USAID
FROM THE AMERICAN PEOPLE

BETTER BIODIVERSITY INTEGRATION THROUGH **GEOSPATIAL ANALYSIS**

SEPTEMBER 2019

GHANA. Photo for USAID, 2017

CONTRACT INFORMATION

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INTRODUCTION

COLOMBIA. Photo for USAID, 2015

Geospatial analysis is an increasingly common tool for biodiversity programming at USAID. Geospatial analysis allows USAID staff and their partners to identify biodiversity priorities, threats and their drivers, and approaches to reducing those threats. In addition, geospatial analysis allows USAID to monitor its biodiversity programs, identify challenges to implementation and adaptively manage.[1] As a result, geospatial analysis is frequently used for biodiversity program design and implementation, and geospatial specialists trained in these methods are often members of both USAID implementing partner and field mission teams.

1 See the USAID publication "Incorporating Geospatial Analysis into USAID Biodiversity Program Design," for more information.

As the use of geospatial analysis for biodiversity programming has increased, so has its use for integration of biodiversity with other development sectors (see Box 1). The benefits of using geospatial tools for integrated programming are substantial. Geospatial analysis allows data from multiple sectors to be displayed in a single place, thus facilitating the identification of shared priorities, challenges and opportunities for cooperation or collaboration. It also allows the identification of specific sites for integrated activities, the design and mapping of coordinated interventions, and the monitoring of spatially explicit performance indicators. Based on these indicators, USAID staff can begin to understand the relationships between outcomes in multiple sectors and to quantify the degree to which integrated programming can yield benefits beyond those possible just through single sector programs.

To support the use of geospatial analysis for biodiversity integration, the USAID Office of Forestry and Biodiversity (E3/FAB) and the Bureau of Latin America and the Caribbean's Environment Team (LAC/RSD/ENV) worked with the USAID BRIDGE project (Biodiversity Results and Integrated Development Gains Enhanced) to develop recommendations for using geospatial analysis in USAID's integrated biodiversity programming. During this work, BRIDGE staff conducted interviews with USAID and implementing partner staff to identify the enabling conditions and best practices for using geospatial analysis for biodiversity integration throughout the program cycle. The resulting guide is a starting point for USAID staff in incorporating geospatial analysis into their own work.


MYANMAR: Spatial awareness exercises. Photo for USAID, 2017

BOX 1 WHAT IS GEOSPATIAL ANALYSIS?

Geospatial analysis is the gathering, display and analysis of data with a spatial component. These data can range from satellite imagery, to global datasets on forest cover, to geographically referenced census information. In addition, these analyses can range from simple display and overlay of data to complex statistical analysis. In all cases, the purpose of geospatial analyses is to answer questions that would not be possible without using spatial data, such as: Where are the biodiversity priorities in a country and how do they overlap with priorities in other sectors? What specific sites might be most appropriate for integrated activities? Are positive outcomes in biodiversity programming correlated with positive outcomes in a partner sector? Answering these questions can help USAID better design and implement integrated programs.

PURPOSE AND STRUCTURE OF THIS GUIDE

The purpose of this guide is to support the use of geospatial analysis for integrating biodiversity conservation with other development sectors at USAID. This guide is divided into four chapters corresponding to the four stages of the program cycle. Each chapter consists of four sections that provide the why, when and how of using geospatial analysis, including the rationale for the use of geospatial data and analysis, enabling conditions, best practices and an example from USAID programming.

This guide is intended primarily for USAID environment staff without a background in geospatial analysis. As such, readers are strongly encouraged to contact mission or Washington geospatial specialists if they are interested in applying these recommendations to their own programming (see "Key Enabling Conditions," below). This said, this guide is also intended to support geospatial specialists at both USAID and its implementing partners in organizing and making the case for their work.

KEY ENABLING CONDITIONS

Certain key enabling conditions for the use of geospatial analysis in integrated programming are important in every stage of the program cycle.

Leadership support. The most commonly cited enabling condition by USAID staff for the use of geospatial analysis in integration is the support of mission leadership. Leadership support provides the foundation for geospatial analysis by enabling the hiring of geospatial staff, acquisition of GIS software and licenses, and long-term details of Washington staff to mission projects. In addition, leadership support during strategy, project or activity development ensures that geospatial needs and questions are incorporated into the planning process from the beginning, and that the results of geospatial analysis are incorporated into mission designs. The rationales for using geospatial analysis provided throughout this guide can be useful in communicating the utility and importance of investing in these methods to leadership and thus gaining their support.

Mission geospatial specialist support. The second-most commonly cited enabling condition is support from mission and Washington geospatial specialists. Geospatial specialists are staff that are trained in geospatial analysis and the geographic information system (GIS) software packages used to organize, display and analyze geospatial data. These personnel can work as part of technical, program office and front office teams, and commonly perform other tasks in addition to geospatial analysis at USAID missions. Interviews with USAID staff indicated that foreign service nationals are often particularly suited to this work due to their familiarity with national institutions and civil society organizations, and their ability to negotiate access to their datasets. The USAID GeoCenter (see "Washington geospatial specialists support" below) maintains the USAID mission geospatial specialists network and supports USAID missions in advocating for, advertising and hiring geospatial specialist positions.

Washington geospatial specialist support. In addition to mission geospatial staff, USAID/Washington provides geospatial support for biodiversity programming through specialized expertise at the Office of Land and Urban (E3/LU) and the USAID GeoCenter. The Office of Land and Urban is the Agency lead for geospatial support for cross-sectoral natural resources management analysis and is available to provide support throughout the program cycle. The GeoCenter provides Agency-wide support for geospatial analysis, including its role as the Agency lead for geospatial needs assessments for missions and geospatial trainings for USAID staff in Washington and the field. The GeoCenter additionally supports a global network of GIS specialists in missions and in Washington; helps missions to hire and onboard these staff; and supports them with a community of practice that boasts more than 50 specialists across the Agency.

Data availability. In addition to technical capacity, data availability is an essential enabling condition for successful geospatial analyses. Gathering and preparing geospatial data for analysis is typically the most time-consuming component of these analyses, and the availability of relevant, accurate and current data is a key criterion in determining whether these analyses should be attempted. Geospatial data on administrative boundaries, population centers and densities, and roads or protected areas are useful throughout the program cycle and are often available from national or international agencies. Other geospatial data are useful at specific stages in the program cycle, such as data on prior programming by USAID or other donors, or data on location-specific threats. These specific data needs are described as relevant in the following chapters.

Geospatial products are typically available from multiple sources, and with multiple extents and degrees of detail. Common sources include national, non-governmental and academic institutions, and data availability can depend on the status of national geospatial infrastructure and presence of technocrats or civil society with geospatial skills. This said, substantial progress toward biodiversity conservation and cross-sectoral programming can be made with global datasets alone. Global data on forest loss, endangered species and critical ecoregions such as those produced by the University of Maryland, the International Union for the Conservation of Nature and the World Wildlife Fund are often a useful starting point. Global and publicly available terrain or satellite image data repositories are also key resources available from the University of Maryland. A full list of these resources is beyond the scope of this guide, but readers are recommended to consult mission or Washington geospatial specialists for more information.

Build in geospatial analysis from the beginning. Lastly, USAID staff consistently cited the importance of preparing early for geospatial analysis during program design, implementation, or monitoring and evaluation. This preparation includes initial meetings between technical, program and geospatial staff to agree on the goals and role of geospatial analyses. It also includes the early identification of skills, staffing and procurement needs for geospatial analysis. Early preparation ensures a clear role for geospatial data and specialists from the beginning of these processes, and provides teams ample time to identify questions and geospatial needs. It also provides the time needed to identify technical assistance needs from Washington and to incorporate geospatial requirements into contracts and agreements.

