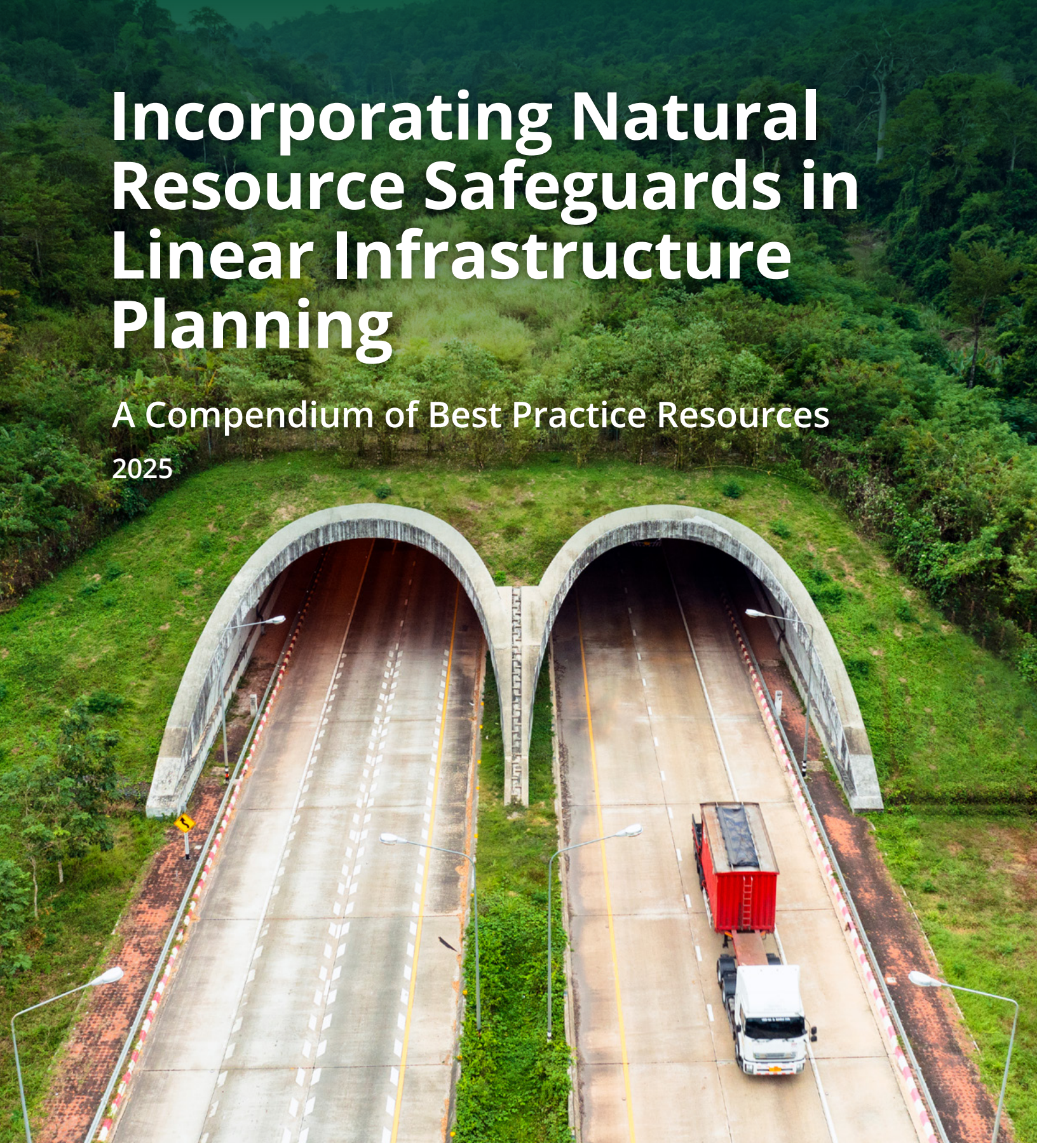
Incorporating Natural Resource Safeguards in Linear Infrastructure Planning

A Compendium of Best Practice Resources

2025



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CENTER for LARGE LANDSCAPE CONSERVATION

Incorporating Natural Resource Safeguards in Linear Infrastructure Planning:
A Compendium of Best Practice Resources

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Acronyms

ADB	Asian Development Bank
ARIES	Artificial Intelligence for Environment & Sustainability
BfN	German Federal Agency for Nature Conservation
BNG	Biodiversity net gain
CBD	Convention on Biological Diversity
CDS	Climate Data Store
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
COP	Conference of the Parties
DNB	De Nederlandsche Bank's
EESV	Essential Ecosystem Service Variables
EIA	Environmental impact assessment
EOSDIS	Earth Observing Systems Data and Information Service
EPA	United States Environmental Protection Agency
ES	Ecosystem services
ESG	Environmental, social, and governance
ESIA	Environmental and social impact assessment
ESR for IA	Ecosystem Services Review for Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
G7	Group of Seven
G20	Group of Twenty
GEF	Global Environment Facility
GIB	Global Infrastructure Basel
GIZ	German Agency for International Cooperation
GRESB	Global Real Estate Sustainability Benchmark
HCV	High conservation value
IAIA	International Association for Impact Assessment

IBAT	Integrated Biodiversity Assessment Tool
ICCAs	Indigenous and Community Conserved Areas
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IISD	International Institute for Sustainable Development
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
LCCA	Life cycle cost analysis
LI	Linear infrastructure
MDB	Multilateral development bank
MEA	Multilateral environmental agreement
NASA	National Aeronautics and Space Administration
NbS	Nature-based solutions
NCEI	National Center for Environmental Information
NGO	Nongovernmental organization
OECD	Organization for Economic Cooperation and Development
OECM	Other effective area-based conservation measure
PPP	Public-private partnership
PSS	Policy support system
Ramsar	Convention on Wetlands
SAVi	Sustainable asset valuation
SDGs	Sustainable Development Goals
SEA	Strategic environmental assessment
SEEA	System of Environmental Economic Accounting
SI Label	Sustainable Infrastructure Label
SLL	Sustainability-linked loan
TESSA	Toolkit for Ecosystem Service Site-based Assessment
ToR	Terms of reference

QI	Quality infrastructure
QII	Quality Infrastructure Investment
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UOB	United Overseas Bank
USAID	United States Agency for International Development
WRI	World Resources Institute

Glossary

Biodiversity

Biodiversity refers to all the different kinds of life found in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. These species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life. Biodiversity supports everything in nature that we need to survive—food, clean water, medicine, and shelter. Biodiversity is typically considered within three inseparable levels—genetic diversity, species diversity, and ecosystem diversity—that interact with and influence the others.

Climate resilience

Climate resilience is about successfully coping with and managing the impacts of climate change while preventing those impacts from growing worse. A climate-resilient society would be low carbon and equipped to deal with the realities of a warmer world. Managing these impacts requires the ability to consider a future that experiences a greater frequency of more extreme events than has been experienced in the past. We can expect more frequent and severe precipitation, higher winds, sea level rises, extended periods of drought, extreme temperatures, and other harmful effects.

Cost-benefit analysis

A cost-benefit analysis is the process used to measure the benefits of a decision or action minus the costs associated with taking that action.

Design consultants

Design consultants are private sector specialists who provide design and implementation services for linear infrastructure (LI) projects (including architects, urban designers, nature-based solutions [NbS] designers, etc.).

Ecological connectivity

Ecological connectivity is defined by the Convention on the Conservation of Migratory Species of Wild Animals (CMS) Secretariat as the **unimpeded movement of species and the flow of natural processes that sustain life on Earth**. Key for the survival of all living things, it enables the functionality of ecosystems, allowing gene flow to occur between populations, and is critical to adaptations to environmental change.

Ecological traps

Scenarios in which rapid change in the environment and natural ecosystems forces organisms to (mistakenly) settle in poor-quality habitats are called ecological traps. This concept emerges from organisms relying on environmental cues to determine a habitat's quality, and if those cues change, affecting the habitat quality indicators, organisms cannot analyze them.

Ecosystem services (ES)

According to the US Environmental Protection Agency (EPA), ecosystem goods and services produce the many life-sustaining benefits we receive from nature—clean air and water, fertile soil for crop production, pollination, and flood control. These ES are important to environmental and human health and well-being, yet they are limited and often taken for granted. There are four types: 1) provisioning services—benefits to people that can be extracted from nature; 2) regulating services—benefits provided by ecosystem processes that moderate natural phenomena; 3) cultural services—nonmaterial benefits that contribute to the development and cultural advancement of people, including how ecosystems play a role in local, national, and global cultures; and 4) supporting services—benefits that cannot be sustained without the consistency of underlying natural processes, such as photosynthesis, nutrient cycling, the creation of soils, and the water cycle.

Edge effect

This term "edge effect" in ecology refers to the impacts of the changes in population or ecological processes that occur at the relatively sharp boundary between two or more habitats.

Environmental impact assessment

The United Nations Environment Programme (UNEP) defines environmental impact assessment (EIA) as a tool used to identify the environmental, social, and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment, and present the predictions and options to decision-makers. By using EIA, both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/cleanup costs, and impacts of laws and regulations.

Green financing

Green financing is defined as the financial flows (from banking, micro-credit, insurance, and investment) from the public, private, and nonprofit sectors to sustainable development projects and programs.

Green and gray infrastructure

Green infrastructure mimics and/or refers to natural ecosystems such as forests, floodplains, wetlands, and soils, which provide multiple benefits for human and ecosystem well-being. Gray infrastructure refers to hard structures such as seawalls, roads, pipes, and water treatment plants.

Habitat fragmentation

Habitat fragmentation is defined as the process during which a large expanse of habitat is transformed into several smaller patches of a reduced total area isolated from each other by a matrix of habitats unlike the original.

Habitat loss

This term refers to the reduction in the land area of natural ecosystems that provide key services, as well as areas where biodiversity thrives, due to human activities such as agriculture, urbanization, deforestation, resource extraction, pollution, climate change, and sea level rise.

Infrastructure financier

An infrastructure financier is an entity, whether governmental, nongovernmental, or international, that oversees the allocation and distribution of substantial funds to support the planning, design, and implementation of infrastructure projects.

Linear infrastructure (LI)

Linear infrastructure is characterized by its straight and relatively narrow form, such as roads, railways, power lines, and canals.

Linear infrastructure engineers

LI engineers are civil and related engineering specialists involved in the planning, design, and implementation of LI.

Linear infrastructure planners

LI infrastructure planners are professionals who specialize in designing, managing, and coordinating the development of transportation networks, utility lines (such as water and gas), and other LI projects. Their focus includes ensuring efficient routes, safety, and environmental considerations for roads, railways, pipelines, and transmission lines.

Mitigation hierarchy

The mitigation hierarchy is a set of guidelines, established through the International Finance Corporation's Performance Standard 6, meant to help development projects prepare for impacts and aim to achieve no net loss of biodiversity. The hierarchy follows avoidance, minimization, restoration, and offsets to reduce development impacts and control any negative effects on the environment.

Nature-based solutions (NbS)

The International Union for Conservation of Nature (IUCN) defines NbS as actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature.

Project Management and Implementation Team

A project management and implementation team is responsible for making decisions related to budget allocation, project planning, and risk mitigation programs and overseeing the design and construction of LI projects. Their role involves coordinating various aspects of LI development to ensure successful project execution.

Public-private partnerships (PPPs)

According to the Organization for Economic Cooperation and Development (OECD), a PPP is a long-term agreement between the government and a private partner whereby the private partner delivers and funds public services using a capital asset, sharing the associated risks. PPPs may deliver public services for both infrastructure assets (such as bridges and roads) and social assets (such as hospitals, utilities, and prisons).

Public officials

Public officials are elected or appointed officials or employees of federal, state, or local government agencies.

Safeguard

Safeguards are actions designed to manage risks, uphold human rights, and ensure that conservation projects deliver better outcomes for communities and nature by identifying, avoiding, and mitigating any negative social and environmental impacts during the planning, financing, designing, implementing, and monitoring of all projects and programs.

Strategic environmental assessment (SEA)

SEA has several definitions depending on the organization, but almost all point out its usefulness in protecting the environment. For example, the US Environmental Protection Agency (EPA) defines SEA as "the process by which environmental considerations are required to be fully integrated into the preparation of plans and programs prior to their final adoption. The objectives of SEA are to provide for a high level of protection of the environment and to promote sustainable development." Similarly, the International Association for Impact Assessment (IAIA) defines SEA as "a process and a tool for evaluating the effects of proposed policies, plans and programmes on natural resources, social, cultural and economic conditions and the institutional environment in which decisions are made."

Sustainable infrastructure certification

To guide the development of inclusive, environmentally friendly, and resilient infrastructure, many standards and associated sustainable infrastructure certification procedures and frameworks have been developed that 1) provide planners, engineers, architects, and other project developers with incentives to develop infrastructure in line with the Sustainable Development Goals (SDGs); 2) attract greater investment from the private sector; and 3) adhere and contribute to the global climate goals.

Wildlife-friendly linear infrastructure

LI projects that incorporate strategies that avoid and/or reduce harm to natural ecosystems and biodiversity can be termed wildlife-friendly infrastructure. Examples include wildlife crossings, canopy bridges, and underpasses.

Executive Summary

Global ecosystems are under threat from the rapid expansion of linear infrastructure (LI)—roads, railroads, power lines, fences, pipelines, and canals. LI development can obstruct wildlife movement, fragment habitats, deplete natural resources, and lead to land-use conversion, impacting communities and the ecosystems they rely on. The effects of past LI development practices that overlooked natural resource safeguards are now being intensified by climate change. Given the long life expectancy of most LI (25 to 100 years), policy, planning, financing, and project development must adhere to the mitigation hierarchy to prevent impacts both now and in the future.

This makes it imperative for project developers and proponents to determine strategies and best practices that avoid, reduce, mitigate, or compensate for adverse impacts from LI project development on people and nature. The goal of infrastructure development processes should be to ensure that ecosystems and their services continue to flourish to ensure countries meet their sustainability and economic goals. Strengthening natural resource safeguards will also enhance the long-term sustainability and resilience of LI, supporting thriving communities and conserving abundant biodiversity across the world.

This report is a compilation of more than 170 papers, reports, and guidelines to curate a list of the essential and globally accepted best practices. These documents, which include articles, policy papers, reports, tools, and online resources, outline high-quality, internationally accepted good practices for safeguarding natural resources during LI development. The report serves as a curated resource for a broad group of LI practitioners, including environmental planners, conservationists, government agencies, engineering firms and consultancies, financiers of LI projects, and community-based organizations. It provides reference articles to help users assess, inform, and benchmark LI practices, with the list of some essential best practices aiming to safeguard nature.

