WORLD RESOURCES INSTITUTE

WEAVING ECOSYSTEM SERVICES INTO IMPACT ASSESSMENT

A Step-By-Step Method | Version 1.0

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FOREWORD

Functioning ecosystems are the lifeblood of the planet. We rely on them to provide our food, clean our water, and filter our air. Individuals, communities, and businesses are profoundly dependent on the services these ecosystems supply.

And yet the world's ecosystems are under increasing strain, often in the name of economic development. Around the globe, we are losing 13 million hectares of forest a year – an area the size of England. In the past century, more than half of the world's wetlands have been drained. And more than half of the world's major rivers have been fragmented by dams and diversions. As a consequence of our actions, roughly two-thirds of the world's ecosystem services are now of lower quality than they were 50 years ago.

The costs of ecosystem degradation are often not fully comprehended until the damage has been done. At the same time, development projects can fail if their dependence on ecosystem services is not fully recognized. When considering new projects, accurate, upfront assessment of both impacts on, and dependencies on, ecosystem services is essential. Here, existing environmental and social impact assessments, meant to judge the impacts of projects on the natural environment and local communities, fall short. Guidance is needed on how to incorporate these vital elements into impact assessment.

Weaving Ecosystem Services Into Impact Assessment: A Step-by-Step Method (Version 1.0) attempts to fill that gap. It provides a practical, six-step method for identifying and managing a project's potential impacts and dependencies on ecosystems and ecosystem services. The report is the product of collaboration between WRI and impact assessment professionals around the world. Together, WRI and partners tested and refined the method on projects in different regions. The results demonstrate that small changes in the conduct of traditional impact assessments can yield substantial benefits for communities, businesses, and the environment alike.

We are fundamentally dependent on healthy ecosystems. We owe it to ourselves to better appreciate this dependence, understand our impacts, and make our actions more sustainable as a consequence.

Andrew Steer
President
World Resources Institute

EXECUTIVE SUMMARY

The services provided by ecosystems play a vital role in human well-being. Although some ecosystem services are easily recognized—food, timber, and freshwater, for example—others may be less apparent. Ecosystems control erosion; reduce the damage caused by natural disasters; and regulate our air, water, and soil quality. A reduction or loss of any of these services and the benefits they provide can have socio-economic ramifications that reverberate beyond environmental damages.

Standard environmental and social impact assessments (ESIAs) do not specifically account for a project's impacts on ecosystem service benefits. As a result, assessments might overlook stakeholders who are vulnerable to ecosystem change, or miss some of the harmful social consequences of a project's environmental effects. Integrating ecosystem services into impact assessments results in a more comprehensive and realistic assessment of a project's immediate and long-term impacts.

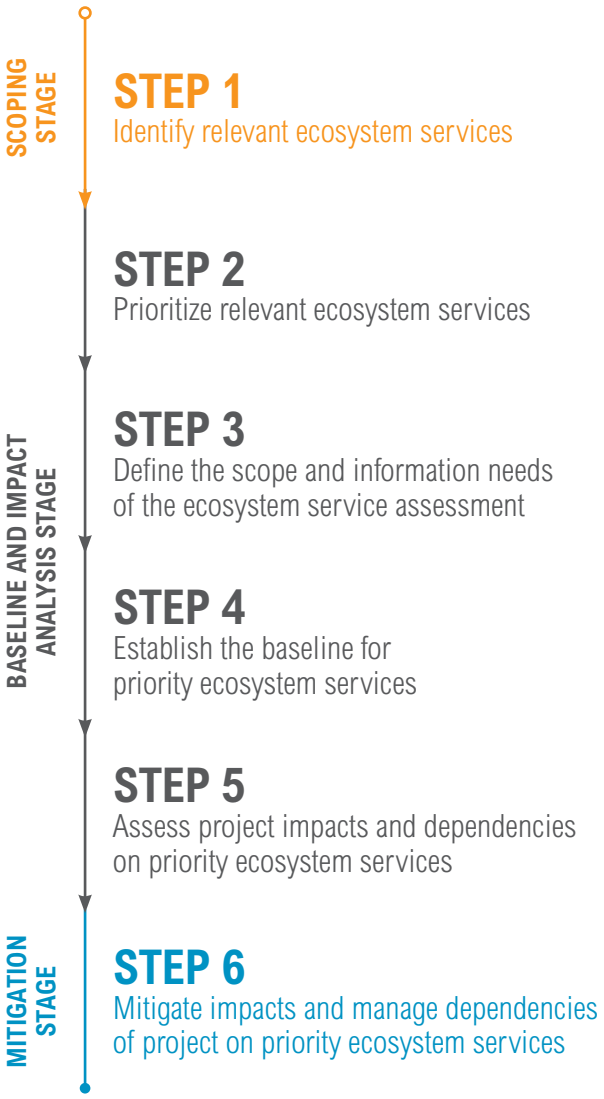
Responding to the need to identify and plan for these impacts, ESIA standards have started to integrate ecosystem services into project impact assessments. The International Finance Corporation's (IFC) performance standards reflect this trend: as of 2012, IFC-financed projects are required to preserve the benefits from ecosystem services. Going a step beyond project impacts, the IFC also requires that the environmental and social risks and impacts identification process considers a project's dependence on ecosystem services. Just as development projects can jeopardize the benefits that flow from ecosystem services, changes in ecosystems can endanger project outcomes.

Until now, there has been little guidance for ESIA practitioners on how to integrate ecosystem services into their impact assessments. The World Resources Institute, in collaboration with ESIA practitioners, developed the "Ecosystem Services Review for Impact Assessment" (ESR for IA) to fill this gap. The ESR for IA is a structured method that guides practitioners through six steps to incorporate ecosystem services into ESIA at the scoping, baseline and impact analysis, and mitigation stages (Figure ES-1).

The ESR for IA can be used for two purposes. First, it identifies measures to mitigate project impacts on the benefits provided by ecosystems. Second, it identifies measures to manage operational dependencies on ecosystems. These goals are reflected in the ESR for IA's four outputs:

- A list of ecosystem services, for inclusion in the ESIA terms of reference;
- Identification of priority ecosystem services to be considered and stakeholders to be engaged in further stages of the ESIA process, for inclusion in the ESIA report;
- Assessment of project impacts and dependencies on priority ecosystem services, for inclusion in the ESIA report; and
- Measures to mitigate project impacts and manage project dependencies on priority ecosystem services, for inclusion in the environmental and social management plans.

Figure ES-1 | **Six steps of the Ecosystem Services Review for Impact Assessment**

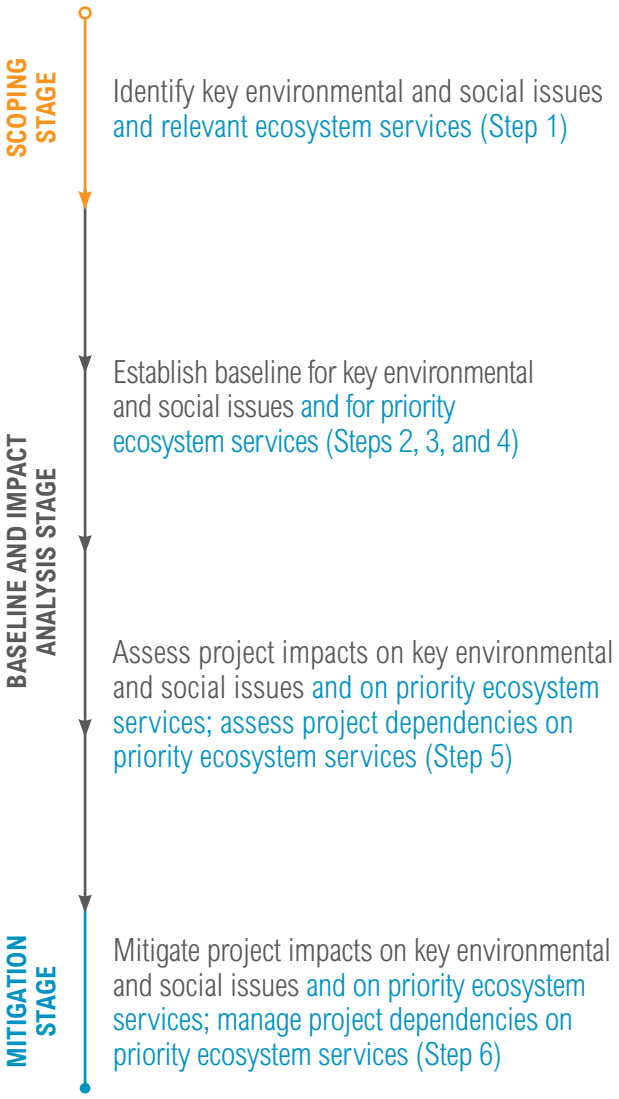


The ESR for IA, rather than replacing the environmental and social assessments that make up the standard ESIA process, complements them with an interdisciplinary, integrated framework. By focusing attention on the socio-economic dimensions of a project's environmental impacts, the ESR for IA can capture the unanticipated costs and benefits of projects more fully than a standard ESIA, and can identify stakeholders who might otherwise be missed. Figure ES-2 illustrates how the six steps of the ESR for IA (blue text) complement the standard ESIA process (black text).

WRI and ESIA practitioners road-tested the ESR for IA by applying the method to projects that had already undergone standard environmental and social assessments. The results were promising. The ESR for IA revealed overlooked social implications of environmental impacts, exposed operational risks resulting from ecosystem change, and identified additional measures for the environmental and social management plans.

Weaving Ecosystem Services Into Impact Assessment: A Step-by-Step Method (Version 1.0) introduces the ESR for IA both to project developers, who can benefit from a broad understanding of the method, and to ESIA practitioners, who require a more detailed understanding. For ESIA practitioners, *Weaving Ecosystem Services Into Impact Assessment Technical Appendix (Version 1.0)* (Landsberg et al. 2014) provides comprehensive technical instructions on implementing each step of the method. We encourage project developers and ESIA practitioners to share their experiences using the ESR for IA with others, for example, through LinkedIn's Business & Ecosystem Services Professionals and Environmental Impact Assessment groups. The lessons learned from their implementation can inform the emerging community of practice around ecosystem services in ESIA and contribute to refinements in the method down the road.

Figure ES-2 | **Standard environmental and social impact assessment process, complemented by the ESR for IA**



BACKGROUND

Changing impact assessment requirements

Since January 1st, 2012, the International Finance Corporation (IFC) has incorporated "ecosystem services" in its Performance Standards to improve the environmental, social, and economic sustainability of its projects. These new IFC Performance Standards, which have been adopted by the Equator Principles Financial Institutions, require client projects to "maintain the benefits from ecosystem services" and also to "conduct a systematic review to identify (...) those services on which the project is directly dependent for its operations" (IFC 2012a, IFC 2012b). Similarly, the European Union (EU) states in its biodiversity strategy to 2020 its intention to "ensure no net loss of biodiversity and ecosystem services" through assessment and mitigation of impacts of EU funded projects, plans, and programs (EU 2011).

