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Sustainable Development Evaluation: Understanding the Nexus of Natural and Human Systems

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Abstract

Environmental threats continue to pose fundamental challenges to the ecosystems that support human life and societies, as demonstrated by the 2018 special report of the Intergovernmental Panel on Climate Change. Sustainable development has three closely interlinked dimensions: social, economic, and environmental. The evaluation profession has focused primarily on the first two, while largely neglecting the environmental dimension, which is fundamental to achieving social and economic goals. As progress in moving toward sustainable development rests on the foundation of natural resources and environment, evaluation cannot continue ignoring them. Evaluating at the nexus of natural and human systems requires approaches and skillsets that encompass both domains, taking into account their differing geographic and time scales. This article draws upon the work carried out by the Global Environment Facility Independent Evaluation Office in evaluating environmental programs and projects in developing countries. The experiences highlight the need for understanding the complex dynamic systems in which the interventions operate and interact. Theory-based evaluations must incorporate the broader system and not be constrained to the internal logic of the intervention. The article also makes the case for mixed methods approaches and methods that can be tailored to answer various types of evaluation questions. This leads to the need for multidisciplinary teams to evaluate at the nexus of environment and development. © 2019 Wiley Periodicals, Inc., and the American Evaluation Association.

Introduction

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) issued a special report that gives a dire warning to humankind that we have until 2030 to limit global warming to 1.5°C above preindustrial levels or face irreversible and severe consequences for both the planet and people (IPCC, 2018). The IPCC affirms that we are already seeing the consequences of global warming through increased extreme weather events, rising sea levels, and diminishing Arctic sea ice. Sea level rise, inundating small islands, and low-lying coastal areas from Bangladesh to Tokyo to the U.S. Eastern Seaboard, seems inevitable. Coastal cities that are the engines of economic development will retreat from the rising seas and extreme storm activity. Such changes will have a direct impact on people everywhere, especially in developing countries. Combined with continued population growth, climate change will lead to significant per capita declines in global GDP. Heat and drought will negatively affect food production, particularly in the lower latitudes. Vector-borne tropical diseases, such as dengue, malaria, and zika, are likely to spread northward, and heat waves will kill an increasing number of people.

These scenarios concretely and dramatically demonstrate the interconnectedness of natural and human systems, and how vulnerable such systems are to even relatively small disturbances. The bad news is that, barring rapid and far-reaching transitions in land use, energy, industry, buildings, transport, and cities, limiting warming to only 1.5°C will be impossible (IPCC, 2018). Technological solutions alone are unlikely to provide adequate responses to these challenges. They will also be very expensive and carry their own risks and unanticipated consequences. The fundamentals that provide sustenance to life on the planet—food, water, the air that we breathe—are entirely dependent on the natural environment. Should this foundation collapse, the economic growth and social development that rest on it would necessarily crumble.

Environmental economics is rightly receiving increased attention, as ecosystems provide tangible goods and services to humankind in terms of food, water, materials, climate regulation, pollination, protection from disasters, and many others. It is nevertheless important to recognize that while the ecosystem services that nature provides to society have a value that can be monetized, in most cases man-made capital cannot substitute for natural capital and so natural capital should be maintained for its own value (Daly, 2005). Furthermore, from an ethical point of view, nature—both living and inanimate—has an intrinsic value that goes beyond its instrumental value (Washington, Taylor, Kopnina, Cryer, & Piccolo, 2017). This includes its cultural and spiritual value. Still, many decision-makers both in the public and private sectors appear to believe that what cannot directly be measured in monetary terms is not worth anything. They ignore the natural environment at their—and our—peril. Evaluators have a responsibility to

bring this aspect to the forefront when decisions are made that affect our common future. Evaluators themselves have to embrace a holistic approach toward sustainable development, which will require changes in the practice of evaluation.

Progress has been made in addressing the environmental challenges at the level of international governance and agreements intended to enhance global responses to the looming environmental crises, but these efforts are not translating into results on the ground. The 2015 Paris Agreement (UN, 2015a) under the United Nations (UN) Framework Convention on Climate Change (UNFCCC), hitherto signed by 195 UNFCCC members, is based on intended voluntary contributions by countries to limit their greenhouse gas emissions. However, IPCC makes it clear that, even if countries lived up to their commitments (which they currently are not doing), climate change will reach dangerous levels in the coming decades.