The report has shortlisted 10 best practices and their supporting information across four thematic areas requiring safeguards from LI development: ecosystems and their services, biodiversity, ecological connectivity, and climate resilience. It draws on published journal articles, white papers, web-based information, and the collective knowledge of professional associations and other LI actors in the sector, as well as the real-world experiences of the authors and their peers.

Here are the 10 best practices (non-exhaustive):

1. Linear infrastructure (LI) proponents should conduct national or regional strategic environmental assessments (SEAs) to comprehensively assess LI programs and their impacts on biodiversity, ecosystem services (ES), ecological connectivity, and climate change.
2. Financial institutions that fund LI projects should have mandatory natural resource safeguards incorporated into their safeguard policies and their underlying standards.
3. Public-private partnerships (PPPs) should distribute and allocate responsibility for safeguarding natural resources fairly among official project partners and embed clauses that ensure adherence to natural resource safeguards in their contracts and agreements.
4. Environmental and social impact assessment (ESIA) should be completed early in the LI project's development cycle, such as for scoping, feasibility, and design.

5. LI project developers should adhere to the mitigation hierarchy to ensure the preservation or enhancement of natural resource values. Priority should be given to avoiding impacts altogether. If avoidance is not feasible, efforts should focus on minimizing negative impacts. Offsetting and compensating for any adverse effects on natural resources caused by the project should be undertaken when no other alternatives are possible.
6. LI practitioners should assess impacts on ecological connectivity and wildlife corridors, based on global guidelines and initiatives, to incorporate wildlife-friendly measures into program and project planning and design processes.
7. LI project developers should integrate climate vulnerability assessments into the development of their SEAs and ESIAs. This should include analyzing the program's or project's capacity to address identified climate vulnerabilities and minimize risks to communities and infrastructure under extreme climate conditions.
8. LI practitioners should account for/include environmental impact mitigation measures in cost-benefit analysis to make informed decisions, assess risks, plan for the long term, and engage stakeholders effectively when developing climate resilience projects.
9. LI project developers must update their procurement practices to integrate considerations of life cycle costs, avoid materials from illegal sources or those with high environmental costs, incorporate actions for conserving biodiversity and addressing climate change in solicitations and contracts, and establish a contractual requirement with a dedicated budget for monitoring programs to assess the effectiveness of mitigation measures in safeguarding natural resources.
10. LI project developers should aim to meet globally accepted sustainable infrastructure certification requirements, not necessarily to obtain certification but to maximize the integration of nature-based strategies in LI plans and designs.

For some best practices, ensuring they are being followed is beyond the control of any individual, agency, or organization. At the highest level, these best practices are broad and address multiple themes. Others are more specific to just one or two of the four themes. A key finding from this review is that the earlier that natural resource safeguards are incorporated into the project development process, the easier it is to ensure they are properly resourced and included in the final design.

In summary, this report highlights the critical importance of embedding natural resource safeguards into the planning, design, and implementation of LI to ensure long-term ecological integrity and community well-being. The 10 best practices outlined here provide a strong foundation for avoiding harm, enhancing climate resilience, and promoting sustainable development. However, this list is not exhaustive—there are likely other practices that are equally important depending on the local and regional context. These 10 should be viewed as a starting point, encouraging stakeholders to identify, adapt, or develop additional safeguards that align with specific ecological, social, climatic, and legal conditions. Early and context-sensitive integration of these practices will be key to building infrastructure that supports both people and nature.

Introduction: Global Context

This introduction provides a broad yet essential global context for understanding the urgency of integrating natural resource safeguards into linear infrastructure (LI) development. The rapid expansion of LI globally—structures that run through a landscape to deliver services to people, such as roads, railroads, power lines, fences, and pipelines—threatens natural heritage. The development of LI that does not adequately consider the ecology of a landscape can impede wildlife movement, fragment intact natural habitats, deplete natural resources and cause widespread land-use conversion when natural habitats are removed or altered to meet other land-use needs. This, in turn, impacts communities and the ecosystems on which they depend. The impacts from prior practices of LI development that have fallen short in safeguarding natural resources are noticeably being exacerbated by a changing climate.

Given that the life expectancy for most LI is 25 to 100 years, policy, planning, financing, and project development must have safeguards in place that follow the mitigation hierarchy to avoid impacts not only in the near term but for many generations into the future.[1] For most new LI developments or major upgrades to existing systems, the journey of safeguarding natural resources begins with the suite of international agreements related to sustaining and enhancing life on land or water and addressing the impacts of climate change to people and nature. International agreements, sustainability goals, and infrastructure investment principles offer a shared framework for planning and implementing infrastructure that supports both human development and ecological integrity.

These multilateral environmental agreements (MEAs) are treaties, conventions, and other instruments that obligate signatory nations to develop or amend national, regional, and local laws; policies; and plans. It spurs the signatory parties to design strategies that will enable LI development to comply with and contribute to the targets set by mutual consent of the parties to the MEAs. Once ratified by a party to the convention, these MEAs cascade from international law to national law and policies associated with the advancement and financing of sustainable development. These efforts seek to articulate approaches for safeguarding natural resources against degradation and overexploitation and reversing unsustainable trends. The following are the major international MEAs:

1. Convention on Biological Diversity (CBD)
2. Convention on the Conservation of Migratory Species of Wild Animals (CMS)
3. Convention on Wetlands (Ramsar)
4. United Nations Convention to Combat Desertification (UNCCD)
5. United Nations Framework Convention on Climate Change (UNFCCC)
6. United Nations Convention on the Law of the Sea (UNCLOS)
7. World Heritage Convention
8. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

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1 Union of Concerned Scientists. Built to Last: Infrastructure and the Climate Crisis. Cambridge, MA: Union of Concerned Scientists, 2021. https://www.ucs.org/resources/built-last

Many aspects of these global agreements are intended to safeguard natural resources. CMS, for example, emphasizes taking steps to protect transboundary movements of wildlife, which in turn requires protecting ecological connectivity. Ensuring climate resilience for infrastructure is emphasized by the UNFCCC. CBD, UNCCD, Ramsar, and CMS prioritize safeguarding biodiversity, wildlife, ecological connectivity, and ecosystems; give attention to the importance of addressing the needs and concerns of Indigenous peoples and local communities; and integrate the role they play in safeguarding natural resources. Biodiversity is often found to be highest on lands traditionally used by Indigenous peoples, and their rights must be safeguarded. The World Heritage Convention and UNCLOS address similar natural resource conservation and the protection and enhancement of ecological connectivity, biodiversity, communities, and ecosystem services (ES).

In addition to the conventions listed above, in 2015, the United Nations General Assembly adopted **the 2030 Agenda for Sustainable Development**. The "2030 Agenda" consists of **17 Sustainable Development Goals** (SDGs) and 169 targets to address five areas of critical importance. Two of these goals are in line with the list of best practices identified in this document: a) protect, restore, and promote sustainable use of terrestrial and coastal ecosystems; sustainably manage forests; combat desertification; and halt and reverse land degradation and biodiversity loss (goal 15), and b) build resilient infrastructure and promote inclusive and sustainable industrialization by fostering innovation (goal 9). In parallel, the private sector is being mandated to develop sustainable environmental, social, and governance (ESG) policies and programs that attract philanthropies, development financiers, and investors interested in seeing their investments put toward infrastructure projects that are complying with international standards.

If planned well, high-quality LI can be designed and built with more cost and time efficiency, increased safety, and positive net benefits, thus, ultimately delivering more effective public goods and services. In 2016, the Group of Seven (G7) nations adopted the **Ise-Shima Principles for Promoting Quality Infrastructure Investment** to serve as a guide for governments, international organizations, multilateral development banks (MDBs), and the private sector to:

1. Ensure effective governance, reliable operation, and economic efficiency given life cycle cost, as well as safety and resilience against natural disasters, terrorism, and cyberattack risks.
2. Ensure job creation, capacity building, and transfer of expertise and know-how for local communities.
3. Address social and environmental impacts.
4. Ensure alignment with economic and development strategies, including aspects of climate change and the environment at the national and regional levels.
5. Enhance effective resource mobilization, including public-private partnerships (PPPs).

Similarly, the Group of Twenty (G20) nations in 2019 adopted the Quality Infrastructure Investment (QII) principles, which provide a strategic direction for infrastructure investment. The QII principles build on the consensus that infrastructure is a significant driver of economic prosperity and that well-built and sustainable infrastructure maximizes the positive impacts of these high-priced investments. The **six QII principles** are the following:

1. Maximize the positive impact of infrastructure to achieve sustainable growth and development.
2. Raise economic efficiency given the life cycle cost.
3. Integrate environmental considerations into infrastructure.
4. Build resilience against natural disasters.

5. Integrate social considerations into infrastructure investment.
6. Strengthen infrastructure governance.

This global context helped shape the direction and scope of this report, guiding the identification of a non-exhaustive list of 10 best practices considered critical for safeguarding nature in the context of LI. While grounded in international norms, these practices are intended as a starting point—meant to be adapted, expanded, or refined to reflect the specific legal, ecological, and social realities of each country and region. This document is intended for a broad audience of LI practitioners, including government agencies, engineering firms and consultants, financiers, and community and conservation organizations. The 10 best practices are organized across four thematic areas that require safeguards in LI development:

1. Ecosystems and their services
2. Biodiversity
3. Ecological connectivity
4. Climate resilience

To identify these practices, the authors conducted an extensive and iterative review process. Using Google and Google Scholar, they searched for literature and resources using key terms related to LI and safeguards. They also conducted targeted searches of trusted websites known for expertise in the four thematic areas. This process yielded more than 170 relevant publications, including journal articles, white papers, reports, tools, and online resources. These materials were evaluated to determine which practices were necessary to emphasize.

The authors also made efforts to trace the origins of the policies, programs, frameworks, and tools that underpin the selected best practices. For example, the 2006 U.S. Government publication *Eco-Logical* emerged from a 1995 memorandum of understanding among federal agencies to promote multi-jurisdictional collaboration in LI development and environmental protection. Similarly, the UK's commitment to the SDGs led to *The Dasgupta Review*, which catalyzed national policies such as "Nature Positive 2030" and "Biodiversity Net Gain."

The 10 best practices (non-exhaustive) are assessed across the infrastructure project life cycle (Figure 1). Some of these practices are broad and cross-cutting, while others are more narrowly focused. Importantly, several fall outside the control of any single individual, agency, or organization. Nonetheless, they collectively represent a critical foundation for improving how LI is planned, financed, and implemented to safeguard both people and nature.

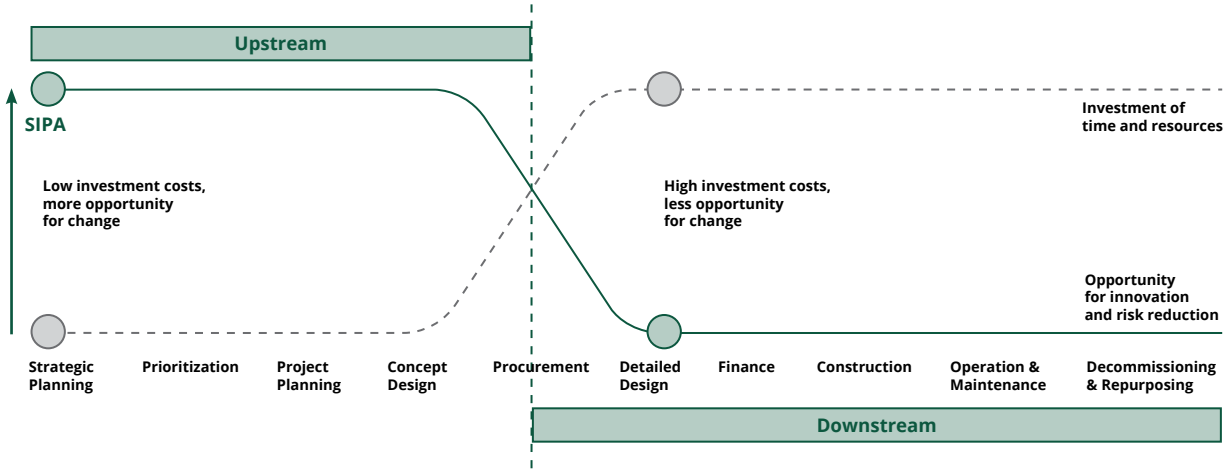

Figure 1: Typical Infrastructure Project Life Cycle. Source: Sustainable Infrastructure Program in Asia (SIPA)

Best Practice 1

Linear infrastructure (LI) proponents should conduct national or regional strategic environmental assessments (SEAs) to comprehensively assess LI programs and their impacts on biodiversity, ecosystem services (ES), ecological connectivity, and climate change.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 1

- In 2006 the Organization for Economic Cooperation and Development (OECD) published ***Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation***. This document provides guidance in understanding SEA, the benefits derived from conducting SEA, principles, and guidance notes for partner-led SEAs, lending partners, and the private sector.
- Portugal has published **methodological guidance** for public institutions, the private sector, and nongovernmental organizations (NGOs) on how to conduct an SEA. The report defines a strategic thinking model, offers methodological guidance, provides a Critical Decision Factors framework, and offers practical guidance in conducting an SEA.
- The International Association for Impact Assessment (IAIA) has established **guiding principles for implementing SEAs**. The IAIA states, "A good-quality SEA process informs planners, decision-makers and affected public on the sustainability of strategic decisions, facilitates the search for the best alternative and ensures a democratic decision-making process."

- **Slootweg (2015)** provides the following approach for incorporating ES into the development of SEAs:
    - Define boundaries of the study area.
    - Identify and map ecosystems (or landscapes) within the study area, including seminatural ecosystems or manufactured landscapes.
    - Describe potential linkages with areas outside the study area.
    - Identify (groups of) stakeholders of each ES.
    - Identify and quantify ES for each ecosystem.
    - Prioritize and value ES for each (group of) stakeholder(s). The value of services can be expressed in social, monetary, or ecological terms.
        - What are the present status and trends for ES?
        - What is the present condition of an ES?
        - Does an ES represent a development opportunity (underexploited) or a constraint (already overexploited)?
        - What are the past and expected future trends?
        - What drivers of change are at work, and at what scale do they work? At what scale can they be managed?
        - What management options are available in the region?
        - Can drivers be influenced by the plan at stake, or are they part of the autonomous development scenario against which a plan is assessed?
        - Are there regulatory or policy frameworks applicable to ES?
    - Disclose gaps in information.
    - Depending on the nature and timing of the SEA, conduct an opportunities and constraints analysis.
    - During impact assessment, reactively assess the consequences of proposed plans for the performance of ES and provide input for the development of mitigation/compensation measures.
- The German Agency for International Cooperation (GIZ) has developed approaches that improve the **integration of ES into development planning** via a flexible and process-orientated approach. The integrating ecosystem services approach is intended to support development planners during the SEA and ESIA processes in identifying the risks and opportunities that arise from people's dependence and impacts on ES. After a review of ES and their importance to humanity, readers are taken through the steps in an easy-to-follow narrative with simplifying diagrams. Along with case studies, each section contains additional reading for more in-depth examination.
- The Royal Society for the Protection of Birds prepared a **guidance document** to support integrating climate change and biodiversity into SEA and a toolkit for identifying, predicting, evaluating, and mitigating biodiversity impacts.