A number of resources presently exist to help practitioners address ecosystem services in their environmental and social impact assessments (ESIA) (IPIECA and OGP 2011, OECD 2008, Slootweg et al. 2006). These documents, however, do not offer detailed instructions on how to effectively integrate ecosystem services throughout the ESIA process. Practitioners identified such a lack of guidance as one of the main barriers to a wider consideration of ecosystem services in ESIA (WRI 2010).

To fill this gap, the World Resources Institute (WRI) worked closely with ESIA practitioners to adapt the Corporate Ecosystem Services Review, Version 2.0 (Hanson et al. 2012) to the context of ESIA and produce a method for practitioners to assess project impacts and dependencies on ecosystem services in the ESIA process. It is known as the "Ecosystem Services Review for Impact Assessment" (ESR for IA). This document, intended for a general audience, offers an abbreviated version of the detailed technical guidance provided in Landsberg et al. 2014 (see Annex 1 for a quick reference guide to the technical appendix).

Version 1.0 of the ESR for IA was informed by the feedback on and implementation of *Ecosystem Services Review for Impact Assessment: Introduction and Guide to Scoping* published in 2011. It also benefited from road-testing the technical appendix on completed ESIAs.[1] Feedback and case studies generated by further implementation of the ESR for IA will inform the community of practice (e.g., LinkedIn's Business & Ecosystem Services Professionals and Environmental Impact Assessment groups).

Introducing ecosystem services

Ecosystems contribute to people's well-being and project performance in many ways. For example, marine fish populations provide nourishment, protein, and cash income for local families and support large-scale commercial fishing. Forested watersheds provide clean water for communities and businesses. Well-functioning ecosystems act as reservoirs of biodiversity that underpin biological production of all types, including agriculture. The contributions of ecosystems to human well-being and business performance are called ecosystem services (see Box 1 for definition of key terms).

Scientists divide ecosystem services into four categories (adapted from MA 2003) (see Table 1 for a standard list of ecosystem services with definitions and examples):

- Provisioning services are the goods or products obtained from ecosystems, such as food, timber, fiber, and freshwater.
- Regulating services are the contributions to human well-being arising from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, and protection from natural hazards.
- Cultural services are the nonmaterial contributions of ecosystems to human well-being, such as recreation, spiritual values, and aesthetic enjoyment.
- Supporting services are the natural processes, such as nutrient cycling and primary production, that maintain the other services.

Additional introductory material on ecosystem services and their incorporation into public and private sector decision-making can be found in the Millennium Ecosystem Assessment reports (http://www.unep.org/maweb/en/index.aspx) and in related videos (e.g., TEDx event with Eva Zabey at http://www.youtube.com/watch?v=OwQOej5_Euo and TED talk with Pavan Sukhdev at http://www.ted.com/talks/pavan_sukhdev_what_s_the_price_of_nature.html).

BOX 1 | KEY TERMS

- **An ecosystem** is a dynamic complex of plant, animal, and micro-organism communities and their nonliving environment interacting as a functional unit.
- **Ecosystem services** are the direct and indirect contributions of ecosystems to human well-being.
- **An ecosystem service benefit** is the gain in human well-being or in project performance derived from the use of this ecosystem service, often in combination with other inputs (e.g., labor and capital).
- A project **impacts** an ecosystem service if the project affects the quantity or quality of that service.
- A project **depends** on an ecosystem service if that service functions as an operational input or process or if it enables, enhances, or influences environmental conditions required for planned project performance.
- **Priority ecosystem services** are those services on which project impacts affect the well-being (e.g., livelihoods, health, safety, culture) of the ecosystem service beneficiaries, and those services that could prevent the project from achieving planned operational performance.
- **The affected (ecosystem service) stakeholders** are the ecosystem service beneficiaries who may be affected as a result of project impacts on priority ecosystem services. Affected stakeholders include future generations who might be prevented from benefiting from ecosystem services as a result of project impacts.
- **The project developers** are the proponents of the project under consideration in the ESIA.
- **The third-party actors** are the stakeholders who are not affected but nevertheless drive change in priority ecosystem services.

Sources: Adapted from UN 1992, Hanson et al. 2012, van Oudenhoven et al. 2012, and de Groot et al. 2010.

Table 1 | **Indicative list of ecosystem services with definitions and examples**

SERVICE	SUBCATEGORY	DEFINITION	EXAMPLES
Provisioning services: The goods or products obtained from ecosystems			
Food	Crops	Cultivated plants or agricultural products harvested by people for human or animal consumption as food	■ Grains ■ Vegetables ■ Fruits
	Livestock	Animals raised for domestic or commercial consumption or use	■ Chickens ■ Pigs ■ Cattle
	Capture fisheries	Wild fish captured through trawling and other non-farming methods	■ Cod ■ Crabs ■ Tuna
	Aquaculture	Fish, shellfish, and/or plants that are bred and reared in ponds, enclosures, and other forms of freshwater or saltwater confinement for purposes of harvesting	■ Shrimp ■ Oysters ■ Salmon
	Wild foods	Edible plant and animal species gathered or captured in the wild	■ Fruits and nuts ■ Fungi ■ Bushmeat
Biological raw materials	Timber and other wood products	Products made from trees harvested from natural forest ecosystems, plantations, or non-forested lands	■ Industrial roundwood ■ Wood pulp ■ Paper
	Fibers and resins	Non-wood and non-fuel fibers and resins	■ Cotton, silk, hemp ■ Twine, rope ■ Natural rubber
	Animal skins	Processed skins of cattle, deer, pigs, snakes, sting rays, or other animals	■ Leather, rawhide, cordwain
	Sand	Sand formed from coral and shells	■ White sand from coral and white shells ■ Colored sand from shells
	Ornamental resources	Products derived from ecosystems that serve aesthetic purposes	■ Tagua nut, wild fowers, coral jewery
Biomass fuel		Biological material derived from living or recently living organisms—both plant and animal—that serves as a source of energy	■ Fuelwood and charcoal ■ Grain for ethanol production ■ Dung
Freshwater		Inland bodies of water, groundwater, rainwater, and surface waters for household, industrial, and agricultural uses	■ Freshwater for drinking, cleaning, cooling, industrial processes, electricity generation, or mode of transportation
Genetic resources		Genes and genetic information used for animal breeding, plant improvement, and biotechnology	■ Genes used to increase crop resistance to disease or pests
Biochemicals, natural medicines, and pharmaceuticals		Medicines, biocides, food additives, and other biological materials derived from ecosystems for commercial or domestic use	■ Echinacea, ginseng, garlic ■ Paclitaxe as basis for cancer drugs ■ Tree extracts used for pest control

Table 1 | **Indicative list of ecosystem services with definitions and examples (cont.)**

SERVICE	SUBCATEGORY	DEFINITION	EXAMPLES
Regulating services: The contributions to human well-being arising from an ecosystem's control of natural processes			
Regulation of air quality		Influence ecosystems have on air quality by emitting chemicals to the atmosphere (i.e., serving as a "source") or extracting chemicals from the atmosphere (i.e., serving as a "sink")	■ Lakes serve as a sink for industrial emissions of sufur compounds ■ Tree and shrub leaves trap air pollutants near roadways
Regulation of climate	Global	Influence ecosystems have on the global climate by emitting greenhouse gases or aerosols to the atmosphere or by absorbing greenhouse gases or aerosols from the atmosphere	■ Forests capture and store carbon dioxide ■ Cattle and rice paddies emit methane
	Regional and local	Influence ecosystems have on local or regional temperature, precipitation, and other climatic factors	■ Forests can impact regional rainfall levels
Regulation of water timing and flows		Influence ecosystems have on the timing and magnitude of water runoff, flooding, and aquifer recharge, particularly in terms of the water storage potential of the ecosystem or landscape	■ Permeable soil facilitates aquifer recharge ■ River floodplains and wetlands retain water—which can decrease flooding—reducing the need for engineered flood control infrastructure
Erosion control		Role ecosystems play in retaining and replenishing soil and sand deposits	■ Vegetation such as grass and trees prevents soil loss due to wind and rain and prevents siltation of waterways ■ Coral reefs, oyster reefs, and sea grass beds reduce loss of land and beaches due to waves and storms
Water purification and waste treatment		Role ecosystems play in the filtration and decomposition of organic wastes and pollutants in water; assimilation and detoxification of compounds through soil and subsoil processes	■ Wetlands remove harmful pollutants from water by trapping metals and organic materials ■ Soil microbes degrade organic waste, rendering it less harmful
Regulation of diseases		Influence that ecosystems have on the incidence and abundance of human pathogens	■ Some intact forests reduce the occurrence of standing water—a breeding area for mosquitoes—which lowers the prevalence of malaria
Regulation of soil quality		Role ecosystems play in sustaining soil's biological activity, diversity, and productivity; regulating and partitioning water and solute flow; storing and recycling nutrients and gases; among other functions	■ Some organisms aid in decomposition of organic matter, increasing soil nutrient levels ■ Some organisms aerate soil, improve soil chemistry, and increase moisture retention
Regulation of pests		Influence ecosystems have on the prevalence of crop and livestock pests and diseases	■ Predators from nearby forests—such as bats, toads, and snakes—consume crop pests

Table 1 | **Indicative list of ecosystem services with definitions and examples (cont.)**

SERVICE	SUBCATEGORY	DEFINITION	EXAMPLES
Regulating services: The contributions to human well-being arising from an ecosystem's control of natural processes (cont.)			
Pollination		Role ecosystems play in transferring pollen from male to female flower parts	■ Bees from nearby forests pollinate crops
Regulation of natural hazards		Capacity for ecosystems to reduce the damage caused by natural disasters such as hurricanes and tsunamis and to maintain natural fire frequency and intensity	■ Mangrove forests and coral reefs protect coastlines from storm surges ■ Biological decomposition processes reduce potential fuel for wildfires
Cultural services: The nonmaterial contributions of ecosystems to human well-being			
Recreation and ecotourism		Recreational pleasure people derive from natural or cultivated ecosystems	■ Hiking, camping, and bird watching ■ Going on safari ■ Scuba diving
Ethical and spiritual values		Spiritual, religious, aesthetic, intrinsic, "existence," or similar values people attach to ecosystems, landscapes, or species	■ Spiritual fulfillment derived from sacred lands and rivers ■ People's desire to protect endangered species and rare habitats
Educational and inspirational values		Information derived from ecosystems used for intellectual development, culture, art, design, and innovation	■ The structure of tree leaves has inspired technological improvements in solar power cells ■ School fieldtrips to nature preserves aid in teaching scientific concepts and research skills
Supporting services: The natural processes that maintain the other ecosystem services			
Habitat		Natural or semi-natural spaces that maintain species populations and protect the capacity of ecological communities to recover from disturbances	■ Native plant communities often provide pollinators with food and structure for reproduction ■ Rivers and estuaries provide nurseries for fish reproduction and juvenile development ■ Large natural areas and biological corridors allow animals to survive forest fires and other disturbances
Nutrient cycling		Flow of nutrients (e.g., nitrogen, sulfur, phosphorus, carbon) through ecosystems	■ Transfer of nitrogen from plants to soil, from soil to oceans, from oceans to the atmosphere, and from the atmosphere to plants
Primary production		Formation of biological material by plants through photosynthesis and nutrient assimilation	■ Algae transform sunlight and nutrients into biomass, thereby forming the base of the food chain in aquatic ecosystems
Water cycling		Flow of water through ecosystems in its solid, liquid, or gaseous forms	■ Transfer of water from soil to plants, plants to air, and air to rain

Source: Adapted from Hanson et al. 2012.