Also in 2015, the 2030 Agenda for Sustainable Development and the attendant Sustainable Development Goals (SDGs) were adopted by 193 UN member States as a global plan of action for people, planet, and prosperity. The entire agenda is seen as resting on three distinct pillars: economic, social, and environmental sustainability (UN, 2015b). The principles outlined in the 2030 Agenda and the SDGs are universally applicable (meaning they apply equally to industrialized and developing countries) and are intended to guide development in the coming decade and a half. All nations, rich and poor, are expected to advance development that is sustainable in terms of social progress, equity and inclusiveness, and economic development without undermining the natural resource base and ecosystems that we all depend on. The seventeen SDGs encompass virtually all spheres of life with the aim of eradicating poverty and strengthening peace in larger freedom. All SDGs are interlinked and each one is intended to reflect the three dimensions—economic, social and environmental—to varying degrees. Yet, the achievement of any of them requires attention to the natural environment. In fact, rather than the three pillars, a more appropriate analogy for the SDGs would be a three-layered cake in which the environment provides the foundation on which the social and the economic layers rest (Rockström & Sukhdev, 2016).

Although the SDGs form a useful globally accepted political and advocacy platform, it is important to develop, implement, and evaluate all policies, strategies, and programs through a sustainable development lens that takes into account the foundational role of the natural environment. The SDGs were a negotiated outcome of a political process. We now know that the global environment requires more attention than given in the SDGs and the 2030 Agenda. Sustainable development implies integration of the domains of human and natural systems. Evaluating sustainable development initiatives, like sustainable development itself, must by definition encompass all of these dimensions that are expressed in natural and human systems and their interactions. This poses practical and methodological

challenges for evaluation, which must operate in a complex dual system and confront issues related to the differing time and geographic scales.

This chapter considers the environmental foundation of sustainable development and explores potential tensions between it and the economic and social dimensions in the context of international development evaluation. The chapter draws upon evaluations conducted around programs funded by the Global Environment Facility (GEF) in developing countries. Toward the end of each 4-year funding cycle, the GEF governing body requires the Independent Evaluation Office (IEO) to conduct a comprehensive evaluation that will inform the programming directions and policy agenda for the next cycle. This article draws in particular on the Sixth Comprehensive Evaluation of the GEF completed in 2017 (GEFIEO, 2017a).

The fundamental argument made is that evaluation has a moral, ethical, and practical imperative to systematically incorporate environmental sustainability into its practice. At the very least, any evaluation must consider the environmental consequences of the evaluand, recognizing that taking the environmental dimensions fully into account may radically change the viability and rationale of the policy or intervention (Rowe, 2019). Evaluating at the nexus of development and environment—as well as addressing sustainable development more broadly—requires a holistic perspective taking into account the particularities, including the differing time horizons and geographic scales of natural and human systems. At a practical level, there are several implications for evaluators to consider:

- I. When scoping an evaluation, it is important to identify the context and to define the boundaries of the broader system in which the evaluand is situated, understanding that the system is bound to be complex and dynamic. This will define the boundaries of the evaluation.
- II. The natural environmental context, the interactions of the intervention in it, and unintended consequences—both positive and negative—must always be considered. In doing so, scientific literature shall be perused to gauge the current knowledge of the topic. It would be a rare case where the intervention did not have environmental implications.
- III. The theory of change must encompass the broader system, including the natural environment, in which the intervention takes place. It is rarely, if ever, sufficient in an evaluation only to consider the internal logic model of the intervention, as if the intervention were to take place in a vacuum.
- IV. The evaluation should be designed with most appropriate methods for each part in mind. In most cases, a mixed methods approach will be needed, encompassing methods that capture changes in both the natural and human systems. Evaluation teams should have expertise in a variety of approaches and subject matters, including the natural environment. Consequently, interdisciplinary teams are the gold standard.

The Environmental Foundation of Sustainable Development

We live in a world faced with multiple environmental challenges and crises. As our immediate surroundings have become seemingly cleaner, this may create an illusion that the environment no longer poses a constraint on economic development, especially in rich countries. However, the immediate costs of air and water pollution in terms of human health and productivity are quite obvious in many countries experiencing rapid economic growth, such as India and China. Moreover, the consequences of global environmental stresses, such as climate change, loss of biodiversity, overexploitation of fisheries and other resources, and chemical pollution are becoming more visible all around the world. Heat waves, wildfires, floods, and droughts take a toll on both human welfare and economic growth.

