

# Mapping Rural Development

How to use GIS to monitor and evaluate projects



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## Originators

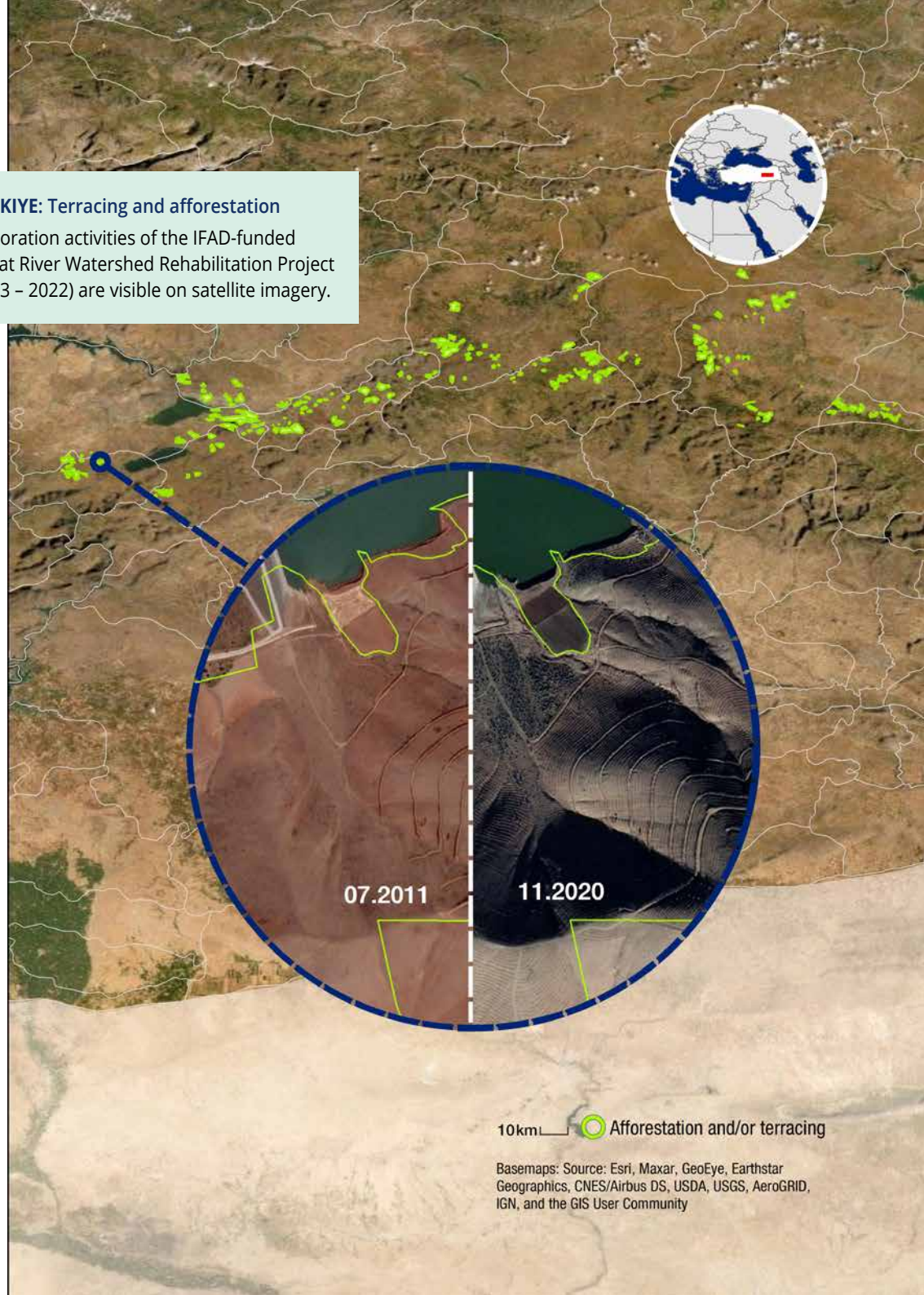
*Oliver Mundy and Athur Mabiso*

**Design:** Tuuli Sauren | **Maps:** Rakhat Zhanuzakova | **Copy editor:** John Laird

**Cover:** Copernicus Sentinel data from 2018 processed by the European Space Agency



**TÜRKIYE:** Terracing and afforestation  
Restoration activities of the IFAD-funded  
Murat River Watershed Rehabilitation Project  
(2013 – 2022) are visible on satellite imagery.



