IEO BRIEF

Measuring Environmental Outcomes Using Remote Sensing and Geospatial Methods

Independent Evaluation Office
GLOBAL ENVIRONMENT FACILITY

This brief presents the environmental outcomes of GEF projects based on remote sensing analysis.

INTERNATIONAL WATERS: LAKE VICTORIA

Context. Lake Victoria, with a surface area of about 68,800 km^2, is the second largest freshwater body in the world. It is a transboundary resource shared by Kenya, Tanzania, and Uganda. Rwanda and Burundi are a part of the upper watershed that drains into Lake Victoria through the Kagera River. The water hyacinth is an invasive weed that was first reported in Victoria Lake in 1988. It spread across the lake, cutting off communities and putting the economic and food security of millions at risk.

Over the past two decades, the GEF has supported the Lake Victoria ecosystem through three primary interventions. These were the Lake Victoria Environmental Management Project (June 1996–December 2005), Transboundary Diagnostic Analysis and Strategic Action Program Development for the Lake Victoria Basin (April 2004–December 2006), and the SIP: Lake Victoria Environmental Management Project II (December 2008–June 2015). The overall objective of these interventions was to address major threats facing the Lake Victoria ecosystem, including nutrient load management in the upstream areas so that the nutrient load is lessened in Lake Victoria and clearing the water hyacinth on site. The first project included Kenya, Tanzania, and Uganda and applied various control methods, including the use of biological agents—natural enemies of the water hyacinth. Since the Kagera River is the primary source of inflow into Lake Victoria and of the hyacinth infestation, the second and third projects were expanded to Rwanda and Burundi. Remote sensing methods were used to observe changes in hyacinth infestation (figure 1).

Results. By the end of 2016, the satellite data derived vegetation productivity measured in terms of the normalized difference vegetation index (NDVI) shows that overall vegetation in Lake Victoria has entered a decreasing

PURPOSE AND METHODS: Remote sensing and geospatial methods are useful, innovative tools for measuring environmental impact. They provide reliable and cost-effective baseline information, help detect changes over time, and track progress toward the achievement of convention targets.

To measure the impacts of Global Environment Facility (GEF) interventions, the GEF Independent Evaluation Office (IEO) has utilized remote sensing across focal areas including biodiversity, land degradation, and international waters.

WEB PAGE: www.gefieo.org/evaluations/measuring-environmental-outcomes-using-remote-sensing-and-geospatial-methods

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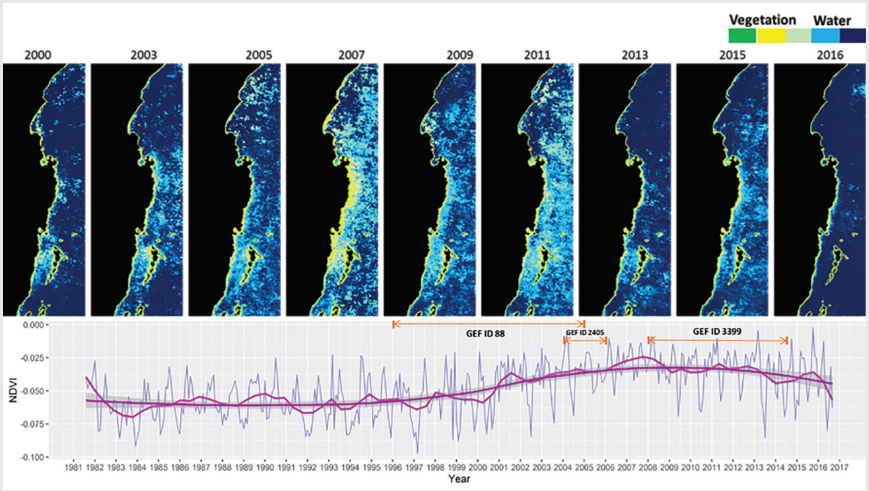
ABOUT US: The GEF IEO has a central role in ensuring the independent evaluation function within the GEF. www.gefieo.org

OPS6
SIXTH COMPREHENSIVE EVALUATION OF THE GEF

FIGURE 1: Vegetation productivity trend around Lake Victoria



NOTE: The data show the project periods and how the amount of vegetation around the western shoreline of Lake Victoria has decreased from its peak value over the last few years

phase. Today, the levels of vegetation productivity have been reduced from their peak and are now about 20 percent more than in 1981.

Link. www.gefieo.org/evaluations/international-waters-focal-area-study-2016

BIODIVERSITY: MEXICO

Context. Since 1990 Mexico has received more than $2.6 billion in GEF grants and cofinancing from national and global sources. The Fund for Protected Areas (FANP), was created in 1998 with GEF support to strengthen Mexico's protected area system. GEF support also helped Mexico consolidate and strengthen the protected area system through major projects such as National System Protected Areas (SNAP I; 1997), the Mesoamerican Biological Corridor Project (2000), and the National System Protected Areas (SNAP II; 2008). These projects were designed to conserve and promote sustainable use of biodiversity, promote social co-responsibility and participatory planning for conservation, remove institutional and technical barriers, and mainstream biodiversity and sustainable criteria in interventions and practices affecting protected areas.