Unfolding Environmental Crisis

All three layers of sustainable development are essential for moving toward a world that can support the aspirations of an ever-increasing population, while maintaining ecosystem health that supports all life on Earth. Yet, the environmental dimension—the foundation on which sustainable development is built—often appears to be treated as an afterthought (Reid et al., 2017). In the development circles, as in society as a whole, there appears to be an assumption that social, economic, and technological progress will take care of sustainability. Evidence, however, suggests that this is not the case.

The IPCC, a body under the auspices of the UN, bases its assessment on the review of best available scientific evidence; in the case of the latest report, over 6,000 scientific studies and thousands of experts were consulted. According to the panel, the benefits of limiting warming to 1.5°C as compared with a 2°C increase, would result in dramatically different outcomes: sea level rise by the year 2100 would be 10 cm less; coral reefs would decline by 70–90% as opposed to disappearing entirely (IPCC, 2018). The Paris Agreement is aimed at limiting global warming to the critical target of less than 2°C over preindustrial levels. Yet, the latest UN Environment analysis reports that global CO₂ emissions from energy and industry have remained stable since 2014, while overall greenhouse gas emissions continue to rise, making it extremely unlikely that the Paris Agreement goals will be met (UNEP, 2017).

Expanded use of energy, and in particular fossil fuels, leads to climate change, while toxic chemicals threaten air, soil, and water and, consequently human health. We live in an era of the “sixth extinction” leading to unprecedented loss of species with irreversible consequences to ecosystem integrity and functions (Caballos, Ehrlich, & Dirzo, 2017). Much of this biodiversity loss is due to deforestation, habitat loss, and fragmentation into small unconnected areas that are not able to support wildlife populations.

The biggest culprits are to be found in logging and in the expansion of agriculture into natural habitats and forests. Only three commodities—palm oil, soy beans, and beef cattle—are responsible for almost 80% of tropical deforestation (Brack, Glover & Wellesley, 2016). As people in still poor countries get richer, the demand for these commodities increases exponentially, placing further pressures on the natural environment.

The planetary boundaries that set the limits to prosperity are stretched dangerously (Rockström, 2009; Rockström et al., 2009). Analyses by Stockholm Resilience Center (Steffen et al., 2015) suggest that planetary boundaries have already been breached beyond the safe operating space for humanity when it comes to biodiversity loss, climate change, and human interference with the nitrogen cycle. Other areas, such as ocean acidification, land system change, and freshwater use are under pressure.

A fundamental driver of resource use, pollution, and environmental strain is the continued growth in human population, also contributing to political and economic tensions. Although population growth rates have generally slowed down, the world population is expected to reach 9.8 billion by 2050, up from the current 7.6 billion (UN, 2017). Most of this increase will take place in Africa and the Middle East, regions that are already stretched in terms of environmental resources, such as water and arable land, as well as jobs and opportunities for young people. Unrest in the Middle East and subsequent refugee flows to Europe and beyond appear linked to environmental security (Hsiang, Meng, & Cane, 2011). A meta-analysis of fifty-five studies found that deviations from moderate temperatures and precipitation patterns systematically increase conflict risk (Burke, Hsiang, & Miguel, 2015). Achieving sustainable development requires a holistic perspective on social, political, economic, and environmental issues.

Dealing With Trade-Offs

Global environmental resources are global public goods that are non-excludable and non-rivalrous—meaning that anyone can use them with no additional cost—which makes their management challenging (Berg, 2011; Ostrom, 1990). For example, clean air does not benefit one country at the expense of others, so countries are not rivalrous in consuming it; nor can any country or group be excluded from consuming clean air. On the other hand, the consequences of polluting a shared public good will fall on all countries using it. Many countries contribute to global environmental problems to varying degrees, and the costs fall on all countries, including those that did not contribute to such problems. At the same time, no country alone can solve them. Environmental issues are intricately intertwined with economic growth, people's livelihoods, and health: the entire social and economic development process, with its political, power, and intergenerational dimensions.

Sustainable development occurs in the nexus where human (social and economic) and natural (environmental) systems meet. There are often trade-offs and conflicting interests between the two. Such trade-offs need to be recognized and carefully managed in policymaking and in designing and implementing development programs and projects (Puri, 2017). Evaluations must bring these trade-offs to the forefront.