The Ecosystem Services Review for Impact Assessment: Integrating ecosystem services into ESIA

The goal of an environmental and social impact assessment is to identify, predict, evaluate, and mitigate "the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made" (IAIA 1999). Standard ESIA assesses environmental and social impacts separately or with limited interdisciplinary analysis. Some aspects of project dependence on ecosystems might be covered by the risk assessment but this assessment is often limited to ecosystem services that constitute operational inputs such as freshwater. As a consequence, certain aspects of project impacts and dependencies may be overlooked. The ESR for IA addresses this problem by providing a structured method to facilitate integration of the environmental and social assessments. In doing so it focuses attention on both the socio-economic dimensions of a project's environmental impacts and the implications of ecosystem change for project performance.

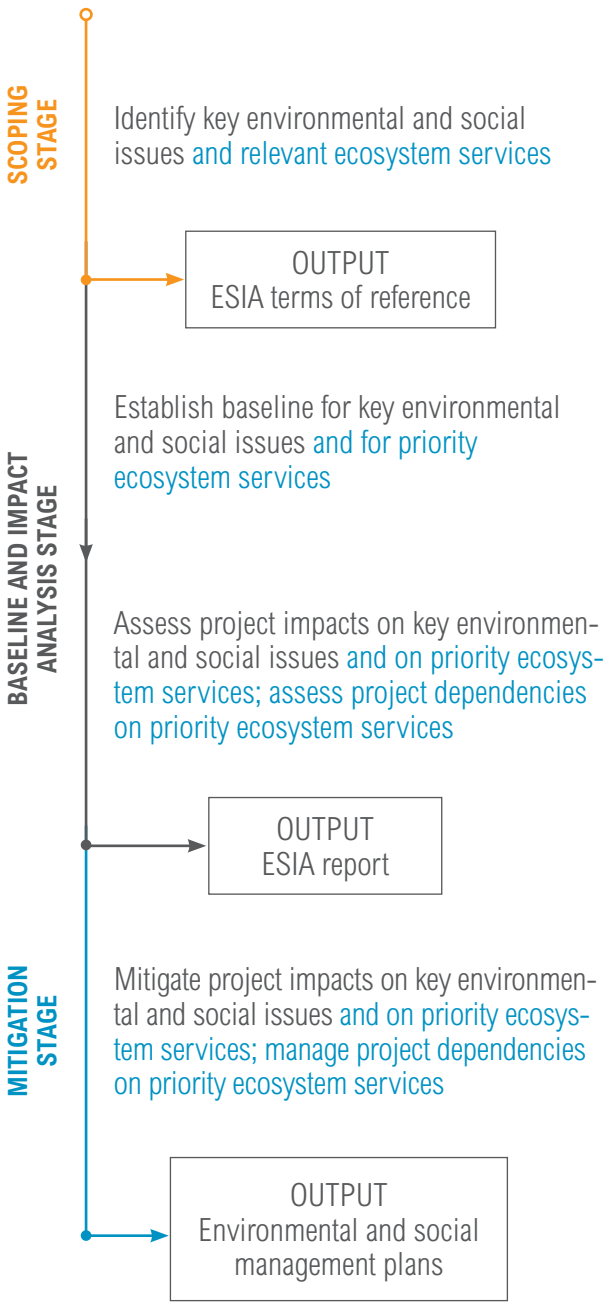
Features

The ESR for IA does not replace the standard ESIA process. Ecosystem service considerations complement what the ESIA process routinely addresses (see Figure 1, blue and black text respectively).

The ESR for IA provides the ESIA team with:

- **A conceptual framework** to link the project to ecosystems, ecosystem services, and benefits derived from ecosystem services;
- **Six steps** for conducting the ESR for IA throughout the ESIA scoping, baseline and impact analysis, and mitigation stages, including Excel spreadsheets.

Figure 1 | **Standard environmental and social impact assessment process, complemented by the ESR for IA**



Outputs

The outputs of the ESR for IA include:

- A list of ecosystem services, for inclusion in the ESIA terms of reference;
- Identification of priority ecosystem services to be considered and stakeholders to be engaged in further stages of the ESIA process, for inclusion in the ESIA report;
- Assessment of project impacts and dependencies on priority ecosystem services, for inclusion in the ESIA report; and
- Measures to mitigate project impacts and manage project dependencies on priority ecosystem services, for inclusion in the environmental and social management plans.

Which projects

The projects that would benefit most from addressing ecosystem services in their ESIA are likely to be those that:

- May alter ecosystems on which people and communities have a high level of dependence for maintenance of their livelihoods, health, safety, or culture. This includes but is not limited to areas of high poverty incidence.
- Depend on ecosystem services for their operations and are therefore vulnerable to ecosystem change that reduces the supply of these services. This includes, for example, projects that share water resources with other stakeholders or require erosion control to maintain agricultural production.
- Are controversial and require the project developers to be proactive in their relations with affected stakeholders to avoid legal battles or delays in project implementation or operation. This includes areas with mobilized indigenous communities or other citizen groups likely to demand project oversight.
- Must address ecosystem services because of legal or financial requirements. This includes the projects that are funded by IFC or the Equator Principles Financial Institutions.

Expected benefits

Implementing the ESR for IA benefits the project developers and affected stakeholders in a number of ways.

Benefits to the project developers:

- *Meet new ESIA requirements regarding ecosystem services.* Ecosystem service-sensitive environmental and social management plans increase the likelihood that the benefits from ecosystem services are maintained over the life of the project, as required by IFC, and that the degradation of ecosystem services is halted, as aspired to by the European Union in its 2020 Biodiversity Strategy.

- *Identify operational risks related to ecosystem services at local and regional scales.* For example, the ESR for IA can assess increased risks of damages from landslides that might occur as a result of deforestation upstream from project facilities.

- *Better understand the implications of project impacts on affected stakeholders' well-being.* For example, the ESR for IA might assess habitat fragmentation caused by the project as significant--even though it would affect only a small, localized area--if local communities have complex and deep-rooted relationships to the habitat in its present condition.

- *Increase the range of mitigation and management alternatives*, potentially enhancing the cost-effectiveness of implementing environmental and social management plans. For example, the ESR for IA can identify incentives for upstream farmers to encourage them to use water-efficient technologies and implement on-farm water conservation techniques. This could increase water availability both to an irrigation project and to downstream farmers who would otherwise be negatively impacted by the diversion of water. To increase project performance, the ESR for IA can also help project developers identify new sources of revenue from project-managed ecosystems (e.g., carbon market).

Benefits to the affected stakeholders:

- *Stakeholder engagement is more inclusive*, identifying and engaging stakeholders whose livelihoods, health, safety, or culture are directly or indirectly affected as a result of impacts on ecosystem services at local or regional scales. For example, project impacts on upstream fish spawning grounds could affect the health and income of fishermen downstream.

- *Assessment of social impacts is more comprehensive.* For example, the impacts of a project on total wildlife populations may be considered low, and mitigation measures deemed unnecessary, in a standard ESIA. Addressing ecosystem services, however, focuses the assessment of project impacts on wildlife populations in hunting grounds, which might differ from the assessment of impact over the total population and can be defined in terms of potential loss in health and income by hunting communities.

- *Affected stakeholders do not lose benefits they derive from impacted ecosystems.* For example, the goal of standard mitigation measures for project impacts on fisheries would be the mitigation of the impacts on fish populations. In contrast, when looking at ecosystem services, the target of mitigation measures would be to maintain pre-project income levels and protein intakes for fishing communities.

METHOD

Overview

The ESR for IA has two objectives. From an impact point of view, the ESR for IA aims to mitigate project impacts on the benefits provided by ecosystems. From a dependence point of view, it aims to provide measures to manage operations dependent on ecosystems to achieve planned performance.

The ESIA team implements the ESR for IA through six steps embedded in the scoping, baseline and impact analysis, and mitigation stages of ESIA (Figure 2)[2]:

1. **IDENTIFY RELEVANT ECOSYSTEM SERVICES.** Identify ecosystem services the project may impact and/or on which the project depends.

2. **PRIORITIZE RELEVANT ECOSYSTEM SERVICES.** Prioritize ecosystem services by identifying which of the relevant ecosystem services, if altered, could affect the livelihoods, health, safety, or culture of their beneficiaries or the operational performance of the project. Only priority ecosystem services are carried forward to subsequent steps. All projects that require an ESIA should at a minimum undertake Steps 1 and 2 to determine whether any ecosystem services should be prioritized and assessed in further stages of the ESIA.