- The World Bank's Global Environment Facility (GEF) supported the preparation of a ***Manual of Procedures on Biodiversity-focused SEA* in the Philippines**. The procedures outline 10 steps to take when conducting a biodiversity-focused SEA:
    - Screening
        - Does the policy, plan, or project automatically require SEA because it is a type that has been screened in, e.g., because it requires appropriate assessment?
        - Is it likely to have significant direct or indirect environmental biodiversity effects?
    - Linking to other plans/processes/programs
        - What are relevant environmental/biodiversity policies and objectives?
        - What other plans and programs could affect, or be affected by, this plan?
        - Does the plan conflict with any of these? If so, what should be done about it?
    - Scoping
        - What are the main biodiversity implications of the policy, plan, or project and its proposed activities?
        - How should they be addressed (methods, level of detail)?
        - Which biodiversity experts need to be involved?
        - What alternatives should be considered to optimize biodiversity benefits and minimize harm?
    - Setting objectives, targets, and indicators
        - Do existing objectives for biodiversity incorporate all important biodiversity interests relevant to this plan?
        - Are policy, plan, or project-specific objectives required to assess impacts?
        - Is it possible to establish clear indicators and targets that allow objectives to be measured?
    - Describing the baseline
    - Identification of options and alternatives
    - Impact prediction, evaluation, identification of alternatives
    - Mitigating risks to biodiversity
    - Consulting and decision-making
    - Monitoring and evaluation
- The **CMS Strategic Plan for Migratory Species 2015–2023** provides a logical and effective way for migratory species targets to be integrated into National Biodiversity Strategies and Action Plans, thereby ensuring they are part of national planning and priority-setting processes. The importance of taking a "migration systems approach" is emphasized, and this implies that conservation strategies give attention not only to populations, species, and habitats but also to the entire span of migration routes

and the functioning of the migration process. This is critical during LI planning stages to avoid impacts on the migratory routes and processes.

- The **Canada National Parks Act** requires each national park to have a management plan that is updated at 10-year intervals. Additionally, **each management plan is required to conduct an SEA** to assess cumulative impacts related to 1) activities and infrastructure within the parks, 2) visitation, 3) climate change, and 4) activities and other pressures outside the park. Ecological connectivity stands out as a cross-cutting theme, as all four themes impact ecological connectivity in different ways and at different scales. The importance of scale in both policy and geographic considerations is emphasized.
- **The Federal Ministry for the Environment and German Federal Agency for Nature Conservation (BfN)** is a cabinet-level ministry of the Federal Republic of Germany that advises and provides the government with a scientific basis for nature conservation and landscape management and ensures that conservation laws are fulfilled.
- The Kingdom of Morocco has been implementing a multiphase **National Sustainable Development Strategy**, and its first principle requires the strategy's development and implementation to adhere to international environmental commitments.
- The **World Database on Key Biodiversity Areas (KBAs)** identifies important sites for biodiversity, including important bird and biodiversity areas, Alliance for Zero Extinction sites, and KBAs identified through hotspot ecosystem profiles supported by the Critical Ecosystem Partnership Fund. Incorporating these sites, the dataset of internationally significant KBAs presented here includes global KBAs, regional KBAs, and KBAs whose global/regional status is not yet determined but that will be assessed against the global KBA criteria within 8–12 years.
- The Government of Nepal has instructed that an SEA be conducted in its **Environmental Protection Act and Rules** before the implementation of a policy, program, or project is put on the government's approved list.
- **The IAIA Best Practice Principles** developed by IAIA, the global professional association of impact assessment experts, are consistent with the performance requirements and standards of most international finance institutions. The document stresses the importance of going beyond a "business as usual approach" by promoting biodiversity-inclusive impact assessment that is in line with the objectives of the CBD, the Ramsar Convention, and CMS. These principles require signatories (parties) to use ESIAs for projects and SEAs for policies, plans, and programs as tools for the conservation and sustainable use of biodiversity and ecosystems and the fair and equitable sharing of the benefits arising from their use. The **full suite of IAIA principles and best practices** is available on the IAIA website.

Best Practice 2

Financial institutions that fund LI projects should have mandatory natural resource safeguards incorporated into their safeguard policies and their underlying standards.

Please note: The resources for this best practice have been collected from WWF's ESG framework as part of the Asia Sustainable Finance Initiative. Learn more about ***the framework****.*

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 2

- MDBs and commercial banks play a critical role in ensuring LI is sustainable, particularly in emerging markets and rural areas. For example, up to US$1.7 trillion per year in infrastructure investments until 2030 are projected to be needed to maintain economic momentum, tackle poverty, and respond to climate change in developing Asia.[2] Some of the major infrastructure financiers and their environmental and social safeguards are the following:
    - **World Bank:** Environmental and Social Framework
    - **International Finance Corporation (IFC):** Performance Standards
    - **European Bank for Reconstruction and Development:** Performance Requirements and Guidance
    - **Asian Development Bank (ADB):** Environmental Safeguards

2 Macfarlane, Alec. "Bridging the Gap: Scaling Up Sustainable Financing for Infrastructure in Asia." International Finance Corporation, July 30, 2022. ifc.org/en/stories/2022/scaling-up-sustainable-financing-asia

- ASN Bank is committed to maintaining and strengthening biodiversity. By 2030, the bank wants all its lending and investment activities to have a net positive impact on biodiversity. The bank has set a long-term biodiversity objective for all its investments. Its aim is to prevent further loss of biodiversity and contribute to net biodiversity gains—and thereby actively strengthen nature in the Netherlands and the wider world. The bank pursues these objectives through the following strategies:
    - **Minimizing biodiversity loss:** The bank aims to reduce the negative impact on biodiversity resulting from its financial activities, recognizing the Earth's capacity to sustain prosperity while respecting ecological limits. More efficient resource management practices are central to the bank's approach, detailed in the ***Sustainability Criteria Guide***.
    - **Enhancing biodiversity gains:** The bank actively invests in nature conservation, renewable energy, and the circular economy to strengthen or restore ecosystems. Collaboration with nature organizations and biodiversity projects, such as the Rijke Noordzee (Rich North Sea) Project, is integral to the bank's efforts.
    - **Developing a monitoring framework:** The bank utilizes the Biodiversity Footprint for Financial Institutions to assess its ecological footprint and track progress. By transparently reporting on its initiatives, the bank aims to raise awareness among financial institutions about biodiversity impacts and promote informed decision-making.
    - **Raising awareness:** The bank is participating in De Nederlandsche Bank's (DNB) Sustainable Finance Platform and co-initiating the biodiversity working group to raise awareness of and address deforestation issues.
- During the UNFCCC COP28, multiple MDBs unveiled a set of shared principles to identify and monitor nature-positive finance. Among these institutions, the Inter-American Development Bank (IDB) demonstrated its robust nature-positive strategy by pledging to **triple climate financing** to US$150 billion over the next decade. Additionally, the IDB is pioneering an innovative finance tool called the Biodiversity and Climate-Linked Mechanism for Ambition (**IDB CLIMA**), offering borrowers a 5% discount upon achieving the nature and climate goals outlined in its loan projects.
- Environment Bank is **pioneering the establishment of a growing network of Habitat Banks** across England, generating high-quality biodiversity units to satisfy stringent biodiversity net gain (BNG) planning requirements for developers. These Habitat Banks, strategically located in ecologically significant areas, offer a diverse range of habitats designed by ecologists in collaboration with local planning authorities to align with local nature recovery strategies. They are funded comprehensively throughout their life cycle, covering capital works, habitat management, ecological monitoring, and detailed reporting. Positioned on low-yielding land to avoid food security impacts, Habitat Banks provide long-term income security for rural landowners through secure annual land leases and management payments, which are especially valuable amid declining government subsidies. By facilitating off-site biodiversity unit provision from local Habitat Banks, the nationwide network minimizes the need for cross-boundary delivery, ensuring that biodiversity benefits remain localized, with on-site BNG delivery within the development site's red line boundary.
- **CapitaLand**, one of Asia's largest diversified real estate groups, had obtained a US$500 million sustainability-linked loan (SLL) in 2020 from United Overseas Bank (UOB), which marked the largest SLL in Singapore's real estate sector. This SLL from UOB is linked to CapitaLand's achievements in the Global Real Estate Sustainability Benchmark (GRESB) for infrastructure and real estate investment globally. The ESG

performance of CapitaLand is explicitly tied to this SLL, providing CapitaLand with the flexibility to use the proceeds from the loans to finance general corporate activities, unlike that of green loans. CapitaLand has announced that this SLL has been significantly advantageous to the group since they achieve interest savings while maintaining or improving their rating on the GRESB.

Best Practice 3

Public-private partnerships (PPPs) should distribute and allocate responsibility for safeguarding natural resources fairly among official project partners and embed clauses that ensure adherence to natural resource safeguards in their contracts and agreements.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 3

- The Global Infrastructure Hub has developed **a risk-sharing tool to support the successful drafting of PPP contracts**. Project preparation is widely accepted as a key driver to ensure investment in infrastructure is transformed into positive outcomes for the public. This is particularly true in the case of PPPs, as they are complicated arrangements for the delivery of infrastructure. A PPP contract that is structured around a project that does not deliver social benefits in a sustainable manner will have a negative impact, irrespective of how well the contract is structured and drafted.
- The IDB has developed **a toolkit for decision-makers to support the development of climate-resilient PPPs**. The toolkit provides a series of decision support tools to help planners involved in the PPP development process think about incorporating climate resilience considerations.

Best Practice 4

Environmental and social impact assessments (ESIAs) should be completed early in the LI project's development cycle, such as for scoping, feasibility, and design.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 4

- The World Bank's ***Guidance Note for Borrowers*** in implementing environmental and social safeguards outlines expectations for assessment of risk during the scoping process and subsequent ESIA. The scoping of the project should identify the extent and complexity of potential environmental and social risks and impacts, and the socioeconomic characteristics of people in the project area.
- The Food and Agriculture Organization (FAO) provides **good guidance** while enforcing the need for adequate project scoping prior to a full ESIA. FAO suggests that, at a minimum, a good ESIA might take 12 months to complete. See an **example terms of reference (ToR) below**:
    - A description of the project and its purpose and extent.
    - A list of all the agencies responsible for the developmental project and the EIA study.
    - A **description of the existing environmental conditions** on the project site and in surrounding areas.
    - The stakeholders that will benefit and be harmed by the fulfillment of the project.
    - The environmental aspects of the project that are likely to be affected.
    - The impacts, both positive and negative, the project will have on the environmental and social aspects of the project area. This is undertaken through **checklists**, **matrices**, or **networks**.

- A list/description of the species endemic to the area that are likely to be affected.
- How in depth the EIA study needs to be: whether baseline data is available or whether the study is sourced from secondary data.
- Possible alternatives for the project in terms of design, site, technology, implementation, etc.
- The legal requirements of the project and future legislation that will need to be drafted.
- Whether the project site comes under special categories, and the legislation regarding the same.
- Recommended mitigation strategies.
- The expertise required for the EIA study.
- The expected time limit for the entire EIA study.
- Natural resource valuation.
- The budget of the study, also called cost-benefit analysis.

- The Environment Institute of Australia and New Zealand Inc. outlines **good practice steps for scoping in impact assessment**.
  - A brief description of the project, including any timescales, ancillary features (such as pipelines or highway improvements), and plans/maps/photos to aid description of the site and the proposal.
  - Feasible alternatives that will be examined in detail and others that have been discounted, and the reasons why.
  - Any relevant strategic or policy decisions that have already been made and that may affect the project.
  - Relevant regulatory standards, policies, guidelines, and other documentation that determine the outcomes that will be considered acceptable by regulators.
  - A list of stakeholders, their interests, and how they will be engaged in the impact assessment process.
  - Methodology to be adopted for impact and risk assessment, including how the significance of impacts and risks will be rated.
  - An initial desktop study of the current environment (including social and economic) values and systems.
  - Identification of applicable studies that have been undertaken by the proponent or other parties to date and the relevance and quality of the studies as they might apply to the project
  - Work that must be undertaken by the proponent to address any information gaps, including the following:
    - The purpose of each of the further studies to be undertaken or methodologies to be adopted for the assessment of each issue.
    - The extent (spatial and temporal) of the study area to be considered for each issue.
    - The intended output for each study.
  - Timing and milestones for the impact assessment.

- Secondary approvals required and the matters to be considered.
- The process for dealing with changes to the scoping document in response to significant project changes or substantial new information.

- The **IAIA provides similar scoping development guidance**.
  - Brief description of the project, including project rationale and objectives.
  - Feasible alternatives.
  - Relevant laws, regulations, and regulatory standards, policies, and guidelines.
  - Identification of key stakeholders, their interests, and how they will be engaged in the impact assessment process.
  - An outline of the consultation process.
  - Relevant environmental impacts to be investigated (physical systems, ecological systems, social systems, archaeological and cultural effects, land-use effects, economic effects).
  - Methodology to be adopted for impact and risk assessments.
- The World Resources Institute (WRI) has been a global leader in ensuring ecosystems and their services are adequately represented in EIAs and protected. WRI has produced a document intended for practitioners of impact assessments to support their work. The Ecosystem Services Review for Impact Assessment (ESR for IA) is a structured methodology that **guides practitioners through five steps** to incorporate ES into ESIA at the scoping, baseline and impact analysis, and mitigation stages. These are the steps:
  - Step 1: Select the scope
  - Step 2: Identify priority ES
  - Step 3: Analyze trends in priority ES
  - Step 4: Identify business risks and opportunities
  - Step 5: Develop strategies for addressing risks
- The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has been formed with the task of producing timely assessments of knowledge on biodiversity and ES and their interlinkages at the regional and subregional levels. The four regions that are to be assessed are **Africa, the Americas, Asia Pacific, and Europe and Central Asia**. The assessments offer a critical analysis of the state of knowledge regarding the importance, status, and trends of biodiversity, ecosystem functions, and ES and their linkages. The direct and underlying causes for the observed changes and the impact that these changes have on the quality of life of people are also assessed. The assessment, finally, identifies a mix of governance options, policies, and management practices that are currently available to reduce the loss of biodiversity and of nature's contributions to people within a region. The assessment addresses terrestrial, freshwater, and coastal biodiversity and covers status and trends, going back in time several decades, and future projections, with a focus on the 2020–2050 period. The objective of the regional assessments is to strengthen the science-policy interface at the regional and subregional levels.

