Photo: Natural and anthropogenic hazards imperil the survival of apes, especially if multiple threats affect already reduced and fragmented ape populations. © Jabruson (www.jabruson.photoshelter.com)

CHAPTER 6

Disaster Management and the Protection of Apes

Introduction

The dramatic reduction in great ape habitats across Africa and Asia presents an imminent challenge to their survival. Loss of forest cover is primarily due to anthropogenic activities (Estrada *et al.*, 2017; Nellemann and Newton, 2002). The natural habitats of apes have long been exposed to natural hazards, including volcanic eruptions, drought, heat waves, hurricanes and cyclones—which cause flooding, landslides, fires and wind damage to the forest structure. The transition to large-scale farming and industrialization, however, has led to an exponential increase in human population and activities that have steadily eroded ape habitat and thereby increased their vulnerability to natural hazards.

In many ape range states, only isolated habitat fragments remain, surrounded by swathes of cleared land used for agriculture. Logging activities and infrastructure development crisscross landscapes, further subdividing ape habitat and disrupting connectivity, while poaching and hunting have directly reduced local ape populations (Estrada *et al.*, 2017). Consequently, many of these populations are living in small pockets of habitat whose resilience to natural hazard impact has been in decline.

Climate change-induced extreme weather events—which have been growing in intensity and frequency—present a clear threat to apes and their habitats.[1] These hazards and events can lead to potentially detrimental behavioral and physiological adaptations, as recently witnessed in Senegal, where extremely hot daytime temperatures led chimpanzees to become more nocturnal, exhibit changing energy needs and display differences in heat regulation (Pruetz and Bertolani, 2009). Furthermore, apes have increasingly been exposed to environmental threats that are directly associated with human activities, such as deliberate forest fires. In orangutans, fires can cause death or injury (such as through smoke inhalation), change activity patterns and lead to starvation-like physiological responses (Erb *et al.*, 2018; Estrada and Garber, 2022; Estrada *et al.*, 2017; see Box 6.2).

An emerging crisis is the exposure of apes to zoonotic diseases from humans, which can lead to deaths and compromise the viability of populations (Dunay *et al.*, 2018; Negrey *et al.*, 2019; see Case Study 6.3 and Chapter 1). While disease hazards constitute a particular risk to captive apes, wild populations are also at risk from potentially infected hunters, local communities, park staff, tourists and other travelers (Muehlenbein *et al.*, 2010). Moreover, captive and free-ranging apes can be exposed to flooding, chemical poisons and other risks (BBC News, 2002; Kooriyama *et al.*, 2013). For more information on managing ape health, informing interventions, see Chapter 4.

Natural and anthropogenic hazards imperil the survival of apes, especially if multiple threats affect already reduced and fragmented ape populations. Disaster management principles provide a valuable set of tools for mitigating or reducing the impact of natural and anthropogenic hazards on both wild and captive apes. See Box 6.1 for standard definitions of common disaster management terminology and concepts. This chapter presents an overview of these principles and examples of their adoption to mitigate the impact of hazards such as flooding and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on apes (see Case Study 6.1, Case Study 6.2 and Box 6.3).

The chapter highlights consideration of the full range of related risks under the approach known as PEESTOLM, which covers political, environmental, economic, social, technical, operational, legal, and media and communications-related risks (Cooper, 2018; WHA, 2018; see Annex IV). Assessments of each of these risks are used to inform the development of mitigation measures to enhance the survival chances of apes in a disaster context. The spectrum of mitigation measures includes avoiding the risk of hazard impacts, reducing the potential consequences of impact and containment of the risk. Annex V provides an example of an emergency preparedness and response questionnaire and Box 6.4 works through the development of a contingency plan.

Key findings include:

- Although both natural and anthropogenic hazards can strike at any moment, their effects can generally be mitigated through the structured and systematic development of risk mitigation measures in advance of any potential hazard impact. Such measures include preventive action aimed at avoiding any impact; preparedness, including the development of detailed plans; the building of capacity and capability for response and recovery; and exercises and simulations.

- In the first instance, the delivery of prevention and preparedness goals is associated with local ape populations and any nearby human communities. In addition, national and global support can raise the levels of readiness with respect to ape populations at risk.
- Targeted research has a part to play in identifying and developing emergency response measures, including by exploring how those measures are likely to benefit at-risk apes.
- The use of risk mapping for ape populations can inform priorities for developing prevention, preparedness and response.
- Active reporting and monitoring of preparedness can help to identify gaps and allows for the tracking of progress.
- Wherever ape-related disaster management structures and arrangements are in place, there are opportunities to adopt a

Photo: When hazards such as forest fires destroy habitat, for instance, apes' access to food and shelter drops significantly faster, causing declines in birth rates and population numbers. Freshly cleared patch of forest that has been burned for agriculture, Gunung Palung National Park, West Kalimantan, Indonesia. © Tim Laman/ naturepl.com

comprehensive approach: risk identification, prevention, preparedness, response and recovery.

- At all levels, government and private agencies and organizations that are responsible for at-risk ape populations could potentially make use of established disaster management systems.

Disasters and Apes

To be valuable, assessments of the probability, type and potential severity of different disasters—in relation to apes, their habitats and the people who live alongside them—require a shared understanding of related terminology and concepts (see Box 6.1).

BOX 6.1
Terminology

Crisis: A system-wide disruption that is typically new, unexpected, uncontrollable or abnormal and that requires immediate solutions or interventions involving collaboration among local stakeholders. A crisis typically affects a particular industry, population or community; local stakeholders are able to address the disruption.

Disaster: A serious disruption of the functioning of a community or society due to an interaction of a hazardous event with conditions of exposure, vulnerability and insufficient capacity to cope with the event. The consequences include significant social, built, economic and environmental losses and impacts. Locally impacted communities are unable to cope and require external assistance and coordination.

Emergency: An actual or imminent natural or anthropogenic event that endangers or threatens life, damages infrastructure or destroys the natural environment, thus requiring significant coordinated and time-critical responses, as well as extraordinary measures to save lives, protect vulnerable individuals and limit damage. An emergency tends to be local or regional, so does not result in serious disruption to the broader community or society. Emergencies can be categorized by size of impact area and multiple simultaneous emergencies in one area may be classified as a disaster.

Hazard: A natural, socionatural or anthropogenic process, anomaly or event that is defined by location, magnitude, intensity, frequency and probability, and that has the potential to directly harm life as well as the built and natural environments and ecosystems. A hazard can cause indirect disruptions to an economy.

Sources: AIDR (n.d.); Al-Dahash, Thayaparan and Kulatunga (2016); Staupe-Delgado (2019); UNDRR (n.d.-b); WHO (2020d); WHO/EHA (2002).

Similarly, common terminology can underpin the development of strategies to mitigate and respond to the impacts of such events and associated challenges, whether directly or indirectly. The severity of impacts depends in part on whether affected apes are in their natural habitat or in captive settings, such as sanctuaries.

Natural and anthropogenic disasters can affect apes directly or indirectly. Potential direct impacts on apes include:

- dehydration due to a lack of access to suitable water sources during drought and extended periods of forest fires;
- malnutrition associated with an acute, long-term lack of access to suitable food sources following ecosystem destruction;
- morbidity related to sustained exposure to forest fire smoke, heat exposure and loss of access to nutritious foods;
- poisoning arising from impacts of industrial hazards;
- mortality, from individual flood- or fire-related fatalities to a reduction in the number of apes in a population, to a point at which recovery may be impossible; and
- fragmentation of local populations in response to a hazard-modified natural environment and changes in ape population distribution and structure.

In a crisis, local expertise and resources can be mobilized to cope with and manage a single or small number of affected apes. Monitoring of a crisis includes assessing the capacity of local resources to stop an escalation of the situation, which could otherwise transition to an emergency and require external assistance. An emergency arises when such a direct hazard impact calls for significant coordination and resources to resolve or stabilize the situation. If there is a risk of population collapse, such as when multiple individuals in different ape communities are affected, the situation is considered a disaster.

Ongoing direct threats to apes—such as deforestation, hunting and infectious disease—are compounded by indirect impacts. When hazards such as forest fires destroy habitat, for instance, apes' access to food and shelter drops significantly faster, causing declines in birth rates and population numbers. Such indirect impacts can threaten ape survival, particularly if hazards recur and population decline becomes irreversible (Behie *et al.*, 2019).

Indirect disaster impacts are also possible wherever ape communities and local human populations are interdependent, as loss and damage to human dwellings, food supplies and the economy can translate into reduced support and care for apes or the forest, competition for food, habitat destruction to support rebuilding, and ape hunting.

The scientific literature on disaster management features limited studies of the hazard impacts on apes and responses for impacted apes. Ape exposure to disasters is poorly understood in terms of scale and frequency. Coverage is more likely in the case of high-profile threats, such as the devastating fires that tear through orangutan and gibbon habitat in Indonesia (see Box 6.2).

Natural hazards associated with climate change are expected to continue increasing in frequency, duration and severity. Among them are cyclones, hurricanes, droughts, heat waves, flooding and forest fires caused by lightning (Malhi *et al.*, 2008; Sergio, Blas and Hiraldo, 2018; Wiederholt and Post, 2010).

Disaster preparedness for captive apes focuses on numerous risks, including flooding, and involves preparedness actions to protect resident animals, their keepers and the facilities. This section presents preparedness actions in two captive settings. Case Study 6.1 examines the management of fires and flooding by a chimpanzee sanctuary on an island in Lake Victoria, Uganda; Box 6.3

BOX 6.2

Forest Fires in Indonesia

In 2015, more than 100,000 forest and peat fires burned more than 26,000 km^2 (2.6 million ha) in Indonesia in 2015 (World Bank, 2016). This burned area included the Sabangau Forest of more than 5,000 km^2 (500,000 ha), which was home to more than 7,000 orangutans (Vidal, 2015). In Borneo, fires destroyed vast areas of habitat and had harmful impacts on the social, economic and natural environments. Forest fire smoke resulted in 500,000 human respiratory disease cases (Vidal, 2015). There was little evidence of a timely, appropriate or coordinated response to these human-caused forest fires.

The effects of hazardous wildfire smoke on orangutan health included negative impacts of smoke and particle inhalation, which caused apes to increase their rest time and decrease their travel time and distances (Erb *et al.*, 2018). Studies show that ongoing exposure of orangutans to forest fire-scarred landscapes is associated with debilitating changes in their behavior and health. The fires led to the loss of nutritious foods, which caused chronic starvation, poor health, aggression and declines in populations (Jong, 2020; Vogel, 2018).

As orangutans are likely to feel the effects of smoke for a few months, long-term impacts are possible (Erb *et al.*, 2018). The frequent exposure of orangutans to the smoke could have severe implications for the population. Between 1999 and 2015, nearly 100,000 orangutans were lost from intact forests in Kalimantan, indicating that their rapid decline is not due only to habitat loss (Imster, 2018).