Given the GEF's long-term support to Mexico and fewer gaps in identifying GEF-supported protected areas, the GEF IEO was able to conduct a robust quasi-experimental analysis to assess the impact of GEF funding. Using propensity score matching and satellite data, the IEO compared GEF-supported protected areas with similar protected areas that did not receive GEF support (figure 2).

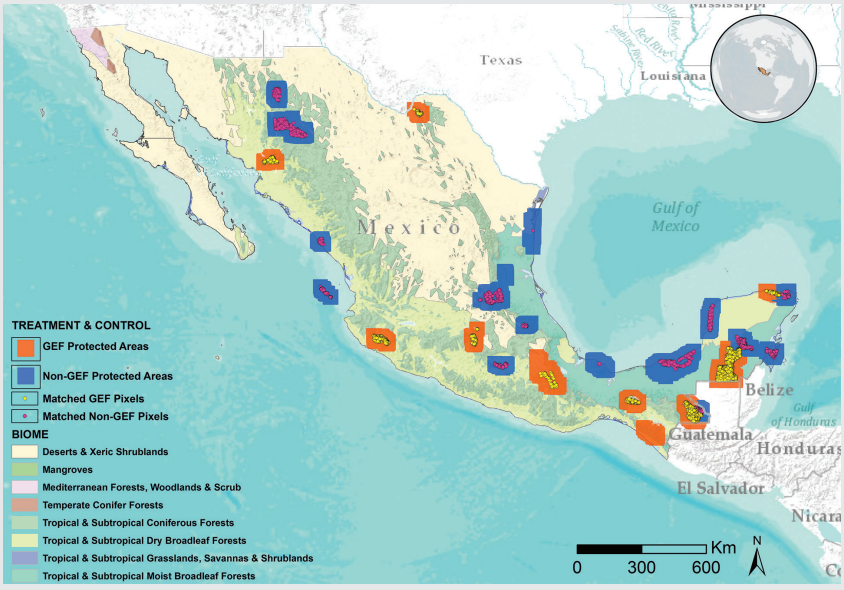
Results. The analyses show that GEF-supported protected areas in Mexico avoided up to 23 percent forest loss from 2001 to 2012 compared to protected areas that did not directly receive GEF support during this period. The results varied across biomes and ecoregions.

Link. www.gefieo.org/sites/default/files/ieo/evaluations/files/ImpactEvaluationSupport-2016.pdf

LAND DEGRADATION (MULTIFOCAL): MADHYA PRADESH, INDIA

Context. The Sustainable Land and Ecosystem Management Country Partnership Program (SLEM-CCP) in India was launched in 2009 with the United Nations Development Programme (UNDP) and the World Bank as lead GEF Agencies. The program was designed

FIGURE 2: GEF- and non-GEF-supported protected areas in Mexico



NOTE: A quasi-experimental research design powered by satellite data was used to find counterfactual non-GEF protected areas to assess the impact of GEF support.

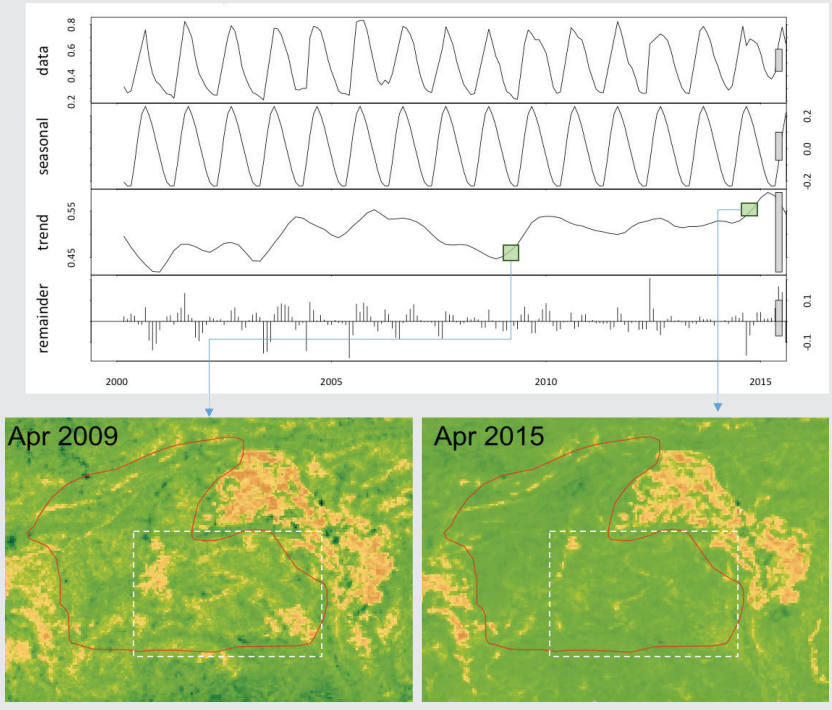
to pilot and demonstrate integrated approaches to management of production systems and generation of global environmental benefits, including adaptation to climate change. The program's three main components were to (1) reverse and control land degradation and biodiversity loss while taking climate change into account; (2) enhance institutional and local adaptive capacity to improve land and ecosystem resilience; and (3) mainstream and upscale SLEM at the local, national, and regional levels.