MYANMAR. Photo by Jason Houston for USAID, 2017

USEFUL RESOURCES

As mentioned above, geospatial specialists and guidance from USAID/Washington are valuable resources for geospatial analysis throughout the program cycle. Following is information for key Washington resources:

Office of Land and Urban (E3/LU)

The Office of Land and Urban is the lead for cross-sectoral natural resource management geospatial analysis at USAID and provides technical support to missions and operating units throughout the program cycle and at any stage of the design, procurement and implementation process. More information is available from:

- The LandLinks website: https://land-links.org/tools-and-mission-resources/geospatial-analytics
- The E3/LU request email address: landmatters@usaid.gov
- E3/LU geospatial specialists: Ioana Bouvier (ibouvier@usaid.gov) and Silvia Petrova (spetrova@usaid.gov)

USAID GeoCenter

The GeoCenter provides support for programming by all development sectors as requested by USAID missions, ranging from data acquisition, to country and regional analytics, to supporting the development of mission strategies and programs. This unit also supports the use of satellite data across the Agency, is responsible for Agency guidance on geospatial data and analysis, provides geospatial training and assistance for hiring of geospatial specialists, and supports the global geospatial specialists network. More information is available from:

- The GeoCenter website: http://geocenter.digitaldevelopment.org/
- The GeoCenter request email address: geocenter@usaid.gov@usaid.gov
- GeoCenter director and deputy director: Carrie Stokes (cstokes@usaid.gov) and Michael Crino (mcrino@usaid.gov)

ADS Guidance, Mandatory References and Additional Help

The USAID Automated Directive Service (ADS) provides Agency-wide guidance on the collection and use of geospatial data through the ADS itself, its mandatory references and additional help documents. Some key resources are:

- ADS 201.3.5.7 G (www.usaid.gov/ads/policy/200/201): This section of the ADS recommends that indicator data be disaggregated to geographical levels that are feasible and useful for management purposes. This guidance is supported by the Additional Help document below.
- Mandatory Reference for ADS Chapters 201 and 579 on Activity Location Data (www.usaid.gov/ads/policy/500/579mab): This mandatory reference to the ADS establishes the requirements governing USAID's development data lifecycle from collecting data to making it accessible. While collecting this type of data occurs at the activity level, its value in promoting analytic rigor, evidence-based decision-making and adaptive management applies throughout the Program Cycle.
- Additional Help for ADS Chapter 579 on Geographic Data Collection and Submission Standards (www.usaid.gov/ads/policy/500/579saa): This additional help document for ADS 579 defines standards and procedures that apply to geographic data used in planning, managing and implementing USAID development programming.
- Additional Help for Monitoring Data Disaggregation by Geographic Location (https://usaidlearninglab.org/library/monitoring-data-disaggregation-geographic-location): This document provides supplemental guidance to ADS 201.3.5.7 G Indicator Disaggregation, and discusses concepts and methods needed to collect and analyze geographically disaggregated indicators for improved performance monitoring, learning and adapting.

CHAPTER 1

COUNTRY AND REGIONAL STRATEGIC PLANNING

DEMOCRATIC REPUBLIC OF CONGO. Photo for USAID, 2018

WHY USE GEOSPATIAL ANALYSIS DURING STRATEGIC PLANNING?

The development of a regional or country development cooperation strategy (R/CDCS) provides a whole-of-mission opportunity for USAID to identify options for integration between biodiversity conservation and other development sectors. During R/CDCS development, USAID operating units consider options for foreign assistance across their portfolio, including possible overlaps and co-benefits between sectors. In addition, prior to R/CDCS development, sections 118 and 119 of the Foreign Assistance Act require that USAID operating units conduct analyses ("118/119 analyses") of actions needed to protect biodiversity and tropical forests, how USAID programming meets those needs, and how the new R/CDCS can respond to the actions needed.[2] Together, 118/119 analyses and R/CDCS development allow USAID staff to identify integration opportunities early in the program cycle and set the stage for integrated projects and activities.

2 118/119 analyses are required for all missions regardless of biodiversity funding status and can be used to inform both biodiversity and other development sector activities. For more information see the Foreign Assistance Act Sections 118/119 Tropical Forest and Biodiversity Analysis Best Practices Guide.

PALAWAN, PHILIPPINES: Local leader explains ancestral domain claim. Photo by Jason Houston for USAID, 2017

Geospatial analysis provides a useful tool for supporting 118/119 analyses, visually communicating their findings and helping incorporate these findings into R/CDCS development. Through geospatial analysis and 118/119 analysis, strategy development teams can visualize overlaps between multiple sectors, identify possibilities for integrated programming and revise these possibilities as new data becomes available. Opportunities for using geospatial analysis during strategic planning include:

1. **Defining the broad geographic scope** of biodiversity programming during 118/119 analyses, using available mission or partner data on priority landscapes.
2. **Verifying key threats** to priority species or landscapes by overlaying their locations with available geospatial data on threats such as forest loss or overfishing.
3. **Forecasting future threats** to biodiversity priorities based on information about drivers of biodiversity and tropical forest loss such as road construction or demographic trends.
4. **Identifying integration opportunities** during 118/119 analyses by overlaying the geographic scope of biodiversity programming with current or proposed programming in other sectors, and programming by other donors if available.
   Box 2 provides examples of the questions that can be answered using geospatial analysis.
5. **Visually communicating** the findings of 118/119 analyses and possibilities for integrated programming in map format, such as overlaps in sector priorities, and use these as part of R/CDCS planning and documentation.
6. **Recording the logic** used to identify R/CDCS priorities and allow it to be modified as new information becomes available.

WHEN TO USE GEOSPATIAL ANALYSIS FOR STRATEGIC PLANNING?

Geospatial analysis can be a powerful tool for identifying integration opportunities across the portfolio of a USAID operating unit. Following are some favorable conditions for the use of geospatial analysis during 118/119 analysis and R/CDCS development:

- **The mission has a geographic story to tell**. Geospatial data and associated analyses are particularly helpful when the mission has identified a geographic story to tell about country-level plans. This is often the case when specific regions, landscapes or species within the country are important for programming in both biodiversity and other sectors, or when a mission's work is geographically concentrated due to institutional or host-country constraints. Geospatial analysis provides an opportunity to tell this story and explain how integration might be possible. This said, both 118/119 and supporting geospatial analyses should provide an objective assessment of biodiversity conservation needs in the host country, rather than justify conclusions that have been previously reached due to institutional constraints.
- **Geospatial data is available from partners at governmental or non-governmental institutions**. As noted above ("Data Availability"), data availability is a key enabling condition for geospatial analysis, and this is particularly true for 118/119 analyses and project design (see below, "Project Design and Implementation"), where data is not separately available from ongoing activities. National-scale datasets on priorities or challenges are powerful tools for identifying broad-scale patterns for development sectors and intersections between them. These can then be used to identify geographies and sector combinations for which integrated programming might be warranted. For example, during 118/119 analyses, national datasets showing geographic trends in population growth might be helpful to illustrate where pressure is increasing on natural resources. For more information, see the "Key Enabling Conditions"above.
- **Geospatial data is available from past or ongoing USAID programming**. To be useful, data from governmental or non-governmental sources should be complemented with geospatial data from USAID programming, including prior Foreign Assistance Act 118/119 analyses, ongoing or past activities, and monitoring and evaluation results. This allows USAID to incorporate institutional considerations such as support for current beneficiaries or gaps in prior programming. For more information, see the "Key Enabling Conditions" above.
- **Activity location data is available about other donors**. If available, country or region-level data on the investments of other donors can allow USAID to identify locations in which programming might be redundant or uniquely valuable.

BOX 2 USEFUL INTEGRATION QUESTIONS

- ***For countries or regions receiving both biodiversity and other development funds***, in what areas has USAID invested significant resources in biodiversity and other sectors, and what areas have high potential for future investments? Of these, what areas do biodiversity and other sectors have in common?
- ***For countries or regions not receiving biodiversity funds***, does mission programming overlap important biodiversity areas such as national parks or biodiversity hotspots and what are the opportunities for integration?
- ***For all countries and regions***, in what areas are non-USAID natural resource management organizations (national and international) working most intensively, and what are the opportunities for USAID's work to complement or fill the gaps left by this work? In addition, in what areas are major infrastructure, extractive or agricultural developments concentrated, and how do these overlap with biodiversity priorities?

BEST PRACTICES

To maximize the benefits of geospatial analysis for 118/119 analyses and R/CDCS development, USAID experience indicates that missions should explore and invest in these tools early in these processes, ensure that they are used to inform strategy, and provide mechanisms for delivery of data from 118/119 contractors to USAID. Following are some key best practices:

