tenure of lands and forests in Africa, even though governments there remain far more reluctant to recognize such customary rights than those in Asia and Latin America (Alden Wily, 2011a, 2016; Nguiffo and Djeukam, 2008). In Asia, around a quarter of all forests had been brought under community ownership by 2009, and that percentage has been rising since (Alden Wily, 2016, p. 2).[19]

This rise in the proportion of community ownership of the world's natural forests reflects the growing recognition that community tenure is a prerequisite for sustainable forest management.[20] This shift is not only a result of acknowledgment that granting such community title is key to effective forest protection, but also a consequence of the fact that forests not owned by communities are more vulnerable to deforestation and are therefore vanishing.

The route to securing such rich and important forests is clear. As demonstrated in the discussed examples from Cameroon and in the relevant literature, however, the roadblocks are many. Concerted urgent action is required to remove those blocks, pursue that path and secure the forests that so many human, and non-human, communities experience as home.

Overall Conclusion

Infrastructure development in ape range states can disturb forest landscapes in ways that have significant, long-term effects on both people and wildlife. Such effects may involve the removal of important species, structural changes that affect the use of the forest, noise pollution, and increased traffic and movement. This chapter's review of the ecological and social impacts of infrastructure development shows that there is an urgent, widespread need to ensure that infrastructure planning processes include effective measures to protect apes, their habitat and local populations.

> "In the application of mitigation measures, particular care must be taken to avoid exacerbating any adverse impacts on indigenous peoples."

Specific recommendations to mitigate the negative direct and indirect impacts of infrastructure development before, during and after project construction include conducting thorough environmental and social impact assessments, as well as ongoing monitoring and data collection (see Chapter 1, pp. 31–38 and Box 1.6); enabling and prioritizing participation through free, prior and informed consent of local forest-dependent populations; and developing appropriate mitigation and adaptation measures to counter any construction-related damage (for more information on The Mitigation Hierarchy see Chapter 4, p. 119). In the application of mitigation measures, particular care must be taken to avoid exacerbating any adverse impacts on indigenous peoples. As discussed in this chapter, deforestation is more likely to be halted if stakeholders recognize forest peoples' land rights and support their age-old approaches to sustaining and being sustained by their ecosystems, than if they evict these communities from their lands in the name of "development" or "conservation."

Countless examples exist of how infrastructure projects have severely affected ape populations and pushed local communities further into poverty, yet counterexamples are hard to find. Unless more effective measures are put in place, governments and private industry will continue to enter forests and exploit natural resources without adequately consulting local communities, without understanding the risks and likely impacts, and without considering the survival or well-being of affected people and wildlife. It follows that unless the environmental, social and economic impacts of infrastructure development are considered in a more holistic way, indigenous communities and endangered species will continue to suffer. This chapter has outlined the main impacts of the business-as-usual model, as well as some of the key measures that can help to prevent and mitigate the harm.

Acknowledgments

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Endnotes

1 For the purposes of this chapter, the term *indigenous peoples* is used interchangeably with *forest peoples*, *forest-dwelling peoples* and *forest-dependent peoples*. The term *local communities* is broader: it also includes farming populations that are local by proximity but tend to see the forest as a resource to be exploited or cleared for agriculture, rather than something that sustains them.

2 For detailed information on the impact of tourism on apes, see Macfie and Williamson (2010).

3 For examples of long-term government plans for infrastructure development, see ETP (n.d.), Indonesia CMEA (2011), SEDIA (2008).

4 For details on the shifting of ranges among bonobos, see Hickey *et al.* (2013); among chimpanzees, see Fawcett (2000), Plumptre and Johns (2001), Plumptre, Reynolds and Bakuneeta (1997) and

Reynolds (2005); among chimpanzees and gorillas, see Rabanal *et al.* (2010); among gibbons, see Cheyne *et al.* (2016); and among orangutans, see Ancrenaz *et al.* (2010).

5 For information on chimpanzee road crossings in Bossou, Guinea, see Hockings (2011) and Hockings *et al.* (2006); in Bulindi, Uganda, see McLennan and Asiimwe (2016); and in Sebitoli, Uganda, see Cibot *et al.* (2015).

6 For details on the impact of human disturbance on African apes, see Junker *et al.* (2012); on bonobos, see Hickey *et al.* (2013); on chimpanzees, see Brncic *et al.* (2015) and Plumptre *et al.* (2010); on Grauer's gorillas, see Plumptre *et al.* (2016b); on mountain gorillas, see Van Gils and Kayijamahe (2010); on western gorillas, see Laurance *et al.* (2006); and on orangutans, see Wich *et al.* (2012b).

7 See, for example, Blake *et al.* (2007), Brncic *et al.* (2015), Geist and Lambin (2002), Hickey *et al.* (2013), Junker *et al.* (2012), Marshall *et al.* (2006), Murai *et al.* (2013), Plumptre *et al.* (2016b), Poulsen *et al.* (2009), Robinson *et al.* (1999), Wilkie *et al.* (2000).

8 For details on crop foraging by chimpanzees, see Hockings, Anderson and Matsuzawa (2009), Krief *et al.* (2014), McLennan and Ganzhorn (2017); by mountain gorillas, see Seiler and Robbins (2016); and by orangutans, see Ancrenaz *et al.* (2015b), Campbell-Smith *et al.* (2011b).

9 See also Chhatre and Agrawal (2009); Nelson and Chomitz (2011).

10 Unpublished FPP trip reports, 2006–17.

11 See, for example, Ordinance No. 74-1 of 6 July 1974 on establishing the rules governing land tenure (especially articles 1, 2, 14, 16) and Ordinance No. 74-2 of the same date on establishing the rules governing state lands (Alden Wily, 2011b, pp. 50–1).

12 Cameroon has not ratified ILO Convention 169; doing so would help cement FPIC as a right. To date, the Central African Republic is the only African country to have ratified the convention, and the island of Fiji the only Asian one (ILO, n.d.).

13 That FPIC is a legally enforceable right is apparent in key regional rulings. Those who seek to override community rights must prove that such action is necessary, proportionate and in the public interest. In a very practical sense, they have the right to have their claim heard and judged in relation to other rights claims. To justify non-consensual conservation measures such as the establishment of protected areas, states must demonstrate that such actions are "strictly necessary" and that "they have chosen the least restrictive option from a human rights perspective to satisfy the stated public interest" (MacKay, 2017).

14 Author interviews with Baka community members, Lomie, Cameroon, February 2010

15 FPP interviews with Bagyeli community members, Cameroon, 2014.

16 FPP staff member observation during a Baka community meeting, Assoumindélé, Cameroon, 2016.

17 FPP staff member observations during field trips to the region, Cameroon, 2016.

18 See also Kigula (2015) and MNRT (2012).

19 See also Oxfam, ILC and RRI (2016) and RRI (2016, 2017).

20 For examples of the growth of community tenure, see FPP, IIFB and CBD (2016).

21 HUTAN–Kinabatangan Orang-utan Conservation Programme (www.hutan.org.my) and IUCN SSC PSG Section on Great Apes.

22 Borneo Nature Foundation (www.borneonature foundation.org) and IUCN SSC PSG Section on Small Apes.

23 Durrell Institute of Conservation and Ecology (DICE), School of Anthropology and Conservation, University of Kent (www.kent.ac.uk/sac) and IUCN SSC PSG Section on Great Apes.

24 Max Planck Institute for Evolutionary Anthropology (www.eva.mpg.de) and IUCN SSC PSG Section on Great Apes.

25 All at Forest Peoples Programme (www.forest peoples.org) at time of writing.

26 Colobus Conservation (www.colobusconservation.org).