Photo: Dam construction tends to have substantial environmental and social ramifications. Grand Poubara dam, Gabon. © Marie-Claire Paiz/TNC

CHAPTER 6

Renewable Energy and the Conservation of Apes and Ape Habitat

Introduction

For thousands of years, humans around the world have been constructing dam-like structures to impound water for drinking and irrigation, to retain and control flood waters, to provide hydroelectric power, to allow for recreational amenities, and for various other purposes (Willems and Van Schaik, 2015). Yet, all too often, developers and regulators fail to consider the collective environmental, social and economic impacts of building dams, including the displacement of communities and the loss of ecosystem function and services (Babbitt, 2002; Poff *et al.*, 1997; Stanley and Doyle, 2003; WCD, 2000).

In 2000, the World Commission on Dams estimated that 40 to 80 million humans had

Photo: Direct impacts of dams include habitat fragmentation and loss due to the construction of dams, reservoirs and associated infrastructure, including new settlements for displaced communities. Construction of the new village of Ban Sam Sang, Lao PDR, for the relocation of four communities due to the construction of the Nam Ou Cascade Hydropower Project Dam 6. © In Pictures Ltd/Corbis via Getty Images

been displaced from their homes through the construction of dams (WCD, 2000). Dams can have major long-term consequences for river health, to the detriment of fish, wildlife and local communities that are reliant on the river system for drinking water, food, habitat and other uses (Brown *et al.*, 2009; Tilt, Braun and He, 2009; WCD, 2000). Even small dams can have a major impact on fish migration and downstream fisheries, water quality, downstream water supply and overall stream flow, including the natural transportation of sediment and nutrients needed to replenish downstream forests and floodplains (Poff *et al.*, 1997).

Hydropower, also known as hydroelectric power, generally provides low-carbon electricity and is often a primary source of energy for developing countries. Driven by the rising demand for electricity in developing economies, as well as a call for low-carbon energy as countries strive to meet emission goals, global hydropower capacity is projected to increase by 53%–77% between 2014 and 2040, and global electricity generation is expected to reach 6,000–6,900 terawatt hours (IEA, 2016, p. 249). This expansion is likely to entail the construction of thousands of large dams and tens of thousands of small dams.

Much of the hydropower potential is to be developed in the river valleys and mountainous areas of tropical regions in Africa and Asia. Since dam construction tends to have substantial environmental and social ramifications, the anticipated expansion of hydropower is certain to affect numerous communities and ecosystems, including great ape and gibbon habitats (Zarfl *et al.*, 2015). Regardless of the projected deleterious effects—and despite the availability of alternatives that are more sustainable, more cost-effective and less likely to marginalize certain social groups economically—the green-lighting of large hydropower projects appears to be unavoidable (DSU, 2016).

This chapter provides a review of the projected expansion of hydropower and the potential effects associated with the proliferation of dams, including the impact on apes and their habitat. It presents an initial estimate of the scope of this impact, assessed by overlaying projected dam build-out with the geographic range of great apes and gibbons. The chapter also features three case studies and a box that highlight best practices and strategies for avoiding and mitigating impacts.

With reference to the Lom Pangar Dam in Cameroon, the first case study considers the challenges of implementing best practices designed to protect apes once a project shifts from the planning to the construction phase. The second case study, which documents recent events in Sarawak, in Malaysian Borneo, explores how community activism and collaboration between communities and scientists can prevent the construction of destructive dams. These case studies are complemented by a box that focuses on a system-scale hydropower planning and design framework—"Hydropower by Design"—as a method to fuse planning for energy and water infrastructure with planning to maintain or restore environmental and social values. In recognition of the fact that hydropower is not the only form of renewable energy production associated with adverse impacts, this chapter features a final case study on the implications of a proposed geothermal plant in Sumatra's Leuser Ecosystem, alongside planned hydropower projects.

The chapter's key findings include:

- The negative impacts of dam construction on apes and their habitats across Africa and Asia are likely to increase over the coming years. Direct impacts include habitat fragmentation and loss due to the construction of dams and reservoirs, and of the roads and transmission lines associated with them; in turn, the roads facilitate access to habitats, thus enabling more widespread poaching and other indirect impacts.
- Hydropower development is likely to impact apes in Asia more significantly than in Africa, with gibbons identified as particularly vulnerable.
- Engagement, sharing knowledge and raising awareness of the potential adverse effects of large hydropower and other renewable energy projects can help at-risk communities avoid exposure to severe environmental and social impacts.
- Cost–benefit analysis is a key step in the planning phase of every large renewable energy project, particularly as it can reveal excessive environmental and social costs, issues related to carbon emissions and potential problems regarding delivery on economic objectives.
- The negative environmental and social impacts of dams and other large infrastructure projects are more likely to be minimized when their development planning incorporates a system-scale approach and draws on existing tools and processes, including the mitigation hierarchy.
- Once dam construction is in progress and mitigation measures have been implemented, ongoing monitoring and management of those measures are needed to verify that they remain effective. Given that both the life of a project and the attention of financiers tend to be finite, however, sustaining such activities represents a foreseeable and critical challenge to indefinite conservation.

Annex VII presents the reasons for, and the ramifications, of the decommissioning of dams.

Global Hydropower: Drivers and Trends

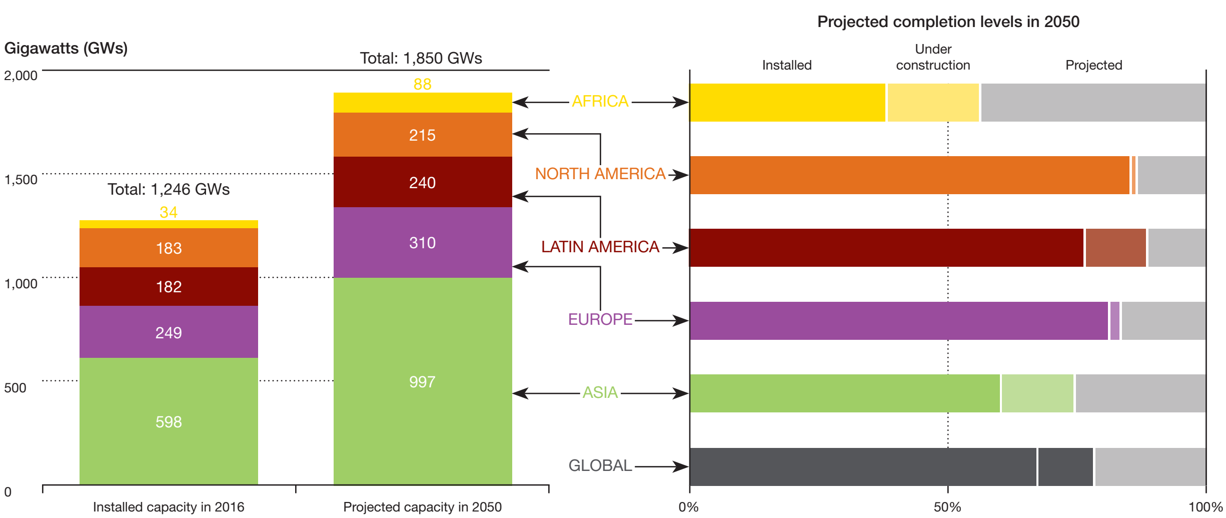
Hydropower accounts for approximately 16% of global electricity generation; it is the primary source of electricity in some countries, such as the Democratic Republic of Congo, Lao People's Democratic Republic (Lao PDR) and Uganda. As of 2014, hydropower represented more than 70% of all renewable electricity (IEA, 2016). Hydropower dams with storage capacity are essentially storing energy and are thus able to respond rapidly to changes in demand. Within an electrical grid, this storage function can facilitate a higher proportion of renewable sources with variable generation, such as wind and solar. Hydropower dams—both conventional and pumped storage—currently account for by far the greatest proportion of the world's electricity storage (Kumar *et al.*, 2011).

Due to the rising demand for electricity in general—and for low-carbon and storable energy in particular—hydropower is drawing about US$50 billion in investments per year, although investment in wind and solar have eclipsed hydro in recent years (Frankfurt School-UNEP Centre/BNEF, 2017). In 2014, the International Energy Agency forecast that by 2040, global hydropower output would grow by about 3,000 TWh, particularly if the world were to transition away from fossil fuel sources of energy to achieve the reduction in emissions necessary to keep global temperature increases below 2° C above pre-industrial values (IEA, 2016, p. 250). Much of this development is expected to occur in Asia, although Africa will see the greatest growth rate in installed hydropower capacity (see Figure 6.1). The majority of hydropower expansion (70%) will occur in river basins that have the greatest freshwater biodiversity and where the well-being of people—including their food sources, livelihoods and cultural values—is most directly tied to healthy rivers and intact valleys (Opperman, Grill and Hartmann, 2015; see Figure 6.2).

Figure 6.2 indicates that the hotspots for hydropower expansion include the river basins of the Amazon, the southern Andes, the Balkan region of southeast Europe, and

FIGURE 6.1

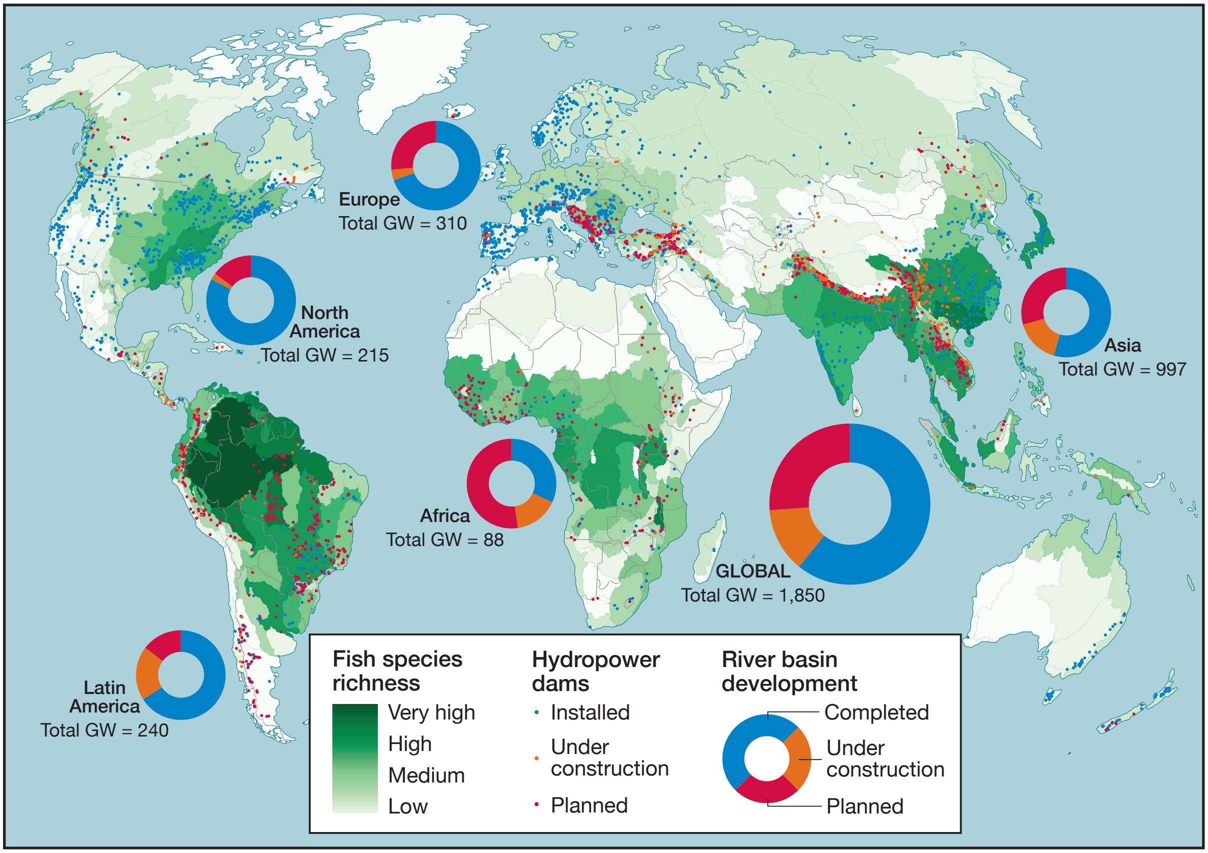
Global Installed and Projected Hydropower Capacity



Source: Opperman, Hartmann and Raepple (2017, p. 21), courtesy of TNC

FIGURE 6.2

Hydropower Development in 2015: Dams Installed, under Construction and Planned



Adapted from: Opperman *et al*. (2015, pp. 16–17), courtesy of TNC

Data sources: Abell *et al*. (2008); IEA (2012); Lehner *et al*. (2011); Zarfl *et al*. (2015)

several regions that support ape populations: South and Southeast Asia (Cambodia, India, Lao PDR, Myanmar and Nepal) and vast areas of Africa.