Forest fire smoke significantly affects the singing of Bornean white-bearded gibbons (*Hylobates albibarbis*). There is a reduction in both the number of singing days and the duration of singing during the fire-prone dry season (Cheyne, 2008a). Gibbon singing communicates information such as alerts for different predator types, proximity to neighbors, and interaction between males and females (Clarke, Reichard and Zuberbühler, 2006; Coudrat *et al.*, 2015). While the behavioral effects of the smoke are not easy to predict, reduced singing at a time when there are usually peaks in singing could negatively affect territorial spacing and defense, communication and reproduction. Increases in mortality, including of infants and juveniles, have the potential to affect population numbers and, ultimately, survival. While the consequences of the reduced singing and the effects of smoke on health have not been specifically investigated, there is no doubt that smoke negatively impacts forests and wildlife (Cheyne, 2008a; Harrison *et al.*, 2007).

The effects of the smoke on the Indonesian economy were significant, particularly with respect to additional air pollution, poor air quality and excessive carbon emissions (Sumarga, 2017). The World Bank Group estimated the impact on the Indonesian economy at US$16 billion, equivalent to about 2% of the country's gross domestic product and more than twice the recovery costs associated with the 2006 Aceh tsunami in Indonesia (World Bank, 2016).

Although the 2015 fires in Indonesia were smaller than the most devastating 1997–1998 fires, they were disastrous (Cassella, 2019; Dennis, 1999; Jim, 1999; Spessa and Field, 2015). While the estimates of how many hectares of forest were burned in 2015 varied considerably, all accounts described the fires as covering vast areas that had no prior history of burning. The long-term effects of multiple fires over relatively short periods can have irreversible impacts on ecosystems (World Bank, 2016). Having compared government data on economic, human and environmental impacts from the 2015 fires with those of previous environmental hazards, Meijaard (2015) characterizes the more recent fire and haze problems as "the biggest man-made environmental disaster of the 21st century."

CASE STUDY 6.1

Flood Response and Recovery in a Chimpanzee Sanctuary in Uganda[2]

The Sanctuary

The Chimpanzee Sanctuary and Wildlife Conservation Trust manages the 0.4-km^2 (40-ha) Ngamba Island Chimpanzee Sanctuary, which is home to 52 chimpanzees in Lake Victoria, Uganda (see Figure 6.1).

FIGURE 6.1

Ngamba Island Chimpanzee Sanctuary, Uganda

Base map data source: OpenStreetMap (n.d.) OpenStreetMap © OpenStreetMap contributors, published under Creative Commons Attribution License CC BY; for more information, see http://creativecommons.org)

The chimpanzee sanctuary is a controlled, semi-captive environment. The island's remoteness offers the apes a degree of safety from humans and other wildlife, yet it also presents risks in relation to forest fires, floods and disease. In 2020, the sanctuary team implemented a successful emergency response in the face of rapidly rising coastal waters and flood risk. The sanctuary subsequently developed a response plan for addressing flooding as well as other risks, including disease outbreak and forest fires.

Figure 6.2 presents the layout of infrastructure on the island. A fenced-off area of about 0.03 km^2 (3 ha) contains two chimpanzee management areas (C and D), staff quarters (B), the veterinary clinic (V) and visitor areas (E). The other 0.37 km^2 (37 ha) make up the main forest enclosure, where the chimpanzees are free to roam every day. A double electric fence (A) is designed to prevent escapes and to ensure continued functioning in case one fence fails.

FIGURE 6.2

Ngamba Island Sanctuary Infrastructure

Notes: Ngamba Island infrastructure includes a double fence (A) that separates the forest enclosure on the left from the sanctuary structures and facilities on the right, including the staff quarters (B), the sleeping area for chimpanzees requiring additional care (C), the isolation ward (D), the veterinary clinic (V) and the visitor areas (E). The proximity of the staff quarters to the chimpanzee sleeping area is useful for nighttime monitoring and quick response. The visitors are situated as far as possible from the apes within the space available. © Joshua Rukundo

The sanctuary's design takes seasonal fluctuations in the lake water levels into account. All chimpanzee areas are on higher ground, including the overnight housing and the outdoor enclosures. Structures occupied by staff and visitors are all on the lower side of the island, where quick evacuation is possible. While unable to suppress inundation, a retainer wall along the shoreline prevents erosion and protects the housing structures in the area most prone to wave action.

The Floods of 2020

As anthropogenic climate change increases the risk of extreme weather events, the island sanctuary's vulnerability to flooding is growing. Rising lake water levels have already led to the loss of about 30% of the land area (see before and after photos below).

Between October 2019 and April 2020, East Africa—and Uganda in particular—witnessed heavy rains, which led to the saturation of rivers, as well as extensive flooding. By May 2020, the water level in Lake Victoria had increased by nearly 1.5 m—from 12 m to 13.42 m, the highest level ever recorded (Cheptoris, 2020; NBI, 2020).

FIGURE 6.3

Ngamba Island Chimpanzee Sanctuary Before, During and After the Floods of 2020

A. Before

B. During

C. After—showing new retaining wall

© Joshua Rukundo, Ngamba Island Chimpanzee Sanctuary

While the rising water levels can be attributed to global warming, environmental degradation caused by humans has accelerated the trend. Loss of forest cover, encroachment on wetlands, lakeshores and riverbanks, and poor land use practices have resulted in soil erosion, which leads to siltation and increased water flow into lakes and rivers. Siltation has also reduced the water storage capacities of the bodies of water. At the same time, increased urbanization has introduced highly impermeable surfaces such as roads, roofs and pavements, which reduce water infiltration into the soil, causing declines in water storage. Similarly, the loss of forests and wetlands limits the local environment's interception and evapotranspiration capacity (Aquatic Habitats in Integrated Urban Water Management, n.d.; Cheptoris, 2020; NBI, 2020).

The 2020 flood waters reached an unprecedented level, the highest in living memory. The resulting inundation of the sanctuary put the welfare of the chimpanzees and those who care for them at risk.

The water submerged a 12–20-meter-wide band of land around the entire island, claiming approximately 0.026 km^2 (2.6 ha) of land cover. A further 0.05 km^2 (5 ha) was waterlogged and temporarily flooded, reducing the useable land cover by almost 20%. The flooding also affected the electric fence that separates the chimpanzees' outdoor enclosure from the sanctuary buildings for staff and guests. In addition, water stagnation caused by the flooding affected the sanctuary's drainage and sewage systems, as underground septic tanks and drainage soak pits were inundated.

The flood-related damage increased the risk that chimpanzees might escape, enter enclosed areas or be exposed to waterborne diseases. Meanwhile, the water-logged areas provided an ideal environment for fish to breed and attracted schools of tilapia. Fishermen intent on trapping the breeding tilapia subsequently sought to gain illegal access to the island, through local communities.

Flooding is potentially life-threatening to the sanctuary chimpanzees. It reduces their access to food, particularly along the western edges of the island, where the vegetation includes thick, thorny mangrove-like trees and bushes that the chimpanzees like to feed on. These areas become especially treacherous to navigate during flooding, when young chimpanzees are most susceptible to getting stuck and drowning. Some flood-related incidents have required sanctuary team intervention to rescue stranded chimpanzees. These high-risk situations can be dangerous for both the animal and the rescuers, as tranquilizing chimpanzees is rarely an option. Team members are not trained in swamp rescue operations or equipped with the required specialized tools.

Risk Management

In response to the 2020 flooding, the sanctuary management team used a risk management approach to analyze the risks, including the potential impacts. The results informed the development of a response and recovery plan to minimize future exposure to flood hazards and to prioritize areas of intervention.

To safeguard the welfare of the animals and the staff, repairs were first carried out on critical structures such as the electric fence, pier (which provides access to the sanctuary for supplies and possible evacuation) and sleeping quarters. This work involved reinforcing weakened areas of the fencing, building a temporary pier, and damming and reinforcing the shoreline with sandbags and rocks at vulnerable spots around the island. The retainer wall along the shoreline was also bolstered after the 2020 floods.

Non-essential staff members left the island and structures that were flooded or at risk of flooding were evacuated. The caregiving team, led by the head-caregiver, carried out daily surveys of flooded land in the forest enclosure to minimize the risk that chimpanzees or other animals might get stuck in bogged areas. During the monitoring activities, they also cleared areas of brush to reduce the risk of animals getting stuck in this dense vegetation if it flooded. The team located areas of stagnant water, which they filled with sand or drained or, in some cases, applied vegetable oil to minimize mosquito breeding. The sewage systems of the visitor facilities were blocked off as they were not in use. This prevented the backflow of sewage from flooded underground waste tanks and reduced the risk of water contamination and exposure to waterborne diseases. The management team established rapid communication and response procedures to manage potential rapid changes in the scenario, such as increased and more prolonged inundation.

While the flooding crisis was managed effectively, it exposed the need for a rapid response and evacuation plan for the sanctuary. Such a plan, which will allow sanctuary staff to prepare for a catastrophic event, is under development. For a preparedness review of Case Study 6.1, see Annex VI.

considers the impact of the infectious disease caused by the SARS-CoV-2 virus, the COVID-19 pandemic, on rescue and rehabilitation centers and their risk management plans. Such preparedness actions work best when considered alongside well-developed and rehearsed procedures that provide guidance on leadership, risk mitigation measures and resources.

As the frequency and severity of natural hazards increase, so too do the risks of associated impacts on animals and their environments (Zhang *et al.*, 2019). Climate change-induced natural disasters may result in rapid shifts in ape distribution, behavior and diversity (Lehmann, Korstjens and Dunbar, 2010). Such changes demand "tougher choices and more proactive crisis-preparation for conservationists, as well as mentality changes for all" (Sergio, Blas and Hiraldo, 2018, p. 1).

Some apes may have subtle responses to severe weather events. A study of the effects of climate change on bonobos (*Pan paniscus*) in the Democratic Republic of Congo (DRC) shows that as precipitation decreased over a 15-year period, the decay times of the apes' nests increased. The number of storms was the main factor driving decay times. The bonobos also adapted to the changing climatic conditions by strengthening nest structures in response to unpredictable, harsh precipitation (Bessone *et al.*, 2021).

Natural disasters do not always result in long-term negative outcomes. In response to hurricanes and a subsequent forest fire, for example, spider monkeys (*Ateles geoffroyi*) developed successful coping strategies such as changes in diet, activity and fission–fusion dynamics (Champion, 2013; Schaffner *et al.*, 2012). Analysis of data on Cayo Santiago rhesus macaques (*Macaca mulatta*) from 1973 to 2018 shows that hurricanes did not lead to detrimental effects at the population level (Morcillo *et al.*, 2020).