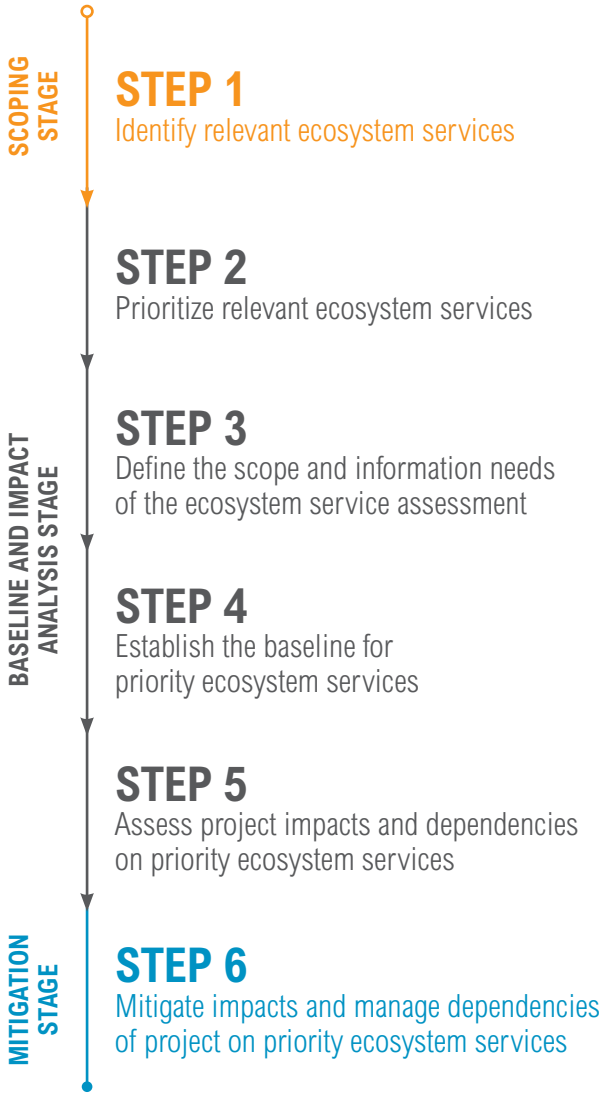
3. **DEFINE THE SCOPE AND INFORMATION NEEDS OF THE ECOSYSTEM SERVICE ASSESSMENT.** Define the boundaries of and identify indicators for the impact and dependence assessments to clarify priority ecosystem services data and analysis requirements for environmental and social practitioners.

4. **ESTABLISH THE BASELINE FOR PRIORITY ECOSYSTEM SERVICES.** Evaluate the condition of priority ecosystem services in the absence of the project.

5. **ASSESS PROJECT IMPACTS AND DEPENDENCIES ON PRIORITY ECOSYSTEM SERVICES.** Predict the changes in priority ecosystem services over the life of the project.

6. **MITIGATE IMPACTS AND MANAGE DEPENDENCIES OF PROJECT ON PRIORITY ECOSYSTEM SERVICES.** Identify measures to at least achieve no loss of the benefits people derive from ecosystems affected by the project and to ensure planned operational performance where the project depends on ecosystem services.

Figure 2 | **Six steps of the Ecosystem Services Review for Impact Assessment**



Who conducts the ESR for IA?

The ESR for IA requires input from both environmental and social practitioners of the ESIA team. The ecosystem service lead (hereafter "ES lead") has the responsibility of guiding, coordinating, and integrating the analyses of these practitioners. Ideally, the ES lead is an ecosystem service specialist.[3] Alternatively, the role can be assumed by an ecologist familiar with the work of social practitioners or a social practitioner comfortable with the ecological component of impact assessments.

The ES lead takes advantage of regular ESIA team meetings to facilitate collaboration among the individual environmental and social practitioners and to integrate their respective assessments. In case the environmental and social assessments are conducted by different companies working independently, the ES lead convenes the relevant environmental and social practitioners on three occasions:

- Ecosystem Service Prioritization Workshop to finalize Steps 1, 2, and 3;
- Ecosystem Service Impact and Dependence Workshop to finalize Steps 4 and 5; and
- Ecosystem Service Mitigation and Management Workshop to finalize Step 6.

Project developers may prefer to have the ecosystem service dependence assessment conducted as part of the risk assessment process. In the context of the ESR for IA, it is assumed that the project must abide by IFC Performance Standards and that both impact and dependence assessments are conducted as part of its environmental and social risks and impacts identification process. Therefore the ESIA team, under the responsibility of the ES lead, conducts both ecosystem service impact and dependence assessments. In the case of the dependence assessment, the team ideally works in close collaboration with project developers.

The ESR for IA also provides a series of spreadsheets to support implementation of the six steps (for an example of such a spreadsheet, see Box 4).

Where to get the information?

The ESR for IA generates new insights into project impact and dependence on the environment primarily by integrating socio-economic and environmental information that is compiled or collected in the standard ESIA process (Table 2).

Table 2 | **Sources of input and information**

SOURCES	RELEVANT FOR STEPS					
	1	2	3	4	5	6
Sources used for social impact assessment. These sources include secondary data (e.g., censuses, historical texts); qualitative interviews; quantitative surveys; and participatory rural appraisal on household assets, income streams, expenditures, vulnerable groups, health status, education level, culture.	X	X	X	X	X	X
Sources used for environmental impact assessment. These sources include secondary data (e.g., state of the environment report, land cover maps), qualitative and quantitative field assessment of biodiversity and ecological health, and assessment of trends in ecosystem condition.	X	X	X	X	X	X
Ecosystem service-specific sources. These sources include papers on how to associate ecosystem services with specific land cover (e.g., IPIECA and OGP 2011, Burkhard et al. 2009, Haines-Young and Potschin 2008) or species (e.g., Kunz et al. 2011), ecosystem service mapping and decision-support tools (some of these tools are reviewed in BSR 2011), and literature on ecosystem service indicators (e.g., UNEP-WCMC 2011, Layke 2009).	X		X			
Project developers. The project's analysts, managers, and executive managers need to provide in-house knowledge and documentation on the project (e.g., feasibility study, risk assessment) to assess the extent of project dependence on ecosystem services. They will also help identify measures to mitigate project impacts and manage project dependencies on priority ecosystem services.		X	X		X	X
Affected ecosystem service stakeholders. Affected stakeholders need to explain their level of dependence on impacted ecosystem services and help identify measures to mitigate (enhance) any loss (gain) in benefits caused directly or indirectly by the project.		X		X	X	X
Third-party actors. These individuals, institutions, or companies need to be engaged to understand how they drive ecosystem change and what factors could influence their impacts on priority ecosystem services.					X	X

Sources: Adapted from Hanson et al. 2012 and IPIECA 2004.

Practitioners seeking detailed technical guidance on implementing the ESR for IA should at this point consult Landsberg et al. 2014. The technical appendix delves into the method in greater depth and walks practitioners through each step and sub-step of the ESR for IA. A case study of a hypothetical mining project runs throughout the appendix, illustrating each step's application.

For generalist readers, a less technical overview of the ESR for IA steps is provided below.

Step 1: Identify relevant ecosystem services

The first step in the ESR for IA is to identify the ecosystem services that are relevant to the project. This list is incorporated into the terms of reference (ToR) for the ESIA. Step 1 identifies both the ecosystem services the project may impact and those on which it may depend.

Identifying ecosystem services the project could impact

The ESIA team identifies relevant ecosystem services by answering the following questions:

1. **WHICH ECOSYSTEMS COULD THE PROJECT IMPACT?** The ESIA team identifies the ecosystems that could be impacted, directly or indirectly, by the project. The team also identifies the ecosystems on which project-related restrictions (e.g., land acquisition, change in land use) could prevent others from deriving benefits from these ecosystems.

2. **WHICH ECOSYSTEM SERVICES COULD THE PROJECT IMPACT?** The ESIA team identifies the ecosystem services supplied by the potentially impacted ecosystems. Several resources list the services typically associated with major ecosystem types (e.g., IPIECA and OGP 2011, Burkhard et al. 2009, Haines-Young and Potschin 2008).

3. **WHICH BENEFICIARIES ARE POTENTIALLY AFFECTED?** The ESIA team identifies the individuals, communities, institutions, and companies (other than the one for which the ESIA is conducted) that could be positively or negatively affected as a result of project impacts on ecosystem services.

Identifying ecosystem services on which the project depends

Ecosystem services contribute to project performance in multiple ways (Box 2). The dependence assessment focuses on determining a project's dependence on ecosystem services for operational performance.

Project dependence on ecosystem services is seldom evaluated in the standard ESIA process which, by definition, considers project impacts (IAIA 1999). This step of the ESR for IA process complements the scoping exercise in a standard ESIA, with the ESIA team and, ideally, the project developers reviewing the full list of ecosystem services (Table 1) and identifying those services that support project operations based on project documentation such as the feasibility study and risk assessment.

BOX 2 | TYPES OF PROJECT DEPENDENCE ON ECOSYSTEM SERVICES

Some of the ways in which ecosystem services may contribute to project performance include (adapted from Hanson et al. 2012):

- Operations: as an input or process for project operations or influencing the physical integrity of project facilities (e.g., provision of freshwater for industrial and agricultural processes, purification of input water of beverage company, protection of project facilities from flooding);
- Regulatory and legal compliance: by minimizing compliance costs related to legal and regulatory requirements (e.g., contribution of effluent treatment by wetlands to compliance with water quality standards);
- Reputation: by contributing to the project's reputation as an environmentally friendly or sustainable business (e.g., project's cleaning of invasive species supporting social license to operate);
- Market and product development: by improving the project's market or product potential (e.g., eco-labeling, new environmental markets, or new revenue streams); or
- Financing: by helping the project meet minimum lending requirements or access more favorable lending terms as a result of its management of environmental risks to the project (e.g., greater scrutiny by global investment banks regarding project risks associated with water scarcity).

Step 2: Prioritize relevant ecosystem services

The second step is to select the ecosystem services on which to conduct the impact and dependence assessments. The ESIA team selects among the relevant ecosystem services those for which project impacts could affect beneficiaries' livelihoods, health, safety, or culture. The team also selects the services that could prevent the project from achieving operational performance. Unlike Step 1, which draws upon available data, Step 2 requires stakeholder engagement (see Box 3 on engaging stakeholders on ecosystem services). The ESR for IA includes the impact and dependence prioritization spreadsheets to help the ESIA team prioritize ecosystem services in a systematic manner (see Box 4 for a snapshot of the impact prioritization spreadsheet).

Only priority ecosystem services will be carried forward in the ESIA process for detailed baseline data collection, impact analysis, and mitigation and management where warranted.

Prioritizing relevant ecosystem services according to project impact

The ESIA team engages with ecosystem service beneficiaries to answer the following three questions:

1. **COULD THE PROJECT AFFECT THE ABILITY OF OTHERS TO BENEFIT FROM THIS ECOSYSTEM SERVICE?** The degree to which a project impacts ecosystem service beneficiaries is determined by whether the impacts interfere with beneficiaries' current and foreseeable use. For example, the discharge of project effluent in a river could affect downstream water users if water quality falls below certain quality standards. Conversely, the project will not affect the recreational benefits of the river as long as visitors do not perceive a change in water smell, color, or quantity.