10km Afforestation and/or terracing

Basemaps: Source: Esri, Maxar, GeoEye, Earthstar  
Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID,  
IGN, and the GIS User Community

## About this manual

This manual is for people working in or supporting rural development projects. It is primarily developed with a focus on IFAD-supported operations. It provides guidance on how to use geographic information systems (GIS) in the monitoring and evaluation (M&E) of IFAD-funded projects. It features case studies and provides practical advice.

This guide was prepared as part of the 2019 IFAD Innovation Challenge “Systematic integration of GIS in IFAD operations (GeoM&E)” entry, led by IFAD’s Environment, Climate, Gender and Social Inclusion Division and the Research and Impact Assessment Division. The initiative was funded by IFAD’s Change Delivery and Innovation Unit and supported by the front office of the Programme Management Department. The design and layout were supported by IFAD’s Adaptation for Smallholder Agriculture Programme.

## Disclaimer

By accessing this manual you acknowledge, accept and agree to the foregoing conditions listed on page 51.

## Acknowledgements

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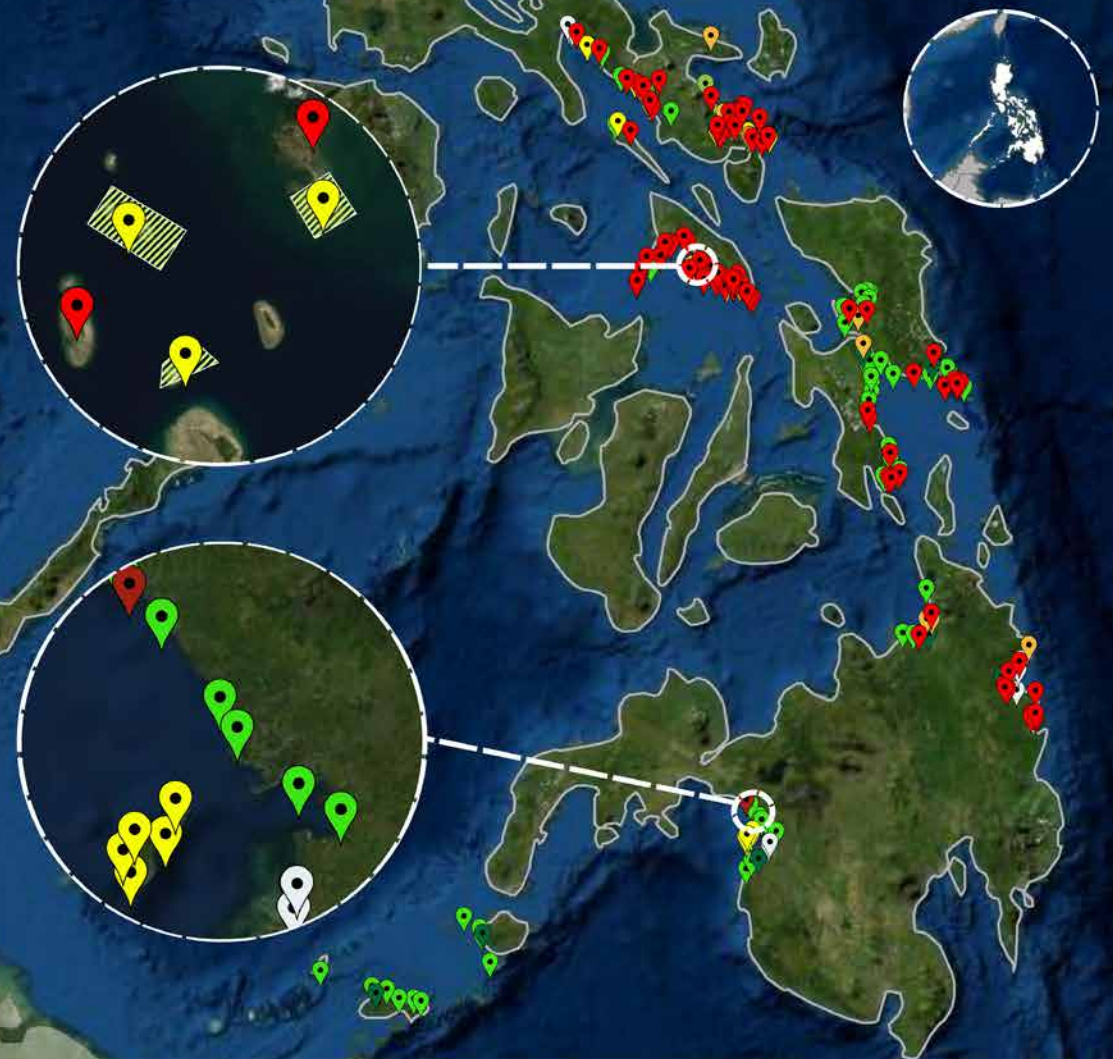
© Sierra y Selva Alta/Alberto Canchari