BOX 6.3

COVID-19 and Its Impact on Ape Rescue Centers

Human–wildlife contact can contribute to the global spread of infectious disease.[3] In confronting the infectious disease caused by SARS-CoV-2, the COVID-19 pandemic, the ape rescue and rehabilitation sector has accorded the highest priority to the safety and well-being of staff, their families and the communities around the centers, as well as the wildlife they seek to protect. The centers have long used personal protective equipment (PPE) such as masks and gloves to minimize the transmission of diseases, parasites and bacteria to and among apes. Their approach to food preparation, quarantining and rehabilitation is also aimed at reducing the risk of cross-contamination and transmission, as is their application of best practices and regularly updated policies (Campbell, Cheyne and Rawson, 2015; Cheyne, Campbell and Payne, 2012).

Field monitoring research, especially following the release of rehabilitant apes, remains key to their safety and wellbeing, so long as close contact and unnecessary risks are avoided. Given the high likelihood that COVID-19 or other infections will continue to pose risks to apes, rescue and rehabilitation centers are devising appropriate longer-term primate monitoring strategies that suitably balance the need to conduct post-release monitoring with the potential harm associated with infections. As monitoring activities typically involve small teams working in areas away from human habitation, they have been able to continue relatively unaffected, albeit with some modifications to reduce the COVID-19 risk.

The translocation of endangered apes for conservation purposes has also become more common, especially for species with limited dispersal ability, since they can find themselves confined to shrinking, fragmented habitats where the risk of early extinction is high. Although apes who undergo translocation are tested prior to release, the process of translocation can increase the risk of disease transmission (Campbell, Cheyne and Rawson, 2015). In view of this risk, the International Union for Conservation of Nature recommended that no reintroductions or translocations of great apes take place during the pandemic (IUCN SSC PSG SGA, n.d.-a).

Rescue and rehabilitation centers are continuing to monitor the situation, as well as international guidance from the World Health Organization. They are complying with instructions from local and national governments to minimize contact with apes, while using PPE to reduce the spread of the virus.

Russon, Kuncoro and Ferisa (2015) report that orangutans in forests affected by fires returned to pre-fire food regimes as the forest recovered. A key survival strategy was their ability to vary diet in response to the availability of different food types across an increased foraging area. In setting aside areas for conservation of a species, practitioners can usefully consider the increased

Photo: Some apes may have subtle responses to severe weather events. A study of the effects of climate change on bonobos in the DRC shows that as precipitation decreased over a 15-year period, the decay times of the apes' nests increased. The number of storms was the main factor driving decay times. The bonobos also adapted to the changing climatic conditions by strengthening nest structures in response to unpredictable, harsh precipitation. © Takeshi Furuichi/ Wamba Committee for Bonobo Research

area needed for recovery after a major disturbance event, rather than just the area that supports a population in times of stability. Back-to-back events may prevent the recovery of a population. Animals with slow reproductive rates, such as apes, or with very specific dietary requirements can be more negatively impacted by even small drops in numbers due to extreme weather or other destabilizing events (Ameca y Juárez, Ellis and Rodríguez-Luna, 2015; Behie *et al.*, 2019).

Managing Risks to Apes

Historically, risk management has focused primarily on risks directly associated with the impact of one or more hazards. The process can be more effective if it addresses the full range of risks, as encapsulated by the acronym PEESTOLM, which stands for political, environmental, economic, social, technical, operational, legal, and media and communications-related risks (Cooper, 2018; WHA, 2018).

While some disaster and emergency management practitioners, including those in Australia, use the PEESTOLM approach, others apply analogous methods. One example is a recent risk assessment that examines the challenges and opportunities in tropical forest and peatland conservation and restoration in Indonesia, with a particular emphasis on areas affected by fire. It examines political, economic, social, logistical, legal and research challenges, which generally align with PEESTOLM risks (Harrison *et al.*, 2020a). The assessment of risks is fundamentally the same across sectors, including with reference to captive animal and wildlife health issues, plant pests, drought, locust plagues, human pandemics and natural disasters such as flooding and forest fires.

Annex IV presents a PEESTOLM risk register for a zoonosis in apes. It shows that

Photo: The focus on COVID-19 prevention had a negative impact on protected and conserved areas around the world. Slashed tourism revenue and tighter budgets for park agencies resulted in layoffs and related reductions in staff activity, restricted management services and drops in conservation effectiveness. © Martha Robbins/ MPI-EVAN

disease risks involve a much wider range of considerations than risks associated with a single event, such as a fire. The need for a review of risks may be triggered by various changes in context, such as the implementation of mitigation measures, the end of a specific time period or expenditure of a mitigation budget.

Risk management guidance from global organizations can also be instructive. The hazard-based contingency planning flow chart described by the World Health Organization (WHO) starts with risk analysis (European Commission, 2021; UNHCR, 2015; WHO, 2018). Disaster risk management is the basis for the United Nations Sendai Framework for Disaster Risk Reduction 2015–2030, which is a good guide to risk assessment for disasters (UNDRR, 2015, n.d.-c). Integrated risk management, utilizing a One Health and disease risk analysis approach, has been used during the COVID-19 pandemic (see Chapter 2).

Compounding Risks

When multiple risks interact—as compounding or cascading risks—they exacerbate potential impacts and consequences. Annex IV uses PEESTOLM to explore the risks associated with a zoonotic hazard in apes. Within the annex, no single risk can be considered in isolation from the other risks. The compounding relationship between some of the risks translates into a greater risk than for any one risk alone. An inability to mitigate one risk leads to further risks. For example, an inability to address operational risks—such as by providing adequate resources for surveillance—can lead to technical risks, such as a failure to detect disease.

A cost–benefit analysis, undertaken as part of emergency preparedness, can help to identify compounding relationships between risks. As discussed in Case Study 6.2, an analysis that is focused only on the costs of managing technical risks that arise directly

CASE STUDY 6.2

COVID-19, Tourism Revenue and Compounding Risks

In general, the exclusive management of technical risk—such as through disease prevention—is likely to lead to compounding risks. A case in point is the management of the technical risks associated with the infectious disease caused by SARS-CoV-2, the COVID-19 pandemic, in the Democratic Republic of Congo (DRC), Rwanda and Uganda, whose economies are tourism-dependent.

In response to the COIVID-19 pandemic, the iconic gorilla conservation parks across these three countries were closed to tourism for protracted periods of 2020 and 2021 (Beament, 2020; Virunga National Park, n.d.-b). This case study reviews the interaction of certain PEESTOLM risks—that is, political, environmental, economic, social, technical, operational, legal and media and communications-related risks—associated with the SARS-CoV-2 hazard/COVID-19 disaster (see Annex IV).

Ramifications of COVID-19 Restrictions on Ape Tourism

In the DRC, Rwanda and Uganda, the negative consequences of halting all ape tourism activities and implementing other measures to prevent the potential infection of apes with COVID-19 included a loss of employment and livelihoods, reductions in local and national income, and cuts in funding for ape conservation.

In Rwanda, for example, the tourism sector—much of which revolves around gorillas—was the largest foreign exchange earner by 2013 and enabled conservation successes (Maekawa *et al.*, 2013; Nielsen and Spenceley, 2010). Measures designed to address only the technical risks associated with COVID-19 effectively curtailed or severely reduced this source of revenue. As a result, conservation efforts were cut back as local economies suffered from the loss of tourism income (Gilardi *et al.*, 2022; Hockings *et al.*, 2020; Kalema-Zikusoka *et al.*, 2021; Richardson, 2021).

The loss in ape tourism revenue also led to a decline in anti-poaching activities and an increase in illegal hunting, including wildlife trapping in Uganda's Bwindi Impenetrable National Park (Guyson, 2021; Ledger, 2020). In the DRC, a baby gorilla was found tangled in a snare in Virunga National Park (Ledger, 2020). The United Nations Educational, Scientific and Cultural Organization (UNESCO) reported that the number of snares increased nearly 40-fold during the year ending in April 2020—from 21 to 822 snares (UNESCO World Heritage Convention, 2020).

Research also indicates that the focus on COVID-19 prevention had a negative impact on protected and conserved

areas around the world, as pandemic-related restrictions gave rise to operational risks. Specifically, slashed tourism revenue and tighter budgets for park agencies resulted in lay-offs and related reductions in staff activity, restricted management services and drops in conservation effectiveness. Park staff members were diverted away from conservation work and instead assigned duties associated with the mitigation of wider community risks from COVID-19. Meanwhile, local, tourism-dependent communities suffered a loss of livelihoods, which were compounded by significant reductions in recruitment and employment opportunities for those working in conservation (Corlett *et al.*, 2020; Hockings *et al.*, 2020). Such operational shortfalls can stunt the development of relevant skills and knowledge, further hampering conservation efforts.

Operational deficits caused by an exclusive focus on technical risks can also weaken public support for conservation. By threatening people's livelihoods and thus their wellbeing, a focus on disease prevention measures can place positive attitudes towards wildlife and the forest at risk (Hall *et al.*, 2004). Managing people's views of animals is key to emergency management that supports positive outcomes for both humans and animals affected by a disaster (McCarthy, Bigelow and Taylor, 2018).

These findings underscore the need to address all relevant risks at the same time. Tackling technical risks is a way to manage disease spread, applying measures to address social and economic risks can protect communities dependent on ape tourism, and reducing operational risks can support the conservation of protected natural areas (Hockings *et al.*, 2020). In recognition of the social, economic and environmental risks associated with COVID-19 prevention measures, the International Union for Conservation of Nature (IUCN) Primate Specialist Group and Wildlife Health Specialist Group similarly called for methods to "offset loss of profit and employment from tourism" and support of public health in local human populations (IUCN SSC PSG SGA, n.d.-a; UNEP, 2020).

Precise estimates of the losses due to the suspension of ape tourism and related activities remain elusive. A 2019 estimate puts the global direct value of wildlife tourism at US$120 billion—or US$346 billion when multiplier effects are accounted for—and the number of jobs at 21.8 million (Hockings *et al.*, 2020). In 2016–2017, the travel and tourism industry that focuses on gorilla tourism contributed more than US$400 million to the Rwandan economy, with 10% benefiting local communities (Fitzgerald, 2022). The loss of this contribution to Rwanda would be significant.

Beyond COVID-19 Restrictions

As pandemic restrictions battered local economies, UNESCO provided emergency funding to Bwindi Impenetrable National Park to support the implementation of COVID-19 safe practices by those who interacted with the gorillas (UNESCO World Heritage Convention, 2020). The funds allowed the staff to continue with the monitoring and surveillance of gorilla health to sustain the early disease detection and response. The funding was also used to extend patrols for the protection of gorillas and to prevent and discourage poaching.