- The Cross Sector Biodiversity Initiative has produced "**Good Practices for the Collection of Biodiversity Baseline Data**," which includes guidance for practitioners in conducting baseline biodiversity surveys during impact assessment. Guidance starts at the process of identifying the area to consider and follows with scoping, conducting desk-based assessments and field-based assessments, incorporating stakeholder and expert input, and reporting.
- The Equator Principles provide **best practice guidance** for conducting biodiversity baseline surveys. A key point made is that baseline surveys require time to complete across the entirety of the year to capture seasonal changes and that surveys that are rushed are likely to result in costly delays, expensive add-ons, and costly species recovery measures due to stakeholder complaints.
- The **Akwé: Kon Voluntary Guidelines** provide recommendations for the conduct of cultural ESIAs regarding developments proposed to take place on, or which are likely to impact, sacred sites and lands and waters traditionally occupied or used by Indigenous peoples and local communities.

Best Practice 5

LI project developers should adhere to the mitigation hierarchy to ensure the preservation or enhancement of natural resource values. Priority should be given to avoiding impacts altogether. If avoidance is not feasible, efforts should focus on minimizing negative impacts. Offsetting and compensating for any adverse effects on natural resources caused by the project should be undertaken when no other alternatives are possible.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 5

- **The Cross Sector Biodiversity Initiative** has developed **guidance notes for implementation of the mitigation hierarchy**. The document does the following:
    - Provides systematic guidance for determining and demonstrating biodiversity loss or gain because of mitigation efforts, highlighting links to ES where available and appropriate.
    - Offers practical measures for predicting and verifying biodiversity conservation outcomes over time and offers insight into documenting and comparing costs and savings resulting from mitigation action or inaction.
- Areas of high conservation value (HCV) can be identified using the **toolkit provided by the HCV Network**. The approach incorporates six criteria into defining an HCV area.
    1. HCV 1: Concentrations of biological diversity, including endemic species and rare, threatened, or endangered species, that are significant at global, regional, or national levels.

2. HCV 2: Intact forest landscapes and large, landscape-level ecosystems and ecosystem mosaics that are significant at global, regional, or national levels and that contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance.
3. HCV 3: Rare, threatened, or endangered ecosystems, habitats, or refugia.
4. HCV 4: Basic ES in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes.
5. HCV 5: Sites and resources fundamental to satisfying the necessities of local communities or Indigenous peoples (for livelihoods, health, nutrition, water, etc.). Identified through engagement with these communities or Indigenous peoples.
6. HCV 6: Sites, resources, habitats, and landscapes of global or national cultural, archaeological, or historical significance, and/or of critical cultural, ecological, economic, or religious/sacred importance for the traditional cultures of local communities or Indigenous peoples. Identified through engagement with these local communities or Indigenous peoples.

- All UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage sites are now considered to be areas where development impacts are not able to be offset and **thus are "no-go" areas for LI development that enable private sector initiatives**.
- **A document** by IUCN outlines new resolutions from the World Conservation Congress in Hawai'i, focusing on stricter "no-go" policies for industrial development in protected areas and other vital biodiversity sites. These resolutions, while not legally binding, aim to influence global conservation efforts by advocating for prohibitions on environmentally damaging activities within protected zones and restrictions on activities outside these areas that could negatively impact them. The source emphasizes that governments, businesses, and investors are urged to adhere to these provisions, with a particular focus on avoiding harm to Key Biodiversity Areas (KBAs) and Indigenous and Community Conserved Areas (ICCAs). The document also acknowledges the challenges and potential unintended consequences of implementing these strict guidelines, suggesting that industry might argue for a case-by-case risk management approach to achieve better conservation outcomes.
- Balvenera et al. (2022) suggest **a set of Essential Ecosystem Service Variables (EESVs)** against which progress toward achieving the SDGs can be monitored. The proposed EESV classes comprise ecological supply, anthropogenic contribution, demand, use, instrumental values, and relational values. Development of specific indicators of these classes for three exemplary ES (food from fisheries, crop pollination, and wildlife viewing) confirms their readiness for global operationalization.
- **European Commission's Biodiversity Policy**: The EU Biodiversity Strategy for 2030 and associated Action Plan is a comprehensive, ambitious, long-term plan for protecting nature and reversing the degradation of ecosystems. It aims to put Europe's biodiversity on a path to recovery by 2030 with benefits for people, the climate, and the planet.
- At the 2021 World Conservation Congress in Marseille, France, the IUCN adopted motion 086 **Wildlife-friendly linear infrastructure**. Among several concerns and requests to members, the motion stated that the IUCN was convinced that the impacts of LI on the environment are sufficiently well-known to be addressed using the mitigation hierarchy (avoid, minimize, restore, compensate).

- A paper on ***Policy Development for Environmental Licensing and Biodiversity Offsets in Latin America*** provides an approach to apply mitigation hierarchy in practice. As an example, to reduce connectivity loss, each stage of road building and operation may be subject to interventions applying the mitigation hierarchy framework. Locations identified to have high landscape connectivity should be avoided during road route selection, and then long-span bridges and crossing structures should be designed for specific targets, combined with other adaptations of the road project to minimize connectivity loss. Residual connectivity loss detected during road operation should be restored by road retrofitting—for example, by improving existing wildlife crossings and installing new ones aiming to restore movement back to pre-road levels. Only after alternatives for these three first steps have been exhausted, residual losses should be compensated with enhancements in ecological connectivity off-site and only as a last resort with financial compensation.
- A **global strategy for road building** was put forward by Laurence et al. (2014). The authors identify areas where agriculture could be expanded with minimal environmental impact and promote a road planning strategy that would prioritize development to maximize agricultural productivity at the lowest cost to the environment. The **analysis and resulting map** prioritize habitat according to environmental value and agricultural importance gradients to identify where road development would have the greatest benefit for the lowest cost to the environment. The analysis and resulting map identified areas that have high biodiversity value and low agricultural value (road free), areas of high value for agriculture (prioritizing road development), areas that are low priority for both agriculture and biodiversity, and "conflict areas"—areas that are high priority for both agriculture production and biodiversity. Alternative income-generating schemes such as payment for ES, ecotourism, and promotion of sustainable harvesting of native species were put forward as options to support biodiversity in conflict areas.

Best Practice 6

LI practitioners should assess impacts on ecological connectivity and wildlife corridors, based on global guidelines and initiatives, to incorporate wildlife-friendly measures into program and project planning and design processes.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 6

- In 2020 the IUCN published ***Guidelines for conserving connectivity through ecological networks and corridors***. The document provides tools and examples based on the latest connectivity science that can be used to establish ecological corridors by connecting protected areas and other effective area-based conservation measures (OECMs) and developing ecological networks for conservation. With formally established ecological corridors in place, the mitigation hierarchy can be readily applied to ensure these corridors remain intact or opportunities can be sought to enhance them. The six guiding principles for establishing ecological corridors are the following:

    1. Ecological corridors are not a substitute for protected areas or OECMs. They are meant to complement protected areas and OECMs.
    2. Ecological corridors should be identified and established in areas where connectivity is required, with the aim of building ecological networks for conservation.
    3. Each corridor should have specific ecological objectives and be governed and managed to achieve connectivity outcomes.
    4. Ecological corridors may consist partly or entirely of natural areas managed primarily for connectivity. Corridors can also cross highly managed areas.

5. Ecological corridors should be differentiated from non-designated areas by the specific uses that are allowed or prohibited within them.
6. To achieve their connectivity objectives, ecological corridors require their own management plans.

- United States: In 2023, the White House issued "**Guidance for Federal Departments and Agencies on Ecological Connectivity and Wildlife Corridors**" in implementing the Bipartisan Infrastructure Law and the Inflation Reduction Act. The following best practices were advised for consideration during planning and decision-making:
  - Elevating the conservation, enhancement, protection, and restoration of connectivity and corridors as a programmatic goal.
  - Planning at the scale of landscapes, waterscapes, or seascapes rather than at the scale of an individual project.
  - Applying ecosystem-based conservation, enhancement, protection, and restoration strategies, including using nature-based solutions.
  - Advancing plans and actions that improve the resilience of corridors to climate change or that conserve corridors needed to facilitate climate adaptation.
  - Engaging meaningfully with local communities so that they have a voice in planning, authorization, and funding decisions.
  - Designing infrastructure to facilitate wildlife movement, ecosystem processes, and ES.
  - Restoring habitat to remove and prevent re-establishment of invasive species and to promote native ecological communities.
  - Avoiding or minimizing adverse impacts that would fragment habitat identified as a priority for connectivity or corridors, and, where not possible to do that, offsetting or compensating for these impacts.
  - Removing, modifying, or avoiding the installation of barriers to wildlife movement along migratory routes.
  - Rehabilitating habitat damaged by natural or human impacts to facilitate continued connectivity.
  - Producing science, data, and tools on connectivity through research, collaborations, and partnerships that are readily applicable to land, water, ocean, and resource management.
  - Using criteria related to connectivity and corridors to inform decisions related to budgeting, project selection, or grant eligibility.
- In meeting its agreements on the CBD's Aichi Targets, which mandate that by 2020 at least 17% of terrestrial land and inland waterways of areas important for biodiversity and ES be formally conserved via a well-managed and connected protected system of areas, the Australian government implemented a nationwide wildlife corridor plan. The government published **a compendium** of the approaches taken with nine case studies. Improving conservation management of ecological connectivity remains a strategic objective. In addition, the Australian government provides **a good overview** of how wildlife corridors are defined and identified.

- The IUCN has published comprehensive guidance for **maintaining ecological connectivity in the development of roads, railways, and canals**. The report illustrates the challenges that these LI modes impose on biodiversity and ecosystems and the importance of taking steps to alleviate these issues given the vast amount of LI that is planned. It covers a wide range of topics, starting from the legislative process for inclusion of the recommended steps and continuing through the life cycle of a project all the way to establishing good monitoring to evaluate the effectiveness of the mitigation measures.
- The IUCN Asian Elephant Transport Working Group published in 2021 ***Protecting Asian Elephants from Linear Transport Infrastructure***, which includes recommendations and examples of elephant crossing structures for roads, railways, and canals. Their ***Handbook to Mitigate the Impact of Roads and Railways on Asian Elephants*** was published in early 2024. It provides specifications and other details on mitigation measures for roads and railways, such as wildlife crossing structures and their associated fencing.
- IUCN has produced **guidelines for preventing and mitigating wildlife mortality associated with electricity distribution networks**. This publication offers a comprehensive overview of the problems of electrocution, mitigating options, and case studies from around the world.
- The Government of Nepal has provided **directives for the construction of wildlife-friendly LI**. The directives provide a briefing on potential impacts of infrastructure on a variety of species and provide guidance on the size of crossing structures required for wildlife along a gradient of body sizes. In addition, forest rules have mandatory provisions for constructing wildlife-friendly infrastructure and habitat management by infrastructure development projects passing from the forest area.
- The ADB published a guidance document in 2019, ***Green infrastructure design for transport projects: A road map to protecting Asia's wildlife biodiversity***, to help project developers.
- The Wildlife Institute of India has published **guidelines for *Power-Line Mitigation Measures to Conserve Bustards*** and a report on ***Eco-Friendly Measures to Mitigate Impacts of Linear Infrastructure on Wildlife***.
- Birdlife International and the CMS Energy Taskforce have developed **TransMit**, a toolkit for supporting mitigation of power line projects to prevent bird deaths due to electrocution and wire collisions.
- **Costa Rica has established 44 biological corridors** covering 33% of the country's territory. As part of the National Program of Biological Corridors, corridors are a key conservation strategy and involve local stakeholders in their management through participatory platforms called Local Committees of Biological Corridors.
- Bhutan established its **wildlife corridor program** in 1999, and, in 2006, it adopted governing rules with **12 corridors initially created**. These wildlife corridors have higher protected status than forest areas but are not considered to be protected areas. However, they have a dedicated team to manage the corridors and monitor compliance.
- Thailand's Ecological Corridors Initiative, led by the **Thailand Department of National Parks, Wildlife and Plant Conservation**, is an effort to increase ecological connectivity between "forest complexes" and protected areas established for their protection. The initiative has identified 174 corridors that would facilitate connectivity within a forest complex, 33 corridors intended to increase connectivity between 17 different forest complexes, and 13 transboundary corridors. When upgrades to roads are determined necessary, this creates an opportunity to incorporate connectivity into the design of the LI.

- In 2018, as a part of its 25-Year Environment Plan, the United Kingdom adopted a new **National Planning Policy Framework**, which includes policies that guide the development of a **Nature Recovery Network**. The Nature Recovery Network is an expanding and increasingly connected network of wildlife-rich habitat across England. It comprises a core network of designated sites of importance for biodiversity and adjoining areas that function as stepping stones or wildlife corridors, areas identified for new habitat creation, and up to 25 nature recovery areas for targeted action. Relevant evidence in identifying and mapping local ecological networks can include main landscape features, which, due to their linear or continuous nature, support migration, dispersal, and gene flow, including any potential for new habitat corridors to link any isolated sites that hold nature conservation value, and therefore improve species distribution.
- To protect its growing population of more than 1,500 individuals, the Government of India has shown strong commitment to conserving and aiding the growth of tiger populations through several initiatives, such as creation of the National Tiger Conservation Authority, amendments to the Wildlife Protection Act, delineating inviolate core area in tiger reserves, and incentivizing voluntary relocation programs. However, it is critical that these key areas and the populations they sustain remain connected with each other to allow genetic exchange through dispersal. The Wildlife Institute of India, **through a report**, has identified key corridors that could help planners and decision-makers identify go/no-go areas and aid the growth of tiger populations in India through conservation measures.
- In 2015, six months after the **standard for wildlife-friendly passage in Gobi and steppe regions for LI development** was adopted at the CMS COP11, the **Mongolian Parliament voted to pass into national law the CMS Guidelines** on mitigating the impact of LI and related disturbance on mammals in Central Asia. The standards are required for roads and railways to allow the safe passage of wildlife in Mongolia.
- **Costa Rica's Biodiversity Law of 1998** embraces the three objectives of the CBD: conservation of biodiversity, sustainable use of resources, and the fair and equitable sharing of the benefits arising from the utilization of genetic resources. The law addresses the social demand to conserve and protect biodiversity and threatened species. It also includes measures on the social demand to conserve, protect, and sustainably utilize biological resources to ensure the quality of life of future generations and the survival of natural heritage.
- Wildlife corridors are a proven conservation spatial strategy to sustain natural communities and be robust to environmental conditions caused by natural and anthropogenic changes. While there has not yet been a determined consensus on which methods are best for conserving landscape connectivity, **Wood et al. (2022) summarize four multispecies approaches** to identifying wildlife corridors that serve the needs of multiple species. These are 1) species agnostic approaches, 2) generic species approaches, 3) single surrogate species approaches, and 4) multiple focal species approaches. The authors also outline six steps to take in identifying corridors: 1) select species, 2) identify species traits, 3) define habitat, 4) define movement capacity, 5) assess connectivity, and 6) prioritize multispecies networks.