Impacts of Hydropower

Extensive research has been undertaken on the environmental and social impacts of hydropower projects.[1] In addition to affecting the connectivity of organisms, nutrient flows, upstream and downstream resources, such projects typically involve the construction of associated infrastructure and significant greenhouse gas emissions, as follows:

Hydrological connectivity. Hydropower dams and reservoirs affect the downstream transport of wood, sediment and nutrients and disrupt the up- and downstream movement of organisms, including fish and invertebrates (March *et al*., 2003). Declines in fish populations negatively affect human communities that rely on migratory fish for food, both up- and downstream (Richter *et al*., 2010).

Impacts on upstream resources, including terrestrial habitats. The impacts on upstream resources typically receive the most attention in debates about dam development. For one, reservoirs behind large dams typically inundate agricultural land

and natural ecosystems, such as wetlands and forests (WCD, 2000). Perhaps more controversially, large dam development can displace human communities, raising serious social justice questions, as those who are displaced are often poor and lack political influence (Scudder, 2005). Terrestrial species, such as apes, are directly affected by impoundment; as reservoirs fill up and forests are replaced by open water, animals who are not killed in the process suffer a permanent loss of habitat. Further, hydropower reservoirs can convert previously passable river channels into impassable barriers for terrestrial apes and other species (WCD, 2000). Thus, hydropower dams and their reservoirs fragment ape habitat and affect dispersal.

Impacts on downstream resources. The impacts of dams on downstream environmental resources tend to be far greater than the upstream impacts, even if they attract less attention. As human livelihoods and communities are often directly tied to functioning river ecosystems, downstream environmental impacts can have considerable social costs (Richter *et al.*, 2010). Large reservoirs trap nearly all sediment, except for the smallest grain sizes, thereby disrupting the delivery of sediment and nutrients to downstream ecosystems, such as floodplains and deltas (Kondolf, Rubin and Minear, 2014). By altering river flows, dams also impair biological processes on which fish, floodplain forests, and other downstream species and ecosystems depend.

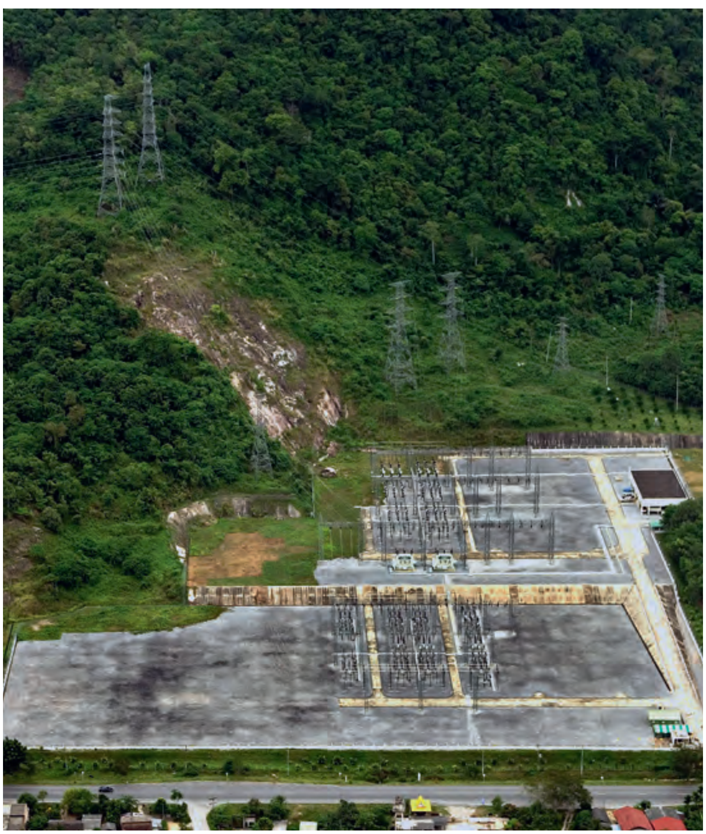
Impacts due to dam construction. In addition to a dam and a reservoir, hydropower development generally requires the construction of access roads and transmission lines, both of which can fragment forests and other habitats, affecting wildlife habitat and movement (Andrews, 1990). Roads, in particular, facilitate access to previously inaccessible areas, leading to an increase in settlement, forest clearing and hunting. During construction, major projects require thousands, or even tens of thousands of workers; in tropical forest regions of Southeast Asia and Africa, temporary settlements near dam sites have been associated with an increase in wild meat hunting (Laurance, Gooseman and Laurance, 2009).

Greenhouse gas emissions. Although hydroelectric dams are widely considered a low-carbon energy option, some reservoirs produce high emissions of greenhouse gases. Reservoirs produce significant amounts of methane, carbon dioxide and nitrous oxide when the land is flooded and organic matter rots and decays. Large dams[2] are the greatest single anthropogenic source of methane, responsible for roughly 30% of all anthropogenic methane emissions (Lima *et al.*, 2007, p. 201). The thermal, chemical and biological conditions in reservoirs in the tropics lead to higher methane emissions than those associated with reservoirs elsewhere (Fearnside, 2016a; Lima *et al.*, 2007). Other dam-related greenhouse gas emissions are linked to the use of fossil fuels during site excavation and building materials such as concrete in dam construction, land clearing for reservoirs, resettlement sites, transmission lines and access roads, and the expansion of irrigated agriculture (Houghton *et al.*, 2012; Pacca and Horvath, 2002).

Studies of the impact of hydropower projects around the world can be instructive with reference to mitigating effects on great apes and gibbons. As suggested above, the process of impounding a reservoir behind a hydropower dam involves the conversion of wildlife habitat, such as forest, into open water, and thus the direct loss of habitat. In addition, reservoirs fragment blocks of habitat and potentially obstruct dispersal routes, as has been the case for giant pandas (*Ailuropoda melanoleuca*) in China (Zhang *et al.*, 2007). A recent study of connectivity corridors in Brazil shows that roads and hydropower reservoirs are among the most

Photo: In addition to a dam and a reservoir, hydropower development generally requires the construction of access roads and transmission lines, both of which fragment forests and other habitats. An electric relay supplied by hydroelectric power from the Bang Dang dam, Thailand. © Thierry Falise/LightRocket via Getty Images

significant variables associated with the impairment of dispersal among jaguars (*Panthera onca*) (Silveira *et al.*, 2014). Similarly, in Costa Rica, the Reventazón hydropower project fragmented a jaguar dispersal corridor; to "offset" the negative impact of the reservoir, the developer funded reforestation of land adjacent to the inundated area to maintain a forested dispersal corridor (IDB, n.d.). Developers also used a biodiversity offset in Cameroon, where a forest reserve was elevated to a national park to compensate for the adverse environmental impacts of the Lom Pangar Dam (see Case Study 6.1). As noted above, the construction of roads and transmission lines linked to hydropower projects can also fragment wildlife habitat (Andrews, 1990; White and Fa, 2014). In discussing the various impacts of hydropower, the chapter highlights potential effects on apes and their habitat.



Hydropower and Apes

The academic literature provides limited information on how hydropower dams and reservoirs affect apes and their habitats (see Chapter 2, pp. 43–60). Since hundreds of dams are proposed within the habitats of great apes and gibbons, assessments of the impact of hydropower expansion are key to the conservation of these species and their habitats.

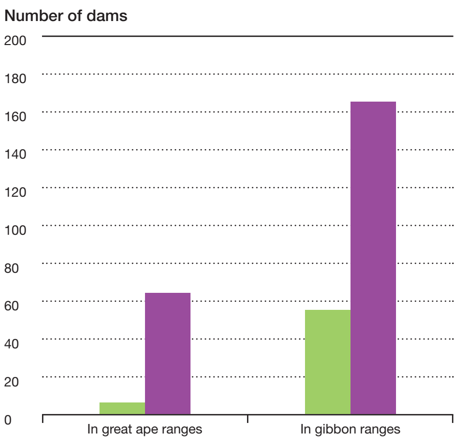
This section presents a simple spatial analysis that was conducted to assess the extent to which hydropower expansion could affect great apes and gibbons and their habitat. The analysis rests on two calculations: (1) the number of installed and planned hydropower dams in ape habitat; and (2) the potential length of new roads associated with planned hydropower dams. Given the lack of information on reservoirs and operations associated with potential future dams, this assessment does not evaluate the impacts of reservoirs, flow alteration, sediment delivery or greenhouse gas emissions, nor does it consider the impacts of resettlement areas, work camps, quarries or other associated infrastructure, or disturbances from transmission lines (see Annex I).

To identify installed and planned hydropower dams, this assessment draws on two sources: (1) the Global Reservoir and Dam (GRanD) Database for installed dams, and (2) a data set of future hydropower dams, which comprises dams that are either under construction or identified in planning documents (Lehner *et al.*, 2011; Zarfl *et al.*, 2015). The GRanD Database covers all types of dams, yet the majority of structures in ape ranges are hydropower dams, or multipurpose dams that include hydropower (Opperman *et al.*, 2015). The species ranges for great apes and gibbons were mapped based on information in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2016b).

FIGURE 6.3

Number of Installed and Future Hydropower Dams in the Ranges of Great Apes and Gibbons

Key: Installed dams
Dams planned or under construction



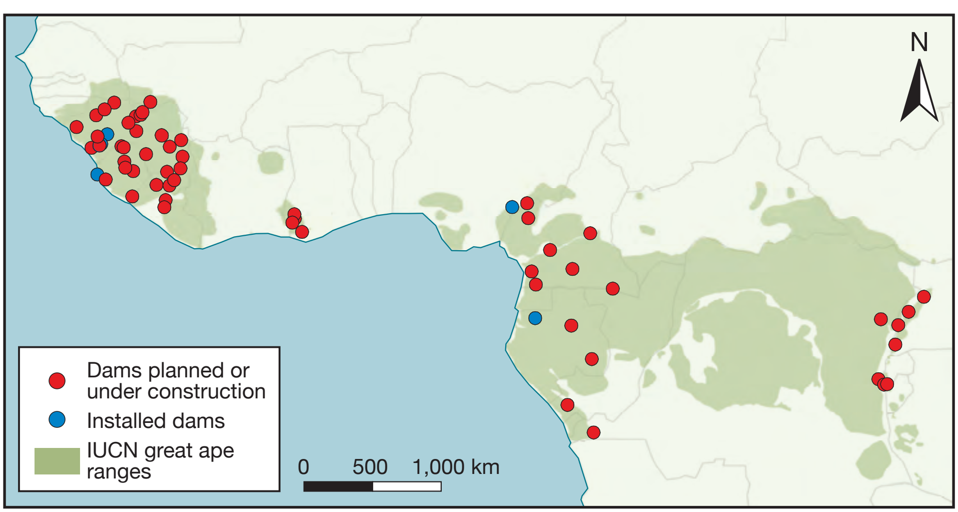
Data sources: IUCN (2016b); Lehner *et al*. (2011); Zarfl *et al*. (2015)

The number of hydropower dams in each ape range was quantified by identifying the intersection of dam locations with great ape and gibbon species ranges. The next step was to estimate the length of new roads associated with hydropower dams that are planned or under construction. It involved calculating the potential road distance between future dams and the roads closest to them based on a "least-cost path" or "path of least resistance," while also taking the local topography into consideration.