In moves that reflected the economic importance of gorilla tourism, governments decided to loosen travel restrictions despite ongoing risks from COVID-19. Uganda reopened its doors to tourism from October 2020 and Rwanda from April 2021 (ATTA, 2020; Read, 2020; Virunga National Park Congo, n.d.). To encourage the return of tourists, the cost of a gorilla experience was reduced (Bizimungu, 2020). At the same time, requirements and procedures were revised to address the remaining technical risks associated with the gorillas' exposure to humans. The requirements included mask wearing, increased minimum distances between humans and apes, training of ape caregivers and COVID-19 vaccination of humans working with apes (Kalema-Zikusoka *et al.*, 2021; Richardson, 2021).

The DRC, Rwanda and the Uganda Greater Virunga Transboundary Collaboration developed a COVID-19 risk register for mountain gorillas (*Gorilla beringei beringei*), based on prior contingency planning for Ebola virus disease. At this writing, the draft risk assessment appeared focused on technical risks, although other risks could be addressed in future revisions (Gilardi *et al.*, 2022; GVTC, 2020). Separately, the Section on Great Apes of the IUCN Primate Specialist Group produced a list of measures to minimize the risk of SARS-CoV-2 transmission to great apes (IUCN SSC PSG, n.d.).

Risk assessments are more effective if they are directly relevant to a specific context. The COVID-19 risk assessment at Chester Zoo, for example, is specific to that zoo's context (Chester Zoo, 2021). While elements of the assessment may be applicable to another zoo, it cannot be adopted wholesale by a similar facility, as contexts vary across zoos. Moreover, the benefits of developing a shared understanding among key stakeholders and the need to validate the applicability of risk treatments during the process of developing and completing a risk assessment are as important as the final risk assessment itself.

Another consideration relates to the legal risks associated with implementing proposed mitigation measures for COVID-19. Steps can be taken to ensure that measures comply with legislation and policies, while also being acceptable to local and Indigenous communities. The 2016 emergency response plan for Hainan gibbons (*Nomascus hainanus*), for instance, acknowledges the need to have such approvals in place ahead of any response actions (Bryant and Turvey, 2017).

from a hazard impact may exclude costs associated with other risks. Such analysis is more useful if it also factors in the benefits of mitigating social, environmental and economic risks, which are likely to be much greater in both the short and long term than the benefits of managing only the technical risks. Funds allocated for managing social and economic risks usually support the management of technical risks as well.

Risk Treatment

Risk mitigation options may be grouped into five categories: avoiding the risk, reducing the likelihood of a harmful impact, reducing the consequences, transferring the risk and retaining the risk (ENISA, n.d.; see Table 6.1). Successful risk mitigation typically involves more than one of these treatment options.

In the case of disease outbreak, risk mitigation with respect to apes in their natural habitat is generally focused on reducing the technical risk of infection. The key measure is to reduce any contact between humans and apes to the absolute minimum (see Case Study 6.2).[4]

Trevidy (2020) examines the option of retaining the risk of apes becoming infected as a way of balancing the technical risks against economic and environmental risks. As discussed in Case Study 6.2, a failure to address economic risks resulting from curtailing local tourism is likely to lead to social risks in the local human population. These compounding risks have the potential to increase the exposure of apes to disease. Measures to reduce such consequences are not readily identified in the published literature.

Gorilla tourism has often been interrupted due to emergencies, including insecurity or risk of disease. Contingency plans for such cases could involve alternative sources of funding to communities affected by technical risk mitigation (Litchfield, 2008). In the first instance, support could be drawn from trust funds or emergency assistance that conservation agencies or international donors such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) have specifically earmarked for gorilla conservation (UNESCO World Heritage Convention, 2020; see Case Study 6.2). In addition, sustainable funding mechanisms could receive contributions sourced as premiums or levies from tourism (Litchfield, 2008).

Longer-term risk reduction measures could focus on diversification of the local economy. Local economies that depend on more than one income stream have the potential to reduce their exposure to disaster impacts and provide ongoing support to

TABLE 6.1

Treatment Options for Mitigating Disaster Risks to Apes

Risk treatment option	Description
Avoid the risk	Decide not to proceed with a measure that is likely to generate or involve unacceptable risk.
Reduce the likelihood	Reduce the likelihood of a harmful impact, e.g., through translocation, early warning or vaccination.
Reduce the consequences	Reduce the consequences of a harmful impact, such as by spreading a susceptible population across multiple habitats.
Transfer the risk	Transfer the risk to another party, such as captive care centers or zoos, to share or bear the risk.
Retain the risk	Retain the risk by accepting the level of risk and planning to manage its consequence, for instance using post-impact triaging.

the local ape population. In Uganda, for example, Conservation through Public Health (CTPH) adopted a diversification approach in providing support during the COVID-19 pandemic. In the absence of gorilla tourism revenue, CTPH worked with affected communities to develop a coffee consortium and to distribute rapidly growing seedlings to encourage the cultivation and sale of produce (Guyson, 2021; see Case Study 2.1).

The UN Environment Programme, working with governments and private partners, has supported local communities in efforts to expand their economic base beyond tourism in ways that benefit both the communities and the natural environment (Refisch, 2021). Local communities that receive monetary and non-monetary benefits from the sustainable management of forests and wildlife are more likely to support and enable related conservation efforts (Junker *et al.*, 2017).

The Disaster Management Continuum with a Focus on Apes

The continuum of prevention, preparedness, response and recovery phases can be used to address disaster risks to apes. The Uganda Greater Virunga Transboundary Collaboration COVID-19 risk register for mountain gorillas (*Gorilla beringei beringei*) has made such use of the continuum phases (GVTC, 2020; see Case Study 6.2). This section discusses each phase in turn.

Prevention

Preventive measures are designed to reduce the impact of natural and anthropogenic hazards—or to avert disasters by enhancing the resilience and reducing the vulnerability of communities and their environments. Prevention provides the opportunity to apply risk treatments well ahead of any impact (see Table 6.1). While preventive efforts tend to be cost-, time- and labor-intensive, they are generally less expensive than response and recovery (Cusick, 2019; European Commission, n.d.). Moving a village to reduce or remove a flood risk, for instance, is certain to require considerable time, effort and expenditure. Over time, however, the return on investment pays for the outlay many times over, and related benefits exceed those of response and recovery measures (Cusick, 2019).

The scientific literature provides few accounts of significant prevention measures undertaken to protect wild apes from the impacts of natural disasters, although efforts to prevent the spread of diseases such as COVID-19 have been documented (see Case Study 6.2). While the emergency response plan for the Hainan gibbon (*Nomascus hainanus*) is principally a preparedness measure, its desired outcome is prevention. The plan is intended for activation in response to predicted typhoons that could threaten this very small population of critically endangered gibbons (Bryant and Turvey, 2017).

Other prevention plans have been tried and tested. In 2017, when Hurricane Harvey struck the Houston Zoo in Texas, the facility had already activated its emergency plan. For four days, staff kept thousands of animals safe in spacious indoor enclosures, which were equipped with food, medicine and an emergency electricity supply (Airhart, 2018).

The long-standing practice of creating conservation areas is aimed at reducing the likelihood of impact from anthropogenic hazards such as forest fires, industrial incidents, dam failures, landslides associated with construction, and conflict situations. Buffer zones around ape conservation areas further decrease the risks of harmful effects.

These areas also need to be sufficiently large and to harbor enough biodiversity to support the recovery of ape populations after an anthropogenic disaster, as food and shelter may initially be in short supply.

To make up for these shortfalls, apes may need to range over a larger area than they did before a disaster. Conversely, access to a greater area reduces the likelihood that apes will face hazard-induced shortages of food and shelter. A conservation area's size and ability to meet the needs of apes can also influence the impacts of natural hazard, such as hurricanes, typhoons, lightning-caused forest fires, flooding and earthquakes. The larger the conservation area, the lower is the likelihood that a single hazard would be able to impact the entire area and its ape populations. As noted above, larger areas offer more opportunities to find scarce foods and shelter in and around a hazard-affected landscape (Behie *et al.*, 2019).

Photo: The long-standing practice of creating conservation areas is aimed at reducing the likelihood of impact from anthropogenic hazards such as forest fires, industrial incidents, dam failures, landslides associated with construction, and conflict situations. © Jabruson (www.jabruson.photoshelter.com)

One method used in preventing forest fires is risk mapping, which identifies at-risk areas and thus enables the implementation of targeted prevention measures. Risk mapping is used in the forests of Central Kalimantan, Indonesia, where human-made fires have caused widespread damage to the ecosystem and biodiversity, as well as to human health and the livelihoods of local people (Lestari and Puspita Ayu, 2020).

Risk mapping is also a common practice in forest fire-prone areas of Australia, where it is used to inform the development and deployment of prevention measures (NSW Rural Fire Service, n.d.-a). Such measures include developing asset protection zones around high-value areas, thinning understory plants and other fine forest fuels, planting low-fire-risk vegetation, placing buffers around forest fuels that are responsible for expanding high-intensity fire behavior in high-risk areas, developing a network of fire trails to form compartments for fire management and providing community fire safety education (Building Code & Bushfire Solutions, n.d.; NSW Rural Fire Service, n.d.-b; SCS, 2017). Like other risk management tools, risk mapping requires sustained effort to ensure the information it provides is accurate and relevant. The integration of risk mapping with seasonal fire forecasting may help to identify areas of higher risk in any given season (Spessa *et al.*, 2015; Sumarga, 2017).

“Preparedness enables the identification of measures to avoid, mitigate and respond during a disaster.”

Another tool used to identify fire-risk distribution and inform fire management is the fire hotspot distribution model, which was described as critical to the success of the peatland restoration program in Indonesia (Sumarga, 2017). Disaster risk reduction efforts also make use of hazard analysis, examples of which can be found on the UN Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) Knowledge Portal (UNOOSA, n.d.). The portal presents information on locations that are at risk of landslides, for example (Cozannet, 2007).

In the case of disease outbreaks such as COVID-19, which can have direct impacts on ape mortality and morbidity, prevention is the most important strategy that protected area authorities and other stakeholders can take (see Case Study 6.3). Many of the risks associated with a disease outbreak, including reputational risk to a sanctuary or conservation authority, are also critical in managing potential impacts (see Annex V; PCI, 2022).

In some large conservation areas, risk mitigation measures include the controversial use of engineered fences. While such fences are not widely used to protect apes, they have had deleterious impacts on other wildlife and ecosystems, such as by disrupting non-target species' movement patterns, isolating populations and exacerbating mortality linked to entanglement in fences. Many have been taken down or modified because they were acting as barriers to wildlife (McInturff *et al.*, 2020).