Economic growth, poverty, and the environment are closely linked, but the relationship has been contested. A quarter century ago, it became a slogan to say that poverty is the worst kind of pollution. As poor people scrambled to make a living, the argument went, they contributed to the deterioration of the environment, because of their immediate needs for survival precluded taking a long-term view on the preservation of natural resources and the environment (UNDP, 1992). A solution to what became known as the poverty–environment nexus was seen to be poverty reduction through economic growth (Dasgupta et al., 2005; Lufumpa, 2005). Another side of the poverty–environment nexus is that poor people, especially in rural areas, tend to be more directly dependent on natural resources for their livelihoods (agriculture, fisheries) and energy, and therefore also more vulnerable to the effects of environmental degradation (PEI, 2017). It is now clear, however, that economic growth does not necessarily translate into poverty reduction, unless policies explicitly focus on distributional effects and equity. Moreover, there is no guarantee that an improved economic situation for the majority would lead to environmental improvements or sustainability. Even if poor people are the first to suffer from environmental degradation, they would often oppose environmental protection efforts if they were to threaten their immediate livelihoods.

The above suggests it is not easy to find solutions that benefit both the environment and local people, while managing pressures from larger societal forces. The drivers of environmental degradation can mostly be found in productive sectors. If evaluation is to contribute to sustainable development and preservation of our natural capital, it must be able to address the trade-offs pertaining to environment and development.

Evolving Integration in the Global Environment Facility

Based on the key role of the environment in sustainable development, environmental challenges must be tackled, and done so with an integrated perspective. The SDGs have been criticized for the lack of recognition of the interdependencies between the various goals (Stafford-Smith et al., 2016). Specifically, critics emphasize the need for greater attention to the interlinkages at various levels: across sectors (e.g., finance, agriculture, energy, transport); across societal actors (local authorities, government agencies, private sector, civil society); and between and among low-, medium-, and high-income countries (Stafford-Smith et al., 2016). Given that the drivers of environmental degradation are mostly found in the productive sectors, it

is imperative to address these when dealing with environmental problems. For example, the loss of globally significant biodiversity is caused by multiple development pressures, including the quest for raw materials (timber, mining), expansion of agriculture, and urban sprawl (GEFIEO, 2016a).

World governments established the Global Environment Facility (GEF) in connection with the Earth Summit (formally known as the UN Conference on Environment and Development, held in Rio de Janeiro, in 1992) in anticipation of increased financial flows from North to South. The mandate of the GEF is to assist developing countries and countries with economies in transition to meet their obligations to multilateral environmental agreements they have ratified. The GEF originally served as the financial mechanism to support the implementation of the Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC). This was later expanded to include the UN Convention to Combat Desertification (UNCCD), the Stockholm Convention on Persistent Organic Pollutants, and the Minamata Convention on Mercury. The GEF also supports transboundary cooperation between countries in shared marine and freshwater ecosystems, as well as sustainable forest management. Since its inception, the GEF has provided direct funding to more than 4,000 projects and programs of \$17.9 billion and mobilized some \$93 billion in co-financing (GEF & IUCN, 2018). In 2018, thirty-nine governments pledged \$4.1 billion to the trust fund managed by the World Bank for the GEF's seventh 4-year replenishment period.

Independent evaluation is a constituent part of the GEF. The IEO director reports directly to the governing Council consisting of donor and recipient country government representatives, who also approve the work program and budget of the office. The IEO's mandate is to conduct evaluations covering GEF performance, results and impacts of programs and projects, and effectiveness and efficiency of institutional, organizational, and governance aspects of the partnership. Programs and projects funded by the GEF are implemented by eighteen agencies, which include the World Bank and regional development banks, UN agencies, international nongovernmental organizations (NGOs), and national agencies in large recipient countries. The GEF is managed by a secretariat and draws upon advice from a Scientific and Technical Advisory Panel (STAP).

The GEF mandate is somewhat different from that of traditional development agencies. Although all agencies must focus on the global environmental problems when implementing GEF projects, the emphasis in their respective mandates between the three sustainable development layers varies considerably. This has in the past led to occasional tensions between the goals of the GEF and those of the implementing agency. For instance, as the single largest agency implementing GEF-financed projects, the United Nations Development Programme (UNDP) is a development agency focusing primarily on the development (human) side of sustainable

development, while GEF objectives are for the protection of the global environment. An evaluation found that this dichotomy had led to a silo effect where the GEF-funded programs were designed and implemented largely in isolation from the mainstream country programs (UNDP, 2010). Sometimes projects intended to address sustainable development in the field are designed based on inadequate understanding of the interlinkages between natural and human systems (Reddy, Uitto, Frans, & Matin, 2006). Hence, the importance of understanding the nexus of human and natural spheres.