BOX 3 | ENGAGING STAKEHOLDERS ON ECOSYSTEM SERVICES

Most steps of the ESR for IA should be informed by stakeholder consultation to the maximum extent practicable. As such, ecosystem services should be integrated into the ESIA's stakeholder engagement program from the outset. However, unlike standard stakeholder engagement, which is led by social practitioners, engaging stakeholders about their dependence on ecosystem services also requires the involvement of environmental practitioners to reflect all the links between ecosystem services and the benefits accrued from their uses. For example, the environmental practitioners link regulating services (e.g., erosion control) and supporting services (e.g., nutrient cycling) to crop production, while the social practitioners assess the importance of crop production to farmers' income and sustenance, and the importance of crop calendars to community cultural and religious events.

Ideally the ES lead would be part of the team conducting the stakeholder engagement. If this is impractical, the ES lead should inform the consultation team of the linkages between ecosystems, priority ecosystem services, people, and the project prior to initiating the stakeholder engagement in order to contribute to the design of the stakeholder consultation tools. Most importantly, the consultation team needs to be provided with the list of relevant ecosystem services so as to elicit input from stakeholders on their dependence on these services. The relevant services can then be prioritized based on stakeholders' dependence. When engaging stakeholders, the consultation team asks them to specify the benefits they derive from these services; where they access them; and recent trends in these services.

Additional detail on stakeholder engagement is provided in Landsberg et al. 2014.

Answering "yes" to any of the following questions indicates that the ESIA team should answer "yes" to question 1:

- *Could the project's impacts on this service push it across a sustainability threshold?* A project might affect the ability of others to benefit from an ecosystem service by pushing it across a sustainability threshold. The project would turn the supply of this service from "adequate" to "inadequate" relative to demand, whether in quantity or quality. A shrimp farm project that converts a large area of mangrove to raise shrimp, for example, substantially decreases breeding grounds for fish and renders current levels of fishing unsustainable in relation to the reproduction rate, undermining the sustainability of the benefits fishermen accrue from fishing.

- *Could the project's impacts on this service trigger a regulatory response?* A project might affect the ability of others to benefit from an ecosystem service by changing its legal status or access. For example, an oil spill could lead to a ban on commercial and recreational fishing.

- *Is this ecosystem service already in short supply relative to demand?* A project is more likely to affect the ability of others to benefit from a service when the demand for this service already outstrips the supply. For instance, in a water-stressed watershed, any water abstraction by the project during the dry months could sharply reduce the benefits derived by other water users.

- *Does any change in this service preclude others from benefiting from it?* A project would affect the benefits others derive from an ecosystem service when these benefits require the service to stay unchanged (this is most likely to happen with cultural services). For indigenous communities, for example, pristine natural environment can be an essential component of culture. Any construction, however small, could damage indigenous sense of place and belonging.

- *Are the project's impacts on this service perceived by others as affecting their ability to benefit from it?* A project is more likely to be perceived as responsible for affecting the ability of others to benefit from an ecosystem service when it causes a relatively large share of total ecosystem change in the area. A project coming on the shore of a lake in an undeveloped area, for example, could trigger fears from the local communities that it will pollute the lake and decrease the availability of fish even if the project treats its effluent.

2. **IF "YES" OR "UNKNOWN" TO QUESTION 1, THEN IS THIS ECOSYSTEM SERVICE IMPORTANT TO BENEFICIARIES' LIVELIHOODS, HEALTH, SAFETY, OR CULTURE?** A project is more likely to affect beneficiaries of ecosystem services if it impacts a service that affected stakeholders identify as substantially contributing to their livelihoods, health, safety, or culture. For example, recreational hunters in the Arctic pick berries when hunting, but they consider this kind of foraging to be a non-essential co-benefit of hunting. Even if foraging possibilities decline as a result of project impacts, the hunters would not experience a noticeable change in their circumstances. By contrast, project impacts on the distribution of reindeer herds would affect hunters' livelihood.

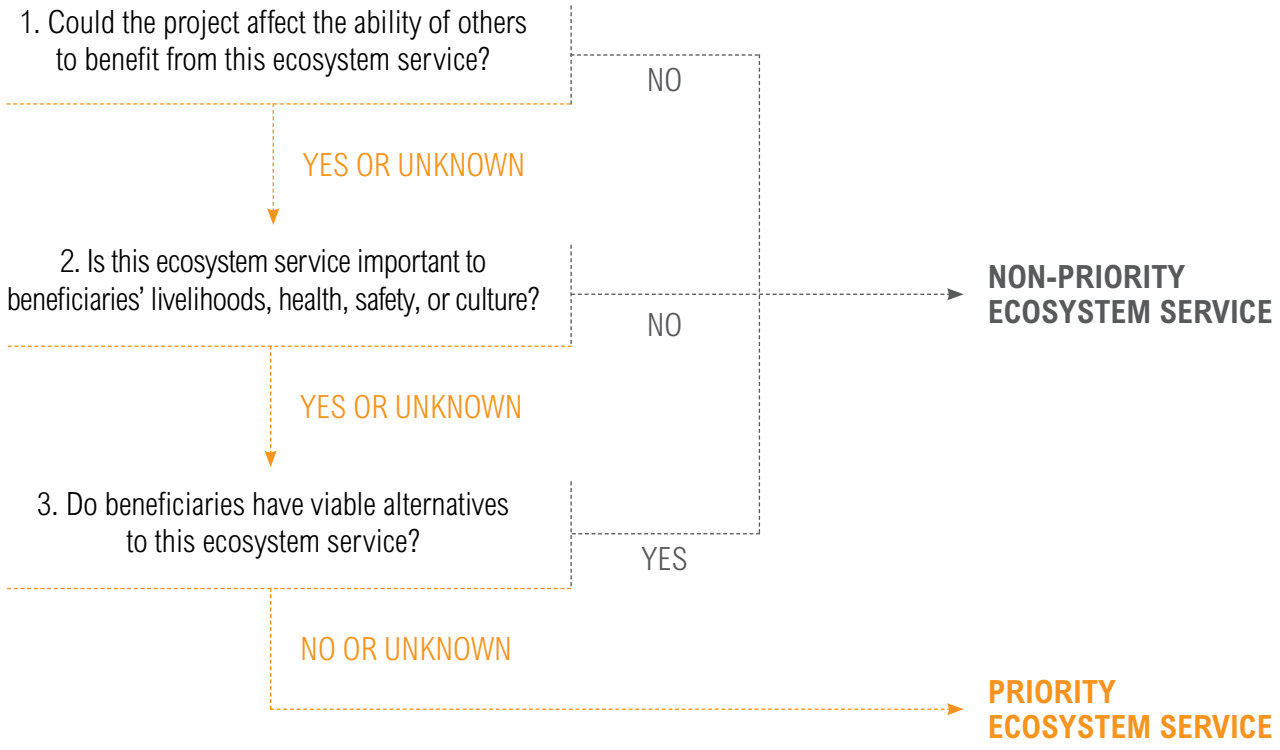
3. **IF "YES" OR "UNKNOWN" TO QUESTION 2, THEN DO BENEFICIARIES HAVE VIABLE ALTERNATIVES TO THIS ECOSYSTEM SERVICE?** Project impacts on an ecosystem service will be felt more acutely by beneficiaries if there are no viable alternatives to that service, leaving them unable to cope with changes in that service. For example, recreational and professional hunters of reindeer in the Arctic both derive health benefits from eating reindeer meat, but they would be affected by a reduction in the availability of reindeer meat differently. Professional hunters in the Arctic are typically poor and cannot afford other sources of animal protein. Recreational hunters, in contrast, have higher income levels and would have alternatives to reindeer meat as a source of protein in their diet. Unlike recreational hunters, professional hunters might suffer protein deficiency as a result of project impacts on reindeer population in hunting areas.

   Affected stakeholders are considered to have viable alternatives to an ecosystem service benefit if they can, without unacceptable physical, economic, or psychological burden, get the same benefit from (1) a non-ecosystem based solution (e.g., get an income from employment, get rent from the project for their land) or (2) an ecosystem service supplied by another

ecosystem (e.g., freshwater from another river in the area). When stakeholders appear to have an ecosystem service alternative, the ESIA team must establish beyond a reasonable doubt that (1) its supply can meet the needs of the affected beneficiaries; (2) the increased use of the alternative service does not compete with existing uses; and (3) the beneficiaries have formal or informal access to the service. For example, local fishermen have a viable alternative to the loss of a fishing ground if they are able to fish in an area: (1) that is equidistant to their landing sites (compared with the lost area); (2) that does not show signs of overfishing; and (3) to which they have fishing rights.

Figure 3 shows the decision tree to select the priority ecosystem services for which project impacts need to be assessed, and possibly mitigated. Priority ecosystem services are those services for which the ESIA team answered "Yes" or "Unknown" to questions 1 and 2, and "No" or "Unknown" to question 3. The ecosystem services that are not categorized as priority ecosystem services will not be considered further in the ESIA. Project impacts on those services, however, might be assessed from an environmental point of view. For example, if project impacts on freshwater quality do not interfere with its drinkability, the ESIA team will not select freshwater as a priority ecosystem service, and therefore will not assess the project's impacts on people's health. However, environmental practitioners might assess project impacts on water quality in terms of freshwater biodiversity.

Figure 3 | **Decision tree to prioritize relevant ecosystem services according to potential project impacts on beneficiaries**



BOX 4 | SNAPSHOT OF THE IMPACT PRIORITIZATION SPREADSHEET APPLIED TO ONE OF THE ROAD-TESTS[4]

The impact prioritization spreadsheet helps the ESIA team systematically answer the three impact prioritization questions for each relevant service and automatically identifies the priority ecosystem services. In the case of the mining project in the Arctic, the road-testers identified ten ecosystem services impacted by the project during Step 1. Using the spreadsheet, they prioritized six of these services, which included "reindeer meat".

The spreadsheet allows prioritizing ecosystem services on a benefit-by-benefit basis following the logic that ecosystem services do not equally contribute to livelihoods, health, safety, or culture. For example, the service "reindeer meat" was prioritized for its contribution to recreational hunters' quality of life, self-esteem, and ability to help others. The service was not prioritized for its contribution to the hunters' food and protein intake because recreational hunters have a varied diet and reindeer meat is not an important contributor. As a result, the ESIA team assessed, in later steps, project impacts on recreational hunters' quality of life, self-esteem, and ability to help others but the team did not assess project impacts on their food and protein intake.