In other areas, fences are used to reduce the risk of some anthropogenic hazards, including disease and invasive species that present a threat to target wildlife. In Australia, for instance, some engineered fences are credited with the successful protection of target wildlife species that had been disappearing from their natural habitat due to predation by and competition from introduced feral animals, such as cats, foxes and rabbits. Fences are best used where the fence perimeter is clear of trees that may otherwise fall over it and provide a way for animals to get to the other side. A fence thus needs to be at the edge of the forested area or have a wide buffer free of trees. Ongoing management, including maintenance and patrols by people and technology, such as cameras and other imagery, support the ongoing integrity of a fence (BCT, 2020; Long and Robley, 2004).

CASE STUDY 6.3

COVID-19 and Mountain Gorillas

In efforts to protect apes from the infectious disease caused by SARS-CoV-2, COVID-19, prevention is the key risk mitigation activity. On that front, action by various stakeholders is essential, as highlighted in the stringent measures of the International Union for Conservation of Nature (IUCN) best practice guidelines for health monitoring and disease control in great ape populations.[5] The stakeholders run the gamut from ape researchers, academics, veterinarians and other health personnel to decision-makers and staff in the ape-based tourism and conservation sectors, all of whom can lead in their areas of responsibility.

The development of control and coordination frameworks for this wide variety of stakeholders has enabled the prevention of outbreaks, the effective use of resources and consistency across emergency response and preparedness activities, while also providing a platform for sharing lessons learned. Typically, government takes the lead in initiating and developing such frameworks.

In March 2020, IUCN's Section on Great Apes and Wildlife Health Specialist Group issued a joint statement on great apes and COVID-19, recommending that visits by humans be reduced to the minimum needed to continue the monitoring of ape safety and health (IUCN, 2020b; UNEP, 2020). The development of risk mitigation measures to prevent exposure of apes to COVID-19 began around the same time (Gillespie and Leendertz, 2020; Reid, 2020; Trivedy, 2020).

Initially, all ape-related tourism was halted in the range states of mountain gorillas (*Gorilla beringei beringei*)—the Democratic Republic of Congo, Rwanda and Uganda. Some restrictions were lifted beginning in October 2020, when Uganda reopened its doors to tourists (ATTA, 2020; Guyson, 2021; see Case Study 6.2). In Bwindi Impenetrable National Park, the training of 130 Uganda Wildlife Authority rangers helped to keep the virus away from the gorillas and enabled monitoring for illness. Additional measures required ape researchers to quarantine for up to 14 days prior to any contact with the gorillas, and all visitors and staff to wear masks, keep a safe distance from the apes, and apply best practice guidelines during visits and health monitoring activities (UNESCO, 2020).

Meanwhile, conservationists worked with local people to support livelihood activities that did not require entry into the forest. They provided goats to reduce the need for hunting and support for growing cash crops, while discouraging apes from entering the areas populated by people (Gibbons, 2020). To prevent the exposure of apes to COVID-19, one practitioner proposed postponing all fieldwork until a vaccine could be secured or the pandemic ended (Reid, 2020). Following this advice could potentially have created negative outcomes for ape conservation and poor social and economic outcomes for the local human populations working for the parks, the researchers and the tourism sector (Trivedy, 2020).

Before the pandemic, research found that more than 98% of the tourist groups visiting the mountain gorillas in Bwindi Impenetrable National Park in Uganda got closer than the recommended 7 meters (Weber, Kalema-Zikusoka and Stevens, 2020; see Chapter 3). Compliance checks for adherence to the biosecurity requirements can help indicate where action needs to be taken to avoid risks.

Businesses and groups associated with ape conservation can validate their compliance with the stated biosecurity guidelines by becoming accredited or certified by a third party. The Wildlife Friendly Enterprise Network, in close partnership with the International Gorilla Conservation Programme—a coalition of Conservation International, Fauna and Flora International and the World Wildlife Fund—is piloting species-focused Gorilla Friendly™ tourism and product certification (IGCP, n.d.; WFEN, n.d.). The program uses best practice based on IUCN guidelines and up-to-date expert advice. The model may also be applicable to other ape species and their environments.

Preparedness

Preparedness is defined as the measures and actions taken for and by a community and community partners prior to an impact by a hazard, ensuring a timely and effective response to hazard impacts. Preparedness enables the identification of measures to avoid, mitigate and respond during a disaster. Many key stakeholder organizations with an interest in disaster management have a guide or manual for preparedness (AIDR, 2020; European Commission, 2021; UNHCR, 2015; WHO, 2017a). The actions underpinning effective preparedness include:

- identification of risks and completion of risk assessments for each risk;
- development of treatments to mitigate risks, starting with the ones that have a high risk rating;
- development of warning systems to alert communities and responders;

Photo: Preparedness regarding at-risk apes in captive or natural settings involves clarity on who is responsible for what actions to protect the apes, including any evacuations or translocations, and who has the authority to make decisions on requisite resources and support actions. © Lwiro Primates Rehabilitation Center

- development of command and control arrangements for a response;
- development and validation of information systems to support timely decision-making, resource deployment and communication to the local community and identified stakeholders;
- development of documentation, including policies, procedures and contingency plans that identify who is responsible for what, where and when;
- acquisition and, if necessary, stockpiling of resources, including stores, personnel, equipment and facilities;

- rehearsal and exercises involving personnel and the community; and
- updating through monitoring and evaluation of each activity in response to changes in context, including with respect to risks, resources and lessons learned regarding responses and exercises (AIDR, 2020; European Commission, 2021; Nelson *et al.*, 2007; UNHCR, 2015; WHO, 2017a).

These preparedness actions are generally carried out sequentially. Once underway, however, the process becomes iterative and can move seamlessly between the activities, with completion of some actions dependent on progress in others.

Preparedness regarding at-risk apes in captive or natural settings involves clarity on who is responsible for what actions to protect the apes, including any evacuations or translocations, and who has the authority to make decisions on requisite resources and support actions (Beck *et al.*, 2007). Trigger points—either in time or as specified events—contribute to a shared understanding of who is to do what at which moment. Fire drills and other types of training are part of preparedness, as exemplified at the Oakland Zoo in the US state of California (Airhart, 2018).

Preparedness allows for a planned, timely, structured and systematic response to an imminent or actual impact by a natural or anthropogenic hazard, rather than a reactive approach to an unfolding, known or potentially dangerous situation. A key overall outcome is to ensure that any impacted local community is resilient and thus better able to cope with a disaster. Resilient communities are characterized by:

- their awareness of the hazards and risks that affect their local area, and of actions they can take to prepare for and mitigate these risks;

- the actions they have taken to anticipate disasters following a hazard impact and to protect their social, built, economic and natural environments before, during and after a hazard impact; and
- their understanding of the arrangements for recovery assistance (Royal Commission into National Natural Disaster Arrangements, 2020b).

A natural or anthropogenic hazard that overwhelms a local community's ability to cope can trigger an emergency and escalate to a disaster. In such situations, communities are forced to rely on the provision of planned and coordinated support and resources from outside.

The lead responsibility for preparedness may rest with a particular local authority, such as a fire authority or land manager in the case of forest fires. The lead authority directs preparedness efforts for the community and other stakeholders, including businesses and relevant government agencies that support the lead agency. For all hazards, this iterative process engages the community, harnesses local knowledge and builds commitment to the preparedness outcomes (Dunlop *et al.*, 2016; Nelson *et al.*, 2007; Redshaw *et al.*, 2017).

Under exceptional circumstances, a single lead agency may need to manage the majority of preparedness activities for a specified hazard impact. Preparedness based on the involvement of many government and non-government agencies and organizations is the preferred approach, however. A multiagency preparedness approach brings together all the agencies with a vested interest in mitigating given hazard impacts to access the knowledge and expertise that is needed to address the full range of risks. While a fire authority focuses on operational and technical risks, it is unlikely to be able to address social, economic or environmental risks, such as the management of apes. Other agencies can take responsibility for mitigating these risks in support of the lead authority.

As discussed in greater detail below, the five key elements underpinning good preparedness are:

- capacity and capability (all resource categories are fit for purpose and in the right place at the right time, including response-specific training);
- documentation (plans, agreements, manuals, guides, policies and procedures);
- governance (oversight, leadership and management arrangements including command control coordination);
- management systems (such as those for warnings, operations, resource tracking, finance and health and safety); and
- usage (drills, exercises, rehearsal and practice) (Cooper, 2018).

Collectively, these preparedness elements work to deliver a timely, structured and systematic mobilization of resources, including personnel and stores, as well as information management during a response. Effective information management, for instance, is critical to facilitating decision-making, resource utilization and timely communication. Each of the five elements is applicable to a wide range of disasters. A resource management system that helps to tackle forest fires, for instance, is equally applicable to flooding (Cooper, 2018).

The preparedness elements are comparable to the key elements of public health emergencies and are closely aligned with preparedness activities for animal health emergencies in North America, which include:

- education and training;
- exercises or simulations;
- monitoring and surveillance;
- networks of key personnel and roles; and

Photo: Capacity building involves developing community resources and knowledge with the corresponding skills, enhancing social relations within the community, and forging links between policy and the community. © Hutan-KOCP

- response plan development and enhancement (Bowman and Arnoldi, 1999; Nelson *et al.*, 2007).

Preparedness is undertaken at the local, regional, national and international levels. The risks are different at each level and thus necessitate different treatment measures. For a preparedness review of Case Study 6.1, see Annex VI.

Capacity and Capability

The capacity and capability to respond to an emergency in a timely manner depends on available skills, structures and resources—including personnel, equipment, facilities, services and transport (Nelson *et al.*, 2007).

Capacity building involves developing community resources and knowledge with the corresponding skills, enhancing social relations within the community, and forging links between policy and the community (Quijano *et al.*, 2016). These outcomes are more likely to be achieved when the process is led from within a community. The same principle applies to a community's ability to boost resource levels significantly in a short time, a process known as surge capacity, as local ownership and local knowledge contribute to a community's resilience and independence. Surge capacity may include the use of spontaneous volunteers from local and more distant communities to assist. Preparedness needs to consider the significant logistical challenges that are typically

associated with these volunteers (AIDR, 2017; Daddoust *et al.*, 2021; DHS, 2019).

Community leaders typically have a sound understanding of their context, including any weaknesses in relevant expertise. Preparedness begins with a risk assessment that considers local capabilities, such as the availability of expertise needed to address technical, social and economic risks. It also involves developing and continually updating a local contingency plan that documents any need for technical support and options to address shortfalls. Facilitators from external organizations have an important role to play in supporting local leaders ensure preparedness and guiding them and their community.

A key element of preparedness is the development of adequate non-human resources, such as stores and equipment. Stockpiling enables timely availability of appropriate resources during disasters, when a community may be isolated from the usual supply chains or sources.