GEF strategies have evolved over the years from seeing the environment in isolation to recognizing the importance of the social, political, economic, and institutional context. Earlier, the biodiversity focal area focused exclusively on protected areas, while the current strategy focuses on addressing pressures on biodiversity loss, notably habitat loss, overexploitation, and invasive species (GEFIEO, 2017a). At the local level, the success of environmental management is closely dependent on generating support from local communities by creating win-win situations (GEFEO, 2006). There has also been a consistent trend toward integration, addressing landscape-level protection holistically. The GEF has also strengthened its focus on gender equality and women's empowerment, which are seen as essential for effectively dealing with global environmental problems. Stronger policies have also been put in place regarding social and environmental safeguards and the engagement of indigenous peoples (GEFIEO, 2017a).

Evaluation Challenges

Evaluation in the nexus faces inherent challenges. Human and natural systems have differing temporal and geographic scales that evaluation must deal with (Birnbaum & Mickwitz, 2009). Natural units, such as watersheds, do not necessarily adhere to political or administrative boundaries. Air and water pollution flows across borders over long distances (for instance, Japan and even the western USA are at the receiving end of air pollution from China). Such scale issues require the explicit attention of evaluators (Bruyninckx, 2009). Environmental and human timescales are often different; projects typically span over a few years, too short for environmental changes to materialize. A recent evaluation of land degradation projects found that environmental impacts on the ground typically take 4.5–5.5 years after project completion to become visible (GEFIEO, 2017b). Rowe (2012) suggested that a two-system evaluation is necessary for dealing with both human and natural systems in environmental evaluation.

Oftentimes, evaluations are framed so that their scope focuses narrowly on an intervention and its direct outputs and outcomes. This does not allow for the broader vision to emerge (i.e., how the intervention is situated in the overall environment and development landscape) nor for an assessment of whether the intervention is making a positive contribution to the issue it is

addressing (be it conserving biodiversity, reducing emissions or pollutants, or any other environmental issue). Apart from lacking the mandate to evaluate the intervention in the broader landscape, and its secondary and sometimes unanticipated consequences, evaluators may lack the competence to work across the natural–human systems. If an intervention achieves its outcomes but does not make a dent in the bigger context it is supposed to influence, it cannot be seen as relevant or having an impact (Berg, 2011).

Every intervention whether at policy, strategy, program or project level occurs in a complex dynamic system that is constantly changing. Bamberger, Vaessen, and Raimondo (2016, p. 5) have defined complexity both in terms of the intervention and the evaluation. The intervention is inclusive of contextual factors and the nature of the system within which the program is embedded, the characteristics of the intervention, the institutions and stakeholders and how they interact, and the nature of causality and the processes of change. The evaluation comprises the purpose of the evaluation, the choice of evaluation design, budget and time constraints, the value orientation of both stakeholders and evaluators, and the methodological preferences of the client(s) and other key stakeholders.

Evaluators must focus on the broader context within which the intervention operates and draw the boundaries of the system (Garcia & Zazueta, 2015). Theory-based evaluation provides a useful framework, but it is important that the theories are expanded beyond the internal intervention logic to encompass the broader system, taking into account the differing time horizons and geographical scales. Logic models cannot be static; they must allow for the dynamic nature of the system and account for how the intervention interacts with other actors and the external environment, which all change over time. Evaluation should not be tied to assessing an intervention against the logic model that was set when the intervention was designed, often years earlier. Rather, evaluation should reconstruct the theory of change, taking into account what has happened in the landscape during the lifetime of the intervention. It is also important for evaluations to identify unintended consequences that arise from the intervention. This requires an open theory of change that allows for reflection on external factors beyond the evaluand. Risks, uncertainties, and potential tipping points in the system have been exacerbated by climate change and other environmental factors, which pose challenges to linear models (Hildén, 2009; Picciotto, 2009).

Evaluating at the Nexus

The sixth comprehensive evaluation of the GEF illustrates in practice some of the possibilities of addressing the effectiveness, results and impact of an organization operating in the nexus of the global environment and human and societal factors (GEFIEO, 2017a). Given the complexity of the context that requires an understanding of both the natural processes and the

drivers of environmental change that often lie in the economic, political and social spheres, it is important to first gain an understanding how these operate and how they are linked to each other. When starting an evaluation, it is recommended to conduct a survey of the current scientific literature to gauge the state of the art of knowledge. Such a review allows us to refine our theory of change and minimize false assumptions. It also helps save time and effort. Understanding the natural and human systems is needed to identify the intervention impact mechanisms. An individual evaluator can of course not be an expert in all fields, so it is useful to build teams that include evaluators and subject matter experts with diverse backgrounds.