The SLEM-CCP consisted of six subprojects mainly located in the dryland zone, which is vulnerable to the degradation of land, water, and forest resources that is likely to be intensified by climate change. Integrated Land Use Management to Combat Land Degradation in Madhya Pradesh was one of these six subprojects. It was implemented in 10 forest divisions of five districts in Madhya Pradesh covering an area of 15,000 ha of degraded bamboo forests. Participatory co-management and rehabilitation of such forests was an important project component. Satellite data from the National Aeronautics and Space Administration (NASA) were used to derive the vegetation index to assess vegetation change in three locations (figure 3).

> **"The application of geospatial approaches in evaluation enables us to address some of the challenges of traditional methods, and cost-effectively collect objective evaluative evidence."**
>
> —Anupam Anand, IEO Evaluation Officer

Results. The canopy cover in the project area has improved over the project period. The NDVI in 2015 increased about 10 percent from 2009 levels. The vegetation significantly improved inside the project area as compared with outside.

FIGURE 3: Vegetation productivity trend in Madhya Pradesh



NOTE: The time-series plot shows increase in vegetation productivity since project start (upper panel). Vegetation productivity maps from before the start of the project and around the end of the project show restored areas (lower panel).

Link. http://www.gefieo.org/evaluations/land-degradation-focal-area-ldfa-study-2017

BIODIVERSITY (MULTIFOCAL): JORDAN

Context. The Jordan Badia is a desert ecosystem spanning 80 percent of the country's area; it is administratively divided into northern, middle, and southern parts. The Badia Ecosystem and Livelihoods Project (BELP) is designed to enhance ecosystem sustainability and local livelihoods through a number of strategic interventions. These include investing in ecotourism and land use planning in the north, developing water harvesting infrastructure, rangeland reserves, and diversification of livelihoods in the south, since raising livestock is the primary income-generating activity. The government of Jordan has also invested in protected areas located in the Badia. In addition to generating multiple environmental benefits such as water availability for food and fodder production, project interventions in the south are expected to result in an increase in vegetation cover and biomass across the 3,000 ha through the direct participation of the beneficiary local communities in maintaining and managing the reserves. Dense time-series remote sensing data from NASA satellites were analyzed to observe progress in the rangeland revegetation program around these reserves.

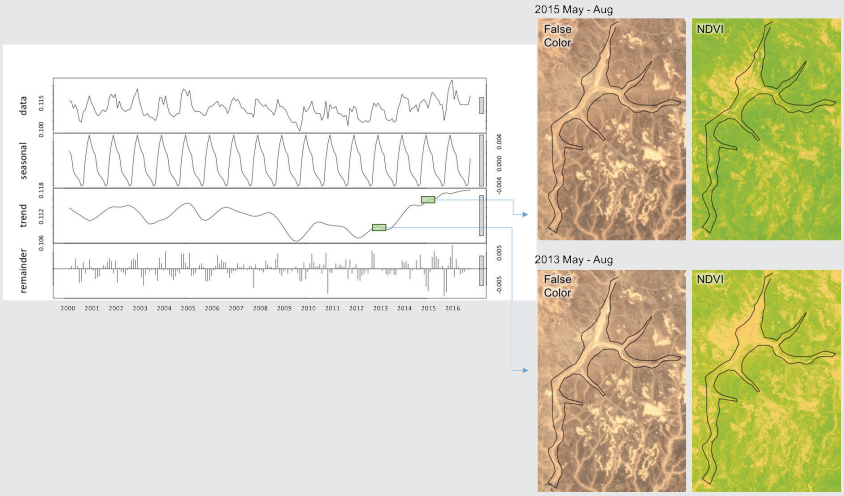
Results. The results show consistent improvement in vegetation cover around all the reserves included in the project. In the Al Hashemiah reserve, the

vegetation growth trend has improved since 2013 (figure 4).The average summer vegetation productivity (NDVI) in 2015 increased to about 10 percent compared to preproject 2012 levels. The vegetation significantly improved inside the range reserve as compared with outside. The remote sensing analysis results were validated by a case study as part of a programmatic approach evaluation.

CONCLUSIONS

Given scarce resources and time constraints, remote sensing and geospatial data and tools could prove to be valuable in complementing other evaluation methods. Use of these tools are a low-cost method of generating baseline information that could provide directions both for future programming and impact assessments. These tools have the potential for use in ecological forecasting, which can then be used in ex ante assessments. Using biophysical and socioeconomic baselines, ecological forecasting can help predict the generation of multiple global environmental benefits regarding ecosystem services such as forest cover, habitat quality, and carbon sequestration at a fine scale, as has been applied by the IEO in Kenya.

FIGURE 4: Vegetation growth trend around the Al Hashemiah reserve



NOTE: The color and NDVI maps corroborate the trend of vegetation growth over a period of two years since the project started.

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