- **Goncalves et al. (2022) have identified forward-thinking recommendations** to improve risk assessments for identifying increasing ecological connectivity opportunities during ESIA. Evidence-based approaches are critical, and the authors suggest:
    - Maintaining ecological corridors.
    - Connectivity modeling using empirical movement data, species occurrence maps, and expert opinions that are tested and validated.
    - Selecting both groups of species and target species that can also be used as indicator species during evaluation.
    - Avoiding setting arbitrary limits to the spatial extent of the ESIA.
    - Recognizing and following the mitigation hierarchy.
    - Considering that landscapes are dynamic.
    - Seeking defragmentation opportunities and restoration of connectivity through mitigation.

Best Practice 7

LI project developers should integrate climate vulnerability assessments into the development of their SEAs and ESIAs. This should include analyzing the program's or project's capacity to address identified climate vulnerabilities and minimize risks to communities and infrastructure under extreme climate conditions.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 7

- The World Bank Group has produced a guide for designing strategies for climate change adaptation and resilience, ***The Adaptation Principles***. This comprehensive guide is meant to be used by those who oversee a nation's wider economic system and focuses on actions that reflect universal principles for effective climate change adaptation. The guide establishes as a priority the need for rapid, robust, and inclusive development and provides six guiding principles:
    1. Ensure development is rapid and inclusive and offers protection against shocks.
    2. Facilitate the adaptation of firms and people.
    3. Adapt land use and protect critical public assets and services.
    4. Help firms and people cope with and recover from disasters and shocks.
    5. Anticipate and manage macroeconomic and fiscal risks.
    6. Prioritize, implement, and monitor interventions.

The guide also includes numerous toolboxes to aid implementation and offers indicators to track progress.

- **Jones and Mearns (2005) provide technical guidance** that can be followed to determine climate risk and adaptation needs. Efforts to determine climate risk on LI, both built and on the horizon, help inform policymakers of the level of resources that will be required to ensure against risk and avoid costly setbacks.
- In 2008, the United States National Research Council's Transportation Research Board conducted an **in-depth study of the impacts of climate change on land, marine, and air transportation in the United States**. The report recommends that state and local governments, as well as private infrastructure providers, incorporate climate change into long-term improvement plans, design, and operations and maintenance activities. It also discusses the potential benefits of using "smart" technologies for monitoring infrastructure, reevaluating infrastructure design standards, updating maps used for flood insurance, and integrating climate change into transportation and land-use planning.
- With the increasing frequency and intensity of natural hazards due to climate change, an infrastructure asset will be expected to endure higher impacts during its lifetime. **Infrastructure Pathways** is a resource for infrastructure practitioners in search of clear, easy-to-navigate guidance on practical ways to integrate climate resilience into day-to-day practice. Infrastructure Pathways provides guidance across nine identified phases of infrastructure project development. In the design phase, relevant here, Infrastructure Pathways offers this: In the design of the infrastructure life cycle, an idea is converted into a practical plan for implementation that describes how the final asset will be built and how it will work. Good design should reflect what society wants, improve the quality of life of those who use it, and ensure the asset is able to function effectively throughout its design life. Climate change requires that the parameters that guide infrastructure design be re-examined to account for the infrastructure's impact on the surrounding environment and the changing climate's impact on the infrastructure.
- Securing the most recent and globally accepted data is critical to conducting a thorough climate risk assessment. The following organizations provide global-level climate data:
    - **WRI's Climate Watch:** **Climate Watch** is an open data platform that brings together dozens of datasets to let users easily search, analyze, and compare countries' climate progress and commitments under the Paris Agreement. The tools and resources found within give a comprehensive overview of the past, present, and potential futures of climate, enabling users to make well-informed decisions on critical climate plans.
    - **Climate Analytics:** **Climate Analytics** delivers cutting-edge science, analysis, and support to accelerate climate action to limit warming to below 1.5°C. Products are intended to empower those most vulnerable—small island developing states and least developed countries—to use the best science and analysis available in the international climate negotiations, as well as develop policies and institutional capacity to adapt to climate change.
    - **Earth Observing Systems Data and Information Service (EOSDIS):** **EOSDIS** provides end-to-end capabilities for managing NASA (National Aeronautics and Space Administration) Earth science data from various sources—satellites, aircraft, field measurements, and other programs. EOSDIS data is easy to find and uses NASA Earth science fully, openly, and without restrictions.
    - **Climate Data Store (CDS):** **The CDS provides freely available climate data** from the EU Copernicus program. The CDS offers a toolbox that allows users to run analytics from CDS computers with just a basic working knowledge of the Python programming language.

  - **National Center for Environmental Information (NCEI):** NCEI manages one of the largest archives of atmospheric, coastal, geophysical, and oceanic research in the world and offers users access to more than 26,000 datasets and products.
  - The **World Bank Group** provides guidance on predicting and valuing climate impacts in road development contracts. Management of the uncertainties of climate risk is key to developing successful and sustainable infrastructure.

- Article 8 of the Paris Agreement enshrines the importance of avoiding, minimizing, and addressing loss and damage and reducing the risk of loss and damage due to climate change, including extreme weather events. It identifies the following areas of cooperation and facilitation to enhance understanding, action, and support for accounting losses and damages:

  1. Early warning systems
  2. Emergency preparedness
  3. Slow onset events
  4. Events that may involve irreversible and permanent loss and damage
  5. Comprehensive risk assessment and management
  6. Risk insurance facilities, climate risk pooling, and other insurance solutions
  7. Non-economic losses
  8. Resilience of communities, livelihoods, and ecosystems

- The UNFCCC Framework provides simple guidance for implementing adaptation and resilience measures. The framework advises that adaptation should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of Indigenous peoples, and local knowledge systems, to integrate adaptation into socioeconomic and environmental policies and actions. Nations have agreed to compile and implement National Adaptation Plans to reduce vulnerability to climate change. Reports on best practices and lessons learned in addressing adaptations offer additional guidance.
- The World Database on Protected Areas provides spatial locations of protected areas collected from international convention secretariats, governments, and collaborating NGOs. The database is managed by the United Nations Environment World Conservation Monitoring Centre.
- The Integrated Biodiversity Assessment Tool (IBAT) is a subscription-based map and reporting tool that provides access to three of the world's most authoritative global biodiversity datasets, such as the IUCN Red List, the World Database on Protected Areas, and the World Database on KBAs.
- There are numerous approaches and tools that can be utilized. Some tools place emphasis on identification of ES, while others emphasize valuation. The team conducting the ESIA should possess the required expertise to ensure the approach and tool(s) of choice are appropriately utilized and fit for purpose. Below are some tools that policymakers/project developers can use to determine and evaluate key ecosystems and their services.
  - **ValuES:** Offers a suite of publications and a navigator tool that provide guidance on steps to take for integrating ecosystem services into development planning and to determine an appropriate

approach for assessing and valuating ES with methods for integrating ES into policy and development planning. ValuES provides links to numerous methodologies that can be utilized for identification of ES, some of which are listed below.

  - **TESSA:** The **Toolkit for Ecosystem Service Site-based Assessment** (TESSA) guides local nonspecialists through a selection of relatively accessible methods for identifying which ecosystems and their services may be important at a site and for evaluating the magnitude of benefits that people obtain from them currently, compared with those expected under alternative land uses.
  - **ARIES:** **The Artificial Intelligence for Environment & Sustainability (ARIES)** is a web-based application built on the **k.LAB** platform. The application has access to all information (data and models) available on the integrated modeling network and provides a dedicated user interface to easily compile accounts within the United Nations SEEA.

- IAIA has developed several guidance documents to undertake climate impact assessments.
  - **Best practice principles for *Climate Change in Impact Assessment***
  - **Principles for assessment of resilience**

Best Practice 8

LI practitioners should account for/include environmental impact mitigation measures in their cost-benefit analysis to make informed decisions, assess risks, plan for the long term, and engage stakeholders effectively when developing climate resilience projects.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 8

- ADB's **report** provides information to decision-makers as to the contribution of the project to society's welfare. The analysis provides a means to systematically identify, quantify, and, wherever possible, value all impacts of the project, including (where relevant) its environmental impacts, even in circumstances when these impacts occur over long time horizons. The role of the economic analysis is to support decision-making, as it provides information about the economic efficiency of investment projects, including the economic efficiency of climate-proofing investment projects. The report clarifies how the economic analysis of climate-proofing measures can inform the design of investments.
- The National Cooperative Highway Research Program has published the guidebook ***Incorporating the Costs and Benefits of Adaptation Measures in Preparation for Extreme Weather Events and Climate Change***. The guidebook provides an overview of cost-benefit analysis and insights into selecting an appropriate approach and examples of how to conduct it.
- The publication ***Life Cycle Cost Analysis for Management of Highway Assets*** documents the state of the practice of life cycle cost analysis (LCCA) and risk-based analysis of state highway agencies' asset management plans for pavements and bridges on the National Highway System of the USA. The document provides tools for conducting LCCA and international examples.

- Together with GEF, the MAVA Foundation, the United Nations Industrial Development Organization (UNIDO), and the International Institute for Sustainable Development (IISD) established the **Nature-based Infrastructure Global Resource Centre** to establish a business case for nature-based infrastructure. They developed the Sustainable Asset Valuation (SAVi) to help policymakers and investors make informed decisions on financing sustainable infrastructure by providing them with a comprehensive analysis of how much their infrastructure projects and portfolios will cost throughout their life cycles, considering risks that are overlooked in a traditional valuation. SAVi uses a combination of system dynamics and project finance modeling to capture the full costs of environmental, social, and governance risks. Moreover, SAVi calculates the dollar value of externalities that result from infrastructure development.[3]
- **Co$tingNature:** **Co$tingNature is a web-based spatial policy support system (PSS)** for natural capital accounting and analyzing ecosystems and their services provided by natural environments (i.e., nature's benefits), identifying the beneficiaries of these services, and assessing the impacts of human interventions. The PSS incorporates detailed spatial datasets at 1 square km and 1 hectare resolution for the entire world, and spatial models for biophysical and socioeconomic processes, along with scenarios for climate and land use. The PSS calculates a baseline for current ES provision and allows a series of interventions (policy options) or scenarios of change to be used to understand their impact on ES delivery. The tool does not focus on valuing nature (how much someone is willing to pay for it) but rather on costing it (understanding the resource, e.g., land area and opportunity cost of nature being protected to produce the ES that humans need and value).
- **EarthEconomics:** EarthEconomics has developed **the Ecosystem Valuation Toolkit**, an evolving suite of online, scientifically grounded analytical tools that provide rigorous analytical support for decision-making that takes nature into account. Two options exist—a version available to the public and a version that is supported by expertise within EarthEconomics. In addition to ES valuation, the Ecosystem Valuation Toolkit includes a benefit-cost analysis that expands traditional cost-benefit equations to include ecosystems and their services to produce efficient, pragmatic, and effective analyses to inform policy and business decision-making.
- **InVEST:** The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) tool is **a suite of free, open-source software models** used to map and value the goods and services from nature that sustain and fulfill human life. It helps explore how changes in ecosystems can lead to changes in the flows of many different benefits to people. InVEST enables decision-makers to assess quantified trade-offs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation. The toolset includes distinct ES models designed for terrestrial, freshwater, marine, and coastal ecosystems, as well as several "helper tools" to assist with locating and processing input data and with understanding and visualizing outputs.

3 International Institute for Sustainable Development. Sustainable Asset Valuation (SAVi). Winnipeg, MB: IISD. Accessed July 30, 2025. iisd.org/savi/

Best Practice 9

LI project developers must update their procurement practices to integrate considerations of life cycle costs, avoid materials from illegal sources or those with high environmental costs, incorporate actions for conserving biodiversity and addressing climate change in solicitations and contracts, and establish a contractual requirement with a dedicated budget for monitoring programs to assess the effectiveness of mitigation measures in safeguarding natural resources.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 9

- The World Bank and the National Metrology Institute of Germany have **developed a toolkit** that can help development partners and governments analyze a country's quality infrastructure (QI) ecosystems, provide recommendations to bridge gaps in the QI ecosystem, support reforms, and build the capacity of institutions.
- The US Trade and Development Agency provides training to public officials in emerging markets on **how to establish procurement practices and policies that integrate life cycle cost analysis and best value determination in a fair, transparent manner**. By adopting life cycle cost analysis into procurement practices, emerging market countries can build sustainable infrastructure with overall savings to their government.
- The IISD has published ***Contracts for Sustainable Infrastructure: Ensuring the economic, social, and environmental co-benefits of infrastructure investment projects***. The report explains how traditional procurement and PPPs that governments adopt to structure infrastructure projects are more costly over the life cycle of a project. To achieve the SDGs, infrastructure identified as needing upgrades and projected to be built must be specifically designed to mitigate economic, social, and environmental

risks, and to generate economic, social, and environmental co-benefits. Conventional project finance valuation methodologies ignore long-term risks and co-benefits that arise from incorporating sustainable concepts into the project. The report offers nine approaches (with more than 50 steps) to consider in drafting infrastructure contracts aimed at phasing out business-as-usual infrastructure investment, incentivizing investment in sustainable infrastructure, and guaranteeing and maximizing the economic, social, and environmental co-benefits of infrastructure projects.

- The Sustainable Infrastructure Foundation, a nonprofit based in Geneva, has developed the **SOURCE platform, a project governance management tool**. SOURCE offers a common framework, incorporating international best practices and private sector requirements, and is adaptable to each country's processes and IT systems to strengthen the capacity of project developers to package sustainable infrastructure projects. The G7 confirms the importance of SOURCE in improving the quality, standards, and governance of infrastructure projects.

Best Practice 10

LI project developers should aim to meet globally accepted sustainable infrastructure certification requirements, not necessarily to obtain certification but to maximize the integration of nature-based strategies in LI plans and designs.

RELEVANT THEMES

PROJECT LIFE CYCLE APPLICABILITY

ENGINEERS AND DESIGN CONSULTANTS

Resources (background/guidance/examples) related to Best Practice 10

- **SuRe® – the Standard for Sustainable and Resilient Infrastructure** is a third party–verified, global voluntary standard developed through a multistakeholder approach incorporating inputs from developed and emerging nations. The standard aims to drive the integration of sustainability and resilience aspects into infrastructure development and upgrades by providing guidance and serving as a globally applicable common language tool for infrastructure project developers, financiers, and public sector institutions. SuRe® aims to 1) establish a common understanding of sustainable and resilient infrastructure between project developers, financiers, public sector institutions, and end users; 2) improve the quality of projects so they are built on sustainable and resilient principles; and 3) help investors identify responsible investment opportunities. SuRe® was developed by GIB and French investment bank Natixis with the support of stakeholders globally. SuRe® complements the Equator Principles and integrates the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability.
- The **FAST-Infra** Sustainable Infrastructure Label (SI Label) is a globally applicable label for projects demonstrating significant positive sustainability performance. It is designed to enable developers and operators to show the positive impact of an infrastructure asset and attract investors seeking assets that positively contribute to sustainable outcomes. The SI Label is also designed to enable transformation of sustainable infrastructure into a mainstream, liquid asset class.