Importantly, both of the global data sets from which dam locations were derived—the GRanD Database and the data set of future dams—contain errors of omission and commission. Greater precision on dam locations may be available from finer-scale analyses that use data collected solely within the geographic range of ape species. Dam data collected at a finer scale may also include additional information that could be used to further improve the quantification of impacts on ape habitat. If, for example, dam data included the size of work camps at each dam, that information could be used to generate a more refined estimate of impacts. Further, the species range data may also contain errors. For instance, some proposed dams that are known to overlap with orang-utan habitat are not included in the data-sets used in this analysis (see Case Study 6.3). Nor does this study capture certain installed

FIGURE 6.4

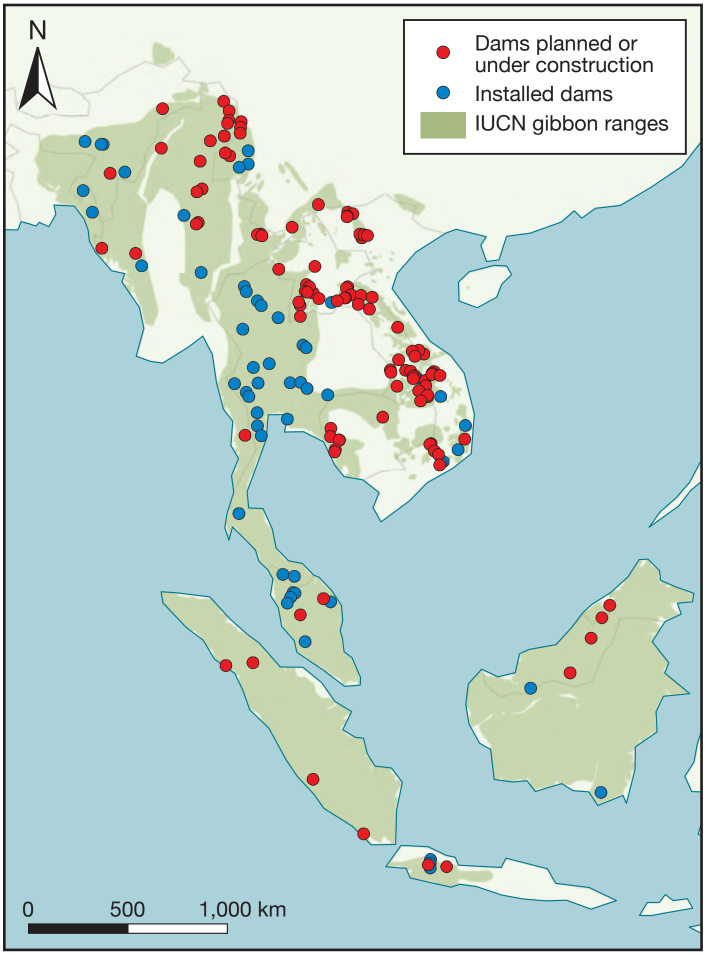
Installed and Future Dams in the Ranges of Great Apes in Africa



Sources: IUCN (2016b); Lehner *et al*. (2011); Zarfl *et al*. (2015)

FIGURE 6.5

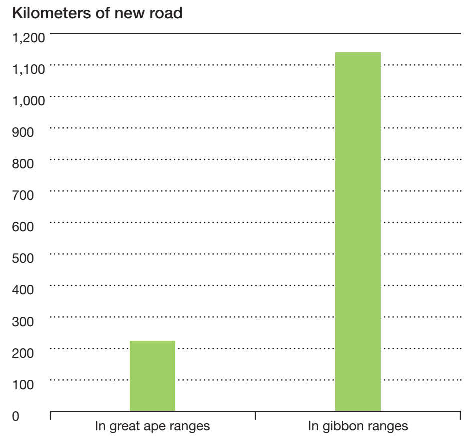
Installed and Future Dams in the Ranges of Gibbon Species in Asia



Sources: IUCN (2016b); Lehner *et al*. (2011); Zarfl *et al*. (2015)

FIGURE 6.6

Estimated Length of New Roads Associated with Construction of Future Hydropower Dams in Ape Ranges



Data sources: IUCN (2016b); Lehner *et al*. (2011); Zarfl *et al*. (2015)

and planned dams that are sited near species ranges and that can thus have a deleterious impact on apes.

Nevertheless, the available data allow for a preliminary assessment of the potential impact of hydropower dams on great apes. The analysis can be used to call attention to the potential challenges of conservation management and to allow governments, scientists, conservation practitioners and the hydropower sector to begin developing strategies for avoiding, minimizing and mitigating impacts.

Results indicate that the impact of hydropower dams within great ape ranges will probably increase considerably in the coming decades (see Figures 6.4 and 6.5). Only six installed dams in the GRanD Database fall within the range of great apes, all in Africa. The number of dams affecting great apes could increase ten-fold, however, as 64 future dams are anticipated within the range of great apes—again, all in Africa. Similarly, the impact of hydropower within gibbon ranges is likely to increase considerably, from 55 dams to 165 (see Figures 6.3 and 6.5). Preliminary estimates indicate that hydropower expansion could lead to the construction of more than 200 km of new roads in great ape ranges and more than 1,100 km of new roads in gibbon ranges (see Figure 6.6).

As noted above, these data sets are known to include errors of commission and omission. The data set of future hydropower dams, for example, excludes a project that has been proposed in the Batang Toru ecosystem of North Sumatra, within the range of orangutans (Zarfl *et al*., 2015).

▶ p. 195

CASE STUDY 6.1

The Lom Pangar Hydropower Dam: Infrastructure and Ape Conservation in Cameroon

Introduction

Cameroon forms part of the Congo Basin rainforest and is home to some of the highest biodiversity on the continent. Its rich biodiversity, which represents 92% of Africa's ecosystems, includes significant populations of great apes, such as the western lowland gorilla (*Gorilla gorilla gorilla*) and the central chimpanzee (*Pan troglodytes troglodytes*), two endangered species whose habitats are in the rainforest (Republic of Cameroon, 2012). By dispersing seeds and maintaining forest health, these "forest gardeners" help to sustain the rich biodiversity in Cameroon.

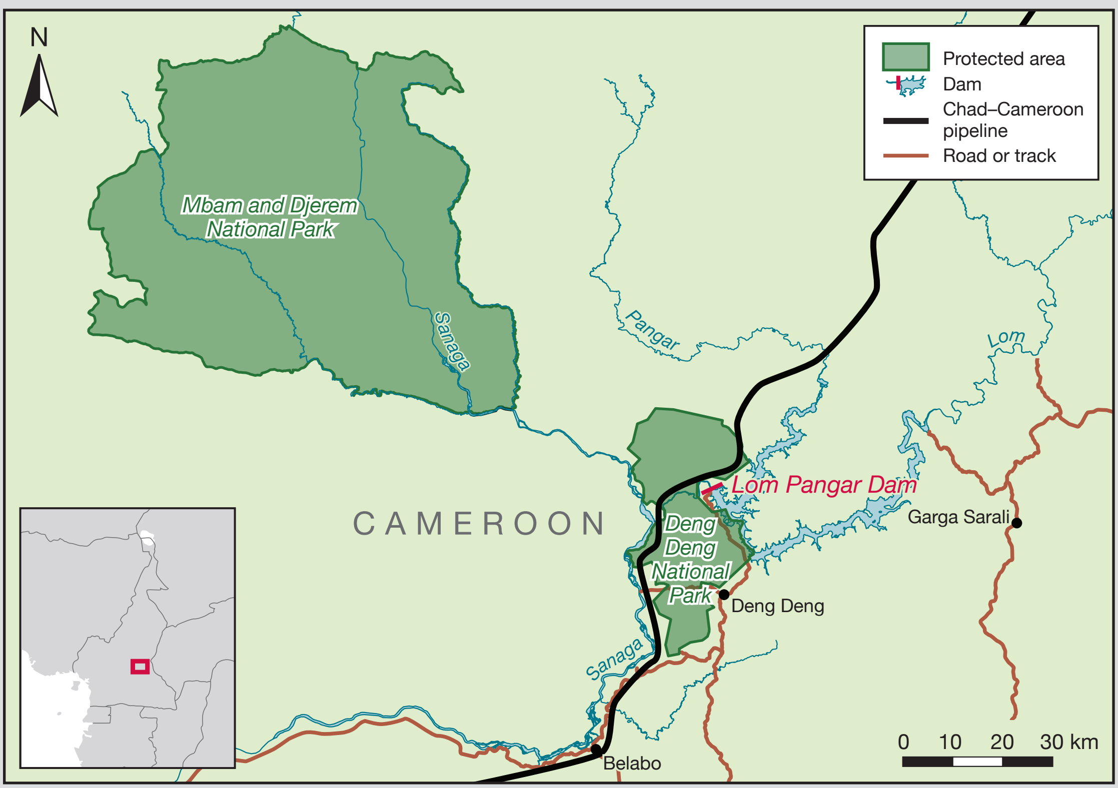
Regardless of their role as keystone species, great ape populations are undergoing a dramatic decline, largely due to poaching, disease and habitat loss, which are driven by demands for wild meat, a lack of law enforcement, corruption and increased access to their once-remote habitat (Dinsi and Eyebe, 2016). Although Cameroon has made some effort to protect gorillas and chimpanzees—including by creating protected areas such as sanctuaries, reserves and national parks (Lambi *et al*., 2012)—the ongoing expansion of industrial agriculture, logging, mining and infrastructure development projects will result in massive losses of habitat unless rapid, targeted action is taken.

In order to achieve its goal of becoming an emerging economy by 2035, Cameroon, a developing and still largely agrarian country, has prioritized infrastructure development. Part of the plan is to add 3,250 km of tarred roads between 2010 and 2020, alongside the construction of new railway lines. Meanwhile, the country aims to reduce the gap between the supply and demand for energy through the construction of several hydroelectric plants and dams, a heavy fuel thermal power plant and a natural gas power station (Republic of Cameroon, 2009b, pp. 59, 61–3). Expanding energy generation is central to the government's ambitions.

Cameroon's energy deficit is considered a serious impediment to its economic growth and development. In 2010, the

FIGURE 6.7

The Lom Pangar Hydropower Dam and Surrounding Area



Sources: © OpenStreetMap contributors (www.openstreetmap.org); UNEP-WCMC and IUCN (n.d.)

country's total installed electricity capacity—comprising on-grid, self-generation and off-grid—stood below 2,000 MW. Hydropower plants accounted for about 73% of the total electricity produced in Cameroon in 2011, and thermal energy and solar sources made up some of the remainder. In order to increase installed hydropower capacity from about 719 MW in 2010 to 3,000 MW by 2020, the government intends to invest heavily in the energy sector (Africa–EU Energy Partnership, 2013). The Lom Pangar Hydropower Project (LPHP) was a critical first step in expanding Cameroon's energy production. This section explores the project's environmental impacts as well as efforts to mitigate them.

The Lom Pangar Dam

Cameroon relies on the LPHP as part of its efforts to provide a long-term solution to its energy supply gap. The primary purpose of the LPHP, which is designed to produce a modest 30 MW of electricity at the dam site, is to regulate the flow of the Sanaga River so as to increase and secure year-round power output for two existing downstream dams and an additional planned dam. While some estimates show that fewer than 20% of rural Cameroonians have access to electricity, the main purpose of the Lom Pangar scheme and the dams that it facilitates downstream will not significantly enhance rural electrification. Instead, the LPHP is geared towards expansion of the aluminum smelters owned by Rio Tinto, the world's largest mining company, which receives electricity at preferential rates (Ndobe and Klemm, 2014).

The management of the Lom Pangar Dam was handed over to the national Electricity Development Corporation in June 2017. A second phase that includes the construction of a 30-MW hydropower plant and electrification of 13 localities in the East Region is ongoing (BRM, 2017; ESI Africa, 2017; World Bank, 2012a). The dam is located in a remote part of eastern Cameroon, near the confluence of the Lom and Pangar rivers. Financing for the LPHP is drawn from a pool of donors, comprised of the African Development Bank, the Development Bank of Central African States, the European Investment Bank, the French Development Agency and the World Bank (ADF, 2011). The total cost of the construction of the dam and associated infrastructure is just under US$500 million (Ndobe and Klemm, 2014).