FROM STEP 1			1. Could the project affect the ability of others to benefit from this ecosystem service?	2. Is this ecosystem service important to beneficiaries' livelihoods, health, safety, or culture?	3. Do beneficiaries have viable alternatives to this ecosystem service?	Priority ecosystem services
Relevant ecosystem services	Potentially affected beneficiaries	Potentially affected benefits				
Reindeer meat	Professional hunters from towns W, X and Y and their households	Income	?	Y	N	1
		Food and protein intake	?	Y	N	1
		Quality of life	?	Y	N	1
		Self-esteem	?	Y	N	1
		Ability to help others	?	Y	N	1
	Recreational hunters from the province and their households	Food and protein intake	?	N		0
		Quality of life	?	Y	N	1
		Self-esteem	?	Y	N	1
		Ability to help others	?	Y	N	1

Legend:
Y Yes
N No
? Unknown

1 Priority ecosystem services
0 Non-priority ecosystem services

Prioritizing relevant ecosystem services according to project dependence

Project dependence on ecosystem services may need to be managed to ensure planned operational performance. The ESIA team engages with the project developers to answer the following questions and identify the ecosystem services that are most likely to hamper operational performance (Figure 4):

1. **COULD THIS ECOSYSTEM SERVICE CHANGE IN WAYS THAT COULD NEGATIVELY AFFECT OPERATIONAL PERFORMANCE?** Project dependence on an ecosystem service needs to be managed when changes in the service are projected to diminish the benefits the project expects to derive from it. Changes in an ecosystem service can be driven both by causes of ecosystem change external to the project and by the project's own impacts.

Answering "yes" to any of the following questions signifies that the ESIA team should answer "yes" to question 1:

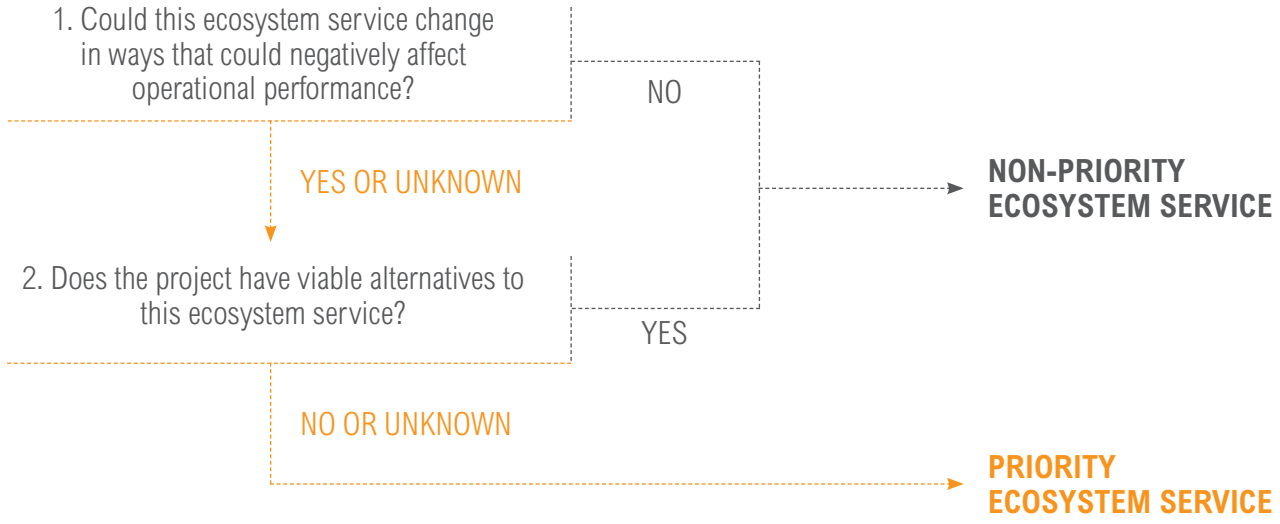
- *Could changes in this service over the life of the project push it across a sustainability threshold?* Changes in an ecosystem service are more likely to lead to a loss in benefit to the project if large changes in the service are expected, or if the service is already close to a sustainability threshold. Economic development and demographic change in an area, for example, might be expected over the life of a project, possibly resulting in substantial deforestation with associated loss in protection from landslides that could be costly to the project.

- *Could changes in this service over the life of the project trigger a regulatory response?* Changes in an ecosystem service are likely to lead to a loss in benefit to the project if they lead to a change in its legal status or access. For example, excessive water abstraction in a watershed might force the government to instigate a system of water permits.

- *Is the supply of this ecosystem service already scarce relative to demand?* Even small changes in an ecosystem service whose supply already fails to meet current demand are likely to translate into a loss of benefit to the project. A fish processing facility might see a sharp drop-off in performance, for example, if targeted fisheries are already overfished.

- *Would any change in the service prevent the project from achieving operational performance?* If project operations depend on the quantity or quality of the service remaining constant, any change in this ecosystem service will affect the project. Undisturbed natural environment, for example, is an essential selling point for high-end tourism operators and even minor alterations to a pristine environment can have consequences for the operators' business success.

Figure 4 | **Decision tree to prioritize ecosystem services according to operational risks to project performance**



2. **IF "YES" OR "UNKNOWN" TO QUESTION 1, THEN DOES THE PROJECT HAVE VIABLE ALTERNATIVES TO THIS ECOSYSTEM SERVICE?** The ESIA team consults with the project developers to evaluate the extent of project dependence on each of the relevant ecosystem services. The management of project dependence on an ecosystem service is critical if the project has no viable alternative to the benefits it derives from that service.

   A project can substitute the benefit it derives from an ecosystem service if it can get the same benefit in a cost-effective way either from a non-ecosystem based solution (e.g., replacing the dilution of contaminants by a river with a wastewater treatment facility) or from an ecosystem service supplied by another ecosystem (e.g., pumping water from another lake). In addition to cost-effectiveness, the following factors must also be assessed to determine whether an alternative is viable: (1) its supply can meet the needs of the project; (2) the project's use or consumption of the alternative service does not compete with existing uses; and (3) the project has legal access to the alternative service.

Figure 4 shows the decision tree to prioritize ecosystem services according to operational risks to project performance. Priority ecosystem services are those ecosystem services for which the ESIA team answered "Yes" or "Unknown" to question 1 and "No" or "Unknown" to question 2.

Step 3: Define the scope and information needs of the ecosystem service assessment

Once the ESIA team has prioritized the relevant services, it establishes the geographical boundaries of the ecosystem service impact and dependence assessments and identifies indicators of impact and dependence. Clarifying geographic boundaries and identifying relevant indicators will ensure that environmental and social practitioners agree on the data to be collected and analyses to be conducted in further stages of the ESIA process.

Delineating the ecosystem service assessment area

The ecosystem service assessment area is the area relevant to the assessment of project impacts and dependencies on priority ecosystem services. It includes (1) the ecosystems that supply the priority ecosystem services and (2) the locations where the project and affected stakeholders access priority ecosystem services.

For example, an irrigation project that diverts water from a river to irrigation canals will have an impact on downstream water users. But the project also depends on the upstream vegetation that affects the quantity and quality of the water available to the irrigation project. As such, the ecosystem service assessment area also includes upstream riverine vegetation.

Identifying impact and dependence indicators

Impact and dependence indicators measure changes in ecosystem service benefits to affected stakeholders and the project. These indicators will be used in Step 4 for determining the baseline for priority ecosystem services and in Step 5 for assessing project impacts and dependencies.

For each priority ecosystem service, the ESIA team identifies two indicators: an indicator of ecosystem service supply and an indicator of ecosystem service benefit.

Indicators of ecosystem service supply

Ecosystem service supply is defined here as the maximum level of ecosystem service that the ecosystem can provide without undermining its future provisioning capacity[5] (adapted from UNEP-WCMC 2011, Kareiva et al. 2011). Ecosystem service

supply is determined by the ecosystem type and condition regardless of whether people actually use or value the service, and it is modeled based on ecological production functions (Kareiva et al. 2011, NRC 2005). A number of tools that map ecosystem service supply are available.[6]

Indicators of ecosystem service supply convey information on how changes in ecosystem type and condition might lead to changes in ecosystem service supply. Indicators of supply are ecological indicators that are socially meaningful. For example, "total number of reindeer" provides information on the quantity of reindeer across its habitat. On the other hand, "total number of reindeer in hunting grounds" provides information on the availability of reindeer to hunters.

Indicators of ecosystem service benefit

An ecosystem service benefit is the gain in human well-being or in project performance derived from the use of the ecosystem service, often in combination with other inputs such as labor and capital (adapted from van Oudenhoven et al. 2012).

Indicators of ecosystem service benefit convey information on how changes in ecosystem service supply might lead to changes in the contributions of an ecosystem service to human well-being or to project performance. Indicators of benefit are socio-economic indicators. They can be monetary or non-monetary.

Linking ecosystem service supply and benefit helps the ESIA team, project developers, and affected stakeholders recognize and understand the manifold socio-economic implications of project impacts and dependencies on ecosystems. For example, in a standard ESIA, the assessment of project water abstraction looks at change in river flows (e.g., cubic meters of water per second). In this case, the indicator does not communicate the implications of water abstraction for local women who fetch water from the river. When looking at ecosystem services, the ESIA team assesses the impact of water abstraction in terms of change in the quantity of water available to these women (e.g., cubic meters of water per person). Change in water availability can, in turn, be linked to a change in time spent by local women to fetch water.

Step 4: Establish the baseline for priority ecosystem services

The fourth step is to determine how priority ecosystem services currently contribute to affected stakeholders' livelihoods, health, safety, or culture. Understanding the relationship between ecosystem services and benefits will help the ESIA team predict in Step 5 how project impacts on ecosystem service supply may affect the benefits affected stakeholders derive from it.

ESIA practitioners rely on the scope of the assessment defined in Step 3 to guide their personal contribution to the baseline. The team engages affected stakeholders during the stakeholder consultation process to establish current ecosystem service benefits. The team also compiles information from ESIA assessment sources such as livelihood surveys, agricultural censuses, health surveys, and anthropological documentation. Step 4 enables the ESIA team to establish current levels of benefit such as:

- 35 reindeers contribute $1,200 to the annual income of the hunters;
- Tourists give poor grades to their safari when animal viewings are less than 100 over a 2-day period;
- Given the present quality of drinking water, there is a 5 percent morbidity rate among children under 5 years old;
- The wilderness of hunting grounds is crucial to their cultural value to hunting communities.

Step 5: Assess project impacts and dependencies on priority ecosystem services

The fifth step is to assess project impacts and dependencies on priority ecosystem services and identify which of these services require mitigation or management measures.

Assessing project impacts on priority ecosystem services

The ESIA team first predicts project impacts on ecosystem service supply and benefits, and then assesses the significance of those impacts.

Predicting project impacts on ecosystem services

The ESIA team first predicts how project impacts on the type and condition of ecosystems could affect ecosystem service supply. Then the team infers from impacts on supply whether affected stakeholders might experience a gain, loss, or no change in benefit (Figure 5). For example, the ESIA team would predict changes in the income of professional hunters from project-driven fluctuations in wildlife habitat and populations, as well as changes in indigenous peoples' sense of belonging from changes in the integrity of their land.