- Gold Standard, established in 2003, is a best practice standard to ensure that projects that reduce carbon emissions feature the highest levels of environmental integrity and contribute to sustainable development. **Gold Standard for the Global Goals** is designed to accelerate progress toward climate security and sustainable development. The standard enables initiatives to quantify, certify, and maximize their impacts toward climate security and the SDGs, while enhanced safeguards, holistic project design, management of trade-offs, and local stakeholder engagement ensure Gold Standard continues to deliver the highest levels of environmental and social integrity.
- The Institute for Sustainable Infrastructure offers third-party verification via its **"Envision" certification process**. Envision provides a consistent, consensus-based framework for assessing sustainability, resilience, and equity in civil infrastructure. Although Envision is predominately North American-centered in focus, the considerations for certification are transferable to other parts of the world.
- **IUCN's Global Standard for Nature-based Solutions** offers a robust framework for designing and verifying nature-based solutions (NbS) that yield the outcomes desired in solving one or several societal challenges. The standard is designed to support users in applying, learning, and continuously strengthening and improving the effectiveness, sustainability, and adaptability of their NbS interventions. The standard consists of eight criteria:
    1. NbS effectively address societal changes.
    2. The design of NbS is informed by scale.
    3. NbS result in a net gain to biodiversity and ecosystem integrity.
    4. NbS are economically viable.
    5. NbS are based on inclusive, transparent, and empowering governance processes.
    6. NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits.
    7. NbS are managed adaptively, based on evidence.
    8. NbS are sustainable and mainstreamed within an appropriate context.

References

1. 117th US Congress. 2021. Infrastructure and Investment and Jobs Act: Public Law 117-58, Nov. 15, 2021. US Government. **congress.gov/bill/117th-congress/house-bill/3684/text**
2. AECOM. 2015. Becoming Climate Resilient: An Executive Business Case for Climate Resilience. AECOM. **aecom.com/wp-content/uploads/2016/08/Becoming_Climate_Resilient_NOV2015.pdf**
3. AECOM. 2021. Climate-Resilient Infrastructure Officer Handbook: Knowledge Module on Public-Private Partnerships for Climate-Resilient Infrastructure. Global Center On Adaptation.
4. African Development Bank Group. 2013. African Development Bank Group's Integrated Safeguards System: Policy Statement and Operational Safeguards. Quality Assurance and Results Department. Safeguards and Sustainability Series. African Development Bank Group. Vol. 1, Issue 1. Tunis.
5. Aiama, D., Edwards, S., Bos, G., Ekstrom, J., Krueger, L., Quétier, F., Savy, C., Semroc, B., Sneary, M., and Bennun, L. 2015. No Net Loss and Net Positive Impact Approaches for Biodiversity: exploring the potential application of these approaches in the commercial agriculture and forestry sectors. Gland, Switzerland: IUCN. 64 pp.
6. Ament, R., Tiwari, S.K., Butynksi, M., Chen, B.S., Dodd, N., Gangadharan, A., Jayasinghe, N., Laur, A., Oppler, G., Wong, E.P., van der Ree, R., Wang, Y. 2021. Protecting Asian Elephants from Linear Transport Infrastructure: The Asian Elephant Transport Working Group's Introduction to the Challenges and Solutions. AsETWG (Asian Elephant Transport Working Group; IUCN WCPA Connectivity Conservation Specialist Group/IUCN SSC Asian Elephant Specialist Group).
7. Ament, R., Clevenger, A.P., van der Ree, R., (eds). 2023. Technical Report: Maximizing ecological connectivity in the development of roads, railways and canals. Technical Report Series, International Union for the Conservation of Nature (IUCN). World Commission on Protected Areas, Gland, Switzerland. **doi.org/10.53847/IUCN.CH.2023.PATRS.5.en**
8. Andersen, D., and Jang, Y. 2021. Biodiversity and Transportation Infrastructure in the Republic of Korea: A Review on Impacts and Mitigation in Developing the Country. Diversity, Vol. 13:519. **doi.org/10.3390/d13110519**
9. André, P., Enserink, B., Connor, D., and Croal, P. 2006. Public Participation International Best Practice Principles. Special Publication Series No. 4. Fargo, USA: International Association for Impact Assessment.
10. Angelici, F.M., and Rossi, L. (eds.). 2020. Problematic Wildlife II: New Conservation and Management Challenges in the Human-Wildlife Interactions. Springer Nature, Switzerland. ISBN 978-3-030-42335-3.
11. Arnell, A., and Danks, F. (eds.). 2022. Mapping Environmental Risks and Socio-Economic Benefits of Planned Transport Infrastructure—Global Picture. United Nations Environment Programme, Nairobi, Kenya.
12. Asian Development Bank. 2003. Asian Development Bank: Environmental Assessment Guidelines. Asian Development Bank.
13. Asian Development Bank. 2009. Asian Development Bank: Safeguard Policy Statement. ADB Policy Paper. Asian Development Bank.
14. Asian Development Bank. 2012. Environment Safeguard: A Good Practice Sourcebook Draft Working Document. Asian Development Bank.
15. Asian Development Bank. 2014. Climate Risk Management in ADB Projects. Asian Development Bank. Publication Stock No. ARM146926-2.
16. Asian Infrastructure Investment Bank. 2022. Asian Infrastructure Investment Bank: Environmental and Social Framework. AIIB.
17. Australian Government. 2012. National Wildlife Corridors Plan: A Framework for Landscape-Scale Conservation. Australian Government. Department of Sustainability, Environment, Water, Population and Communities. ISBN 978-1-921733-61-1.
18. Balvanera, P., Brauman, K.A., Cord, A.F., Drakou, E.G., Geijzendorffer, I.R., Karp, D.S., Martín-López, B., Mwampamba, T.H., and Schröter, M. 2022. Essential ecosystem service variables for monitoring progress towards sustainability. Current Opinion in Environmental Sustainability. Vol. 54:101152. ISSN 1877-3435. **doi.org/10.1016/j.cosust.2022.101152**
19. Bartlett, R. 2019. Visioning Futures—Improving Infrastructure Planning to Harness Nature's Benefits in a Warming World. WWF-US. Washington, DC, USA.

References (Continued)

20. Beier, P., and Loe, S. 1992. A Checklist for Evaluating Impacts to Wildlife Movement Corridors. Wildlife Society Bulletin. Vol. 20:434-440.

21. Beita, C.M., Murillo, L.F.S., and Alvarado, L.D.A. 2021. Ecological Corridors in Costa Rica: An evaluation applying landscape structure, fragmentation-connectivity process, and climate adaptation. Conservation Science and Practice. **doi.org/10.1111/csp2.475**

22. Berghöfer, A., C. Brown, A. Bruner, L. Emerton, E. Esen, D. Geneletti, M. Kosmus, R. Kumar, M. Lehmann, F. Leon Morales, E. Nkonya, T. Pistorius, J. Rode, R. Slootweg, U. Tröger, H. Wittmer, S. Wunder, H. van Zyl. 2016. Increasing the Policy Impact of Ecosystem Service Assessments and Valuations—Insights from Practice. Helmholtz-Zentrum für Umweltforschung (UFZ) GmbH, Leipzig, and Deutsche Gesellschaft für Internatio nale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany. 31 pp. **cifor-icraf.org/publications/pdf_files/Reports/RWunder1601.pdf**

23. BirdLife International. 2023. TransMit: The evidence-based toolkit for mitigating powerline-related avian mortality. **datazone.birdlife.org/info/transmit**

24. Blackwood, L., Renaud, F.G., and Gillespie, S. 2022. Nature-based solutions as climate change adaptation measures for rail infrastructure. Nature-based Solutions. Vol. 2:100013. **doi.org/10.1016/j.nbsj.2022.100013**

25. Brown, J. 2006. Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects. US Department of Transportation, Washington, DC. **environment.fhwa.dot.gov/env_initiatives/eco-logical/Report/eco_index.aspx**

26. Brownlie, S. and Treweek, J. 2018. Biodiversity and Ecosystem Services in Impact Assessment. Special Publication Series No. 3. Fargo, USA: International Association for Impact Assessment.

27. Bullock, J.M., Ding, H. 2018. A Guide to Selecting Ecosystem Service Models for Decision Making: Lessons from Sub-Saharan Africa. World Resources Institute, Washington, DC.

28. Byer, P., Cestti, R., Croal, P., Fisher, W., Hazell, S., Kolhoff, A., and Kørnøv, L.A., and Kørnøv, L. 2018. Climate Change in Impact Assessment: International Best Practice Principles. Special Publication Series No. 8. Fargo, ND, USA.

29. Cadman, M., Chavan, V., King, N., Willoughby, S., Rajvanshi, A., Mathur, Willoughby, S., Rajvanshi, A., Mathur, V., Roberts, R., and Hirsch, T. 2011. Publishing EIA-Related Primary Biodiversity Data: GBIF-IAIA Best Practice Guide. IAIA Special Publication Series No. 7. August 2011. **iaia.org/wp-content/uploads/2025/02/BEST-PRACTICE-Publishing-Biodiversity-Data.pdf**

30. CADRI Partnership. 2020. Compendium of Good Practice on Resilient Infrastructure. CADRI Partnership.

31. Cardinale, P., Greig, L., and Miller, P. 2013. Good Practice Handbook—Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. International Finance Corporation, World Bank Group.

32. Carter, N.H., Zuckerwise, A., Pradhan, N.M.B., Subedi, N., Lamichhane, B.R., Hengaju, K.D., Acharya, H.B., and Kandel, R.C. 2023. Rapid Behavioral Responses of Endangered Tigers to Major Roads During COVID-19 Lockdown. Global Ecology and Conservation. Vol 42:e02388. **doi.org/10.1016/j.gecco.2023.e02388**

33. CDP. 2021. Shaping High-Quality Mandatory Disclosure: Taking Stock and Building Upon the TCFD Recommendations. CDP Report. CDP, London, England.

34. Center for Climate and Energy Solutions. 2019. What is Climate Resilience and Why Does It Matter? Climate Essentials. C2ES, The Center for Climate and Energy Solutions. Arlington, VA, USA.

35. Clements, T., Helen, F., Laurie, A., Luna, M., Miquelle, D., Fao, M., Wingard, J., Wood, P., Zahler, P. 2018. Larger Than Tigers: Inputs for a Strategic Approach to Biodiversity Conservation in Asia. Regional Reports. European Commission. Brussels, Belgium.

36. Clevenger, A.P., and Huijser, M.P. 2011. Wildlife Crossing Structure Handbook, Design and Evaluation in North America. Publication No. FHWA-CFL/TD-11-003. US Department of Transportation, Federal Highway Administration. Lakewood, CO, USA.

37. Convention on the Conservation of Migratory Species of Wild Animals. 2015. Guidelines for Addressing the Impact of Linear Infrastructure on Large Migratory Mammals in Central Asia. Convention on Migratory Species Scientific Council. **cms.int/en/publication/guidelines-addressing-impact-linear-infrastructure-large-migratory-mammals-central-asia**

References (Continued)

38. Cosmoiu, D., Danciu, A., Meyer, H., Breuer, A., Keeley, A., Danzinger, F., Grilmayer, R. 2022. Recommendations towards standardization for ecological corridors. SaveGREEN Project Consortium. **ceeweb.org/ducuments/publications/T3.2_Recommendations_Final_Web.pdf**

39. Costanza, R., d'Arge, R., de Groot, R., et al. 1997. The value of the world's ecosystem services and natural capital. Nature. Vol. 387:253–260. **doi.org/10.1038/387253a0**

40. Croal, P., Tetreault, C., and members of the IAIA IP Section. 2012. Respecting Indigenous Peoples and Traditional Knowledge. Special Publication Series No. 9. Fargo, USA: International Association for Impact Assessment.

41. Dodd, N., Butynski, M., Ament, R., Chen, S., Jayasinghe, N., Lim, J.C., Saaban, S., Tiwari, S.K., van der Ree, R., Wang, Y., Wong, E.P. (2024). Handbook to Mitigate the Impacts of Roads and Railways on Asian Elephants. AsETWG (Asian Elephant Transport Working Group; IUCN WCPA Connectivity Conservation Specialist Group/IUCN SSC Asian Elephant Specialist Group).

42. Environment Institute of Australia and New Zealand Inc. 2023. Good Practice in Impact Assessment. **eianz.org/resources/impact-assessment-guidelines/good-practice-in-impact-assessment**

43. Environmental Protection Agency, Ireland. 2021. Good Practice Guidance on SEA Screening. Environmental Protection Agency, Ireland. ISBN 97-1-80009-009-5.

44. Equator Principles Association. 2022. Equator Principles Guidance Note to Support Effective Consistent Application of the Equator Principles. **equator-principles.com/app/uploads/PUBLIC-Guidance_Application-of-EP.pdf**

45. Equator Principles Association. 2020. Equator Principles, EP4: A financial industry benchmark for determining, assessing and managing environmental and social risk in projects. **equator-principles.com/app/uploads/The-Equator-Principles_EP4_July2020.pdf**

46. Equator Principles Association. 2020. Evaluating Projects with Affected Indigenous Peoples. Equator Principles. Guidance Note. **equator-principles.com/app/uploads/Affected_Indigenous_People_Sep2020.pdf**

47. Equator Principles Association. 2022. Best-Practice Note on Biodiversity Baseline Assessments. **equator-principles.com/resources/**

48. Equator Principles Association. 2022. Best-Practice Note on Biodiversity Baseline Surveys. Equator Principles Finance Institutions. **equator-principles.com/resources/**

49. Equator Principles Association. 2022. Guidance Note To Support Effective Consistent Application of the Equator Principles. Equator Principles Finance Institutions. **equator-principles.com/resources/**

50. Equator Principles Association. 2022. Guidance Notes on Application of the Equator Principles. **equator-principles.com/resources/**

51. European Bank for Reconstruction and Development. 2019. Environmental and Social Policy. European Bank for Reconstruction and Development, London, United Kingdom.

52. European Commission. 2021. Commission Notice: Technical Guidance on Sustainability Proofing for the InvestEU Fund. Notices from European Union Institutions, Bodies, Offices, and Agencies, 13.2.2021 C 280/1.

53. European Commission. 2021. Technical Guidance on Sustainability Proofing for the InvestEU Fund. Notices from European Union Institutes, Bodies, Offices, and Agencies. C 280/1.