As the lead financier on the project, the World Bank assigned the project its highest environmental and social risk rating, Category A (see Box 5.1 and Annex VI). This categorization is reserved for projects that are likely to have significant adverse environmental impacts. The project received this rating in part since "the dam site is located next to portions of the Deng Deng Forest that are critical habitats, particularly because of the presence of a viable population of gorillas, and a significant population of chimpanzees" (World Bank, 2009, p. 5).

The Deng Deng National Park

The Deng Deng National Park (DDNP), which overlaps with the LPHP area, harbors a significant population of the northernmost population of the western lowland gorilla. In 2010, the Wildlife Conservation Society estimated that 300–500 gorillas lived inside the DDNP and in an adjacent logging concession (Live Science, 2011). The DDNP is also home to other threatened mammal species, including the central chimpanzee, black colobus (*Colobe satanas*), elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*) and giant pangolin (*Smutsia gigantea*) (Boutot *et al*., 2005; EDC, 2011b).

When the World Bank agreed to finance the Chad–Cameroon oil pipeline in 1998, it insisted that the pipeline be rerouted to avoid any impacts on the Deng Deng Forest and its biodiversity (Dames and Moore, 1997; World Bank, n.d.-c). In fact, the potential impacts on the forest are among the reasons the Bank was reluctant to support the LPHP when Cameroon first sought financing in the early 2000s. At that time, the World Bank requested an environmental and social impact assessment (ESIA) to ensure that the LPHP would not have adverse effects on the Deng Deng Forest. In its review of the ESIA, the Bank cited concerns over potential impacts on great apes, especially during the construction phase, because of the large number of people expected to move to the area (EDC, 2011a, 2011b).

In 2012, in a sudden reversal of its earlier position, the World Bank decided to help finance the LPHP even though a portion of the Deng Deng Forest would be flooded by the dam's reservoir. To offset[3] impacts, the Bank required that the forest's status be upgraded from a forest reserve to a national park (World Bank, 2012a, 2012b). The Deng Deng National Park was thus created by decree on March 18, 2010; its surface area, which initially covered 523 km^2 (52,374 ha), was extended to 682 km^2 (68,200 ha) in 2013. The Wildlife Conservation Society provides technical assistance in the management of the DDNP, based on an ad hoc service contract with Cameroon's Ministry of Forests and Wildlife and its Electricity Development Corporation, with financial support from the French Development Agency (WCS, 2015b).

An enlarged Deng Deng functional ecosystem, referred to as the Deng Deng Technical Operations Unit, was created in 2010. Although it is yet to be gazetted, it includes the DDNP, two forest logging concessions, close to 20 community forests and two research forests. The Unit is spread out over a surface area of about 5,000 km^2 (500,000 ha); it harbors an estimated 990 gorillas who are roughly equally divided between the DDNP and the periphery of the park (IUCN, 2014c; Kormos *et al*., 2014). One proposal involves the creation of an additional national park, the Lom Pangar National Park, to counteract hunting in the Mbam and Djerem National Park following development of the dam and the Chad–Cameroon pipeline. The proposed park would cover 1,775 km^2 (177,480 ha) within the dam project area and the pipeline corridor (Haskoning (Nederland B.V. Environment), 2011).

Threats to the Deng Deng Great Apes

While the creation and expansion of the DDNP were welcome conservation steps, significant threats to the great apes, as well as their habitat, remain. These include flooding, poaching, electrocution, and habitat degradation and

Photo: The Chad–Cameroon pipeline cuts through the Cameroonian rainforest. It was rerouted to avoid the Deng Deng forest, a portion of which will be flooded by the Lom Pangar Hydropower Project. © Gail Fisher/Los Angeles Times via Getty Images

loss, coupled with hunting pressures associated with artisanal mining.

Flooding

In September 2015, the contractors of the LPHP began a partial impoundment, or filling, of the dam's reservoir (EDC, n.d.-b). This step was highlighted in the project's ESIA (EDC, 2011b). Non-governmental organizations (NGOs) expressed significant concern that the full impoundment of the reservoir, which would cover approximately 590 km^2 (59,000 ha), about 320 km^2 (32,000 ha) of which is forest, would flood critical habitat of the gorillas, trapping them on islands or pushing them into populated areas (GVC, BIC and IRN, 2006). As a result, gorillas would be more exposed to poachers, the risk of disease transmission would grow due to more frequent contact with people, and human–wildlife conflict would increase in line with crop raiding (Kalpers *et al.*, 2011). Many other, slower-moving species would likely drown during this phase.

Poaching

Large infrastructure projects tend to attract a huge influx of migrants in search of employment opportunities (WCS, 2011). In fact, the LPHP's own ESIA indicates that an estimated 7,000 to 10,000 people were expected to move to the area seeking jobs and secondary employment (Goufan and Adeline, 2005, p. 6). In a 2011 memorandum of understanding with the project contractor, China Water and Electricity Corporation, the Cameroon National Employment Fund agreed to facilitate the recruitment of an estimated 2,000 Cameroonians to work on the dam site (Agence Ecofin, 2012). Many others are likely to move to the project area without guaranteed employment, giving rise to a peripheral economy that would probably depend in part on poaching for wild meat and ivory trafficking, and that would also lead to further degradation of natural habitats.

In addition to permitting an influx of people during the construction phase of the dam, the Electricity Development Corporation intends to allow commercial fishing in the waters of the reservoir, anticipating an annual production of 1,500 tons of fish and an income of CFA 40 billion (US$65 million) (EDC, n.d.-a). Fishing opportunities are likely to draw even more people into the region, which is certain to increase pressure on biodiversity, including threats to the great apes (Goufan and Adeline, 2005; Mbodiam, 2016).

Transmission Lines

Although most tree species of high commercial value have already been exploited through illegal artisanal logging near the villages in the area, a further 5.28 km^2 (528 ha) of the Deng Deng Forest are to be cleared for the construction of transmission lines. Once the project goes live, it will present a risk of electrocution to wildlife (see Chapter 2 and Annex I).

Construction activities and noise pollution during the building of the transmission lines will also disrupt and temporarily displace local wildlife. A transmission corridor with a width of up to 50 m will cut into ape habitat along the eastern edge of the DDNP. Since this area represents a marginal strip of their habitat, the impact will probably be limited, depending in part on dispersal routes from the flooded land (AfDB, 2011b).

Artisanal Mining

Although the project area holds important gold reserves, the government abandoned its plan to ensure gold extraction from the reservoir area prior to impoundment as it would have delayed the project (Mbodiam, 2010). In view of the huge mining potential of Cameroon's East Region, however, the area is likely to attract artisanal and small-scale miners. Indeed, anecdotal evidence suggests that unauthorized mining operations are already under way in the DDNP itself (Charles-Innocent Memvi Abessolo, personal communication, 2016). Apart from disrupting behavior, altering habitat, reducing food resources and dispersing wildlife populations, such mining activities are associated with increased hunting pressures and disease transmission (ASM-PACE and Phillipson, 2014). Similar links between artisanal and small-scale mining and impacts on apes have been documented in the eastern Democratic Republic of Congo (Spira *et al.*, 2017).

Mitigation Measures and Outcomes

In light of the adverse impacts identified through the ESIA process, the project developer and financiers set in place a number of mitigation measures. Nevertheless, environmental concerns persist with respect to the DDNP's staffing and viability.

Staffing of Deng Deng National Park

The LPHP relies on the deployment of rangers in and around the DDNP to control access to the park and to discourage and monitor poaching activities. The project put an emphasis on higher numbers of staff during the construction period of the dam, when the area would be most heavily populated. Once construction activities are complete, the number of rangers in the area is to be reduced to a base-case level.

The proposed number of guards to monitor the DDNP is one ranger per 10 km² (1,000 ha) within the park itself, and one per 25 km² (2,500 ha) in areas that are less vulnerable to poaching (EDC, 2011c; Charles-Innocent Memvi Abessolo, personal communication, 2016). Of the 58 managers and other staff members involved in securing and monitoring the DDNP and its periphery, only 17 are permanently assigned to the park; the rest are on temporary transfer from other services (MINFOF, 2015).

The number of permanent staff is modest for a protected area of more than 680 km² (68,000 ha), not including the periphery, especially given that the environmental and social management plan calls for 70 community guards and ecoguards (EDC, 2011c; MINFOF, 2015). Compounding the problem of insufficient personnel is the inadequate training of most of the staff.

There is clear evidence that poaching continues despite the presence of ecoguards at the DDNP. In 2015, 1,270 kg of wild meat was seized, including 20 kg of chimpanzee, and 290 kg of monkey and gorilla (MINFOF, 2015).

The Viability of Deng Deng National Park

In part to ensure the viability of the great ape populations, the World Bank established the DDNP as a biodiversity offset to be preserved in perpetuity. Yet, while the LPHP will facilitate access to the DDNP well beyond the period of construction, project financiers are expected to exit the project and thus cease monitoring by the end of 2018 (World Bank, 2012c). Therefore, a key question revolves around long-term viability and financial sustainability, including staffing and equipment for park surveillance.

The DDNP was expected to progress towards financial sustainability by drawing a growing number of ecotourists, but recent figures cast doubt on that assumption. In 2015, the park received only 23 visitors—17 nationals and 6 foreigners—yielding a total fee of CFA 88,500 (US$150). In addition to park visits that year, auction sales of seized illegal forest products from poaching and illegal logging raised only CFA 1.1 million (US$1,891) (MINFOF, 2015). The lack of investment in the DDNP is evidenced by the ongoing absence of a dedicated DDNP office building. The park's temporary office is housed in one of the control posts.

Acknowledging that revenue from ecotourism is likely to be insufficient, the U.S. government insisted, as a condition of approving the project at the World Bank, that a portion of the water tariffs generated by hydropower installations be devoted to helping sustain the park financially. The installations are located downstream of Lom Pangar and payments are expected once the LPHP becomes operational. These details are included in the project appraisal document, which provides details on the World Bank's proposed credit to the government of Cameroon for the LPHP (World Bank, 2012c).

Arrangements to allocate a portion of the water tariffs to the DDNP have yet to be made, however. The matter is of relative urgency as construction activities are due to draw to a close over the course of 2018. These arrangements were to be finalized prior to full impoundment of the reservoir, which is also expected in 2018. Even once those arrangements are made, it is unclear what role the project's financiers will have in ensuring that the funds are utilized as intended, and what means they have to ensure compliance, should the agreement not be respected. The French Development Agency ceased payments to sustain the park in August 2016, the anticipated deadline.

Conclusions

The World Bank and other development financiers entered into the Lom Pangar Hydropower Project with full knowledge that such massive infrastructure in a remote and ecologically sensitive part of Cameroon was likely to have adverse

Photo: The number of permanent staff involved in securing and monitoring the DDNP is insufficient to ensure the protection of the western lowland gorillas and other species. © Chris Chaput

effects on important populations of great apes. Acknowledging the risks that the LPHP posed to these populations, the World Bank and other financiers stressed that instituting requirements to guarantee the preservation of the Deng Deng Forest, through the creation of an offset, was the only hope of ensuring the survival of the region's great apes (EDC, 2011a, 2011b, 2011c; World Bank, 2012a, 2012b, 2012c). However, evidence of the viability of these measures is clearly lacking, and the few reports from site visits point to deficiencies in efforts to guard the area against poaching. The lack of effective and regular monitoring means that the current status of great ape populations in the park is unclear.

Furthermore, the financial sustainability of Deng Deng National Park remains uncertain. The completion of dam construction means the World Bank will reduce its oversight of the project, and the project completion date at the end of 2018 will signal the termination of the World Bank's involvement, and that of the African Development Bank, the European Investment Bank, the French Development Agency and other financiers. Meanwhile, the lack of progress in developing the arrangements to ensure that a portion of the water tariffs derived from hydropower production will be devoted to Deng Deng National Park suggests that the park's viability is in danger.