1. USAID operating units should clarify the **story** they want to tell or **questions** they want to answer early in the process—ideally during the development of 118/119 scopes of work[3] and prior to 118/119 analyses. Box 2 provides examples of questions that can be answered using geospatial data. As part of this process, missions should also identify the data and analyses needed to meet these needs, and use this information to prepare scopes of work for future support.
2. In order to answer these questions, **scopes of work** for 118/119 analyses should include the identification, gathering and analysis of geospatial data and inclusion of these results in 118/119 documentation; and the sharing of these data, analyses and documentation with the mission when complete.
3. Missions should evaluate the composition of 118/119 contractor **teams** to ensure that they contain geospatial expertise. Agency geospatial specialists can help provide the technical experience needed to design, procure, implement and communicate the results of 118/119 analyses.
4. In preparation for 118/119 analyses (for example, prior to fieldwork or during work planning) the mission and its 118/119 contractor should determine the quality and quantity of available geospatial **data**, and use these to prioritize analyses from most to least feasible. Key data can include the location of important species, ecosystems, watersheds and protected areas; landuse and landcover; weather and climate data; and ecosystem loss and its drivers. Consultation with a mission or Washington geospatial specialist is useful in assessing the quality of data and feasibility of analyses (see above, "Key Enabling Conditions" and "Useful Resources").
5. The USAID Foreign Assistance Act Sections 118/119 Tropical Forest and Biodiversity Best Practices Guide (the 118/119 Guide) recommends that at least four **maps** be included in 118/119 analyses: main ecosystems; forested areas and land uses; protected areas including forest reserves; and aquatic and marine resources.
6. Geospatial **analyses** conducted as part of the 118/119 analysis or during R/CDCS phase one can complement these recommended maps and inform technical discussions throughout the analysis process. Geospatial analyses can also help answer and refine the questions identified above and develop a narrative that can directly inform R/CDCS development.
7. Even seemingly **simple** geospatial analyses can be surprisingly valuable. Simple overlays of the priorities or prior programming of sectors can highlight key opportunities and provoke thinking for integration.
8. **Collaboration** should be encouraged between the contractors responsible for 118/119 analyses and USAID geospatial specialists at the mission or in Washington including writing this collaboration into 118/119 contracts and, if possible, having a USAID geospatial specialist accompany the 118/119 team during field visits.
9. Once 118/119 analyses are concluded, all data and analyses used by the 118/119 contractor should be **delivered** to USAID with clear documentation of their origins, use and results. This permits USAID to replicate or update these analyses in the future if needed (see above, "ADS Guidance, Mandatory References and Additional Help").

3 A template for 118/119 scopes of work can be found at: https://rmportal.net/biodiversityconservation-gateway/gateway-resources/foreign-assistance-act-sections-118-119-tropical-forest-and-biodiversity-analysis-best-practices-guide

AN EXAMPLE FROM USAID PROGRAMMING

In 2018, USAID/Jamaica conducted a 118/119 analysis in preparation for development of their second CDCS. To conduct the analysis, the mission assembled a team of environmental specialists from the West Indies region, supplemented with geospatial expertise from staff with the USAID E3/ Land and Urban Office. As a starting point, these geospatial specialists used the recommendations of the 118/119 Guide and gathered data on four topics: ecosystems, forested area and land use, protected areas, and aquatic and marine resources. They also aimed, where possible, to conduct geospatial trend analysis on forest loss and threats to biodiversity.

The Land and Urban Office geospatial analysts identified nine key global datasets yielding data on landcover (Figure 1), freshwater and marine ecosystems (Figure 2), and protected areas and biodiversity conservation priorities (Figure 3). In addition, the analysts obtained locations from other sectors and overlaid these on the biodiversity data to identify possibly overlaps between USAID programming and biodiversity priorities (Figure 3). Furthermore, based on global forest loss datasets, Land Office staff were able to identify areas of forest loss in priority ecosystems such as coastal mangroves (Figure 4). Though mission planning is still ongoing, these data and simple analyses have provided an opportunity to identify biodiversity priorities, threats, and conservation and integration opportunities in Jamaica.

FIGURE 1

Eight landcover classes for Jamaica, where shades of green indicate vegetation, shades of purple indicate wetlands and black indicates urban areas.

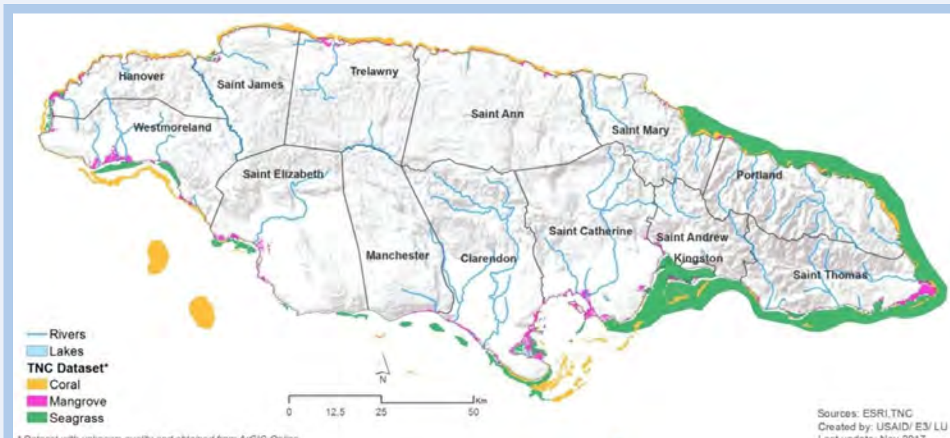


FIGURE 2

Aquatic ecosystems for Jamaica, where yellow indicates coral, pink indicates mangroves, green indicates seagrass and blue indicates lakes.

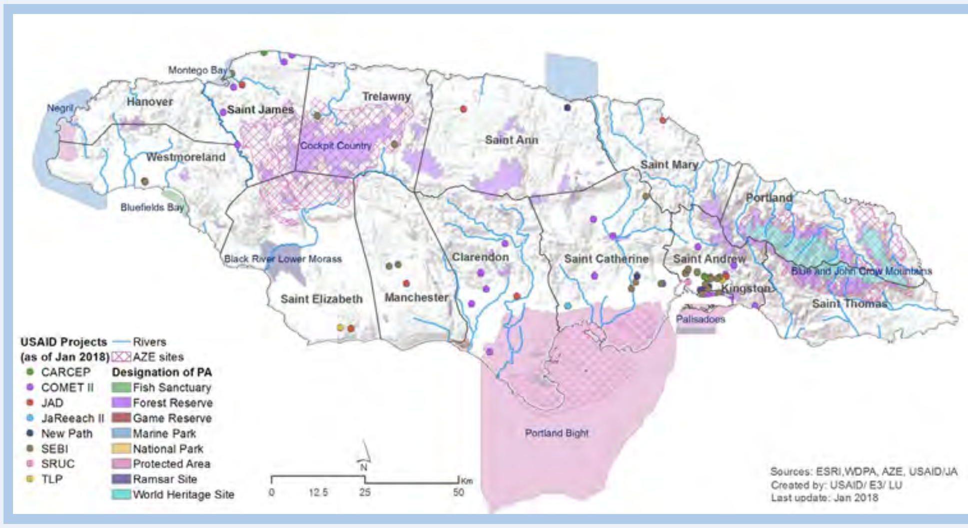


FIGURE 3

Protected area locations (solid colors) and **Alliance for Zero Extinction sites** (hatched colors) overlaid with locations for eight **USAID programs** (points).

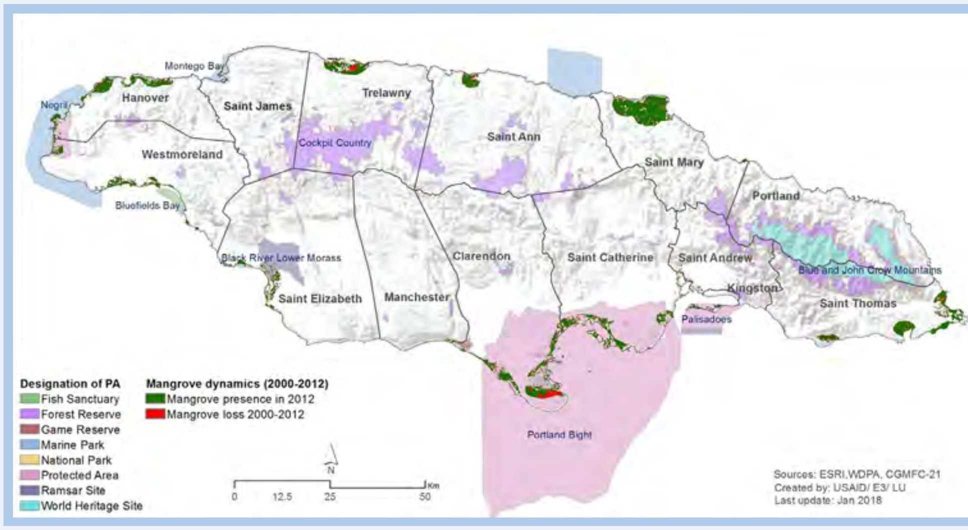


FIGURE 4

Mangrove ecosystem distribution and loss from 2000 to 2012 (green and red, respectively), overlaid on **protected areas for Jamaica** (solid colors).