54. European Commission. 2021. Technical Guidance on the Climate Proofing of Infrastructure in the Period 2021–2027. Notices from European Union Institutes, Bodies, Offices, and Agencies. C 373/2.

55. European Financing Institutions Working Group on Adaptations to Climate Change. 2016. Integrating Climate Change Information and Adaptation in Project Development: Emerging Experience from Practitioners, Version 1.0. EUFIWACC.

56. European Union. 2020. Activities that Qualify for Rio Markers in Sustainable Infrastructure Projects. Quick Tips. Greening EU Cooperation.

57. European Union. 2020. Green Mobility: Anchoring Environment and Climate Ambitions in the Transport and Mobility Sector. Quick Tips. Greening EU Cooperation.

References (Continued)

58. European Union. 2020. Integrating the Environment and Climate Change in Infrastructure Projects. Quick Tips. Greening EU Cooperation.

59. FAO. 2014. Respecting Free, Prior and Informed Consent. Governance of Tenure Technical Guide No. 3. Food and Agriculture Organization, United Nations. Rome, Italy.

60. Foden, W.B., and Young, B.E. (eds.). 2016. IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change. Version 1.0. Occasional Paper of the IUCN Species Survival Commission No. 59. Cambridge, UK and Gland, Switzerland: IUCN Species Survival Commission. 114 pp.

61. Georgiadis L. 2020. A Global Strategy for Ecologically Sustainable Transport and Other Linear Infrastructure. IENE, ICOET, ANET, ACLIE, WWF, IUCN, Paris, France.

62. Gibson, G., and O'Faircheallaigh, C. 2010. IBA Community Toolkit: Negotiation and Implementation of Impact and Benefit Agreements. Walter and Duncan Gordon Foundation. Toronto, ON, Canada. **gordonfn.org**

63. Global Center on Adaptation. 2021. Climate-Resilient Infrastructure Officer Handbook. Knowledge Module on Public-Private Partnerships for Climate-Resilient Infrastructure Version 2.0. Global Center on Adaptation. Rotterdam, The Netherlands. **gca.org/reports/climate-resilient-infrastructure-officer-handbook/**

64. Global Infrastructure Basel Foundation. 2021. SuRe Standard—The Standard for Sustainable and Resilient Infrastructure. Basel, Switzerland. **sure-standard.org**

65. Goncalves, L.O., Kindel, A., Bastazini, A.G., and Teixeira, F.Z. 2022. Mainstreaming Ecological Connectivity in Road Environmental Impact Assessments: A long way to go. Impact Assessment and Project Appraisal. Vol. 40:475–480. **doi.org/10.1080/14615517.2022.2099727**

66. Gullison, T., Hardners, J., Anstee, S., Meyer, M. 2015. Good Practices for the Collection of Biodiversity Baseline Data. Prepared for the Multilateral Financing Institutions Biodiversity Working Group & Cross Sector Biodiversity Initiative.

67. Haines-Young, R., Potschin, M. 2009. Methodologies for defining and assessing ecosystem services. Final Report, Joint Nature Conservation Committee, Project Code C08-0170-0062, 69 pp.

68. Hardner, J., Gullison, T., Anstee, S., Meyer, M. 2015. Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning. Multilateral Financing Institutions Biodiversity Working Group.

69. Haufler, J.B., Baydack, R.K., Campa, H., Kernohan, B.J., Miller, C., O'Neil, L.J., and Waits, L. 2002. Performance measures for ecosystem management and ecological sustainability. Wildlife Society Technical Review 02-1.33 pp.

70. Hill, A.C., Mason, D., Potter, J.R., Hellmuth, M., Ayyub, B.M., and Baker, J.W. 2019. Ready for Tomorrow: Seven Strategies for Climate-Resilient Infrastructure. Hoover Institution, Stanford University. Stanford, CA, USA.

71. Hilty, J., Worboys, G.L., Keeley, A., Woodley, S., Lausche, B., Locke, H., Carr, M., Pulsford, I., Pittock, J., White, J.W., Theobald, D.M., Levine, J., Reuling, M., Watson, J.E.M., Ament, R., and Tabor, G.M. 2020. Guidelines for conserving connectivity through ecological networks and corridors. Best Practice Protected Area Guidelines Series No. 30. Gland, Switzerland: IUCN.

72. HM Government. 2023. 2030 Strategic Framework for International Climate and Nature Action. London, United Kingdom. **gov.uk/government/publications/2030-strategic-framework-for-international-climate-and-nature-action**

73. Hong, S., Park, H.B., Kim, M., and Kim, H.G. 2022. History and Future Challenges of Roadkill Research in South Korea. Sustainability. Vol. 14:15564. **mdpi.com/2071-1050/14/23/15564**

74. Hove, A., Liu, X., Stubhan, T., Kim Fuerst, N., and Downing, L. 2020. International Standards for Sustainable Infrastructure: An Overview. Sustainable Infrastructure Alliance. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Gmb.

75. Swanson, Darren, Deborah Murphy, Jennifer Temmer, and Todd Scaletta. Advancing the Climate Resilience of Canadian Infrastructure: A Review of Literature to Inform the Way Forward. Winnipeg: International Institute for Sustainable Development, July 2021. **iisd.org/system/files/2021-07/climate-resilience-canadian-infrastructure-en.pdf**

76. Organisation for Economic Co-operation and Development (OECD). DAC Guidelines and Reference Series: Applying Strategic Environmental Assessment – Good Practice Guidance for Development Co-operation. Paris: OECD Publishing, 2006. **oecd.org/environment/environment-development/37353858.pdf**

References (Continued)

77. United Nations General Assembly. Transforming Our World: The 2030 Agenda for Sustainable Development. A/RES/70/1. New York: United Nations, October 21, 2015. **un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf**

78. IAIA. 2002. Strategic Environment Assessment: Performance Criteria. Special Publication Series No. 1. International Association for Impact Assessment. Fargo, ND, USA. **iaia.org/wp-content/uploads/2025/02/BEST-PRACTICE-SEA-Performance-Criteria.pdf**

79. IBAT Alliance. 2021. Considering Biodiversity for Solar and Wind Energy Investments. IBAT Briefing Note. IBAT Alliance. **ibat-alliance.org/**

80. ICF. 2018. Best Practices and Resources on Climate Resilient Natural Infrastructure. Report prepared for: Canadien Council of Ministers of the Environment, PN 1581.

81. IDB Sustainable Infrastructure Platform. 2018. IDBG Framework for Planning and Financing Sustainable Infrastructure Projects. Technical Note No. IDB-TN-1385. Inter-American Development Bank. Washington, DC USA.

82. IEMA. 2015. IEMA Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation. Institute of Environmental Management and Assessment. Lincoln, UK.

83. IFC. 2012. IFC Performance Standards on Environmental and Social Sustainability. International Finance Corporation, Washington DC, USA.

84. IFC. 2012. Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts. International Finance Corporation, World Bank Group.

85. IFC. 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. International Finance Corporation, World Bank Group.

86. IFC. 2013. Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. Good Practice Handbook. International Finance Corporation, Washington, DC. USA.

87. IFC. 2019. International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. International Finance Corporation, World Bank Group. Washington, DC, USA

88. IFC. 2021. Guidance Note 1: Assessment and Management of Environmental and Social Risks and Impacts. International Finance Corporation, World Bank Group.

89. IFC. 2022. Analysis of Best Practices in Environmental Disclosure Policies: A review of 101 policies worldwide based on five criteria for high-quality disclosure. International Finance Corporation, Washington, DC.

90. ILO. 2013. Understanding the Indigenous and Tribal People Convention, 1989 (No. 169). Handbook for ILO Tripartite Constituents / International Labour Standards Department. International Labour Organization. Geneva, Switzerland. ISBN: 978-92-2-126243-5.

91. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 2015. Preliminary Guide Regarding Diverse Conceptualization of Multiple Values of Nature and its Benefits, Including Biodiversity and Ecosystem Services. United Nations IPBES Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 4th Session. Kuala Lumpur, Malaysia.

92. Islam, S., and Zhang, Y. 2019. The Potential of Strategic Environmental Assessment to Reduce Disaster Risks through Climate Change Adaptation in the Coastal Zone of Bangladesh. International Journal of Climate Change Strategies and Management. Vol. 11:137–153. **emerald.com/ijccsm/article/11/1/137/127533/The-potential-of-strategic-environmental**

93. Ituarte-Lima, C., Schultz, M., Hahn, T., McDermott, C., Martinez-Peña, R., and Cornell, S. 2018. CBD voluntary guidelines for safeguards: implementation pathways, Information Document for the 14th Conference of the Parties for the Convention on Biological Diversity, Sharm El-Sheikh, Egypt.

94. IUCN. 2016. IUCN Policy on Biodiversity Offsets. International Union for the Conservation of Nature. **iucn.org/resources/file/iucn-policy-biodiversity-offsets**

95. IUCN. 2020. Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN. ISBN: 978-2-8317-2058-6. **portals.iucn.org/library/node/49070**

References (Continued)

96. Jones, M.D., Marshall, B.M., Smith, S.N., Crane, M., Silva, I., Artchawakom, T., Suwanwaree, P., Waengsothorn, S., Wuster, W., Goode, M., and Strine, C.T. 2021. How do King Cobras Move Across a Major Highway? Unintentional wildlife crossing structures may facilitate movement. Ecology and Evolution. Vol. 2022:12:e8691.

97. Kaszta, Z., Cushman, S., Htun, S., Naing, H., Burnham, D., Macdonald, D.W. 2020. Simulating the impact of Belt and Road Initiative and other major developments in Myanmar on an ambassador felid, the clouded leopard, Neofelis nebulosa. Landscape Ecology. Vol. 35:727–746.

98. Landsberg, F., Treweek, J., Mercedes, S.M., Henninger, N., and Venn, O. 2013. Weaving Ecosystem Services Into Impact Assessment: A Step-by-step Method, Version 1.0. World Resources Institute. Washington, DC, USA.

99. Least Developed Countries Expert Group. 2012. National Adaptation Plans. Technical guidelines for the national adaptation plan process. Bonn: UNFCCC secretariat. Bonn, Germany. December 2012. **unfccc.int/NAP**

100. Leavitt, S.M., et al. 2021. Natural Climate Solutions Handbook: A Technical Guide for Assessing Nature-Based Mitigation Opportunities in Countries. The Nature Conservancy, Arlington, VA, USA.

101. Mackey, B., Bradby, K., Gould, L., Howling, G., O'Connor, J., Spencer-Smith, T., Watson, D.M., and Young, V. 2023. Connectivity Conservation: Forging the Nexus between biodiversity protection and climate action in Australia. Policy Discussion Paper 1/23. Climate Action Beacon, Griffith University, Queensland. DOI: **doi.org/10.25904/1912/4644**

102. Mahood, S.P., Silva, J.P., Dolman, P.M., Burnside, R.J. 2018. Proposed power transmission lines in Cambodia constitute a significant new threat to the largest population of the critically endangered Bengal florican Houbaropsis bengalensis. Oryx. Vol. 52:147–155.

103. Martín Martín, J., Garrido López, J.R., Clavero Sousa, H., and Barrios, V. (eds.). 2022. Wildlife and power lines. Guidelines for preventing and mitigating wildlife mortality associated with electricity distribution networks. Gland, Switzerland: IUCN.

104. Morrison-Saunders, A. and Arts, J. 2023. Public Participation in Impact Assessment Follow-up. Special Publication Series No. 12. Fargo, USA: International Association for Impact Assessment.

105. Mullan, M. 2018. Climate-Resilient Infrastructure: Policy Perspectives. OECD Environment Policy Paper No. 14. Organization for Economic Cooperation and Development. ISSN 2309-7841.

106. Murton, G., and Lord, A. 2020. Trans-Himalayan power corridors: Infrastructural politics and China's Belt and Road Initiative in Nepal. Political Geography. 77:102100. **doi.org/10.1016/j.polgeo.2019.102100**

107. Narain D, Sonter LJ, Lechner AM, Watson JEM, Simmonds JS, Maron M. 2023. Global assessment of the biodiversity safeguards of development banks that finance infrastructure. Conservation Biology. Vol. 37:e14095. **https://pubmed.ncbi.nlm.nih.gov/37042094/**

108. Narain, D., Maron, M., Chen Teo, H., Hussey, K., and Lechner, A.M. 2020. Best-practice Biodiversity Safeguards for Belt and Road Initiative's Financiers. Nature Sustainability. Vol. 3:650–657. **doi.org/10.1038/s41893-020-0528-3**

109. National Academies of Sciences, Engineering, and Medicine. 2020. Incorporating the Costs and Benefits of Adaptation Measures in Preparation for Extreme Weather Events and Climate Change Guidebook. Washington, DC: The National Academies Press. **doi.org/10.17226/25744**

110. National Academies of Sciences, Engineering, and Medicine. 2023. Integrating Resilience Concepts and Strategies into Transportation Planning: A Guide. Washington, DC: The National Academies Press. **doi.org/10.17226/27192**

111. National Environment Management Authority (NEMA). 2020. Guidelines for Strategic Environmental Assessment (SEA) in Uganda. National Environment Management Authority, Kampala, Uganda. **nema.go.ug/en/wp-content/uploads/2025/01/STRATEGIC_ENVIRONMENTAL_ASSESSMENT_SEA__guidelines_2020_final_0.pdf**

112. National Research Council of the National Academies. 2008. Potential Impacts of Climate Change on U.S. Transportation. Transport Research Board. Washington, DC, USA. ISBN 978-0-309-11306-9.

113. Neugarten, R., Savy, C. 2012. A Global Review of National Guidance for High Conservation Value. Conservation International and Africa Biodiversity Collaborative Group (ABCG), Washington, DC.

References (Continued)

114. Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N., Butchart, S.H.M., Dudley, N., Elliott, V., Gerber, L.R., Gutierrez Arrellano, C., Ivanić, K.-Z., Kettunen, M., Mandle, L., Merriman, J.C., Mulligan, M., Peh, K.S.-H., Raudsepp-Hearne, C., Semmens, D.J., Stolton, S., Willcock, S. 2018. Tools for measuring, modelling, and valuing ecosystem services: Guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas. Gland, Switzerland: IUCN. 70 pp.

115. OECD. 2018. Climate-Resilient Infrastructure. Policy Perspectives, OECD Environment Policy Paper No. 14. Organization for Economic Cooperation and Development.

116. OECD. 2008. Strategic Environmental Assessment and Adaptation to Climate Change. DAC Network on Environment and Development Co-operation (Environet). Organization for Economic Cooperation and Development.

117. Ojwang', G.O., Wargute, P.W., Said, M.Y., Worden, J.S., Davidson, Z., Muruthi, P., Kanga, E., Ihwagi, F., and Okita-Ouma, B. 2017. Wildlife Migratory Corridors and Dispersal Areas: Kenya Rangelands and Coastal Terrestrial Ecosystems. Government of the Republic of Kenya.