In conclusion, the DDNP and its great ape population remain at risk of further degradation once the project concludes, unless urgent action is taken to ensure oversight beyond the project completion date and a secure revenue stream for the park. Given that the attention of financiers is typically finite, large infrastructure projects such as the LPHP can present critical, yet foreseeable, challenges to indefinite conservation. This case study demonstrates that even when the adverse impacts of an infrastructure project are acknowledged and assessed early on, they can nevertheless threaten the survival of endangered species such as gorillas and chimpanzees.

CASE STUDY 6.2

Community Resistance Against Infrastructure in Malaysian Borneo: The Case of the Baram Dam

Introduction

In 2006 the federal government of Malaysia embarked on a series of proposed economic corridors in an attempt to stimulate global and domestic investment in rural areas across the country. One of these corridors was the Sarawak Corridor of Renewable Energy (SCORE). It was to be established in Sarawak, one of two Malaysian states on the island of Borneo, and the largest of Malaysia's 13 states.

As part of SCORE, at least 12 dams were to be completed in Sarawak by 2030 (Shirley and Kammen, 2015). Two of these have already been completed: the Bakun and Murum dams (see Figure 6.8). Plans for the Baram Dam, which was next in line, were met with extensive community resistance from the indigenous communities in the Baram River Basin. Construction on the Baram Dam had been scheduled to start in 2014 but, by March 2016, after several years of community resistance, the state government legally withdrew its claim over the indigenous land earmarked for the dam site. This case study documents how a grassroots movement successfully prevented the realization of a large infrastructure project that had been backed by the government.

Background

The Bornean Rainforest

The third largest island in the world, Borneo is part of the Sunda Shelf, which extends from Vietnam to Borneo and Java. The rainforests of Borneo are a biodiversity hotspot acknowledged to be among the world's most species-rich ecosystems. At least 15,000 plants, of which 6,000 are found nowhere else in the world, grow in the swamps, mangroves and lowland and montane forests of the island. Borneo is home to an estimated 222 mammals (44 endemic), 420 birds (37 endemic), 100 amphibians and 394 fish species (19 endemic). Orangutans and gibbons share Borneo's forests with a number of other primate species, including langurs (*Semnopithecus*), macaques (*Macaca*), proboscis monkeys (*Nasalis larvatus*), slow lorises (*Nycticebus*) and tarsiers (*Tarsius*) (WWF, n.d.-a, n.d.-b).

The Baram River Basin lies in northeastern Sarawak (see Figure 6.8). The waters originate in the Kelabit Highlands along the border with Kalimantan (Indonesian Borneo), flow through the mountain highlands and hills for more than 400 km, and lead into the South China Sea (Encyclopaedia Britannica,

FIGURE 6.8

Baram River Basin and the Bakun and Murum Dams

Sources: © OpenStreetMap contributors (www.openstreetmap.org); UNEP-WCMC and IUCN (n.d.)

1998). The forests of the Baram River Basin are home to a wide variety of fauna and flora, including gray gibbons.

Logging and Deforestation

In the past several decades logging has had a great impact on the forests of Sarawak; lush tropical rainforests are disappearing at an astonishing rate. Between 2005 and 2010, forest loss in Sarawak exceeded 2% per year, a rate higher than in any other major tropical forest territory. Between 2006 and 2010, about 9,000 km² (900,000 ha) of Sarawak's forest was lost—43% was converted to oil palm and 21% to timber plantations (Lawson, 2014).

From 1981 to 2014 Sarawak was governed by Abdul Taib Mahmud, who has been accused many times of gross environmental and human rights abuses for personal gain (Global Witness, 2012; Straumann, 2014). During his tenure, the state became one of the largest exporters of tropical timber in the world. In 2010, Sarawak accounted for 25% of the world's source-country exports of tropical logs, 15% of global tropical lumber and almost half of all tropical plywood —quite a feat for a forest estate that represents just 0.5% of the global total. Fewer than 5% of Sarawak's intact forests remain in a pristine state, unaffected by logging or plantations, with dire consequences for its wildlife and indigenous communities, which depend on the forests (Global Witness, 2012).

The Indigenous Population

The people of the Baram River are mainly indigenous Kayan, Kenyah and Penan, with a few Iban, Kelabit and Saban communities. They depend on healthy rivers and forests for their livelihoods. The native customary rights (NCR) of indigenous groups over their ancestral land are enshrined in the Sarawak Land Code and protected under the Malaysian Constitution (Colchester *et al*., 2007). Nevertheless, the government has proceeded to license nearly the entirety of Sarawak, including land claimed for NCR, for logging and plantations, while simultaneously blocking attempts by communities to have their NCR land mapped, recognized and gazetted (Global Witness, 2012).

The people of Baram have a history of resisting deforestation in the area. Since the late 1980s, when logging and agricultural expansion began to change the landscape of Sarawak, indigenous communities resisted through protests and blockades against logging companies. Resistance has often led to arrests and political persecution, with the result that several prominent activists fled Malaysia in the 1990s. In the past several years the government has relaxed its approach to environmental and human rights activists; however, deadly conflicts are still occurring between indigenous activists and land developers.[4]

SCORE Hydroelectric Dams

The government of Sarawak and the dam builder, Sarawak Energy Berhad (SEB), have claimed that the energy produced by the SCORE dams would transform Sarawak into a developed state by the year 2020. Yet the project's 12 large hydropower dams were primarily designed to power the expansion of oil palm plantations and energy-intensive industries (Shirley and Kammen, 2015).

After five decades of delays, the Bakun Dam was opened in 2011, but since then it has only operated at half-capacity (Sarawak Report, 2014). This was the first of the SCORE dams to be built; looming at a height of 205 m, it is the largest dam in Asia outside of China (International Rivers, n.d.-a). The Murum Dam, the second in the SCORE series, officially opened in September 2016 (Then, 2016). The government began preliminary work on the Baram Dam in 2011 but officially canceled all works in March 2016, due to grassroots resistance. The Baleh Dam is next in line to be built, and while the government approved its environmental and social impact assessment in 2016, the details of the proposal and the ESIA have not been publicly released.[5]

The acronym SCORE stands for Sarawak Corridor of *Renewable* Energy, but the adjective "renewable" is inaccurate in this context, as the SCORE development plan entails the exploitation of coal reserves, the construction of new coal power plants and deforestation to accommodate the expansion of oil palm plantations (Shirley and Kammen, 2015). The power generated by the SCORE dams is intended to feed energy-intensive industries, such as aluminum and steel production. SEB, a state-owned electricity supplier under Sarawak's Finance Ministry, is responsible for the planning of all hydropower projects and coal plants in Sarawak. It is chaired by Abdul Hamed Sepawi, a cousin and one of the closest business allies of Sarawak's former chief minister, Taib Mahmud (Bruno Manser Fonds, 2012a, 2012b).

The Renewable and Appropriate Energy Laboratory (RAEL), an independent energy research facility at the University of California, Berkeley, recently conducted an in-depth analysis to explore the implications of building the SCORE dams, and the potential for clean energy solutions for Sarawak. The RAEL research agenda covered three main project areas: (a) modeling long-term, utility-scale electricity-generation alternatives for Sarawak to determine trade-offs across different technologies; (b) exploring to what extent rural communities in dam-affected areas would be able to satisfy energy access needs using local resources; and (c) demonstrating a rapid assessment method for estimating the impact of mega-projects on biodiversity. RAEL's research results call into question the necessity of building additional dams in view of potential lower-cost, lower-impact clean energy alternatives in the state (Shirley and Kammen, 2015).

The RAEL results show that the energy that would be produced by the SCORE dams is unreasonably excessive, even if the aims were to sustain aggressive growth in Sarawak. The SCORE initiative assumes an energy demand growth rate of more than 16% per year through 2030 (Shirley and Kammen, 2015). To put this in perspective, China's energy demand growth rate barely exceeded 10% for three years during the height of its industrial boom (Dai, 2013). The RAEL models show that there are a number of alternative choices to SCORE that meet future demand at an aggressive 7% energy demand growth rate and a very aggressive 10% energy demand growth rate at a lower cost than the SCORE plan. The Bakun Dam alone satisfies one-third of the demand by 2030 under a 10% growth assumption, and half of the demand under a 7% growth assumption. Two existing dams (Bakun in central and Batang Ai in southwestern Sarawak) and recently installed combined gas and coal-fired generators are sufficient to meet demand at a 10% growth rate if properly managed (Shirley and Kammen, 2015).

Social and Economic Impacts: Baram, Bakun and Murum

Although most of the dams are sited on native land, indigenous communities have not been properly consulted and are being forcefully relocated. The Baram Dam would have created a reservoir covering around 400 km² (40,000 ha) of forest and would have displaced up to 20,000 indigenous people (Lee, Jalong and Wong, 2014). Communities that were displaced because of construction of the Bakun and Murum dams have been severely impacted by relocation.

In 1998 the government of Sarawak relocated about 10,000 people to make way for the Bakun Dam. Two decades after resettlement, the displaced people are still struggling to eke out a living. The government required resettled communities to pay for their own housing, which forced many families into debt. Communities that had been able to catch fish in the river, hunt and gather forest products no longer have access to forests, and pollution from the dam has decimated fish stocks. Each family was promised 0.04 km² (4 ha/10 acres) of farmland but was only provided 0.01 km² (1.2 ha/3 acres), much of it a half-day's journey away from the resettlement sites; moreover, a large portion of the "farmland" is infertile, rocky and sandy land. This has not been enough to sustain a living (International Rivers, n.d.-a).

Similarly, communities displaced in 2013 by the Murum Dam are struggling in their resettlement sites. Construction of the dam began in 2008, even though neither the initial ESIA nor the resettlement action plan had been made public. The project developers did not begin an ESIA until after construction was already under way, and the resettlement plans were leaked in 2012 (International Rivers, n.d.-d).

The Sarawak government began resettling around 1,500 indigenous people from the Murum Dam area in July 2013. The resettlement sites are surrounded by vast expanses of oil palm and land earmarked for logging concessions to politically connected timber companies (International Rivers, n.d.-d). As of January 2018, the communities still had not been allocated land to cultivate. During a visit led by the Sarawak-based NGO Save Rivers to the Kenyah resettlement site at Tegulang in October 2016, the residents remarked that they felt as though they were "in jail."[6] Without land, they cannot grow food for their families or to sell at the market, and they are stranded without transportation to larger towns. The government has reduced their monthly rations twice, but the community still has no way of earning income or growing or gathering food to make up for the lost rations.

Photo: After five decades of delays, the Bakun Dam was opened in 2011, but since then it has only operated at half-capacity. Bakun Hydroelectric Dam, Sarawak, Malaysia. © MOHD RASFAN/AFP/Getty Images

The dams also inflict considerable economic costs on the state. The Bakun Dam was built over the course of two decades at a total cost that was astronomically higher than projected. The dam was originally expected to cost MYR 2.5 billion (US$564 million), excluding transmission and all non-dam-related infrastructure. While the official expenditure figures have risen to MYR 7.4 billion (US$1.7 billion), researchers from the National University of Singapore put the cost of the Bakun Dam at MYR 15 billion (US$3.5 billion), six times the original estimate (Sovacool and Bulan, 2011). Construction began in 1994 and the dam was meant to be operational in 2003. It was not completed until 2011, but even today, it is not running at full capacity. The Murum Dam has also incurred significant cost overruns. It cost Sarawak MYR 530 million (US$120 million) more than the original price, according to the 2016 Auditor-General's report (Kallang, 2016).

Environmental Impacts

If the SCORE vision were to be realized as initially planned, 2,425 km² (242,500 ha) of rainforest would be destroyed to allow for the impoundment of reservoirs and the construction of dams, and additional land would be cleared for resettlement sites. The Bakun Dam reservoir alone covers 695 km² (69,500 ha)—about the size of Singapore (Kitzes and Shirley, 2015). Given that the rainforests of Borneo are among the most biodiverse terrestrial ecosystems in the world, it comes as no surprise that the three dams—Bakun, Baram and Murum—would have a tremendous impact on the rich biodiversity of the area.