Documentation

Documentation developed as part of preparedness is used to inform response and recovery actions. The suite of documentation includes risk assessments, policies, procedures, manuals, guidelines and plans at different levels to address various risks, such as hazard-specific plans, business continuity plans and plans designed to address economic risks, which are usually applied at the regional or national level. A contingency plan is part of the documentation and is not a substitute for the full range of preparedness activities.

A contingency plan is effective so long as it is up-to-date, appropriate, and understood by the relevant community and those who are expected to implement it. It identifies courses of action to be taken by individuals in various roles, the allocation of resources and information-handling processes (IFRC, 2021; Nadler, 2019; UNDRR, n.d.-a; WHO, 2018; ZAHP, 2017). Warning activation and levels of alert may be included in the plan. Box 6.4 presents a short guide to the development and contents of a contingency plan. Some of the following contingency plans and similar documents explicitly cover apes:

- COVID-19 Pandemic Guidelines (OVAG, 2020a);
- *Emergency Response Plan for the Hainan Gibbon* (Bryant and Turvey, 2017);
- the Greater Virunga Transboundary Collaboration's "Regional EVD and COVID-19 Contingency Plans for Mountain Gorillas" (GVTC, 2020);
- Orangutan Veterinary Advisory Group Contingency Plan (Appendix 2) for facilities and services associated with orangutans in captivity (OVAG, 2020b);
- Rwanda's *Ebola Virus Disease (EVD) Contingency Plan* (The Republic of Rwanda, 2018);
- "Contingency Planning for All Hazards and Foreign Disease" in *Fowler's Zoo and Wild Animal Medicine Current Therapy* (Nadler, 2019);
- the Food and Agriculture Organization and Network of Aquaculture Centres in Asia-Pacific's "Contingency Planning" (FAO and NACA, 2001);
- the Global Federation of Animal Sanctuaries' webinar on "Contingency Planning for Sanctuaries and Rehabilitation Centers" (GFAS, 2017);
- the Zoo and Aquarium All Hazards Partnership's *Contingency Planning for the Exotic Animal Industry: Workshop* (ZAHP, 2017); and
- the Zoological Best Practices Working Group's *Planning Roadmap: A Basic Guide for Emergency Planners for Managed Wildlife Facilities* (ZBPWG, 2011).

BOX 6.4

Contingency Plan Development and Ape-Related Contents

The process of developing a contingency plan is as important as the final plan. The development process engages community members and other stakeholders who intend to use the plan as a basis for the response. Features of an effective contingency plan include clarity, operational relevance, feasibility and realistic intended use of resources (WHO, 2018). The development process involves:

- carrying out risk analysis at the appropriate level for the plan;
- identifying risk mitigation measures;
- developing preparedness actions and evaluating risk mitigation measures;
- drafting the plan based on preparedness actions, specifying details of warning services and who is to do what, when and where;
- undertaking evaluation, exercises and reviews of the plan; and
- updating the plan through periodic reviews.

Contingency plans typically contain the following elements, usually in this order:

- an overview or context, including of ape populations at risk, disaster history and specific emergency arrangements, such as legislation and policies;
- an assessment of ape populations and potential hazards at the time of plan drafting;
- an up-to-date assessment of potential hazards and risk assessments;
- a forecast of the most likely outcomes for each risk event (consequences);
- risk mitigation measures for reducing both likelihood and consequences; and
- the assignment of responsibilities for each functional area and detailed requirements with respect to expertise and other resources.

A contingency plan does not include information described in procedures, policies or guidelines. These stand-alone elements underpin response actions and tasks (IFRC, 2021; Nadler, 2019; WHO, 2018; ZAHP, 2017).

The above-mentioned contingency plan to protect gorillas from COVID-19 in the Greater Virunga Landscape of the DRC, Rwanda and Uganda was developed by the Greater Virunga Transboundary Collaboration, with support from Gorilla Doctors, the International Gorilla Conservation Programme, UNESCO, the World Wildlife Fund and Partners In Conservation at the Columbus Zoo and Aquarium in the US state of Ohio (Gilardi *et al.*, 2022; UNESCO, 2020). The plan aims to "protect mountain gorillas, conservation personnel, tourists and park adjacent communities from SARS CoV-2, the emergent coronavirus that causes the human disease COVID-19" (GVTC, 2020, slide 5). The plan is for both COVID-19 and Ebola virus disease, which was the basis for the initial version of the plan (Gilardi *et al.*, 2022).

In captive or semi-captive settings such as sanctuaries, rehabilitation centers and zoos, the framework for a contingency plan includes the resident animals, their keepers and the facilities. Such plans consider animal behavior, veterinary care and temporary shelter away from the hazard impact area. The most effective procedures are broad enough to cover multiple types of disasters but also specific enough to address unique local characteristics (Quijano *et al.*, 2016; ZBPWG, 2011).

Governance

Clear command, control and coordination structures for an emergency response can support critical decision-making and actions by those with the authority to protect apes. The most common governance structures are based on incident command and control systems and are used across a wide range of emergencies and disasters, including natural disasters, medical emergencies and industrial disasters (AFAC, 2017; FEMA, 2017; HHS, 2012). All agencies and organizations within an emergency response—including those involved with the conservation of apes—fall under a command and control structure to deliver the shared objective through the best use of available resources (AFAC, 2017; FEMA, 2017).

An example of good governance is the structure that underpinned the successful transboundary collaboration between the DRC, Rwanda and Uganda across the

Greater Virunga Landscape, including after the outbreak of COVID-19 (Gilardi *et al.*, 2022; Refisch and Jenson, 2016). The collaboration supported management in the interest of gorilla conservation across a conflict-sensitive landscape.

Good leadership skills are necessary to secure optimum outcomes from a governance structure. People tend to be more responsive to leaders who come from and understand their community (Polygeia, 2016; Toppenberg-Pejcic *et al.*, 2019). If local leadership lacks requisite skills and abilities, it may be necessary to overcome those shortcomings during the preparedness process, to avoid having to recruit an external expert during a response. Research indicates that community leadership plays an important part in building trust with a community and, in so doing, community support and commitment (Sakamoto *et al.*, 2020; Waugh and Liu, 2014).

In 2015 the WHO released a statement on the lessons learned from its Ebola response, which had begun in December 2013 (ReliefWeb, 2015). Subsequent analysis of the response identified governance weaknesses, proposed that local authorities be charged with greater accountability and responsibility, and called for enhanced governance structures around information policy and resource management (Moon *et al.*, 2015; Park, 2022).

Management Systems

Management systems are the arrangements, policies, procedures and structures that are required to manage information during a response. They can come in the form of digital software or simple, manual systems, depending on the context. During responses, such systems are commonly expected to:

- inform the selection and management of strategies, tactics and taskings;
- develop and maintain high levels of shared situational awareness across the numerous stakeholder groups;
- inform critical decision processes at all levels;
- manage information collection, processing, analysis, interpretation and visualization; and
- manage the risks associated with human and organizational factors (Royal Commission into National Natural Disaster Arrangements, 2020b; Sakurai and Murayama, 2019; UNDRR DesInventar Sendai, n.d.).

In addition to capturing, holding, analyzing and interpreting information, including through modeling, management systems can contain and serve as a platform for the use of policies, doctrines, procedures and manuals, as well as information technology (Royal Commission into National Natural Disaster Arrangements, 2020b; Sakurai and Murayama, 2019; UNDRR DesInventar Sendai, n.d.).

> “The process of developing a contingency plan is as important as the final plan.”

The past decade has seen a proliferation of management systems. The recent trend has been to develop systems that can integrate the management of information in a single domain that was previously undertaken by multiple stand-alone products. Disaster managers have also benefited from significant advances in the systematic collection, collation, analysis and sharing of information among stakeholders in the field, community members and social media users.[6]

These management systems involve real-time data mining (extraction), including analysis of social media posts and the real-time use of social media to keep communities up to date (Elichai, 2018; Yin *et al.*, 2012; Zheng *et al.*, 2013). When Hurricane Sandy battered New York in 2012, the mining of social media by emergency services to track damage, warn the public and prioritize actions demonstrated the value of data

Photo: An example of good governance is the structure that underpinned the successful transboundary collaboration between the DRC, Rwanda and Uganda across the Greater Virunga Landscape, including after the outbreak of COVID-19. The collaboration supported management in the interest of gorilla conservation across a conflict-sensitive landscape. Virungas from Bwindi Impenetrable NP, Uganda. © Martha Robbins/ MPI-EVAN

mining (Cohen, 2013; Stewart and Wilson, 2016). Data mining of social media messages became essential to disaster managers by 2017, when it was used to inform response and recovery actions during Hurricane Harvey (Ngamassi *et al.*, 2022).

Systems for the early detection of natural hazard impacts such as tsunamis and forest fires are increasingly being integrated into warning systems for at-risk communities and responders (UNISDR, 2010). An early warning system is defined as:

> the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss (GDPC, n.d.).

The Global Tsunami Warning System, for example, implements tsunami early warning systems that are used to assess tsunami risk and educate communities about preparedness measures (IOC-UNESCO, n.d.). In the case of forest fires, the earlier the detection, the more readily contingency plan actions can be carried out to reduce the exposure of apes to smoke and heat. Uncrewed forest fire detection systems are designed to sense smoke and heat

signatures, even in remote areas (Dampage *et al.*, 2022).

In Australia, the national bushfire monitoring system Digital Earth Australia Hotspots presents information about hotspots across Australia, Indonesia and Papua New Guinea (Australian Government, 2021). During the 2019–2020 Australian bushfires, integrated automatic and manual systems—including the hotspots system, aircraft and satellite-based imagery of fire behavior, weather activity, and forest fuel loads—informed the distribution of targeted early warnings by social media regarding catastrophic fire danger. One of these early warnings allowed for the translocation of some Australian native wildlife from a sanctuary. At-risk wallabies, bettongs and koalas (*Phascolarctos cinereus*) were captured and moved out of harm's way. Months later, the animals were returned to their recovering habitat (Nobel, Rybicki and Martin, 2020).

There is an absence of examples of early warnings for the presence of disease in apes. The early detection of disease in wildlife increases the chances of successful disease management (Mörner *et al.*, 2002). Establishing preventive surveillance that supports early detection of pests and disease, including zoonoses, is crucial to ape conservation, as is instituting control measures such as biosecurity protocols in ape populations (Guimarães *et al.*, 2020). A global, systematic approach to zoonosis surveillance to support an early warning system and decision-making would assist responders in protecting apes and other species.