118. Organization for Economic Cooperation and Development. 2006. Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation. DAC Guidelines and Reference series. OESCD Publishing. ISBN 92-64-02657-6.

119. Organization for Economic Cooperation and Development. 2020. OECD Compendium of Policy Good Practices for Quality Infrastructure Investment, **oecd.org/finance/oecd-compendium-of-policy-good-practices-for- quality-infrastructure-investment.htm**

120. Paemelaere, E.A.D., Mejia, A., Quintero, S., Hallett, M., Li, F., Wilson, A., Barnabas, H., Albert, A., Li, R., Baird, L., Pereira, G., Melville, J. 2023. The road towards wildlife friendlier infrastructure: Mitigation planning through landscape-level priority settings and species connectivity frameworks. Environmental Impact Assessment Review. Vol. 99:107010. **doi.org/10.1016/j.eiar.2022.107010**

121. Parkiwakam, M., Joshi, A., Navgire, S., and Vaidyanathan, S. 2018. A Policy Framework for Connectivity Conservation and Smart Green Linear Infrastructure Development in the Central Indian and Eastern Ghats Tiger Landscape, Volume 1. Wildlife Conservation Trust, Mumbai, India.

122. Partidario, M.R. 2012. Strategic Environmental Assessment Better Practice Guide: Methodological guidance for strategic thinking in SEA. Portuguese Environment Agency and Redes Energeticas Nacionais (REN), SA. Lisbon. 2012. ISBN:978-972-8577-62-9.

123. Patterson, C., Torres, A., Corol, M., Cumming, K., Hanson, M., Noble, B., Tabor, G., Treweek, J., Jaeger, J.A.G. 2022. Treatment of Ecological Connectivity in Environmental Assessment: A global survey of current practices and common issues. Impact Assessment and Project Appraisal, Vol. 40:460–474. **doi.org/10.1080/14615517.2022.2099728**

124. Phalan, B., Hayes, G., Brooks, S., Marsh, D., Howard, P., Costelloe, B., Vira, B., Kowalska, A., Whitaker, S. 2018. Avoiding impacts on biodiversity through strengthening the first stage of the mitigation hierarchy. Oryx, Vol. 52:316–324.

125. Raina, A., Lawrence, M., Bullock, R., Budin, K.J. and Olievschi, V. 2022. Railways in Developing Countries: A Global Review. Mobility and Transport Connectivity Series, Transport Global Practice. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0.

126. Ramsar Convention Secretariat. 2010. Impact assessment: Guidelines on biodiversity-inclusive environmental impact assessment and strategic environmental assessment. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 16. Ramsar Convention Secretariat, Gland, Switzerland.

127. Rana Magar, P., Karki, J. B., Magar, L. K., Bolakhe, S. and Kunwar, N. 2022. Wildlife road-kills on the Tikauli section of East-West Highway in Barandabhar Corridor Forest, Chitwan, Nepal. Nepalese Journal of Zoology 6(2):17–24. **doi.org/10.3126/njz.v6i2.51878**

128. Renner, I., Emerton, L., & Kosmus, M. 2018. Integrating Ecosystem Services into Development Planning: A stepwise approach for practitioners. GIZ. Deutsche Gesellschaft Fur Internationale Zusammenarbeit (GIZ) GmbH.

129. Robertson, L., Jenkins, B., Jones, M., Bond, A., Imperiale, A.J., Dusík, J., Ladikas, M., and Viliani, F. 2021. Resilience Assessment International Best Practice Principles. Special Publication Series No. 11. Fargo, USA: International Association for Impact Assessment.

130. RPS Consultants. 2021. EPA Good Practice Guidance on SEA Screening. Environmental Protection Agency, Ireland. ISBN 978-1-80009-009-5.

References (Continued)

131. Secretariat of the Convention on Biological Diversity, Netherlands Commission for Environmental Assessment. 2006. Biodiversity in Impact Assessment, Background Document to CBD Decision VIII/28: Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment, Montreal, Canada. **cbd.int/doc/publications/cbd-ts-26-en.pdf**

132. Secretariat of the Convention on Biological Diversity. 2004. Akwé: Kon Voluntary Guidelines for the Conduct of Cultural, Environmental and Social Impact Assessment regarding Developments Proposed to Take Place on, or which are Likely to Impact on, Sacred Sites and on Lands and Waters Traditionally Occupied or Used by Indigenous and Local Communities Montreal, 25 pp. (CBD Guidelines Series).

133. Senecal, P., Goldsmith, B., Conover, S., Sadler, B., and Brown, K. 1999. Principles of Environmental Impact Assessment Best Practice. International Association for Impact Assessment & Institute of Environmental Assessment, UK.

134. Senecal, P., Goldsmith, B., Conover, S., Sadler, B., and Brown, K. 1999. Principles of Environmental Impact Assessment Best Practice. Special Publication Series No. 00. International Association for Impact Assessment, Institute of Environmental Assessment, UK.

135. Serebrisky, T., Watkins, G., Ramirez, M.C., Meller, H., Frisari, G.L., Melo, R., Georgoulias, A. 2018. IDBG Framework for Planning, Preparing, and Financing Sustainable Infrastructure Projects. Technical Note No. IDB-TN-1385. Inter-American Development Bank.

136. Slootweg, R. 2015. Ecosystem services in SEA: are we missing the point of a simple concept? Impact Assessment and Project Appraisal. **tandfonline.com/doi/pdf/10.1080/14615517.2015.1096039**

137. Slootweg, R. 2021. Linear Infrastructure and Migratory Species: The role of impact assessment and landscape approaches. Prepared on behalf of the 5th meeting of the Sessional Committee of the CMS Scientific Council, Convention on Migratory Species, Bonn, Germany.

138. Slootweg, R., Kolhoff, A., Verheem, R., Hoft, R. 2006. Biodiversity in EIA and SEA: Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment. Background Document to CBD Decision VIII/28. Secretariat of the Convention on Biological Diversity. ISBN-13 : 978-90-421-1811-9.

139. Stenek, V., Christophe, J., and Connell, R. 2010. Climate Risk and Financial Institutions: Challenges and Opportunities. International Finance Corporation, Washington, DC.

140. Sustainable Banking and Finance Network. 2023. SBFN Toolkit: Developing Sustainable Finance Roadmaps. Version 1.0. International Finance Corporation | World Bank Group.

141. Swanson, D., Murphy, D., Temmer, J., Scaletta, T. 2021. Advancing the Climate Resilience of Canadian Infrastructure: A review of literature to inform the way forward. International Institute for Sustainable Development.

142. Swanson, D., Murphy, D., Temmer, J., Scaletta, T. 2021. Advancing the Climate Resilience of Canadian Infrastructure: A Review of Literature to Inform the Way Forward. International Institute for Sustainable Development. Winnipeg, Canada. **iisd.org/publications/climate-resilience-canadian-infrastructure**

143. Tang, D., and Kelly, A.S. 2016. Design Manual. Building a Sustainable Road to Dawei: Enhancing Ecosystem Services and Wildlife Connectivity. WWF-Myanmar.

144. Tang, D., and Scott Kelly, A. 2016. Building a Sustainable Road to Dawei: Enhancing Ecosystem Services and Wildlife Connectivity. WWF. Design Manual.

145. The Biodiversity Consultancy. 2018. HCV and PS6: Why do the Different Approaches Matter to Industry? Industry Briefing Note of The Biodiversity Consultancy, Cambridge, UK.

146. The Biodiversity Consultancy. 2021, Species Threat Abatement and Restoration (STAR)- A Global Metric Supporting Nature-Positive Action. IBAT Briefing Note. IBAT Alliance. **app.ibat-alliance.org/pdf/star_industry_briefing_note.pdf**

147. The Cadmus Group. 2018. USAID Environmental Compliance Factsheet: Ecosystem Services in Environmental Impact Assessment. USAID Global Environmental Management Support Program.

148. The Nature Conservancy. 2021. Natural Solutions Toolkit: Geospatial Decision Support Tools and Web Apps to Catalyze Conservation. The Nature Conservancy (TNC).

References (Continued)

149. The Development Corridors Partnership. 2022. Impact Assessment for Corridors: From Infrastructure to Development Corridors. Hobbs, J., and Juffe-Bignoli, D. (eds.). Cambridge: The Development Corridors Partnership.

150. The World Bank. 2016. World Bank Environmental and Social Framework. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

151. Trocme, M. 2015. Best-Practice Guidelines and Manuals. Chapter 59 in: Handbook of Road Ecology, 1st Edition, Edited by: Rodney van der Ree, Daniel J. Smith, and Clara Grilo. John Wiley & Sons Ltd.

152. UNESCO. 2022. UNESCO Guidance for the World Heritage "No-Go" Commitment: Global Standards for Corporate Sustainability. United Nations Educational, Scientific and Cultural Organization. Paris, France. **doi.org/10.58337/NMCZ6168**

153. United Nations Development Programme. 2019. Accelerating Climate Ambition and Impact: Toolkit for Mainstreaming Nature-Based Solutions into Nationally Determined Contributions. New York, USA: UNDP.

154. United Nations Environment Programme. 2021. Guidelines for Integrating Ecosystem-based Adaptation into National Adaptation Plans: Supplement to the UNFCCC NAP Technical Guidelines. Nairobi.

155. United Nations Environment Programme. 2021. International Good Practice Principles for Sustainable Infrastructure. Nairobi. ISBN No: 978-92-807-3846-9.

156. United Nations. 2015. Transforming Our World: The 2030 Agenda For Sustainable Development. A/RES/70/1.

157. USAID (US Agency for International Development). 2017. Climate Risk Management for USAID Projects and Activities: A Mandatory Reference for ADS Chapter 201.

158. USAID (US Agency for International Development). 2021. Final Report: Building a foundation for linear infrastructure safeguards in Asia. Authors: Ament R, Stonecipher G, Butynski M, Weinheimer CG, Hoff K. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. US Agency for International Development, Washington, DC. 54 pp.

159. USAID ((US Agency for International Development). 2021. Annex 1: Spatial analyses of linear infrastructure threats to biodiversity in Asia. In: Building a foundation for linear infrastructure safeguards in Asia. Authors: Creech T, Stonecipher G, Bell M, Butynski M, Clevenger AP, Ament R. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. US Agency for International Development, Washington, DC. 98 pp.

160. USAID ((US Agency for International Development). 2021. Annex 2: Existing capacity and constraints to undertake wildlife-friendly linear infrastructure in Asia. In: Building a foundation for linear infrastructure safeguards in Asia. Authors: Neelakantan A, Stonecipher G, Van Epp T, Laur A, Butynski M, Breuer A, Ament R. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. US Agency for International Development, Washington, DC. 60 pp.

161. USAID ((US Agency for International Development). 2021. Annex 3: Case studies of wildlife-friendly linear infrastructure in Asia. In: Building a foundation for linear infrastructure safeguards in Asia. Authors: Clevenger AP, Viela T, Bonine K, Stonecipher G, Butynski M, Ament R. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. US Agency for International Development, Washington, DC. 114 pp.

162. USAID (US Agency for International Development). 2021. Annex 4: The impacts of linear infrastructure on biodiversity and habitats in Asia. In: Building a foundation for linear infrastructure safeguards in Asia. Authors: Gangadharan A, Krishna C, Stonecipher G, Butynski M, Clevenger AP, Ament R. Prepared by Perez, APC for Contract no. AID-OAA-I-15-00051/AIDOAA-TO-16-00028, ESS WA#13. US Agency for International Development, Washington, DC. 151 pp.

163. USAID.(US Agency for International Development). 2022. USAID Environmental Compliance Procedures: Title 22, Code of Federal Regulations, Part 216. USAID. **ecfr.gov/current/title-22/chapter-II/part-216/**

164. Vanclay, F. 2003. International Principles for Social Impact Assessment. Impact Assessment and Project Appraisal. Special Publication Series No. 2.

165. Vanclay, F., Esteves, A.M., Aucamp, I., Franks, D.M. 2015. Social Impact Assessment: Guidance for Assessing and Managing the Social Impacts of Projects. International Association of Impact Assessment. Fargo, ND, USA.

166. Vasiliev, D., 2021. Road Infrastructure and Biodiversity Conservation. In International Conference on Reliability and Statistics in Transportation and Communication (pp. 371–377). Cham: Springer International Publishing.

References (Continued)

167. Verheem, R. 2002. Strategic Environmental Assessment: Performance Criteria. International Association of Impact Assessment. Special Publication Series No. 1.

168. Villarroya, A., Barros, A.C., Kiesecker, J. 2014. Policy Development for Environmental Licensing and Biodiversity Offsets in Latin America. PLoS ONE 9(9): e107144. **doi.org/10.1371/journal.pone.0107144**

169. Webb, B., Dix, B., Douglass, S., Asam, S., Cherry, C., Buhring, B. 2019. Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide. US Federal Highway Administration. FHWA-HEP-19-042.

170. White House. 2022. Fact Sheet: President Signs Executive Order to Strengthen America's Forests, Boost Wildfire Resilience, and Combat Global Deforestation. White House Briefing Room Statements and Releases.

171. Wildlife Conservation Division. 2010. Regulatory Framework for Biological Corridors in Bhutan. Part III: Policy Recommendations and Framework for Developing Corridor Management Plans. Royal Government of Bhutan.

172. Wildlife Institute of India. 2020. Power-Line Mitigation Measures. Second Edition. Wildlife Institute of India. Dehradun, India.

173. Wildlife Institute of India. 2016. EcoFriendly: Measures to Mitigate Impacts of Linear Infrastructure on Wildlife. Wildlife Institute of India, Dehradun, India.

174. Wildlife Institute of India. 2020. Power-line Mitigation to Conserve Bustards. Second edition. Wildlife Institute of India, Dehradun, India.

175. Wingard, J., A. Collins, A. Pasqualato, R. Payton, and M. Pascual. 2022. Crossing the Tracks: The Legal Implications of Establishing a Wildlife Friendly Corridor Along the Trans-Mongolia Railway. (K. Olson and S. Bolortsetseg, Eds.). Legal Atlas, LLC, commissioned by the Wildlife Conservation Society. August 2022.

176. Wood, S.L.R., Martins, K.T., Dumais-Lalonde, V., Tanguy, O., Fanny, M., St-Denis, A., Bronwyn, R., Martin, A.E., and Gonzalez, A. 2022. Missing Interactions: The Current State of Multispecies Connectivity Analysis. Frontiers in Ecology and Evolution. Vol. 10. **doi.org/10.3389/fevo.2022.830822**

177. World Bank. 2016. World Bank Environmental and Social Framework. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

178. World Bank. 2019. Belt and Road Economics: Opportunities and Risks of Transport Corridors. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.

179. World Bank. 2022. Climate Toolkits for Infrastructure PPPs. The World Bank Group. Washington, DC, USA.

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