The RAEL team conducted biodiversity impact studies for these three SCORE dams and uncovered alarming facts. Using global species range data, geographic information system (GIS) tools and species area scaling relationships, the team predicted three distinct measures of biodiversity impact: the total number of species affected by the dams, the number of individuals affected and the number of potential species extinctions that could result (Kitzes and Shirley, 2015).

The study found that the dams would have a negative impact on at least 57% of Bornean bird species and 68% of Bornean mammal species. The affected species include endangered and critically endangered birds and mammals, such as Abbott's gray gibbon (*Hylobates abbotti*), the Bornean bay cat (*Catopuma badia*), the Bornean peacock-pheasant (*Polyplectron schleiermacheri*), the flat-headed cat (*Prionailurus planiceps*), the smoky flying squirrel (*Pteromyscus pulverulentus*), Storm's stork (*Ciconia stormi*), the Sunda otter civet (*Cynogale bennettii*) and the Sunda pangolin (*Manis javanica*). In addition, the study found that two-thirds of all tree and arthropod species would be impacted, resulting in four tree and 35 arthropod species extinctions. The number of species extinctions does not take into account the potential extinction of subspecies or local populations, both of which may be critical to species' long-term viability (Kitzes and Shirley, 2015).

The study also provided numbers on individual organisms that would be lost—arthropods, birds, mammals and trees that would perish because of loss of habitat from clear-cutting and inundation. The three dams alone would cause the loss of an estimated 3.4 million individual birds and 110 million individual mammals. To put this into perspective, that is more individual birds than were counted in the North American Breeding Bird Survey in 2012 and more individual mammals than the entire inventory of cattle in the United States in 2012. A minimum of 900 million individual trees and 34 billion individual arthropods would also be lost (Kitzes and Shirley, 2015).

Community Resistance in Baram

The Formation of Save Rivers

In 2011 the state government began to hold briefing sessions about the proposed Baram Dam and started construction of the road to the dam site. In October of that year, eight Sarawak-based civil society organizations that were concerned about the implications for the people and the forests of Baram joined forces to form the Save Sarawak Rivers Network (Save Rivers), whose mission is to build broad-based support to educate and mobilize the public against the plans to build dams.

The first actions by Save Rivers were designed to raise awareness among the urban and rural populations about the dam and its implications. On February 16–18, 2012, the group organized an initial statewide conference in the city of Miri for representatives from the Bakun, Baram and Murum river basins. Following the conference, delegations from Save Rivers conducted roadshows, traveling by vehicle and boat to remote villages throughout the Baram river basin to inform communities about the proposed Baram Dam and its implications for them. At that point, the preliminary ESIA had been completed by Fichtner, a German consulting company employed by SEB; however, the full ESIA had not yet been initiated and the majority of impacted villages had not been informed about the plan to build the dam. The roadshows were conducted in all of the villages that were at risk of inundation; most villagers heard about the dam construction plans for the first time during these events.

Community Organizing, Nonviolent Direct Actions, Awareness Building

Since its formation, Save Rivers has continuously organized events and trips to build awareness and strengthen communities. Roadshows are conducted regularly to provide villagers with information and update them on the latest developments. One of the largest trips occurred in January 2013, through what is called the "Baram Wave." A delegation from Save Rivers travelled upriver in motorized canoes to distribute information and build solidarity. The group slowly made its way downstream, distributing information and encouraging canoes from each village to join. A flotilla of around 50 canoes arrived at Long Lama, the closest town to the access road for the dam site and, together with residents from around Baram, they held a rally to demonstrate their opposition to the dam. The Baram Wave fulfilled several vital functions, including raising awareness and solidarity among Baram

Photo: Long Lama blockade, the structure that blocks the access road to the Baram Dam site. © Jettie Word, The Borneo Project

communities and voicing the communities' concerns to government officials.

The next large event occurred in May 2013, alongside the International Hydropower Association (IHA) conference that was hosted by SEB in Kuching, in western Sarawak. Save Rivers brought together residents from Baram, local and international politicians, and local and international NGOs for an alternative conference on indigenous rights that included several protests and marches held outside of the IHA venue. The alternative conference drew supporters from around the state and around the country, greatly increasing local and national awareness about the issues and building solidarity.

In August 2013 the Sarawak government took the first steps to extinguish the land rights of indigenous communities near the Baram Dam site—without their consent (Lee *et al.*, 2014). In response, Save Rivers traveled up and down the Baram River, helping the communities establish two blockades to prevent dam workers from accessing the proposed site of the Baram dam. One blockade was built centrally among Baram villages as a rally point. The second blockade was constructed at the beginning of the access road to the dam site near Long Lama. The blockades prevented construction, surveying work and logging at the proposed dam site, halting all progress. The blockades not only physically disrupted work on the dam, but also acted as community centers and observatories for monitoring illegal logging. In spite of numerous government attempts to dismantle the structures and disperse community members, the blockades have been continuously maintained and managed since October 2013. They are the longest-running blockades in the history of Sarawak, and their maintenance has required significant efforts. When the blockades were formed, Save Rivers also helped the communities file a suit against the government, in which they collectively demanded that their customary lands be returned.

In conjunction with blockades, rallies and roadshows, Save Rivers organized cross visits between Baram villages and communities that were forcefully relocated because of the Bakun Dam. During these visits the people of Baram were able to speak directly with individuals who had been evicted and witness for themselves what happens during resettlement. Save Rivers also organized several large conferences in Baram to distribute information and strategize among communities, as well as various acts of nonviolent direct action throughout the country. One of the larger events occurred in June 2015 during a visit by then chief minister Adenan Satem to the town of Long Lama for a bridge inauguration. Save Rivers rallied hundreds of Baram residents to line the streets of Long Lama and express their opposition to the dam. Their voices were heard loud and clear, and the chief minister acknowledged Save Rivers in his speech (Radio Free Sarawak, 2015).

Research and Publications

In addition to raising awareness and promoting community organization, the campaign against the Baram dam coordinated with local and international experts to produce several publications and studies about the situation.

A fact-finding mission to determine how SEB and the government had engaged with the communities of Baram was conducted by local experts and supported by several local and international groups. Based on detailed interviews in 13 villages along the Baram River, the mission report reveals how indigenous communities were denied information, prevented from participating in studies and decision-making, coerced into accepting the dam through threats and intimidation, and thus denied their rights, as ascribed under international agreements and treaties, to their lands and territories, self-determination, and to free, prior and informed consent (see Chapter 2). The report, entitled *No Consent to Proceed*, received significant media attention (Lee *et al.*, 2014).

Save Rivers also worked with experts from the University of California to increase transparency on energy development in Sarawak. As mentioned above, the RAEL team produced three studies that greatly informed the campaign. The studies show in detail that the energy that would be produced by SCORE is superfluous, and that the impacts on biodiversity would be severe. They also lay out a plan to increase rural energy through small renewable systems, such as solar and micro-hydro structures (Kitzes and Shirley, 2015; Shirley and Kammen, 2015; Shirley, Kammen and Wynn, 2014).

The RAEL studies were used to strengthen community resilience, as well as to increase awareness in the government. In March 2015 Save Rivers organized a trip to distribute the RAEL studies throughout Baram. The results reaffirmed and gave credence to the demands of the people. Three months later Save Rivers organized a meeting that brought together local activists, politicians, Dan Kammen, the founding director of RAEL, and Chief Minister Satem to discuss the energy options and the demands of the Baram people. Following the meeting, Satem, who has since died, asked for an alternative proposal to the SCORE dams, which was submitted in July 2015. In January 2018, the authorities had yet to respond to the submission. The campaign was working to resubmit the proposal and arrange a meeting with the new chief minister.

International Solidarity

In addition to networking among stakeholders, researchers and politicians, the campaign against the Baram Dam generated considerable international solidarity. International organizations have provided funding, strategy, media and networking support. In October 2015, Save Rivers, the Borneo Project and the Bruno Manser Fund organized the World Indigenous Summit on Environment and Rivers (WISER) to mark the second anniversary of the blockades. WISER brought together indigenous leaders who are fighting dams around the world, including the late Goldman Prize winner Berta Cáceres. Together, the WISER participants wrote the Baram 2015 Declaration on Dams and the Rights of Indigenous People. The Summit rallied more than 1,000 people from Baram at various events, building solidarity and drawing significant media attention.

Victory: Land Returned to Communities

On March 15, 2016, the Sarawak government revoked its claim to the land that would have been used for the Baram Dam, thereby legally restoring indigenous land rights and officially stopping all progress on the dam (Mongabay, 2016a). Stopping the Baram Dam was an unprecedented success for indigenous rights in Sarawak. This victory was won at a time when dams around the world were under increasing scrutiny. For Malaysia, where the space for civil society is constantly shrinking, the success of Baram gives hope to other struggles for rights and the environment (HRW, 2016).

Challenges and the Path Forward

The campaign experienced many challenges along the path to defeating the dam. One of the principal divisive tactics of the government was to divide the communities and label the people who opposed the dam “anti-development.” The government also removed anti-dam village leaders, or headmen, and replaced them with pro-dam headmen.

In Sarawak activists often face exclusion from society. Many people choose to remain silent for fear that the government will withdraw support in the form of development projects and education grants. Leaders of the opposition to the Baram Dam have been socially ostracized by friends and family members who do not agree with the campaign.

Activists have also faced legal battles. SEB tried to sue 23 activists for tampering with samples and equipment at the dam site. As the land for the dam site has now been legally returned to the community, SEB has withdrawn the suit.

In spite of the victory against the dam, the blockades remain intact and running. The blockades now serve as a venue for community events instead of obstructing access to the dam site. Communities are wary that a new government may try to reinstate the project. To gear up for this possibility, Save Rivers is now focusing on campaigns to build long-term land rights protection measures in Baram through the Baram Conservation Initiative. The Initiative actively seeks to facilitate development systems that are chosen and managed by rural communities, in harmony with their environment. At the time of writing, the two main program aims were to establish a community-managed conservation zone and to build sustainable village-scale electrification systems, such as micro-hydro and solar systems.

A key lesson from the campaign against the dam is the importance of raising awareness in communities. Without proper knowledge of the situation, communities cannot act. Increasing awareness allows people to choose how to respond to projects.

Fostering community-based development models is key to avoiding the environmental and social destruction of large infrastructure projects. The promotion of community-based systems requires a paradigm shift away from top-down infrastructure projects that harm rural communities and forests.

BOX 6.1

Hydropower by Design

Introduction

The hydropower sector, governments, scientists and civil society groups have worked, often collaboratively, on finding ways to improve the sustainability of hydropower development and to achieve more balanced outcomes between energy development and other values. More balanced outcomes can occur at two scales:

- the planning and siting of new dams at the system scale (that is, at the scale of a river basin or a region); and
- the design and operation of individual dams.

Recognizing that the sustainability of hydropower is a function of the system and individual scales, The Nature Conservancy (TNC) developed an approach that integrates both scales: "Hydropower by Design." The approach encompasses a range of methods and tools to improve the planning, siting, design and operation of hydropower, as well as the mitigation of its adverse impacts (Opperman *et al.*, 2015, 2017; TNC, WWF and UoM, 2016). Hydropower by Design is a shorthand term for integrated, system-scale planning and management using a number of existing tools and processes, including the mitigation hierarchy (see Chapter 4, p. 119). By applying this approach, hydropower developers can:

- **avoid** building dams at the most damaging sites by directing development towards sites that result in less impact, specifically by identifying the spatial arrangement of dams that can produce optimal outcomes across social, environmental and economic values;
- **minimize** impacts, such as through best practices during construction;
- **restore** key processes and resources by adapting the design and operation of individual dams (such as building fish passage structures and managing the release of environmental flows to maintain or restore downstream floodplain fisheries); and
- **offset** adverse impacts that cannot be avoided, minimized or restored by investing in compensation to achieve no net loss of biodiversity.