The E3/Land and Urban Office geospatial specialists also identified access to current national datasets as an obstacle to deepening spatial analysis for Jamaica. For example, geospatial data on land use and land cover, protected area boundaries and data developed by the Jamaica National Forestry Department were not available. Therefore, though the specialists were able to include land use and land cover maps for 1998 and 2013, and a qualitative analysis of the change between the two years was included in the 118/119 analysis annexes, the 118/119 team was not able to quantify these changes and analyze their underlying drivers. In addition, data on environmental concerns identified during the prior 118/119 analysis—including natural disasters, fires and water pollution—were not available, additionally limiting the scope of geospatial analyses. Despite these shortcomings, this work illustrates the potential of geospatial data and analyses based on global datasets to illuminate the opportunities for integrated biodiversity programming in USAID host countries.

CHAPTER 2

PROJECT DESIGN AND IMPLEMENTATION

GUATEMALA. Photo by Jason Houston for USAID, 2017

WHY USE GEOSPATIAL ANALYSIS FOR PROJECT DESIGN AND IMPLEMENTATION?

Project design and implementation is a key stage in the development of integrated programming, and allows USAID staff to translate strategy-level opportunities for integration into project-level theories of change and proposed activities. During this process, design teams can use the broad geographic areas identified during strategic planning to identify specific project locations. Based on these locations, design teams can identify geographic overlaps between sectors, projects that might benefit from integration, and specific interactions that can serve as the foundation for integration. These can then be used during project implementation in the initial scoping of USAID activities.

MYANMAR: Technical training in land tenure and geospatial methods. Photo for USAID, 2017

Geospatial analysis can be used to support this process by helping to convert the broad zones identified in CDCS and 118/119 analyses to specific target areas, identifying geographic overlaps between sectors, and identifying possible projects and locations for integrated programming. Following are some opportunities for using geospatial analysis for this work:

1. **Mapping specific biodiversity focal interests** within the geographic scope identified during strategic planning, including key ecosystems and species.
2. **Mapping the specific priorities of other sectors**, and **identifying interactions** between these and biodiversity priorities based on neighboring or overlapping programming areas, upstream-downstream interactions and other linkages.
3. **Selecting specific projects and locations** for integrated activities based on the magnitude and strength of these interactions.
4. **Communicating this logic** in project appraisal documents (PADs), discussions with USAID and other U.S. Government stakeholders, and externally facing requests for information.
5. **Capturing the logic and data** used during design for future review during activity implementation, and monitoring and evaluation.
6. **Supporting** and facilitating collaborative work across the mission with maps and analyses suggesting how activities can work in the most complementary and synergistic manner.

WHEN TO USE GEOSPATIAL ANALYSIS FOR PROJECT DESIGN AND IMPLEMENTATION?

Project design and implementation is an ideal opportunity to introduce geospatial analysis and planning into a mission's work. Doing so, however, requires a meaningful investment by USAID in the time and staffing necessary to support this work. Following are some of the conditions under which geospatial analysis can most successfully support project design and implementation:

- **Mission programming is geographically concentrated**. Geospatial analysis during project design and implementation is most useful when programming in multiple sectors is focused on a specific geographic region. Under these conditions, mapping programs and identifying overlaps are more likely to yield immediate insights and support integrated projects.
- **Geospatial data is available from past or ongoing USAID work**. As is the case for R/CDCS development, data on prior USAID programming can help staff identify existing priorities for individual sectors or gaps in programming. At the project scale, specific geographic overlaps between these gaps or opportunities between sectors can suggest locations for possible integrated activities. For example, close proximity between ongoing water and sanitation activities, and upstream protected areas that provide clean water might indicate opportunities for integrated programming.
- **Geospatial data is available from governmental or non-governmental organizations**. As is also the case for R/CDCS development, governmental or non-governmental organizations can be key sources of the data needed to identify priorities or challenges for individual sectors. These data can range from health and demographic survey data, to educational testing results, to biodiversity conservation priorities and threats. At the project scale, even simple overlays of these data can suggest specific geographies and sectors in which integration might be possible.

DEMOCRATIC REPUBLIC OF CONGO: Training on collecting field data using GPS receivers at the University of Kinshasa. Photo for USAID, 2011

BEST PRACTICES

Project design and implementation is a complex process that includes staff from multiple USAID offices and operating units. To maximize the benefits of geospatial analysis for this process, its role in this process should be defined early and it should ideally receive support from mission leadership (see above "Key Enabling Conditions"). Having ongoing geospatial technical capacity available at the mission through internal staffing or long-term detail is also important. Following are some key best practices:

1. Before beginning the design or implementation process, the mission should identify their **goals** for geospatial analysis and the questions they need to answer.
2. Based on the above, the project design or implementation team should establish a commonly agreed **role** for geospatial specialists and data, and identify key questions for project development. This process should be flexible to allow the project design team to ask new questions as the discussions progress.
3. As a starting point, the team should determine what **data** they might need and how to get it. When evaluating data, the team should consider data quality, appropriateness to the questions at hand, spatial extent, data age and the methods used to generate the data. For example, do global datasets of protected areas and landuse provide sufficient detail and accuracy for project design, or might higher-resolution data from governmental or non-governmental organizations be more appropriate? More information on data quality and collection can be found in the introductory comments above ("ADS Guidance, Mandatory References and Additional Help").
4. USAID **partners** can be an excellent source of data, both for the locations of existing USAID programming and for biodiversity priorities, threats and interactions with other development sectors.
5. During this process, geospatial analyses and maps should be used to **inform** the project design process by enabling scenario development and discussion. For example, if the project would like to assess the opportunities for integration between forest conservation and water provision to vulnerable communities, maps and analyses could be used to overlay datasets on forest and population centers rather than displaying and analyzing them separately. Maps or analyses in program documents should be accompanied by explanatory narrative.
6. The analyses used to inform project design should be clearly **documented**, including the data and maps that helped guide decisions at each stage in the process, and the analyses and data used to generate them. This process and its results should be summarized in the PAD or its annexes.
7. Following the project design process and during project implementation, it is useful for the mission to have access to **continued geospatial support** to support adaptive project management, either internally, on detail or on contract.

VIETNAM: Community coastal landscape mapping. Photo by TetraTech for USAID, 2017

AN EXAMPLE FROM USAID PROGRAMMING

In 2016, USAID/Honduras decided to integrate their biodiversity conservation, agriculture and nutrition, governance and education portfolio, and this integrated approach was then documented in the PADs for each sector. After developing their country strategy and designing these PADs, multi-sector meetings at the mission revealed that these topics were linked by a common theme: water. Intact, forested ecosystems provide the water needed to meet food security, nutrition, and sanitation goals; and the protection of forests and equitable allocation of water requires strengthening of governance and educational systems. Due to the geographic concentration of USAID programming in the west of the country, this integration work had strong support from mission leadership and was facilitated by a mission geospatial specialist.

To identify the best locations for integrated programming, the mission began by mapping their activities and priorities in food security, governance, education and biodiversity. The Feed the Future team mapped its household interventions across the region's 131 municipalities (Figure 5); the education team mapped areas with the lowest reading scores for third and sixth grade (Figure 6); and the governance team analyzed municipal capacity and status to identify potential activity locations. In addition, the mission mapped biodiversity hotspots from a combination of global datasets including data from the International Union for the Conservation of Nature and the World Wildlife Fund (Figure 7).

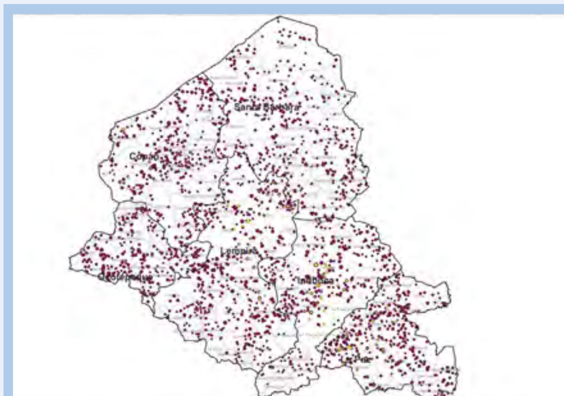


FIGURE 5

Locations of USAID Feed the Future and nutrition activities, in western Honduras, indicated by red and yellow points respectively. Data provided by the USAID Alliance for the Dry Corridor (ACS) and Mercado projects.

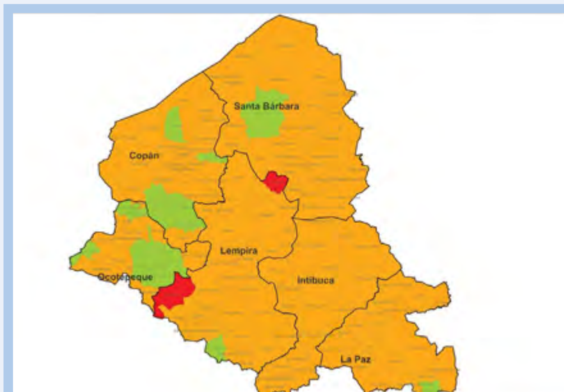


FIGURE 6

Reading scores for third and sixth grades for municipalities in western Honduras, where green indicates highest scores and red lowest scores. Data provided by the Honduras Ministry of Education.