As Figure 5 shows, this version of the ESR for IA does not assess project impacts in combination with other causes of ecosystem change (e.g., other projects' impacts, climate change).

Assessing significance of project impacts on affected stakeholders

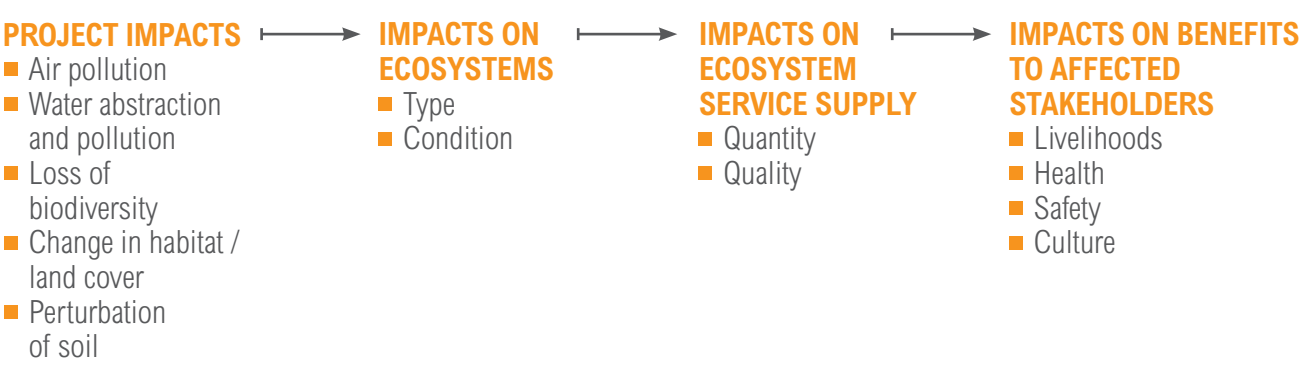
Impact significance is determined by the magnitude of the impact and the sensitivity of the receptor (Scottish Natural Heritage 2009).

When assessing the significance of impact on an ecosystem service, the ESIA team assesses impact magnitude in terms of size, frequency, duration, reversibility, and intensity of impact on the service benefit.

The ESIA team engages the affected stakeholders to evaluate their sensitivity to the predicted change in ecosystem service benefit according to the extent to which they can adapt to this change. Affected stakeholders are more or less able to adapt successfully to a change in ecosystem service benefit according to the breadth and diversification of their asset portfolio. Affected stakeholders' assets include (DFID 1999):

- Human capital (e.g., health, knowledge, skills, information, ability to labor);
- Social capital (e.g., relationships of trust, membership of groups, networks, access to wider institutions);

Figure 5 | **From project impacts on ecosystems to impacts on benefits to affected stakeholders**



- Physical capital (e.g., water, sanitation, energy, transport, communications, housing, and the means and equipment of production);
- Financial capital (e.g., regular remittances or pensions, savings, supplies of credit); and
- Natural capital (e.g., land, water, wildlife, biodiversity, environmental resources).

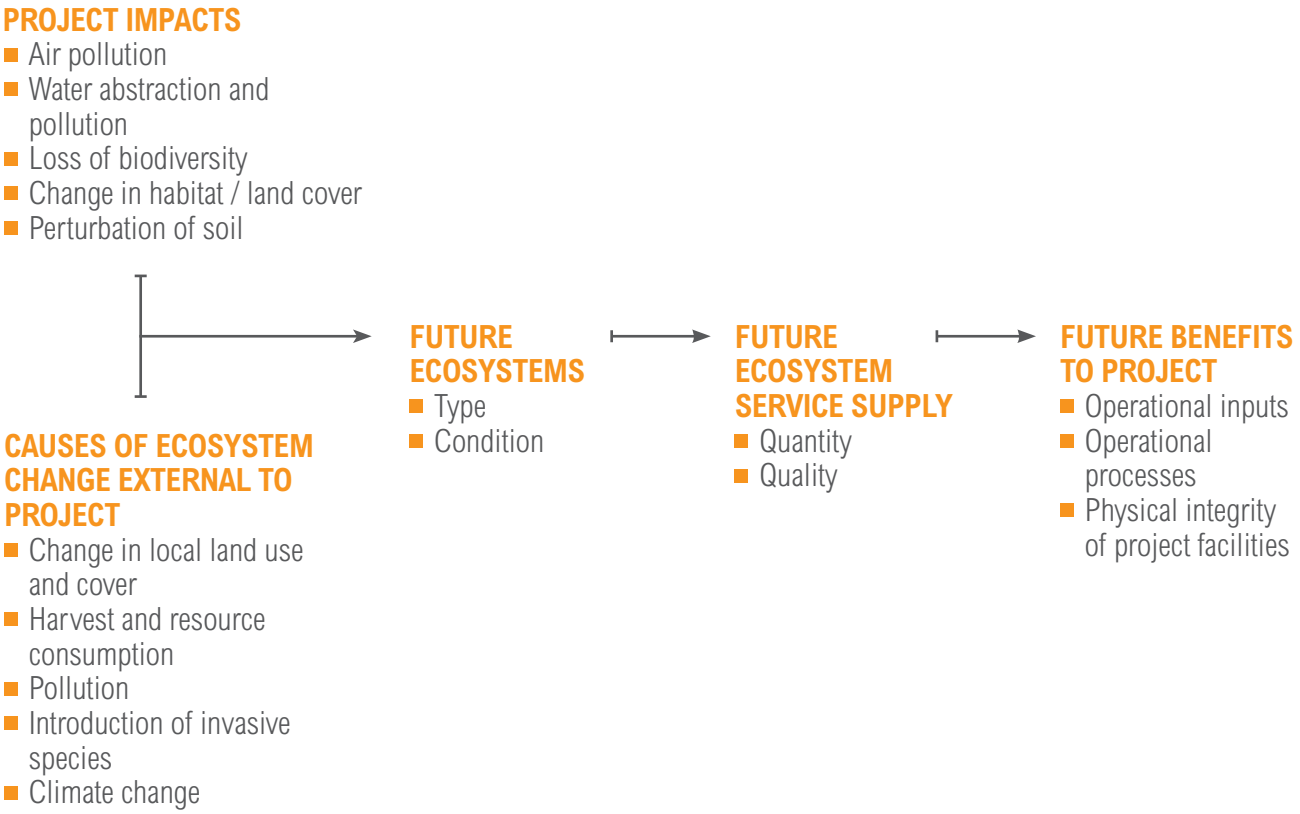
For example, the loss of income and food from restricted access to grazing lands could be assessed as being of moderate significance for agro-pastoralists, but of high significance for pastoralists, because the agro-pastoralists have a complementary livelihood strategy, while the pastoralists do not, making them more vulnerable to changes in the benefits they derive from livestock.

Based on the significance of project impacts on ecosystem services, the ESIA team identifies the ecosystem services for which project impacts need to be mitigated (see Step 6).

Assessing project dependencies on priority ecosystem services

The ESIA team first predicts the supply of priority ecosystem services over the life of the project, and then, in collaboration with the project developers, assesses whether predicted supply could prevent the project from achieving planned project operational performance (Figure 6).

Figure 6 | **From causes of ecosystem change external to the project and project impacts, to future benefits to the project**



Predicting ecosystem services over the life of the project

The ESIA team predicts the future supply of priority ecosystem services based on the causes of ecosystem change external to the project, as well as the project's impacts on these services.

Five causes of ecosystem change are considered to have the greatest impact on the supply of ecosystem services: (1) changes in local land use and land cover; (2) unsustainable harvest and resource consumption; (3) pollution; (4) introduction of invasive species; and (5) climate change (Ash et al. 2010). The ESIA team identifies which causes are relevant to each priority ecosystem service by studying recent trends in its supply. Either the ESIA team will be able to project current trends into the future, or current trends will need to be adjusted to reflect changes in socio-economic factors such as:

- Major demographic changes (e.g., in- or out-migration that has a large effect on the rate of land use change and resource harvesting);
- Major economic changes (e.g., increased market access through improved road infrastructure that can incentivize increased crop production or natural resource harvesting);
- Major changes in technology (e.g., shift from shallow wells to piped drinking water supplies, which generally increases per capita water demand);
- Major regulatory changes (e.g., strict implementation of a ban on consumption of wildlife, which could decrease consumption of bushmeat).

Predicting loss in project operational performance related to ecosystem services

The contribution of an ecosystem service to project performance depends on the extent to which the supply of that service meets the level required by the project to meet its performance goals. If the ESIA team and the project developers determine that the supply of a service is unlikely to meet the level anticipated by project developers, project performance is likely to be lower than developers estimated. For example, a project has an annual budget for treating its wastewater to meet local water quality standards. This budget assumes that a nearby wetland partly treats the project effluent. If the dependence assessment suggests that the wetland would be degraded over the project life and would not treat wastewater as expected, the project would need to treat more of its effluent at the project site, increasing the cost of abiding by local regulations.

In case of a shortfall in ecosystem service supply, the ESIA team could cost out either the associated lost performance or increased operational costs. This economic valuation is a proxy for the value of the ecosystem service to the project and might help the team determine whether management measures are cost-effective in Step 6.

The project developers identify the ecosystem services for which the loss in operational performance is unacceptable. The project's dependence on these services needs to be managed in Step 6.

Step 6: Mitigate impacts and manage dependencies of project on priority ecosystem services

The sixth and last step identifies measures to mitigate impacts and manage dependencies on ecosystem services for incorporation into the environmental and social management plans (ESMPs). The success of these measures will be monitored and assessed against the objectives of (1) at least achieving no loss of ecosystem service benefit by affected stakeholders, and (2) ensuring planned operational performance, respectively.

Mitigating project impacts on priority ecosystem services

In ecosystem service-inclusive ESMPs, mitigation measures are designed to ensure that affected stakeholders maintain the benefits they derive from priority ecosystem services.

The ESIA team follows the mitigation hierarchy to identify measures to avoid, minimize, restore, and offset losses in ecosystem service benefits, and to enhance gains in ecosystem service benefits (Figure 7). Often a combination of avoidance, minimization, restoration, and compensation measures will be employed. For example, the ESIA team needs

Figure 7 | **Mitigating and enhancing project impacts on ecosystem service benefits**

Source: Adapted from Rio Tinto 2008.