Example 1: Evaluating Multiple Benefits

One of the component evaluations focused on the achievement of multiple benefits through an analysis of a growing portfolio of multifocal area projects in the GEF (GEFIEO, 2017c). These projects have been designed to produce benefits through both environmental and socioeconomic outcomes. A majority of the projects target a combination of biodiversity, land degradation, and climate change outcomes. To be effective in protecting biodiversity or enhancing the sustainability of land management, projects need to enhance benefits to affected local populations. Carbon sequestration through sustainable forest management and improvements in vegetation cover is among the most effective ways to combat climate change. Taking a mixed methods approach, the evaluation consisted of three main components—portfolio evaluation, detailed case studies, mechanics/institutional evaluation.

The first component—the evaluation of the portfolio—identified spatial, temporal, and institutional trends across 250 projects operating in 460 sites. The evaluation team constructed and analyzed a dataset of design characteristics and outcomes using quantitative methods, such as propensity score matching, causal tree analysis, and multiple linear regression. Geospatial analysis was used to track forest cover and vegetation productivity changes in project sites. These approaches allowed the evaluation team to quantify on-the-ground environmental changes over time, and hone in on their determinants.

To dive deep into the different types of benefits generated by the projects and to understand the dynamics and explanatory factors, a second component involved five projects in four countries (Brazil, China, Malawi, and Senegal) that were selected for detailed case studies. For each of the projects, interviews were conducted with key national and local-level stakeholders ranging from government and international organization officials to local communities and civil society organizations. Further geospatial analyses on changes in forest cover, vegetation productivity, and land use were performed to verify and complement data acquired from qualitative sources.

The third component of the evaluation focused on the mechanics and institutional aspects of such complex multifocal projects. This component sought to assess the perspectives of different parts of the partnership in designing and implementing the projects. Low institutional capacity to implement project activities was found as a particularly significant obstacle to achieving outcomes.

The evaluation found that most of the projects aim to address the drivers of biodiversity loss, land degradation, and deforestation/forest degradation. Positive environmental outcomes were reported in terms of reduction of environmental stress or threats, ecosystem-level improvements, soil productivity, and vegetation cover. A large segment of the projects led to socioeconomic outcomes, including increased income or access to capital and natural resources by local populations, as well as improved cooperation, reduced conflict, and enhanced gender equality. These findings from an analysis of project-level evaluation reports corroborated by the field-based case studies resulted from synergies created in activities such as tree planting, ecosystem protection and rehabilitation, introduction of clean energy, reducing fuelwood use, and sustainable land management practices, including use of organic waste as fertilizer. Low institutional capacity, poor project management, and overly ambitious project objectives were found to be hindering the achievement of outcomes at the project level.

All case study projects reported trade-offs, confirming evidence from literature (Hirsch et al., 2011; McShane et al., 2011), between environmental and socioeconomic outcomes. These stemmed from restrictions to community access due to biodiversity conservation limiting access to timber, meat, and other natural resources that could provide income to local people. Similarly, trade-offs appeared between different environmental objectives, such as firewood extraction to replace fossil fuels in Senegal, or planting maize for fodder to reduce grassland grazing by cattle in China, both of which needed to be reconciled with the need for biodiversity protection. There were also temporal trade-offs, like in Brazil where landowners traded short-term benefits from timber and cash crops for longer term biodiversity protection and ecosystem services that would eventually enhance agricultural productivity. Finally, scale was found to be important in terms of conflicting priorities between national and local priorities. All case study projects employ strategies to mitigate trade-offs and enhance synergies.

Example 2: Evaluation of Lake Victoria Environmental Management

At a project level, the IEO conducted a case study of the Lake Victoria basin where the GEF has had a long-term engagement to rehabilitate the lake ecosystem for the benefit of the people living in the catchment and the national economies of countries in the catchment: Burundi, Kenya, Rwanda, Tanzania, and Uganda. Lake Victoria is the second largest

freshwater body in the world and its catchment is one of the most densely populated areas, with more than two million people directly or indirectly dependent on the fishing industry. Their livelihood was direly threatened by the emergence of a water hyacinth invasion starting in the late-1980s. The water hyacinth—an invasive species—spread quickly, creating a thick layer that prevented fishermen from accessing the lake, and hampered water supply and treatment. Malaria and other diseases increased as the hyacinth beds created breeding grounds for mosquitoes.