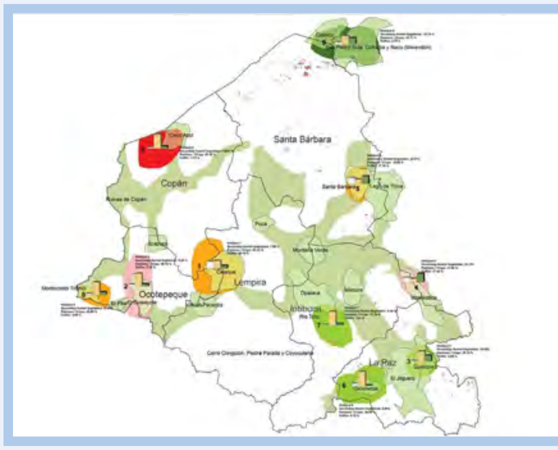


FIGURE 7

Biodiversity hotspots and corridors for western Honduras, where hotspots are colored by degree of forest loss such that green is lowest and red is highest. Data provided by the Forest Conservation Institute (ICF), the University of Maryland Department of Geographical Sciences and USAID Honduras.

The mission then overlaid these data to find opportunities to co-locate and co-program Feed the Future, municipal governance and biodiversity activities. Mission staff initially identified over 90 municipalities in which USAID's programming requirements were aligned, of which 87 became the focus areas for their integrated activities (Figure 8). Staff reported that this mapping exercise facilitated cross-sectoral conversations and increased their understanding of different sector activities.

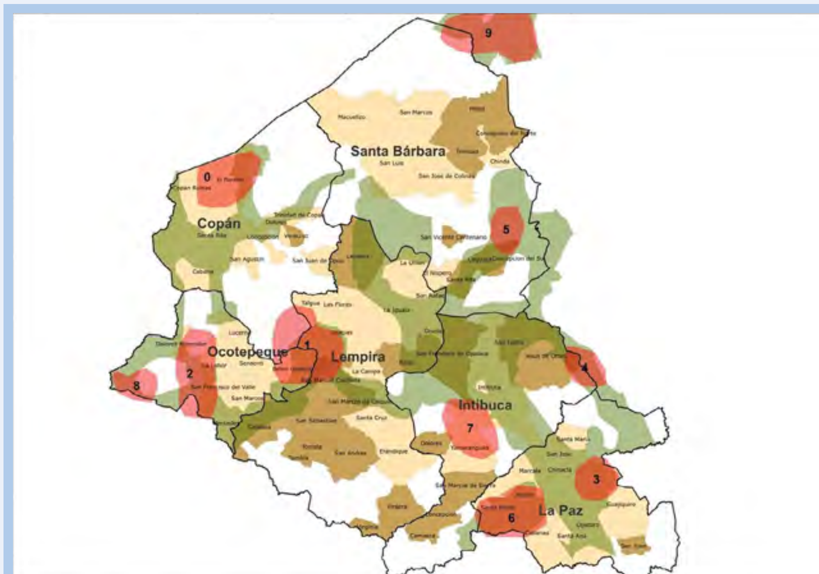


FIGURE 8

Overlaid data from all sectors used to select final 87 integration municipalities for western Honduras. Red areas indicate biodiversity hotspots, green indicates biological corridors, and brown and yellow indicates municipalities selected from Feed the Future and nutrition analyses. Data provided by USAID Honduras.

During implementation, USAID Honduras and its implementing partners have continued to use and develop geospatial tools as a basis for decision making. These include land-use platforms to identify and analyze the main causes for land-use change, water information platforms to support the identification of irrigation system locations based on water availability and uses, and the creation of service need heat maps to prioritize actions aimed at improving service provision.

BRAZIL. Photo by European Space Agency / Copernicus Sentinel-2A

WHY USE GEOSPATIAL ANALYSIS DURING ACTIVITY DESIGN AND IMPLEMENTATION?

Activity design and implementation is the point at which USAID and its implementing partners turn the projects developed earlier in the program cycle into on-the-ground activities. In the context of integrated programming, activity design and implementation is an opportunity to identify activities from multiple sectors that would benefit from biodiversity integration and coordinate interventions across sectors. The goal of this process is to achieve outcomes in multiple sectors that would not have been possible through non-integrated programming.

NEPAL: Community assessment of red pandas in the Sacred Himalayan Landscape. Photo by WWF for USAID, 2010

Geospatial analysis is a common component of biodiversity program design and implementation as these programs are usually designed and implemented for specific geographic units such as national parks or other high biodiversity value areas. Geospatial analysis can play a role in integration by identifying the places in which the overlaps between biodiversity and other activities are strongest, the specific ecosystems and human populations that will benefit, and the potential mechanism of those interactions. Following are some opportunities for using geospatial analysis to support integrated activity design and implementation at USAID:

1. **Identifying specific sites** for integrated programming that are valuable for both biodiversity conservation and other development goals.
2. **Mapping key features** in the integrated sectors such as species or ecosystem distributions, population centers and health indices, or other key metrics.
3. **Constructing models** and developing scenarios that link ecosystem distributions, land cover or other biodiversity metrics to other development metrics and use these to design programming. For example, models of the relationship between storm damage reduction and mangrove or coral reef extent can be used to attach monetary values to specific stretches of reef and support investment in those ecosystems' conservation (see example below).
4. **Guiding activity implementation** by selecting locations and interventions based on the key features and models identified above.
5. **Achieving integrated activity goals** that can only be met by using geospatial data and analyses—for example, using satellite data and ecological models to link forest cover to water production, and thus calculate appropriate values for payment for ecosystem services schemes.

WHEN TO USE GEOSPATIAL ANALYSIS FOR ACTIVITY DESIGN AND IMPLEMENTATION?

Activity design and implementation is the program cycle stage at which geospatial analysis is most commonly used by USAID and its partners. Maps of activity beneficiaries and implementation areas are commonly required to target and monitor interventions, and implementing partners often include geospatial specialists on staff to meet these needs. In addition, solicitations and procurements may explicitly require spatial analysis to realize key activity goals. These conditions make the use of geospatial analysis for biodiversity integration particularly feasible. This said, geospatial analysis yields its best return-on-investment under specific enabling conditions, including the following:

- **Geographically overlapping or ecologically connected projects**. Geospatial analysis is particularly useful when programming areas for multiple sectors overlap geographically or are ecologically connected. For example, changes in forest cover at the headwaters of watersheds can reduce water quality or increase flooding, thus affecting downstream human populations; and inland agricultural activities can increase river sediment and nutrient concentrations, significantly affecting coastal ecosystems. These relationships can serve as the basis for integrated programming, and geospatial analysis provides a means of analyzing these relationships in USAID programming, as described below.
- **Existing geospatial relationships or analyses**. Geospatial analysis can be a powerful tool for measuring and analyzing the connections between ecological and human systems by pinpointing the location of these interactions, measuring their strength and supporting the planning of interventions. For example, by estimating the quantity and economic value of ecosystem services delivered by an ecosystem, geospatial analysis can help estimate the appropriate value for payment for ecosystem services systems. These relationships, often expressed as geospatial models, are substantially easier to implement when they have previously been developed for the activity area or for similar ecosystems.
- **Geographically discrete beneficiaries**. Geospatial analysis is also particularly helpful when the beneficiaries of the integrated activities—both human and non-human—can be mapped to specific places. For example, activities that target specific human populations, ecosystems or species may be easier to integrate using geospatial analysis than governance activities with regional or national-scale interventions.
- **Geographically explicit outcomes**. Geospatial analysis may be required if the outcomes in any or all of the integrated sectors are defined, measured or evaluated in geographic terms or using geospatial data. For example, programs that use satellite data to target and measure the effectiveness of forest conservation or agricultural interventions may require geospatial analysis during integrated implementation.

ZAMBIA: Locating fields during land tenure mapping. Photo for USAID, 2017

BEST PRACTICES

Activity design and implementation is a complex process, and geospatial analysis can help facilitate biodiversity integration throughout. Some recommendations to do this include the following:

1. Include **geospatial specialists** in mission or implementing partner staff and employ **local geospatial staff** whenever possible. Geospatial specialists are essential for planning, conducting and interpreting geospatial analyses, during both activity design and implementation. In addition, local staff are more likely to be aware of national geospatial datasets and to have colleagues working in government or civil society institutions that can facilitate access to these data.