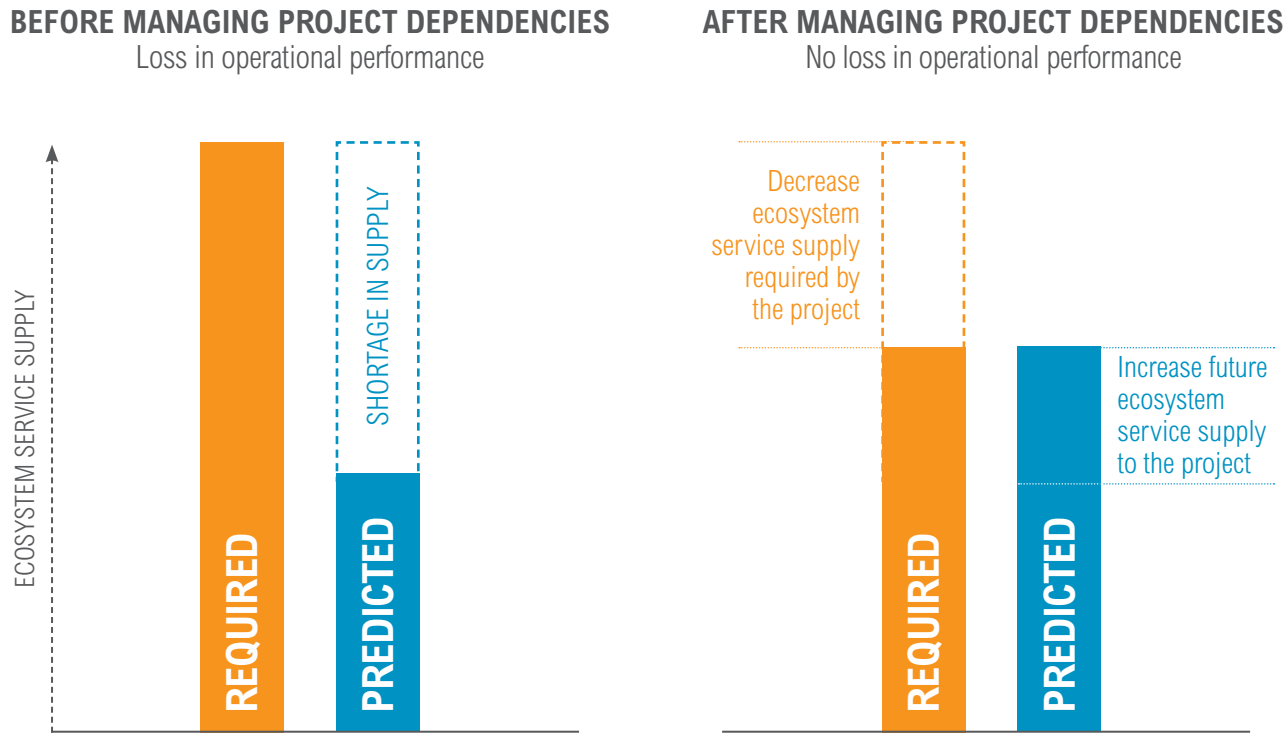
to mitigate the loss in cultural identity of local communities brought about by project activities that compromise the wild condition of traditional hunting areas. If there is still a loss after avoidance measures are explored, the ESIA team could propose minimization measures such as scheduling project-related road transportation in a manner that would reduce the impact on the experience of hunters. If a combination of avoidance and minimization measures is insufficient to mitigate for the loss in cultural identity, the ESIA team could propose restoring the hunting areas as part of project decommissioning and closure. Finally, if additional mitigation measures are required, the team could recommend that affected hunters be permitted to use the project's private roads in order to expand their range and access new hunting grounds.

If, even after proposed mitigation, there is still an anticipated residual loss in benefit, the ESIA team should engage the affected beneficiaries to determine whether the residual loss would be acceptable to them. If the residual loss in benefit is deemed unacceptable by the affected stakeholders, alternatives for the project should be considered.

Managing project dependencies on priority ecosystem services

The ESIA team in collaboration with the project developers identifies a list of cost-effective measures to manage the operational risks to project performance arising from ecosystem change.

Figure 8 | **Managing project dependencies on ecosystem services to ensure planned operational performance**



These measures can either increase the supply of the ecosystem service (blue arrow in Figure 8) and/or decrease the supply required by the project to achieve planned operational performance (orange arrow in Figure 8). In the case where the project underestimated its annual wastewater treatment costs, the ESIA team could propose wetland restoration measures to maintain the wetland capacity to treat project effluent. Alternatively (or in combination), the ESIA team could propose recycling wastewater to decrease the project's dependence on the wetland.

If no more cost-effective measures can be identified to manage project dependence on priority ecosystem services and predicted losses in operational performance are still unacceptable to the project developers, the feasibility of the project as presented in the ESIA should be reconsidered.

CONCLUSIONS

The ESR for IA is a work in progress. However, the early road-tests are promising. They demonstrated that the ESR for IA has the potential to:

- Unveil unidentified social impacts and operational risks;
- Enhance understanding of the socio-economic dimensions of environmental impacts and the operational implications of ecosystem change; and
- Reveal additional mitigation measures for social impacts and management measures of operational risks.

WRI is supporting road-testing of the ESR for IA on ongoing ESIAs and encourages project developers and ESIA practitioners wanting to implement the ESR for IA on their own to reach out to the authors if they need technical support. WRI is interested in receiving feedback from implementing the ESR for IA, including, but not limited to, its added value; challenges of incorporating ecosystem services into standard ESIA; associated costs in terms of conducting complementary analyses and collecting additional data; and its success at facilitating cooperation among environmental and social practitioners.

APPENDIX I. QUICK REFERENCE GUIDE TO THE ESR FOR IA

IMPACT ASSESSMENT	IMPACT SUB-STEPS	BRIEF GUIDANCE TO SUB-STEPS
Step 1: Identify ecosystem services relevant to project impact	1.1 Identify ecosystems the project could impact	Review land cover maps to identify potentially impacted ecosystems.
	1.2 Identify ecosystem services the project could impact	Review standard list of ecosystem services and develop a matrix of services that each potentially impacted ecosystem provides.
	1.3 Identify potentially affected ecosystem service beneficiaries and benefits	Review social profile of project area and identify the people who depend on potentially impacted ecosystem services for their livelihoods, health, safety, and culture.
Step 2: Prioritize relevant ecosystem services according to project impact	2.1 Identify ecosystem services for which project impacts could affect the ability of others to derive benefits	Preliminary estimate of the extent of change in ecosystem services and determination of whether these changes could affect people's livelihoods, health, safety, or culture.
	2.2 Identify ecosystem services that are important to beneficiaries' livelihoods, health, safety, or culture	Hold meetings with stakeholders to assess people's dependence on potentially affected ecosystem services.
	2.3 Identify ecosystem services for which beneficiaries have no viable alternatives	
Step 3: Define the scope and information needs of the ecosystem service impact assessment	3.1 Delineate the ecosystem service impact assessment area	Localize the impacted ecosystems and the locations where people access services.
	3.2 Identify indicators of project impact on ecosystem services	Review literature and engage stakeholders to identify indicators relevant to assessing ecosystem impacts on people's livelihoods, health, safety, and culture.
Step 4: Establish the baseline for priority ecosystem services	4.1 Assess current ecosystem service use and benefit	Engage stakeholders to establish relationships between ecosystem services and people's livelihoods, health, safety, and culture for the indicators identified in Step 3.
	4.2 Assess sustainability of current ecosystem service use and benefit	Conduct field visit, review existing literature, and engage stakeholders about recent trends in ecosystem services.
Step 5: Assess project impacts on priority ecosystem services	5.1 Predict project impacts on ecosystem service supply	Infer impacts on ecosystem service supply from project impacts on ecosystems.
	5.2 Predict project impacts on ecosystem service benefits	Predict impacts on people's livelihoods, health, safety, and culture based on impacts on ecosystem service supply.
	5.3 Assess significance of project impacts on affected stakeholders	Assess the magnitude of impacts on people's livelihoods, health, safety, and culture; and their sensitivity to these impacts. Identify ecosystem services for which impacts need to be mitigated.
Step 6: Mitigate project impacts on priority ecosystem services	6.1 Mitigate loss and enhance gain in ecosystem service benefit	Review existing mitigation measures and supplement them to at least achieve no loss of ecosystem service benefits by implementing the ecosystem service mitigation hierarchy.

DEPENDENCE ASSESSMENT	DEPENDENCE SUB-STEPS	BRIEF GUIDANCE TO SUB-STEPS
Step 1: Identify ecosystem services relevant to project dependence	1.1 Identify which ecosystem services support project operations	Review project description to identify ecosystem services on which the project directly depends.
	1.2 Identify the benefits the project derives from ecosystem services	
Step 2: Prioritize relevant ecosystem services according to project dependence	2.1 Identify ecosystem services expected to change in ways that could negatively affect operational performance	Predict trends in ecosystem services over the life of the project and determine whether these trends could imperil operational performance.
	2.2 Identify ecosystem services for which the project has no viable alternatives	Review with project developers alternatives to benefits derived from ecosystem services.
Step 3: Define the scope and information needs of the ecosystem service dependence assessment	3.1 Delineate the ecosystem service dependence assessment area	Locate the ecosystems on which the project depends and the places where the project accesses the services.
	3.2 Identify indicators of project dependence on ecosystem services	Review project documentation and engage project developers to identify indicators relevant to assessing ecosystem change in terms of changes in operational performance.
Step 4: Establish the baseline for priority ecosystem services	N/A	N/A
Step 5: Assess project dependencies on priority ecosystem services	5.1 Predict ecosystem service supply over the life of the project	Infer changes in ecosystem service supply from ecosystem changes over the life of the project.
	5.2 Predict loss in operational performance related to ecosystem services	Predict loss in operational performance based on future ecosystem service supply. Identify unacceptable losses in operational performance.
Step 6: Manage project dependencies on priority ecosystem services	6.1 Manage operational performance related to ecosystem services	Review existing mitigation measures and supplement them to achieve planned operational performance by managing ecosystem service use by and supply to the project.

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ENDNOTES

1. The projects on which the ESR for IA was implemented retrospectively were: a mining project in the Arctic, a wind farm project in Asia, a mining project in Africa, and an agro-business project in Latin America.

2. It is assumed that the ESIA team will conduct stakeholder engagement starting from the baseline and impact analysis stage. If the ESIA team conducts stakeholder engagement earlier in the ESIA process, it can implement Steps 2 and 3 during the scoping stage.

3. A directory of ecosystem service specialists can be found at http://projects.wri.org/ecosystems/experts.

4. This example is based on one of the ESIAs on which the ESR for IA was conducted retrospectively. However, it has been slightly adapted to maintain the anonymity of the project itself.

5. Similar concepts are those of carrying capacity, maximum contaminant absorption, and maximum sustainable timber yield.

6. Various mapping tools are reviewed in BSR 2011 and Center for Ocean Solutions 2011.

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