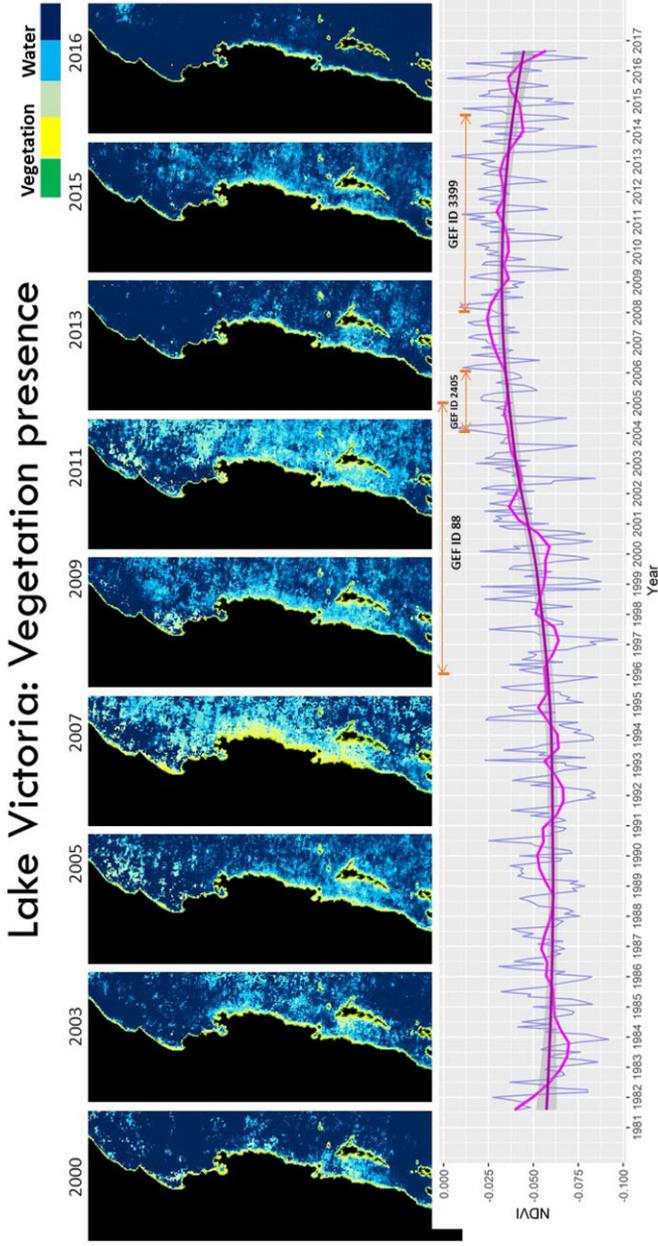
The three countries directly bordering the lake—Kenya, Tanzania, and Uganda—signed a Lake Victoria Environment Management Plan Tripartite Agreement in 1994. The countries approached the GEF through the World Bank for a project to support them in tackling the environmental problem. The project was approved in 1997 (Ollila, Uitto, Crepin, & Duda, 2000). The first project was subsequently followed by two follow-up projects to address the lingering problem.

The International Waters Program Evaluation conducted by the IEO (GEFIEO, 2016b) utilized remote sensing analysis to demonstrate changes in the Lake Victoria environmental status and the hyacinth infestation, relating it to the project interventions over time. The study measured the Normalized Difference Vegetation Index (NDVI) derived from daily observations over the lake aggregated at temporal and spatial dimensions. The availability of a time series of satellite imagery allowed IEO to overcome the lack of environmental baseline information from the early stages of the intervention. While the analysis showed distinguishable seasonal characteristics, the interannual trend detected from remote sensing analysis showed that the overall NDVI continued to increase until 2008 (48% over the base year of 2000) and only started decreasing after that (Figure 3.1).

This demonstrates the time lag in achieving environmental status improvements. Although the projects were generally well designed and embedded in the national development plans of the basin countries, employing and testing comprehensive approaches to the management of the lake ecosystem and controlling the water hyacinth, it still took a decade or more to see results. Demonstrating the importance of drawing the system boundaries, analysis showed that the initial focus on the three lacustrine countries was not adequate, as the source of the infestation was upstream and the water hyacinth was found to be entering the lake through Kagera River. Consequently, the second project approved in 2008 included the upstream countries of Burundi and Rwanda.