Some progress has been made in the development of approaches that serve to improve the environmental and social performance of individual hydropower dams. Among these is a tool to measure the relative sustainability of projects—the Hydropower Sustainability Assessment Protocol ('the Protocol') (IHA, 2010). However, a number of major impacts from hydropower cannot be mitigated effectively at the scale of a single dam and project-level sustainability cannot address the complex issues posed by multiple hydropower developments across a river basin or region.

With respect to apes, certain impacts from hydropower can be addressed through best practices at the project scale, but some of the most important conservation objectives—such as the maintenance of large blocks of intact forest or connectivity between forests—can only be addressed through system-scale approaches that influence the spatial configuration of hydropower development, encompassing dams, reservoirs, roads and transmission lines.

When applied to ape conservation, the principles of Hydropower by Design can be organized to follow the mitigation hierarchy:

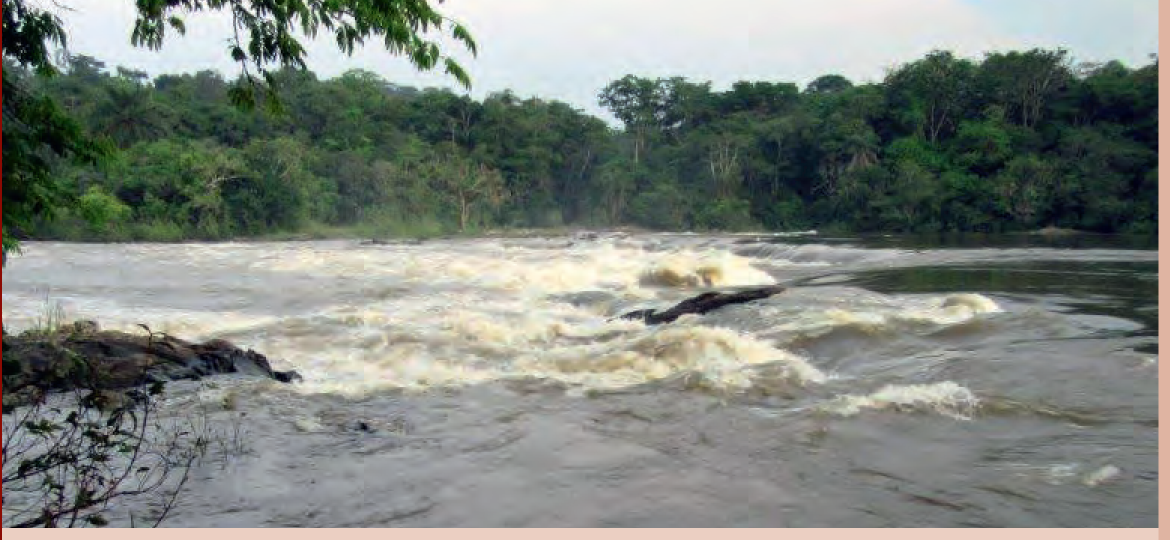


Photo: The negative environmental and social impacts of dams and other large infrastructure projects are more likely to be minimized when their development planning incorporates a system-scale approach and draws on existing tools and processes, including the mitigation hierarchy. Proposed site of a hydropower project, 'Chutes de l'Impératrice Eugénie' waterfalls, Ngounié River, Gabon. © Matthew McGrath

- **Avoid**. National parks and other formally protected areas should be maintained as no-go areas for dam development. System-scale planning can also be used to avoid siting or licensing projects that would impact high-value ape habitat outside of protected areas, such as dispersal corridors and large swaths of intact habitat. Multi-objective planning and analysis can identify investment options—combinations of project site, design and operation—that perform well across a range of metrics; such "win–win" or "close to win–close to win" outcomes can contribute towards energy targets while protecting the most important ape habitats. Ideally, areas that are "avoided" through a system-scale planning process would also receive formal protection from future development, potentially funded via mitigation or compensation measures, as described below. The most effective spatial planning for siting focuses not just on dams and reservoirs, but also on the siting of associated roads and transmission lines.
- **Minimize impacts during development and operation**. To protect apes, hydropower developers can implement management plans that minimize impacts during construction and operation. Construction management plans can include best practices to prevent workers from hunting for wild meat or engaging in other activities that harm wildlife. The environmental management plan for the Trung Son Hydropower Project in Vietnam, for example, includes a ban on hunting and possession of wild meat in the construction camps (Integrated Environments, 2010). During operation, a portion of revenue from a hydropower project could be dedicated to conserving intact forest in the watershed upstream of a project. This type of management fund can benefit projects by ensuring that upstream land cover promotes reliable flows of water and avoids excess sedimentation from land clearing and road construction. Wherever upstream watersheds also provide habitat for wildlife, including apes, this management fund can also be used to protect that habitat.
- **Compensate or offset**. Even if efforts are made to avoid and minimize impacts, the expansion of hydropower systems will almost certainly result in net negative impacts to natural resources such as ape habitat. For these "residual impacts," mitigation policies can promote compensation—investments in restoration or protection intended to "offset" residual impacts. For example, compensation funding could be used to support the durable protection of high-quality habitats that may be threatened by new development impacts by formally designating them protected areas and providing funding for their management. Compensation funding could also be dedicated to reforestation of migration corridors for apes; this type of funding was made available to reforest a corridor for jaguars with the Reventazón project in Costa Rica, for example (IDB, n.d.).

The outcomes of Hydropower by Design analysis and implementation are dependent on the participation and buy-in of all relevant stakeholders over the duration of the development process. In addition to governments, developers and financiers, a stakeholder group includes representatives from communities that may be directly or indirectly affected by the development of hydropower dams, as well as representatives with relevant expertise from academia and civil society. The stakeholder group is relied upon to identify social and environmental resources that may be impacted by the proposed hydropower development, determine whether the metrics used to assess those impacts are adequate through an iterative process, and participate in the decision-making process to select a hydropower build-out that best balances the trade-offs between development, conservation and social issues.

If the stakeholder group is not collaborative and transparent, the ultimate build-out of hydropower projects may not represent the best trade-off, with possible repercussions for environmental and social resources, including great ape and gibbon habitat. However, the process of identifying environmental and social resources and quantitatively measuring the impacts of a given hydropower build-out scenario on those resources inherently makes the planning process more transparent, even if the final decision is made in a political context that does not fully embrace the collaborative process that is at the heart of Hydropower by Design.

Implementing Hydropower by Design

In practice, Hydropower by Design is most effective when it is incorporated into the policies and practices of the key actors within the hydropower sector. Key actors are governments, financial institutions and hydropower companies, including developers and contractors.

Governments

Governments are generally in the best position to implement the concepts behind Hydropower by Design, particularly because they direct the planning of energy systems and license individual projects. A strong planning and site selection role by the government can identify both the river reaches or projects that should be developed, as well as the areas that should be protected, thereby reducing conflicts and increasing certainty for stakeholders, including hydropower developers, conservation organizations and local communities (Opperman *et al*., 2017). For example, in the 1980s Norway conducted comprehensive studies of undeveloped rivers and river basins and identified a subset that would be eligible for hydropower development and another subset to be protected from future development, thereby reducing conflict and increasing certainty for energy development and other values (Wenstop and Carlsen, 1988).

In addition to planning, government licensing processes can be influential in determining which projects are built and which priority habitats are granted protection. Licensing agencies can identify areas for which licenses will not be granted (a categorization that is functionally equivalent to an "avoid" designation); they can also determine mitigation requirements for licenses, such as by setting compensation ratios based on impacts. However, such decisions are vulnerable to being overturned unless they are made durable through formal protected status. Particularly rare or important habitat types can have high compensation ratios (such as 5 ha of protection

Photo: Low water levels at the Mae Guang Udom Tara dam. In 2015, Thailand's key reservoirs fell to the lowest since 1987, and farmers were warned to delay planting their main rice crop. A number of major impacts from hydropower cannot be mitigated effectively at the scale of a single dam and project-level sustainability cannot address the complex issues posed by multiple hydropower developments across a river basin or region. © Dario Pignatelli/Bloomberg via Getty Images

or restoration per impacted hectare). Compensation funding generated for development that impacts habitats can then be used for acquisition or management of other high-value habitats. Colombia is integrating this approach into its licensing process for large infrastructure projects, including hydropower (Opperman *et al*., 2017).

Hydropower by Design does not necessarily require governments to adopt new policies or regulatory structures. Rather, existing policy or regulatory tools—such as energy master plans, strategic environmental assessments, environmental and social impact assessments, and licensing—can be updated or refined to move hydropower development away from a single-project focus and towards a system approach.

Financial Institutions and Developers

A variety of financial institutions fund hydropower projects, including private commercial banks and multilateral institutions such as the World Bank and the Asian Development Bank. Financial institutions can apply environmental and social policies to determine which projects they will fund and to attach conditions to their financing, such as mitigation requirements. Multilateral financial institutions have comprehensive environmental and social safeguards. However, these safeguards are generally applied at the project scale, and a review of hydropower standards by the International Institute for Environment and Development (IIED) concluded that few standards or safeguards address system planning or options assessments that can screen out detrimental projects (Skinner and Haas, 2014).

Specific hydropower-related risk screening tools can be used as a complement to general safeguards. The World Bank has acknowledged that, for its projects, the Hydropower Sustainability Assessment Protocol is a useful risk-screening tool that can be applied before its own safeguards (Liden and Lyon, 2014). The IIED review reported that only 10%–15% of new hydropower projects around the world were covered by international standards or safeguard processes. It concluded that the Protocol "represents the best currently available 'measuring stick' for respect for the [World Commission on Dams] provisions in individual projects" as it offers a set of principles that many civil society organizations see as the "gold standard" in terms of sustainability for dam development and operation (Skinner and Haas, 2014, pp. xi, 44, 75).

An "early planning facility" is an additional mechanism through which multilateral funders could help move hydropower development towards system-scale approaches (Opperman *et al*., 2017). Such a facility would combine funding and technical assistance to support governments in conducting system planning with the goal of developing a pipeline of projects. Projects that emerge through this process would represent low-risk opportunities for developers and investors that are consistent with objectives for the sustainable management of river basins or regions.

Developers generally do not have the ability to plan or manage at the scale of a system, with some exceptions (such as when a single company has multiple concessions or projects in a basin or when a company secures a contract to conduct a basin plan). However, companies can follow policies or practices that support sustainable hydropower, for example by adopting corporate sustainability standards or by using risk-screening tools such as the Protocol. Companies that recognize the value of reducing risk and uncertainty for hydropower development could signal their support for Hydropower by Design to governments and funders and find ways to contribute to its adoption.

CASE STUDY 6.3

Not All Renewable Energy is Sustainable: A Geothermal Project in the Leuser Ecosystem, Sumatra, Indonesia

On August 16, 2016, the governor of Aceh province wrote to the central government's Ministry of Environment and Forestry, requesting that a "core area" of the Gunung Leuser National Park (GLNP) be rezoned to allow development of a major new geothermal project. The location in question lies in the Kappi Plateau region of the park, in the northernmost province of the island of Sumatra, Indonesia (Hanafiah, 2016; see Figure 6.9).

Together, the Gunung Leuser, Bukit Barisan Selatan and Kerinci Seblat national parks comprise the Tropical Rainforest Heritage of Sumatra World Heritage site (UNESCO WHC, 2017). Covering 8,630 km² (862,975 ha), the GLNP itself is a UNESCO biosphere reserve and a Heritage Park of the Association of Southeast Asian Nations (ASEAN). It is contained within the confines of the 26,000-km² (2.6 million-ha)

FIGURE 6.9

Proposed Large-Scale Energy Infrastructure Projects in the Leuser Ecosystem and Beyond

Map and Data Sources: © Rupabumi Digital Indonesia Map, Scale 1:50,000, BAKOSURTANAL, 1978; Ministry of Forestry Decree 190/Kpts-II/2001; About Demarcation of Leuser Ecosystem in Aceh Province; Leuser Ecosystem spatial plan draft; Aceh Spatial Plan; and Secondary Data. Courtesy of SOCP.