During the preparedness phase, the following management systems are typically integrated to facilitate collection, collation and integration between two or more of the systems:

- an operations management system for diverse information sources associated with response operations, such as technical investigations and case management; field observations, including local knowledge, areas impacted; imagery and maps; loss and damage reports and casualties (human and animals); and for actions relating to analyses, such as by wildlife specialists and other experts;
- a records management system to provide a single point of reference for all records;
- a resource management system to manage all resources—including people—throughout each phase, not only during response, but also through prevention and to recovery;
- a health, safety and wellbeing system to meet the legislative requirements and ethical obligations for response personnel and the local human population (see Chapter 5); and
- a financial management system to track the costs of personnel and resources in addition to actual expenditure (Myers and Zrinski, 2022).

Each of these systems has a role during preparedness, response and recovery. During preparedness, all the resources that are likely to be activated and deployed in a response can be added to a resource management system, along with the details about each resource—such as contract details for equipment and contact details, next of kin and qualifications for people.

In addition to managing information about individual at-risk apes and all actions relating to apes, the systems can generate related reports and analysis, such as for wildlife specialists and decision-makers.

The activation of each of these systems is usually subject to policy and procedures. Procedures usually include triggers for activation. Activating the systems early and even preemptively is essential if they are part of an integrated early warning system.

Photo: If ape populations are mismanaged during a response, for example, actions such as translocations can have negative consequences that may necessitate additional recovery actions. Similarly, at the group level, the disruption of an ape family during a rescue can complicate the recovery of individuals or the whole family. © IAR Indonesia (YIARI)/ MoEF of Indonesia

The value of the information in each system extends beyond response and recovery. The information can be analyzed to inform reviews and debriefs, support the development of major reports and provide a critical resource for peer-reviewed research.

Usage and Exercises

Preparedness entails the routine and regular use of governance arrangements, documentation, management systems and resources, including during everyday activities such as drills, exercises, simulations and small-scale responses. These activities provide opportunities to practice, validate and assess the following elements:

- proposed response measures;
- documentation, such as a contingency plan;
- information systems;
- capacity and capability, including training; and
- the relationships between responders and the community (AIDR, 2017).

To maximize preparedness, exercises can be run at the community, regional and national levels, as well as for each of the stakeholder groups, including ape conservationists, first responders, logistics personnel, technical analysts and communication specialists (Bowman and Arnoldi, 1999). Reviews of exercises and simulations help to identify strengths as well as opportunities for improvements. The WHO's guide to contingency planning includes a section on exercises (WHO, 2018). Various manuals describe the development of exercises that are to be conducted in different contexts (AIDR, 2017; WHO, 2017b).

There is a dearth of information on exercises and simulations regarding impacts of hazards on apes in the wild. Formal reporting on exercises and simulations linked to at-risk apes could help to fill this knowledge gap.

Response

Emergency responses to an imminent or actual hazard impact tend to focus on the immediate and short-term needs of ape populations and neighboring human communities. A situation assessment informs actions to limit (further) damage and meet the medical and wellbeing needs of the ape and human populations. As a response progresses, these plans are continually adapted to the evolving situation.

In late 2018, when forest fires raged in California, some zoos were forced to choose between minimizing resident animals' exposure to the widespread smoke and restricting their freedom to roam. Both options can lead to stress. The Los Angeles Zoo, for one, evacuated small primates and birds to prevent their exposure to smoke from a nearby fire (Airhart, 2018). In such situations, preparedness is crucial, as there is too little time to plan evacuations from scratch.

Evacuation management includes decisions that can be made during preparedness, when there is time and space to consider and develop the best options. The optimal resources to support the best evacuation outcomes for animals can be put in place during preparedness. Clarity of who does what, where and when is best determined during preparedness. Further, preparedness provides an opportunity to test a proposed plan and allow the animals to become comfortable with each aspect of the evacuation.

Responses to a hazard impact can include the transfer of apes to previously identified safe havens. The emergency response plan for Hainan gibbons proposes translocation as an option for some emergency situations

(Bryant and Turvey, 2017). It acknowledges that translocations are not without risks, but that the risks have been successfully managed elsewhere in the past (see Case Study 4.1). Wherever such transfers are considered, effective preparedness covers both apes and humans.

Priority actions in response to a hazard's impact on apes usually include ensuring the animals' safety and access to shelter, water and food. Triage and treatment are likely if apes are injured or unwell due to the effects of forest fire smoke, heatwaves or falling debris. Since resource needs are generally significant and often overwhelm local capacity and capability, resourcing is a key risk to be considered during the preparedness phase.

In response to an infectious disease hazard, including zoonosis, the focus is initially on control and containment actions designed to limit any spread to and within ape populations, and from apes to humans. Early detection—including provisional advice and early response—can deliver the best outcomes (Moon *et al.*, 2015; National Research Council (US), 2001; WHO, 2014). Responses to a disease in apes benefit from well-developed and rehearsed command and control, policies and procedures to support robust and timely decision-making on priorities, and resource allocation.

Many emergency responses attract spontaneous volunteers from near and far, including if the aim is to protect wildlife. The successful management of volunteers can be a key success factor in achieving the best outcomes for apes. Planning for volunteers can be part of preparedness (AIDR, 2017; Daddoust *et al.*, 2021; DHS, 2019).

While recovery is often described as the phase that follows a response, it actually commences during the response phase. Actions taken during a response can affect the extent and delivery of recovery. If ape populations are mismanaged during a response, for example, actions such as translocations can have negative consequences that may necessitate additional recovery actions. Similarly, at the group level, the disruption of an ape family during a rescue can complicate the recovery of individuals or the whole family (Bryant and Turvey, 2017; Palmer, 2018; Sherman, Ancrenaz and Meijaard, 2020).

Recovery

For ape and human communities alike, recovery from the impacts of a hazard typically takes place under conditions that constitute a "new normal." Recovery activities may include the restoration of ape habitat, which can involve planting species that meet apes' shelter and food requirements. If a habitat is or has become prone to forest fires, recovery actions can be designed to support the relocation of apes to lower-risk landscapes, for example, through translocations.

A recovery is successful if it delivers resilience to the affected community, such that they would be able to cope with future hazard impacts and any ensuing disaster. The best outcome of recovery is when a community is no longer at risk from a hazard impact. This recovery outcome was achieved by rebuilding Grantham in the Lockyer Valley on higher, non-flood-prone ground following the catastrophic 2011 floods in southeast Queensland, Australia (QRA, 2011).

“From prevention through to recovery, community engagement is essential to successful outcomes of each phase of disaster management.”

Delivering resilience is possible if recovery actions simultaneously seek to address needs in the natural, economic, social and built environments, as the revitalization of each contributes to that of a community. Allocating support for the rehabilitation of the natural environment, for example, generates local employment opportunities that give rise to social and economic benefits. Sustained effort and financial support are required throughout the recovery phase. Post-emergency funding earmarked for the recovery of communities can also help to build support for conservation efforts (Dinsi and Eyebe, 2016).

An example of recovery in action is the return of gorilla-based tourism in Rwanda during the post-conflict period of the late 1990s. After gorilla-based tourism was initiated in 1979, the number of tourists per year grew steadily, reaching 6,900 in 1989, only to plummet during the genocide of 1994 (Maekawa *et al.*, 2013). The recovery of tourism was slow, with just 417 tourists in 1999, yet by 2008 that figure had soared to more than 17,000 (Nielsen and Spenceley, 2010). The strategy developed by Rwanda was key to the ongoing development of the ape-based tourism sector, which by 2013 was the largest foreign exchange earner of the national economy (Maekawa *et al.*, 2013).

Community Engagement in Disaster Management

From prevention through to recovery, community engagement is essential to successful outcomes of each phase. During prevention and preparedness, the process may be driven by lead government agencies and organizations, but it also requires engagement and mobilization from the local community, including residents, community organizations, institutions and businesses (Dunlop *et al.*, 2016; Isakov *et al.*, 2014; Nelson *et al.*, 2007; Redshaw *et al.*, 2017). Community engagement is critical to all phases of disaster management—prevention, response and recovery (Sakamoto *et al.*, 2020; Waugh and Liu, 2014).

Key to community engagement are opportunities for local residents and groups to become involved in protecting their built, natural and social environments (Royal Commission into National Natural Disaster Arrangements, 2020a). Technical advisors and external support personnel can facilitate and support local engagement, so long as they resist the temptation to take over. Indeed, concerns regarding the ownership of outcomes—along with differences in organizational cultures and approaches—can act as barriers to community engagement. Residents may need to air grievances, resolve existing conflicts or simply become familiar with government or agency representatives before they can begin to place their trust in an emergency management system (Dunlop *et al.*, 2016).

Lessons from the response to the Ebola epidemic in 2013–2014 point to serious shortfalls in outreach and engagement strategies (Oosterhoff, Mokuwa and Wilkinson, 2015; ReliefWeb, 2015; The Ebola Gbalo Research Group, 2019; Toppenberg-Pejcic *et al.*, 2019). In Guinea, Liberia and Sierra Leone, authorities displayed a lack of understanding of community culture and social norms, which could otherwise have served as a means of harnessing community participation and support. In practice, they dismissed local procedures for activities such as burials and instead implemented their own (Halter, 2018; Mokuwa and Richards, 2020). Nevertheless, local communities demonstrated their capacity to deliver positive outcomes by blending their cultural understanding with the authorities' expectations (Mokuwa and Richards, 2020; Richards, 2016).

In Sierra Leone, where community care centers were established as part of the Ebola response, authorities suffered from insufficient specialized community engagement expertise as well as concerns around a lack of local ownership, poor coordination and the exclusion of certain communities. These weaknesses affected levels of support and participation in response actions. Given the opportunity to deliver on required outcomes, however, communities did demonstrate their abilities (Oosterhoff, Mokuwa and Wilkinson, 2015).

In a statement on the 2013 Ebola experience and subsequent internal reforms, the WHO itself recognized that a significant obstacle to an effective response had been inadequate engagement with affected communities and families (ReliefWeb, 2015). Subsequent research has confirmed the importance of local communities and that engagement approaches are more effective when they are adjusted to the needs of target communities (The Ebola Gbalo Research Group, 2019; Toppenberg-Pejcic *et al.*, 2019).

Monitoring and Review

Ongoing monitoring and review of ape-related disaster management, which remains in its infancy, can enhance outcomes across all phases in ways that meet the needs and expectations of governments at all levels, international organizations, local communities and key stakeholders, such as those in conservation. The learnings from monitoring and review are the basis for enhancing future responses to hazard impacts on apes.