2. Make use of existing, **long-term national datasets** generated by national agencies or research organizations, but be aware of any **inaccuracies** in these data. National institutions are often seen as more trustworthy by host country stakeholders than non-national datasets, but these data should not be used uncritically. This is particularly important for demarcations of administrative units and naming conventions, which can vary between ministries or departments.

3. Make use of **global datasets** to supplement national datasets, if acceptable to national partners. Though global datasets may lack the detail of national-level datasets, they can provide key information on factors such as forest loss and threatened species or ecosystems based on internationally recognized methods and data.

4. Always remember the saying, **"garbage in, garbage out."** Modern geospatial tools allow the production of polished maps and analytic products regardless of the quality of the data used or of the analyses themselves. Analysts should thus ensure that data and analyses meet the needs of USAID or its partners, and that all methods, datasets, assumptions and limitations are well documented. More information on geospatial data quality standards may be found above (see "ADS Guidance, Mandatory References and Additional Help").

5. Support the use of **open source** geographic information systems such as QGIS and SMART in USAID activities. By avoiding the often large costs of commercial software, these tools can lower the barrier to the use of geospatial analyses and support the sustainability of USAID work.

6. Ensure that geospatial analysis is actively used to **answer key questions** for activity design and implementation, and not simply to produce maps.

7. **Document all processes** used to gather, generate and analyze geospatial data.

8. Following USAID requirements, ensure that all activity geographic and indicator data is regularly **shared** with USAID and that final data are submitted for archiving and future analyses. In addition, these data should be geographically disaggregated to the highest degree possible (see "ADS Guidance, Mandatory References and Additional Help").

AN EXAMPLE FROM DEVELOPMENT PROGRAMMING

Coral reef and mangrove ecosystems provide a variety of benefits to people, including income from tourism and protection from storm damage. For this reason, these ecosystems are key targets for biodiversity conservation and restoration efforts during integrated programming. To identify locations that meet biodiversity conservation, tourism and climate change adaptation goals, The Nature Conservancy (TNC) used publicly available data to map the value of coral reef and mangrove ecosystems across the world. These results are available through the online Mapping Ocean Wealth Explorer website (maps.oceanwealth.org).

To calculate the value of coral reefs for storm protection, TNC worked with collaborators from the Environmental Hydraulics Institute of Cantabria (Spain) and the University of California, Santa Cruz to combine ecological, engineering and economic approaches to estimate the benefits of reefs for flood reduction to people and property. These analyses were calculated globally, resulting in an open, world-wide dataset on potential avoided-damage valuations (see Figure 9 for an example from the Dominican Republic and Haiti). Similar analyses on the coastal protection values of mangroves are currently being refined at the global scale.

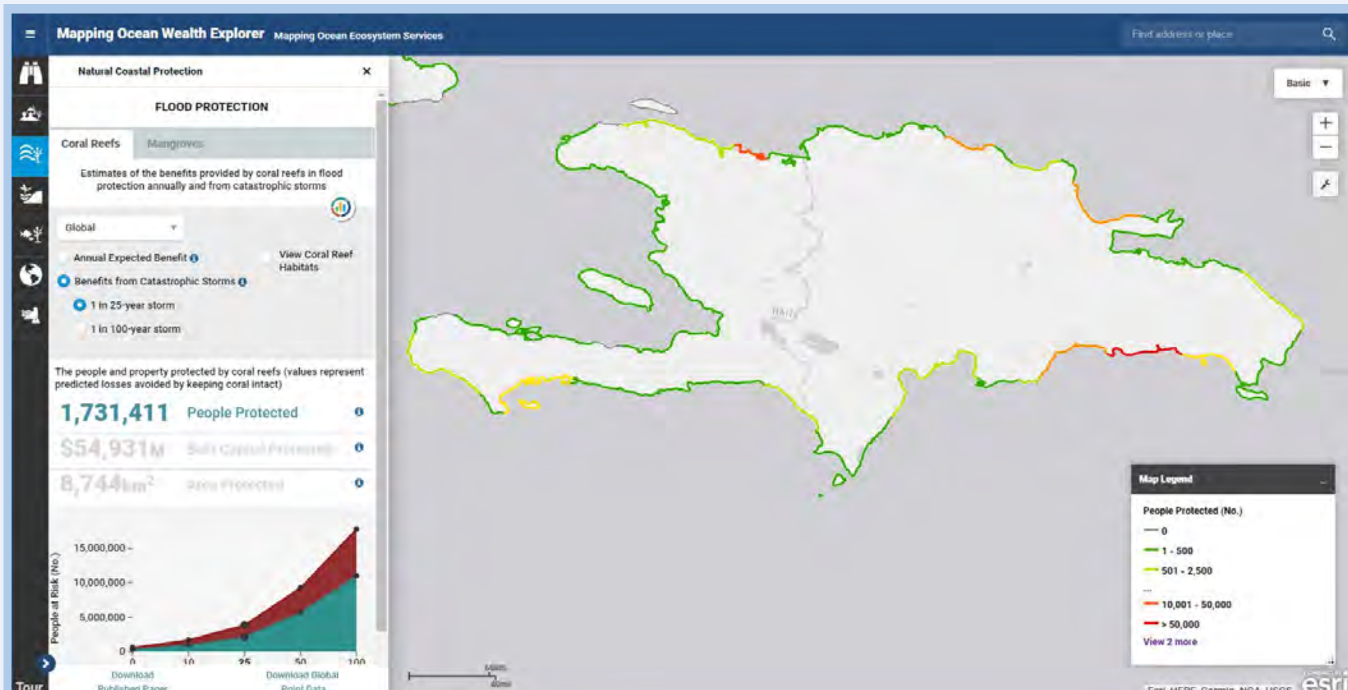


FIGURE 9
The value of coral reefs in protecting coastal communities in the Dominican Republic and Haiti from storm damage, where warmer colors indicate higher values.

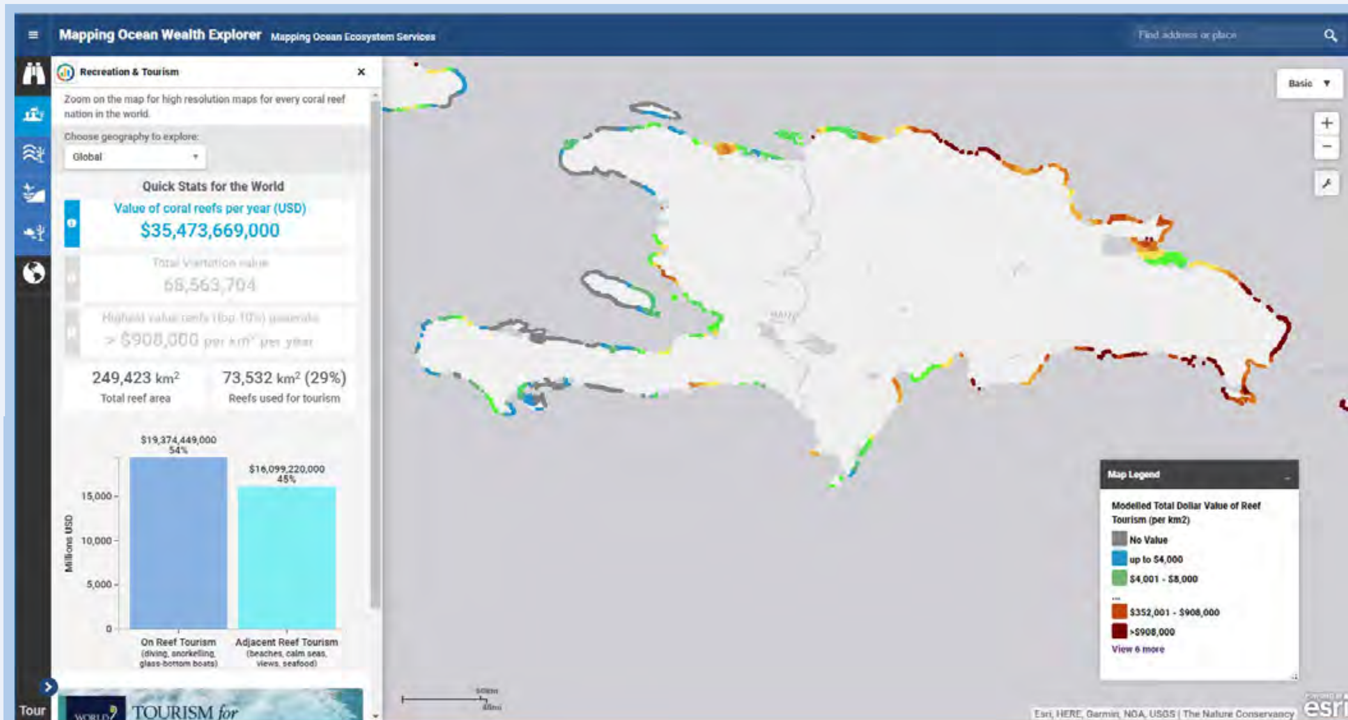


FIGURE 10

The value of coral reefs for tourism in the Dominican Republic and Haiti, where warmer colors indicate higher economic values as estimated from tourist visitation rates and expenditures.