The GEF international waters program has for the past two decades used a framework that tracks progress at three levels: process, stress reduction, and environmental status (Uitto, 2004). The case of Lake Victoria focused on evaluating the environmental results in terms of improved environmental status, which often take a long time to materialize. It is therefore important to track the steps taken along the way. The process indicators refer to actions by the project or other intervention. The stress reduction

Figure 3.1. Tracking Water Hyacinth Infestation in Lake Victoria Using Remote Sensing Imagery.



Source: GEFIEO, 2016b.

indicators refer to the results of these actions that relieve the pressure on the environment. This can be verified, for example, by measuring the actual amount of pollutants that are released to the waterbody from point or non-point sources. These intermediate outcomes are important yardsticks, as they happen earlier in the process than environmental changes, are easier to attribute to the intervention, and are essential in leading to the impact on the ground. Conducive enabling environment as manifested in policy, legal, and regulatory frameworks is particularly important (GEFIEO, 2017d). Institutional strengthening, capacity development, and enforcement of the laws and regulations are needed. Again, these processes may take a long time and are contingent on many factors, such as the scope of the proposed law, political sensitivities, competing interests of different constituencies, budgetary constraints, and the stability and capacity of the government institutions (GEFIEO, 2017e).

Conclusions

This article demonstrates the interlinked nature of the three layers of sustainable development, with the social and economic layers resting on the natural environmental foundation. Land, water, and biological resources are essential for the survival and wellbeing of humankind. The evaluation examples provided illustrate the challenges in evaluating in the nexus between natural and human systems. They also provide pointers from state-of-the-art evaluation to address these challenges.

Evaluators need to take a comprehensive view and not evaluate individual interventions in isolation from their context. Scoping an evaluation must start with an analysis of the complex dynamic system in which the intervention is situated. It is important to identify the system boundaries within which the intervention operates and the different components of the system with which the intervention interacts. In doing so, it is advisable to draw upon existing knowledge, which will include reviewing relevant scientific literature. We need to understand the drivers of environmental change, which are most often found in the human realm: including production of economic goods, energy, population growth, and urbanization.

Equally important is to understand how the activities undertaken to promote certain objectives impact the natural environment, through resource use and extraction, changes in land use/cover, deforestation, pollution, etc. Understanding the drivers and motivations, including linkages to economic incentives as well as policy and regulatory frameworks, is necessary to analyze the situation holistically and to assess the intervention in its context, including its unintended and unforeseen consequences. This type of analysis is versatile and can be used equally in summative as well as formative evaluation.

Once we have set the foundation for the evaluation with a logic model that is informed by the best available science and that incorporates the

dynamic complex system context, it is important to identify appropriate methods based on the object of the evaluation and the questions we want to answer. Evaluation approaches and methods must be driven by the evaluation questions. Too often, we see evaluations that are designed to apply specific methods irrespective of the purpose of the evaluation or the characteristics of the evaluand. In our experience, mixed approaches and methods are most often needed. As evident from the above examples, limiting evaluation to experimental and quasi-experimental approaches, such as randomized controlled trials (RCTs), would not have been able to explain the complex interactions between the human and natural systems over time and space.

We have pioneered the use of geospatial tools for analyzing environmental change (Lech, Uitto, Harten, Batra, & Anand, 2018). These tools are very useful to establish a time series of observable changes in factors, such as land use/cover, vegetation, infrastructure, and other physical phenomena. They can also be used to measure the level of economic development through techniques, such as mapping of nightlights. We have also used tools, such as machine learning and causal tree analysis, to isolate the determinants of observed environmental change. While these tools can often provide information about what has happened, understanding the drivers and mechanisms behind such changes commonly requires verification and ground-truthing. Hence, mixed methods that combine policy analysis and field work will result in the best evaluations.

Evaluating sustainable development at the nexus does not take place automatically. There is a need for capacity in the organizations, as well as a common understanding between evaluators, commissioners, and users of evaluation. Evaluators must have the mandate and vision to look beyond individual interventions and their direct outcomes, whether they operate primarily in the development arena or have direct environmental objectives. Evaluations must be informed by current scientific knowledge about human and natural systems interactions. There is a need to develop a more integrated evaluation framework to connect the environmental, economic, and social dimensions of sustainable development. Theory-based approaches still appear best suited to evaluation in the nexus, but they must address the complex relationships, differing time, and geographical scales. Multidisciplinary teams and utilization of multiple methods are needed to materialize this vision.

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