Leuser Ecosystem, which experts, including the IUCN, consider one of the world's "most irreplaceable protected areas"; it is ranked 33rd out of more than 173,000 protected areas worldwide (Le Saout *et al.*, 2013). Protected under Indonesian law as a national strategic area for its environmental protection function, the Leuser Ecosystem is one of the largest contiguous intact rainforests in the whole of Southeast Asia, and the last place on Earth where orangutans, rhinos, elephants and tigers coexist in the wild (Rainforest Action Network, 2014).

The proposed project site lies at the very heart of the Leuser Ecosystem, in the Kappi Plateau. This area not only harbors some of the last remaining wild populations of all four of these iconic and critically endangered species, but is also the core of the only remaining major corridor between the eastern and western blocks of the ecosystem. Degrading this region would dramatically reduce the long-term survival prospects for these and a multitude of other species. Indeed, any major development within the Kappi Plateau will only serve to denigrate the Tropical Rainforest Heritage of Sumatra, which has been inscribed on the list of World Heritage in Danger since 2011. Given the extensive road and settlement infrastructure that would inevitably accompany construction, the ecosystem's Outstanding Universal Value would undoubtedly be severely depleted (UNESCO WHC, 2016). Destruction of the Leuser Ecosystem would also have far-reaching consequences for valuable ecological services, such as water supplies, carbon storage and disaster mitigation. A newly published study funded by the European Union determined that the forests of Aceh, more than 50% of which are in the Leuser Ecosystem, are worth approximately US$1 billion per year to Aceh's economy—if fully conserved (Baabud *et al.*, 2016).

The Geothermal Project and Its Environmental Impact

Despite its critical importance in Southeast Asia, the Kappi Plateau is threatened by construction of a major new geothermal power plant by PT Hitay Panas Energy, an Indonesian subsidiary of the Turkish company Hitay Holdings (Hanafiah, 2016). This plan came to light after Indonesia's president publicly called for the country to become energy self-sufficient and to increase the use of geothermal energy to 23% by 2025 (Antara News, 2015; Tempo, 2017). Subsequently, the country's minister of energy and mineral resources announced, "I invite every stakeholder to study and make every effort to achieve these targets" (Antara News, 2015). In response to these policies and statements, numerous "renewable energy" projects are being planned and developed throughout Indonesia. The Kappi geothermal project is among the most pressing for those concerned about the continued conservation of the Leuser Ecosystem (Laurance, 2016c).

As of 2015, Indonesia had an installed production capacity of 1,345 MW, derived from ten geothermal plants (Mansoer and Idral, 2015). The PT Hitay Panas Energy project—one among several new sites under consideration in Aceh—is being proposed inside the Leuser Ecosystem. The governor of Aceh requested rezoning of an area covering 50 km^2 (5,000 ha) in Kappi for the purposes of geothermal development, even though a 25 MW site is only likely to require 10–40 ha for the power plant itself (Modus Aceh, 2016; T. Faisal, personal communication, 2017).

Interestingly, the company has not made details of its plans public, so it is difficult to ascertain the true potential environmental impact of the geothermal plant throughout the phases of exploration and drilling, construction, operation and maintenance, all of which will incur environmental impacts. During construction and drilling, transportation of heavy equipment is required, so an access road to the site will need to be built. Temporary workers will need access and housing. As an example, another geothermal plant of comparable size (20 MW) at Lahendong in North Sulawesi recruited more than 900 workers for the construction phase (Rambu Energy, 2016).

The target area in Kappi is forested and mountainous and has never had any form of prior road access. The nearest road is more than 10 km away at its nearest point and, due to the mountainous terrain, access to it would require a new road more than 10 km long. While such a new road could theoretically be removed after the construction phase, removal would not prevent severe damage from occurring to the forests, as roads open access for illegal logging, mining, encroachment and poaching of wildlife. Currently, the closest substation for transmitting electricity is more than 150 km away, in Takengon, and overhead transmission towers (150 kV) would therefore need to be built every 300 m from the plant to the substation, necessitating substantial clearing along the entire length of the route (T. Faisal, personal communication, 2017).

Land clearing, road construction, vehicle traffic and power plant construction can affect ecosystem services through increased erosion and runoff, increased risk of fire, toxic spills and disturbance of water, and interference with seed dispersal. These activities also pose a high risk to wildlife and species diversity. In addition, noise pollution threatens to disrupt breeding, migration and foraging behavior in this previously undisturbed area (Tribal Energy and Environmental Information, n.d.).

On September 15, 2016, the managing director of PT Hitay Panas Energy submitted a report requesting that the "core area" of the GLNP be rezoned as a "utilization area." Kappi is within a core area of the park by virtue of the fact that it meets stringent government criteria and regulations on biodiversity and habitat composition. As part of the core area, it cannot legally be exploited for geothermal development. In contrast, permits may be approved for geothermal energy developments in utilization areas, so long as the land does not harbor a concentration of priority biota communities (HAkA *et al*., 2016).

Indonesia's Ministry of Environment and Forestry, through its Directorate General for Conservation of Natural Resources and Ecosystems, publicly stated that the request to rezone the area, and thereby enable the geothermal plant to go ahead, would be rejected (Satriastanti, 2016). At the end of September 2016, the ministry informed the head of the GLNP that no rezoning of any part of the park's core area would be possible, regardless of recent Indonesian legislation, Law No. 21 of 2014 on Geothermal Energy, which allows for

Photo: Indonesia is pushing to become more energy independent and move away from traditional fossil fuels for electricity generation. New regulations opening up the possibility of geothermal energy projects in conservation areas highlight the pressure for new energy projects in areas that render them unsustainable and extremely damaging to the environment and conservation. Geothermal plant, Indonesia. © BAY ISMOYO/AFP/Getty Images

geothermal operations within the utilization area of conservation zones (Republik Indonesia, 2014; Satriastanti, 2016).

It later came to light that Hitay had previously commissioned an Indonesian university—Universitas Gadjah Mada (UGM)—to assess the feasibility of geothermal development on the site. Contrary to expectations, given the above-mentioned background, the assessment team made a "strong recommendation for changing the zoning in the Kappi area" in a report that was submitted to the Ministry of Environment and Forestry on December 1, 2016. One week later, at a meeting held at the GLNP headquarters in Medan, North Sumatra, the findings of the UGM study were shared with a group of NGOs and community members (PT Hitay and UGM, 2016). Subsequently, in a detailed review of the UGM surveys, a consortium of environmental NGOs identified poor survey design and other reasons why the UGM report was wholly inadequate, both for determining whether the requested rezoning was permissible within the Kappi Plateau and for arriving at the stated conclusions and recommendations. The review emphasized that the core area status should be maintained in view of comprehensive GLNP and other NGO data, which had been ignored or misrepresented by the UGM team, and based on current criteria and laws governing the zoning of conservation areas (Laurance, 2016a).

Yet, even though data from the GLNP and local NGO affiliates strongly support the rejection of the rezoning request, the matter is not yet fully settled (Satriastanti, 2016). Ongoing meetings and correspondence indicate that neither Hitay nor the GLNP considers the proposed project to be off the table, meaning that conservation NGOs and other civil society groups remain vigilant to ensure the development does not go ahead.[7]

A Chance for Change?

The Indonesian government's effort to move away from non-renewable energy sources, as part of its sustainable development strategy, is to be lauded. Such a pathway, however, should not include the destruction of one of Southeast Asia's most valuable conservation areas. The geothermal potential of the Seulawah and Takengon regions of Aceh have been thoroughly assessed and are already known. Both locations are also far closer to existing transmission networks and major population concentrations. As such, they could provide sustainable energy alternatives, meeting all of the president's goals, but without the destructive impact of development in the irreplaceable forests of the Leuser Ecosystem.

In addition to the proposed geothermal plant in the Kappi Plateau area, the Aceh government is also seeking approval and funding for several other large-scale infrastructure projects, including plans for mega-hydropower developments in the Jambo Aye, Kluet and Tampur water catchments (Gartland, 2017; see Figure 6.9).

Beyond the borders of Aceh province are additional sites of serious concern, in particular a major new hydropower project in the very fragile habitat of the recently identified Tapanuli orangutan (*Pongo tapanuliensis*)—the Batang Toru forests in North Sumatra province. The proposed project is especially worrying as this population of orangutans is genetically unique and among very few in Sumatra living outside of the Leuser Ecosystem. In fact, the new species immediately became the most endangered great ape species in the world, with fewer than 800 individuals remaining. The planned project would devastate a river catchment in which the highest densities of the Tapunuli orangutan are found. It would also sever an essential corridor linking two of the three main forest blocks that still harbor the new species, which could easily place the species on an irreversible path to extinction (Nater *et al*., 2017; Stokstad, 2017; Wich *et al*., 2016; see the Apes Overview).

With the push for Indonesia to become more energy independent and move away from traditional fossil fuels for electricity generation, and with the passing of new regulations that open up the possibility of geothermal energy projects in conservation areas, it is clear that there is strong pressure for new energy projects in areas that render them unsustainable and extremely damaging to the environment and conservation.

Instead of relying on unsustainable, large-scale energy generation schemes in unspoiled locations, Indonesia could significantly increase its electricity production by investing in smaller-scale 'run-of-river' hydropower schemes and other renewable resources. These would have a negligible environmental impact and provide a more stable and resilient power supply than would a few large, destructive schemes.

Conclusion

Hydropower represents a significant source of electricity for many countries and features in many economic development plans and projections. As this chapter shows, however, its negative impacts are concentrated in areas—river valleys and forested mountains—that have considerable environmental and social value, such as helping to buffer the effects of climate change, hosting river fisheries, encompassing habitat for apes and providing vital resources for local communities. Furthermore, as research has demonstrated, the oft-touted economic benefits of dams rarely materialize for the vulnerable sectors of society (see Annex VII).

Hydropower is expanding rapidly in remaining ape habitat, including in Southeast Asia and Central and West Africa. The preliminary assessment presented in this chapter suggests that the impacts of hydropower on apes and ape habitat will increase considerably in the coming decades. In this context, stakeholder engagement can serve to raise awareness, especially among indigenous and other local communities that are likely to be adversely affected by the construction of dams or geothermal plants. Such engagement can also help to identify opportunities for avoiding or mitigating negative impacts.

Some progress has been made in the development of tools that can serve to improve the environmental and social performance of individual hydropower dams. Nevertheless, many hydropower impacts are not effectively addressed at the scale of the system. This is particularly true for hydropower's impacts on apes, whose conservation requires large blocks of connected habitat. A system-scale approach to hydropower planning and management—including siting, licensing, mitigation and best practice during construction and operation—provides the best opportunity for hydropower expansion to be consistent with the conservation of environmental and social values, including the protection of apes and their habitat. To be successful, the application of such an approach requires collaboration among a range of actors in the hydropower development process, including governments, funders, developers and civil society.

Acknowledgments

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Endnotes

1 See, for example, Richter *et al.* (2010) and WCD (2000).

2 The International Commission on Large Dams defines a "large dam" as one that has "a height of 15 metres or greater from lowest foundation to crest or […] between 5 metres and 15 metres impounding more than 3 million cubic metres" (ICOLD, n.d.).

3 Both the Campo Ma'an National Park and the Mbam and Djerem National Park were created to "offset" the adverse effects of the Chad–Cameroon oil pipeline. There is currently no evidence that these offsets were created with the aim of achieving "no net loss" as defined by the Business and Biodiversity Offsets Programme (BBOP, 2012).

4 In July, 2016 an indigenous land rights activist was killed in the city of Miri, purportedly in connection with his activism. In October of the same year, a clash between NCR landowners and people allegedly hired to intimidate them resulted in one death (Sarawak Report, 2016).

5 The ESIA was open for comments, as stipulated in Sarawak's procedures; however, it was not openly published or available to the public. Rather, a limited number of copies were available in a few government offices, where the public could read them. Comments had to be made within 30 days of publication. The ESIA was approved on March 13, 2015 (P. Kallang, personal communication, 2016).

6 Author interviews with residents, Tegulang, Sarawak, Malaysia, October 2016.

7 Confidential information and correspondence provided to the authors.

8 Arcus Foundation (www.arcusfoundation.org/what-we-support/great-apes).

SECTION 2