In addition, to calculate the value of coral reef ecosystems for tourism, TNC combined data on tourist arrivals and expenditures with use data for dive sites, dive shops, hotels and the location of photographs uploaded to the social media site Flickr to estimate the number of visitors to coral reefs. Using these values, they were then able to estimate the amount of tourist spending along specific stretches of coastal reef, resulting in a global dataset on tourism economic valuation. These values were originally calculated at the global scale, but TNC has refined the analysis for the Caribbean region using a combination of traditional literature searches and machine learning methods (see Figure 10 for an example from the Dominican Republic and Haiti).

These analyses demonstrate how geospatial analysis can be used to identify locations where development programming at targeted conservation and restoration sites can yield benefits in multiple sectors simultaneously. In cooperation with public- and private-sector partners, TNC uses analyses like these to identify priority sites for ecosystem services and conservation potential, both in the Caribbean and globally. For USAID, these analyses could serve as activities in their own right or as a valuable tool for identifying sites for future integrated programming. Though this work was not funded by USAID, TNC is currently implementing the USAID Caribbean Marine Biodiversity Program (2014-2019) to promote conservation and integration throughout the Caribbean. Geospatial analyses were also used by the USAID Dominican Republic mission as part of their 118/119 analyses with support from the Washington, DC Land and Urban Office.

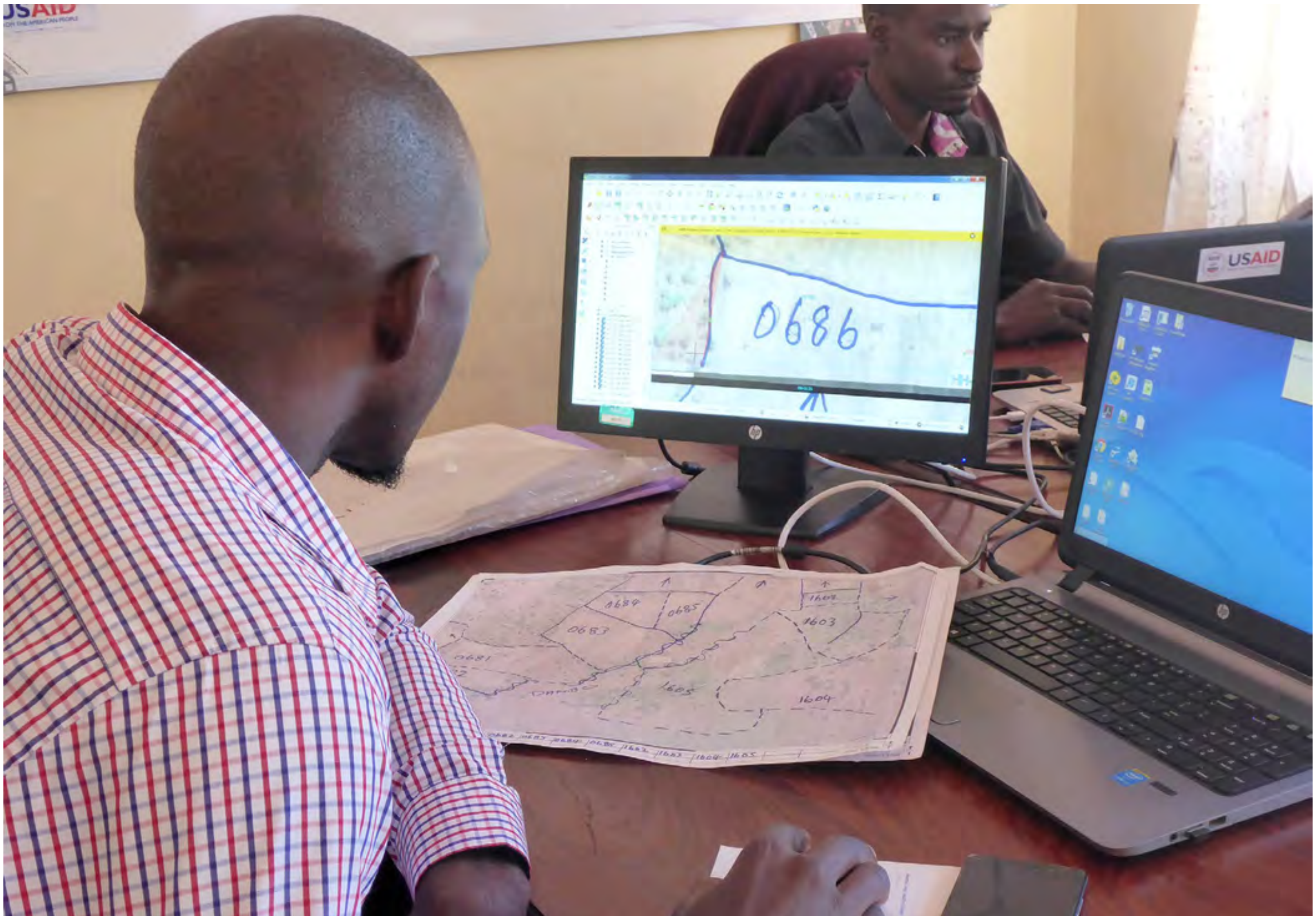
CHAPTER 4

MONITORING AND EVALUATION

NAMIBIA. Photo by S. Felton for USAID, 2011

WHY USE GEOSPATIAL ANALYSIS DURING MONITORING AND EVALUATION?

Monitoring and evaluation allows USAID operating units to gauge the performance of their portfolio, test underlying assumptions and adjust their programming accordingly. In the context of integrated biodiversity programming, monitoring and evaluation allows USAID staff to ensure that integrated activities remain integrated during implementation, and to determine whether investments in integrated programming yield benefits exceeding those from single-sector programming. By answering these questions, USAID staff can adaptively manage current programming and make informed decisions about when and how to integrate in the future.



ZAMBIA: Digitizing map data during land tenure mapping. Photo by TetraTech for USAID, 2017

Geospatial analysis is a uniquely useful tool for monitoring and evaluating integrated programs. By selecting key indicators and collecting location data for those indicators, USAID staff can identify places in which integration is succeeding or failing, frame questions about underlying assumptions, and target evaluations to answer these questions and improve future programming. Geospatial analysis also allows monitoring and evaluation teams to incorporate spatial data such as digital maps of forest cover, population densities, development indices or other data into their analyses. Some opportunities for using geospatial analyses for integrated monitoring and evaluation include:

1. **Tracking the implementation** of integrated programming to ensure that integrated activities are "drawn together" and do not devolve into unrelated programs that happen to share a joint monitoring mechanism.
2. **Measuring the relationship** between the performance of overlapping indicators, i.e., do positive outcomes in one sector correspond to positive outcomes in another?
3. **Testing assumptions** underlying integrated programming, i.e., do the benefits of integrated programming exceed those expected from single-sector programming?
4. **Supporting the design of evaluations** by identifying locations from indicator data for additional study about the determinants of successful integrated programming
5. **Adjusting programming** and learning about when and how to integrate future programming.

WHEN TO USE GEOSPATIAL ANALYSIS FOR MONITORING AND EVALUATION?

Geospatial analysis is a potentially powerful tool for understanding cross-sectoral interactions between USAID activities and testing the benefits of integrated programming. However, these analyses usually require additional investment by USAID and its partners in data collection and analysis, and USAID staff must weigh the benefits of this approach against costs in time, contractor resources and USAID expertise. Following are some conditions under which the use of geospatial analysis for integrated monitoring and evaluation can be particularly successful:

- **Indicators are measured at the local scale for specific beneficiaries and locations**. Interventions whose outcomes can be measured for specific beneficiaries or at specific locations (e.g., schools, fields or forests) can yield substantial data for geospatial analysis, while activities implemented at regional or national scales (e.g., legislative or judicial reforms) may not yield sufficiently detailed indicator data.
- **Geographic data is collected for multiple sectors**. Geospatial analysis is most useful for integrated monitoring and evaluation when indicators can be tracked spatially, indicator tracking methods are similar and activity-level location data is collected for both biodiversity and partner sector activities.
- **Activities are geographically close to each other and have a high number of indicator observations**. Geospatial analyses are more likely to yield reliable results for neighboring or overlapping activities with abundant indicator data.
- **Indicators have similar levels of geographic detail**. Though it is possible to measure the relationship between, for example, regional reforms in governance systems and local improvements in wildlife trafficking, this relationship is easier to measure when both reforms and trafficking events are measured at local scales.
- **USAID staff have a clear assumption about integration that they would like to test**. Assembling the necessary indicator data and preparing it for analysis is easier when teams have a specific question in mind, rather than a "fishing expedition." For example, an integrated agriculture and conservation program might ask if sustainable agriculture interventions yield reductions in deforestation in community forests (for more information, see the example in this chapter).