Monitoring and review are commonly associated with response, although they are equally applicable to the prevention, preparedness and recovery phases. With reference to prevention and preparedness, monitoring and evaluation questions can include the following:

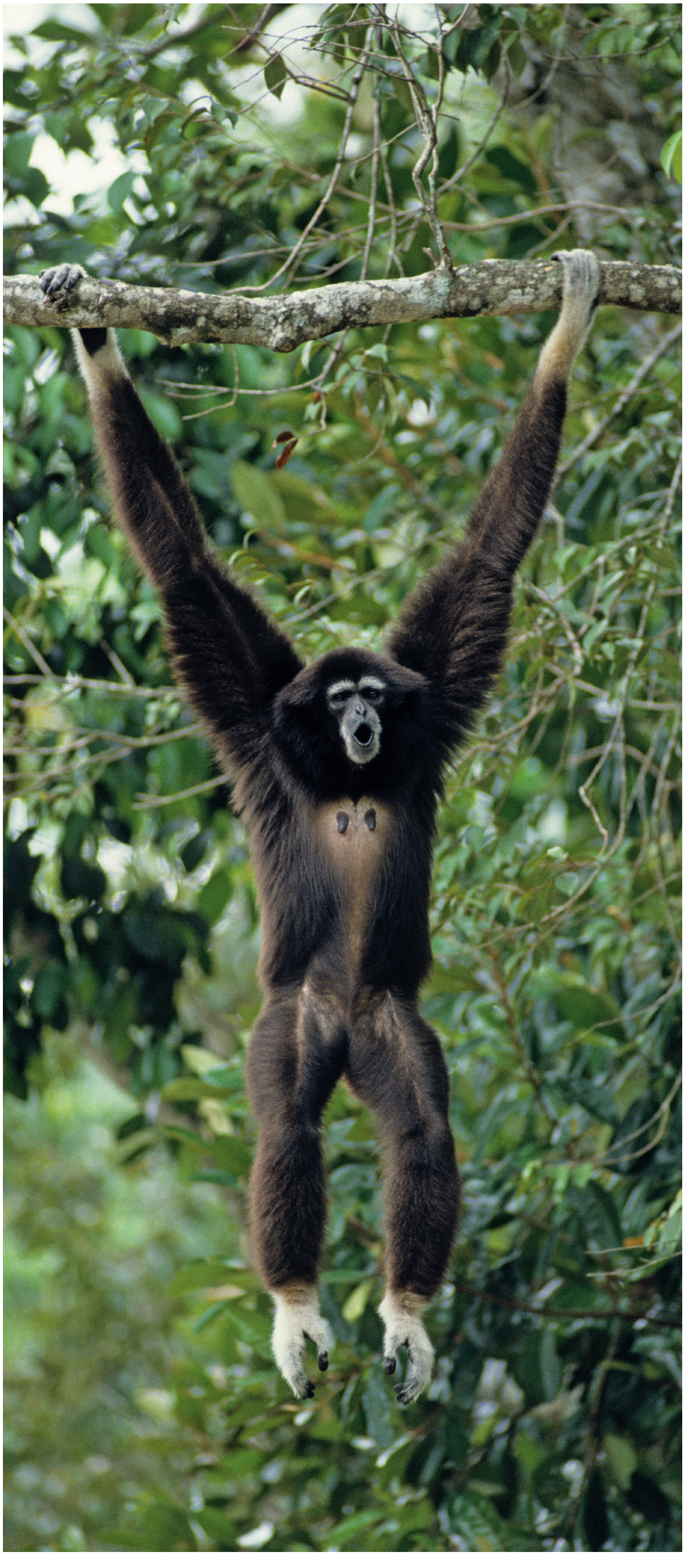
- Are the preparedness measures delivering specified outcomes to deliver a mission readiness response?
- Are the preparedness measures relevant and appropriate?
- Are the preparedness measures still relevant and can they still be implemented?
- Did the risk assessment process identify the full range of hazards and risks?
- Have there been changes to the hazards and risks?
- How effective was prevention and preparedness in addressing the risks?

Monitoring and review activities can produce any of several outputs:

- reviews at specified intervals, conducted by internal or external reviewers;
- formal or informal investigations and research;
- internal and external audits, such as those required for maintenance of accreditation or maintenance of certification;
- lessons identified from exercises; and
- operational debriefs or after-action reviews.

In turn, these outputs—referred to as "lessons identified"—can inform and underpin future actions in each phase. Under

“The learnings from monitoring and review are the basis for enhancing future responses to hazard impacts on apes.”



ideal circumstances, the lessons identified are transformed into lessons learned. If the identified lesson is that a community was not adequately consulted or acknowledged during the preparedness phase, that lesson can become learned through the establishment of a structured and systematic consultative process that successfully engages the community.

In its 2015 statement, the WHO reported on the lessons that were identified and learned during the 2013 Ebola response. The statement made clear that the world was ill prepared for a large-scale, sustained disease outbreak (ReliefWeb, 2015). Many of the lessons in that statement and related reports are equally applicable to potential hazard impacts on apes and ape conservation (Moon *et al.*, 2015; Park, 2022). The lessons—which align well with the abovementioned elements of good preparedness, namely capacity and capability, documentation, governance, management systems, and usage and exercises—include the following:

- A timely and rapid response to outbreaks requires allocated contingency funds.
- Ensuring that the development of information systems is fit for purpose and operational use at short notice. The information system data remain up to date through data integration and report production for logistics, resources, laboratory services and coordination.
- The provision of timely, relevant information on health emergencies is critical in meeting the needs and expectations of different stakeholders, including response decision-makers, the various levels of government, communities and non-government actors.
- Developing expertise in community engagement benefits both the preparedness and the response phases.

- Improvements in governance, such as clarified command and control arrangements, can encourage seamless collaboration between all response levels—from the central coordination to regional offices and operational control. Clarity regarding the assignment of roles, accountability and responsibility at the local, regional and national levels can further enable cooperation.
- Developing local, regional, national and international capacity and capabilities can serve to support a timely, effective response.

During international responses, the lead agency guides global prevention, preparedness and response actions and helps to keep related concerns at the top of national and global agendas (Moon *et al.*, 2015; Park, 2022; ReliefWeb, 2015).

Separately, the Lessons Learned Annex provides useful findings from the literature on emergencies and crises affecting zoos (ZAHN, 2011). Compiled by the Zoo Animal Health Network, the annex features topics such as administration, procedures and communication, as well as detailed lessons on issues including:

- approvals and formal permissions for specific roles to access facilities, use information systems and move through roadblocks;
- command and control, including who is in charge;
- updating of documents such as contact lists;
- expertise requirements for managing media to maintain reputation and image;
- personnel availability and training, including specifically for responses and cross-training across roles and tasks;
- use of protocols;
- record-keeping and management;
- relationships with local authorities; and
- suitability of technology (ZAHN, 2011).

Conclusion

There are opportunities for reducing the impact of natural and anthropogenic hazard impacts on ape populations. The structured and systematic disaster management approach that comprises prevention, preparedness, response and recovery phases can serve as a framework for appropriate planning and action.

Best practice applied in a range of sectors—including One Health, public health, biosecurity emergencies and disaster risk reduction—addresses the full range of strategic risks, as well as the compounding effects across risks, rather than focusing solely on the immediate impacts of a single hazard. In efforts to achieve effective risk management, social, economic and environmental risks have parity with technical and operational risks. The following actions can improve the outcomes for hazard-affected free-living and captive apes:

- prioritizing global and national agenda activities, including research, that can inform best practice for ape populations at risk from hazard impacts;
- mapping global hazard risks for ape populations;
- targeting research to develop an understanding of minimum requirements for apes to survive hazard impacts, including successive impacts from different or the same hazard;
- prioritizing the building of capacity and capability across jurisdictions to support disaster management for at-risk ape populations;
- monitoring and evaluating the occurrence and severity of hazards that affect apes;

Photo: Ongoing monitoring and review of ape-related disaster management, which remains in its infancy, can enhance outcomes across all phases in ways that meet the needs and expectations of governments at all levels, international organizations, local communities and key stakeholders, such as those in conservation. © Roland Seitre/Minden/naturepl.com

- encouraging increased reporting of disaster management activities and creating a global library of documentation for managing hazard impacts on apes;
- ensuring clarity of command and control arrangements at all governance levels in and across jurisdictions;
- fostering high levels of community engagement in areas where apes are at risk of being affected by hazard impacts on the social, built, economic and natural environments, and building on existing local knowledge and practices;
- developing information management systems that support local and global shared situational awareness and critical decision-making;
- establishing alternative funding models for local communities that are exposed to social and economic risks in response to hazard impacts on apes and those communities; and
- setting up contingency funds for dealing with disasters that affect ape populations and can subsequently lead to economic, social and other risks to human communities.

Through collaboration, agencies and organizations involved in conservation and development in ape range states can share their knowledge, skills and documentation to maximize the return on efforts without requiring all stakeholders to follow the same script.

Acknowledgments

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Box 6.1: Kevin Cooper

Box 6.2: Susan Cheyne

Box 6.3: George Omondi

Box 6.4: Kevin Cooper

Case Study 6.1: Joshua Rukundo

Case Study 6.2: Kevin Cooper

Case Study 6.3: Kevin Cooper

Endnotes

1 Alvarez-Berríos and Mitchell Aide (2015); C2ES (2022); Estrada *et al.* (2018); Graham, Matthews and Turner (2016); Lehmann, Korstjens and Dunbar (2010); McBean (2004); Meehl *et al.* (2000); Mirza (2003); Seneviratne *et al.* (2012); Wiederholt and Post (2010); Zhang *et al.* (2019).

2 Unless otherwise indicated, the information presented in Case Study 6.1 is based on the author's knowledge and 12 years' experience working at the Chimpanzee Sanctuary and Wildlife Conservation Trust, including as executive director since 2020, and on internal documents and reports to which he had access.

3 Calvignac-Spencer *et al.* (2012); Harrison *et al.* (2020b); Kilbourn *et al.* (2003); Rwego *et al.* (2008); Santos, Guiraldi and Lucheis (2020).

4 Gillespie (2019); Gillespie and Leendertz (2020); de Haas (2020); Lappan *et al.* (2020); Melin *et al.* (2020); Reid (2020); Santos, Guiraldi and Lucheis (2020).

5 Bales (2020); Gilardi *et al.* (2015); Gillespie (2019); Gillespie and Leendertz (2020); de Haas (2020); Lappan *et al.* (2020); Melin *et al.* (2020); Reid (2020); Santos, Guiraldi and Lucheis (2020); IUCN SSC PSG SGA (n.d.-a).

6 Royal Commission into National Natural Disaster Arrangements (2020b); Beydoun (2018); Ogie *et al.* (2018); Sakurai and Murayama (2019); UNDRR DesInventar Sendai (n.d.).

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8 Helmholtz Institute for One Health (www.helmholtz-hzi.de/en) and Robert Koch Institute (https://www.rki.de).

9 University of Minnesota (https://twin-cities.umn.edu).

10 Borneo Nature Foundation (www.borneonaturefoundation.org).

11 Chimpanzee Sanctuary and Wildlife Conservation Trust (https://ngambaisland.org).