BEST PRACTICES

Though monitoring and evaluation typically occurs later in the program cycle than other tasks, monitoring and evaluation strategies must be developed early in the program cycle to ensure that indicator requirements are clear in solicitations and that baseline, implementation and end-of-activity data are planned for, budgeted and properly collected. This is particularly true for geospatial approaches to monitoring and evaluation, which require additional attention during planning and solicitation. The following best practices make successful geospatial analyses possible:

1. Prior to developing or implementing monitoring and evaluation plans, the mission should hold a **multi-office meeting**—including technical and program office staff as appropriate—in which geospatial specialists, monitoring and evaluation specialists, and technical staff discuss the role of spatial analysis in mission monitoring and evaluation strategies.
2. When developing monitoring and evaluation plans, **identify geographic overlaps** between programming in biodiversity conservation and other sectors. This includes both intentionally integrated programs and non-integrated programs that may yield positive or negative effects on each other.
3. For these activities, **identify outcomes** that can be used to observe the influence of the sectors on each other and determine whether integrated interventions are on track and yielding the intended results.
4. In addition, identify assumptions and **frame questions** about the interactions between the sectors early in the process and identify those that might be answered by using geospatial analysis. Geospatial specialists can be particularly helpful in identifying appropriate uses of geospatial analyses.
5. Based on these outcomes and questions, identify indicators for which location data can be collected and the required degree of geographic detail. In addition, **identify indicators** that might be monitored over time using remote sensing such as forest loss or reforestation, or agricultural expansion or intensification. Note that activities implemented at the local scale may be well-suited to geospatial analysis (e.g. agricultural interventions), but regional or national-scale activities may not (e.g. improvements to policies, laws and regulations).
6. Ensure that the collection of location data for these indicators is specified in **activity procurements or agreements** and is consistent with new ADS mandatory references (see below).
7. Prior to activity implementation, collect **georeferenced baseline data** to ensure that the effects of integrated programming can be measured.
8. Ensure that location data is collected as specified, and that it is used for **geographically explicit monitoring** of integrated activities such that programs can identify locations requiring adaptive management and those demonstrating success.
9. Use geospatial data to identify sites for **geographically explicit evaluations** to determine what factors do and do not lead to successful integration (i.e. particularly successful or non-responsive locations), if possible using matched intervention and non-intervention sites.

In addition to these recommendations, all USAID activities are now required to collect information on the location of their activities as explained by a mandatory reference for ADS chapters 201 and 579 and an Additional Help document for ADS Chapter 579 (see above for more information, "ADS Guidance, Mandatory References and Additional Help"). This requirement provides USAID staff in technical and program offices with the institutional support and guidance needed to gather and use geospatial data for monitoring and evaluation. Please see the section "Useful Resources" in the introduction above for more information.

AN EXAMPLE FROM USAID PROGRAMMING

As part of USAID/Central Africa Regional's Program for the Environment (CARPE), the African Wildlife Foundation, International Institute for Tropical Agriculture and University of Maryland promoted participatory mapping combined with sustainable agriculture in the Maringa-Lopori-Wamba Landscape in northern Democratic Republic of the Congo. From 2010 to 2015, this program engaged 90 village communities in the region using a combination of participatory land-use planning and agricultural interventions. Based on this work, the CARPE consortium decided to ask a fundamental integration question: if communities delineate agricultural lands and intensify production on those lands, do they increase crop yields while simultaneously reducing encroachment on intact forest?

To answer this question, the team gathered data on a variety of georeferenced indicators, including forest loss and implementation of sustainable agricultural practices. Using global datasets on forest loss, the team compared tree cover loss for community forests where villages were receiving agricultural interventions versus community forests areas for villages that did not. They found that although tree cover loss was observed in all community forest areas during the project intervention period, forest loss was approximately 27% lower in villages receiving interventions (Figure 11, blue hatched areas; Figure 12, green line) than in those not receiving interventions (Figure 11, yellow hatched areas; Figure 12, red line) when compared to the 17-year average of annual tree cover loss (2001-2017). In addition, geolocated surveys of the village populations also showed that farmers in the intervention area practiced different management strategies from those in the non-intervention area.

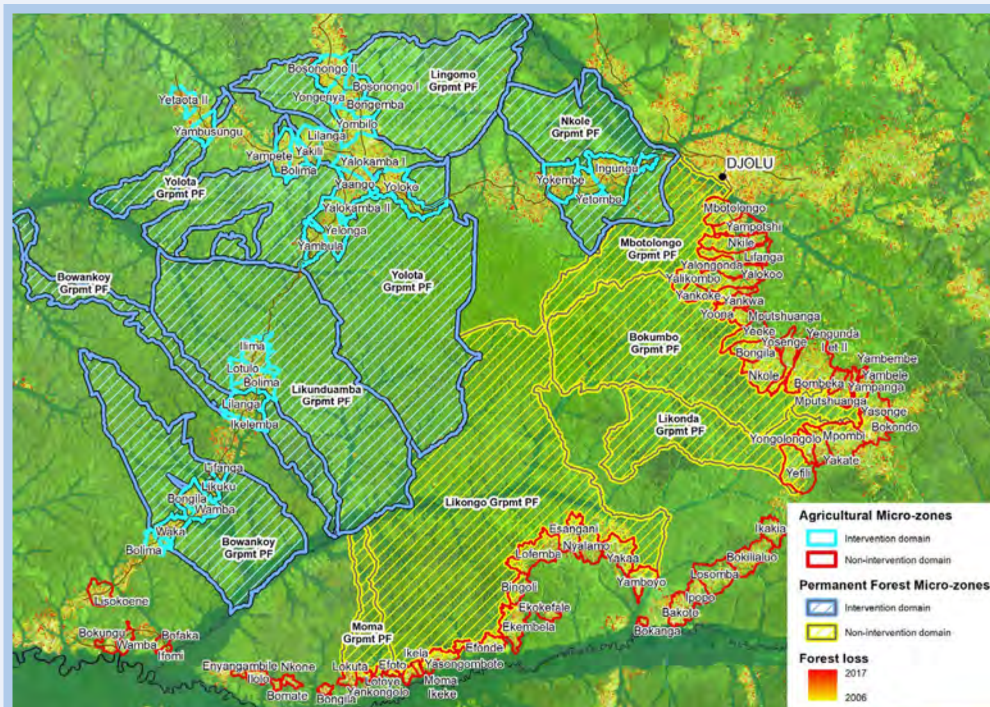


FIGURE 11
Location of intervention domains (blue and lavender) and non-intervention domains (red and yellow) in the Maringa-Lopori-Wamba landscape, overlaid on forest loss data for 2000 to 2015 (yellow to red pixels). Results provided by the University of Maryland.

In summary, this analysis suggests that sustainable agricultural techniques and land-use planning in Central Africa serve both to promote food security and to safeguard biodiversity in the form of reduced forest loss.

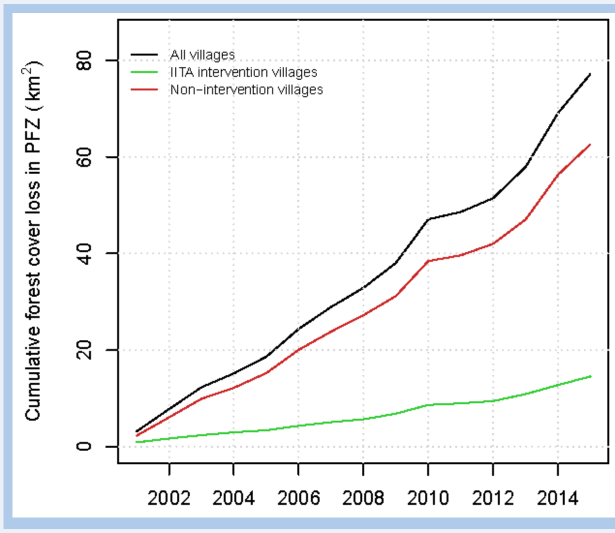


FIGURE 12
Cumulative forest cover loss between 2001 and 2015 in permanent forest zones (PFZs) in the Maringa-Lopori-Wamba landscape, where the green line indicates the intervention region, the red line indicates the non-intervention region, and the black line indicates all villages. Results provided by the University of Maryland.

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