**PERU:** Farmers hold maps of the Strengthening Local Development in the Highlands and High Rainforest Areas Project (2012 - 2019). The maps show the current state of the project and its targets for the future.



# 1. Why use GIS to map investments?

**PHILIPPINES:** Investment sites of the IFAD-funded Fisheries, Coastal Resources and Livelihood Project (2015 – 2021)



- Bay management multi-purpose building
- Support Facility - Tiwi Hatchery
- Watchtowers
- Fish sanctuary delineation (points)
- Fish landing facilities (jetty ports)
- Livelihood Training Center
- Seaweed solar dryers, fish dryers and storage facilities
- Artificial reef deployment
- Fish processing equipment
- Mangrove rehabilitation
- Fish sanctuary (areas)

Base maps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

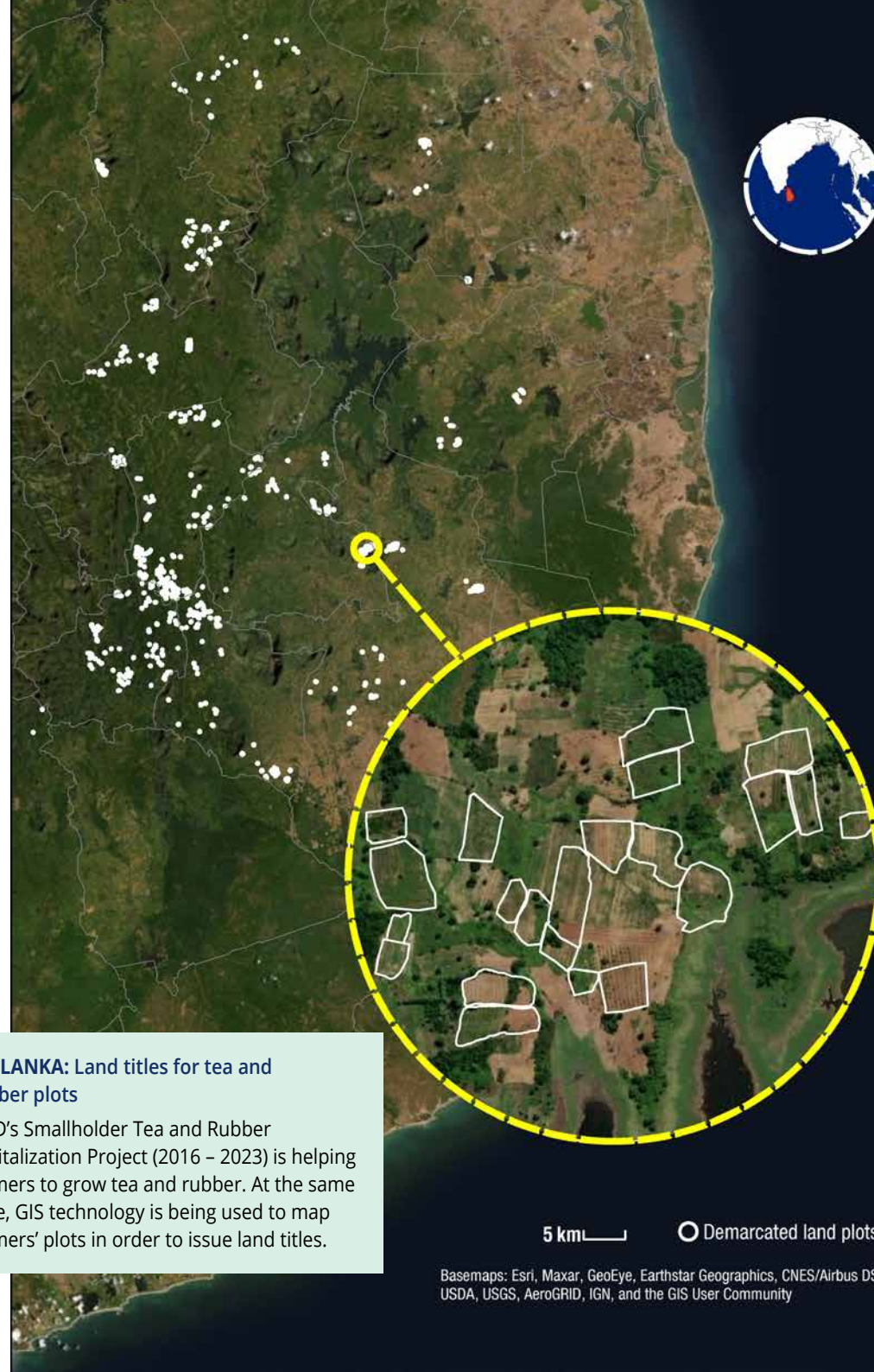
# 1. Why use GIS to map investments?

If a picture is worth 1,000 words, then a map must surely be worth far more. Especially if it is a map enriched with data – one that shows what and where things are planned, are happening, and have been achieved. Like a photograph, a map can tell a story. But it can also give contexts, show locations and relationships, and create understanding. Maps are extraordinarily powerful ways of recording, presenting, communicating and archiving information.

That is especially true in rural development. Rural roads, irrigation schemes, wells, crop processing facilities, marketplaces, afforestation and pasture rehabilitation are all typical subjects for rural development projects. Many have a spatial dimension – which means that they can be mapped. Doing so gives project managers and donors valuable insights about the project's activities and impacts.

A geographic information system (GIS) is a system that creates, manages, analyses and maps all types of data. For all project stakeholders, collecting geospatial data as part of the regular monitoring and evaluation (M&E) process makes it possible to ensure that the activities planned are actually taking place. It also opens up new possibilities for improving their effectiveness.

Mapping project investments in a systematic manner has many benefits. It gives IFAD robust data that it can use to manage activities, to measure their success in reducing rural poverty and hunger and benefiting their target groups, and to design future activities. GIS-supported M&E can enhance transparency, accountability and visibility, attracting further funding and, ultimately, contributing to the Sustainable Development Goals.



## SRI LANKA: Land titles for tea and rubber plots

IFAD's Smallholder Tea and Rubber Revitalization Project (2016 – 2023) is helping farmers to grow tea and rubber. At the same time, GIS technology is being used to map farmers' plots in order to issue land titles.

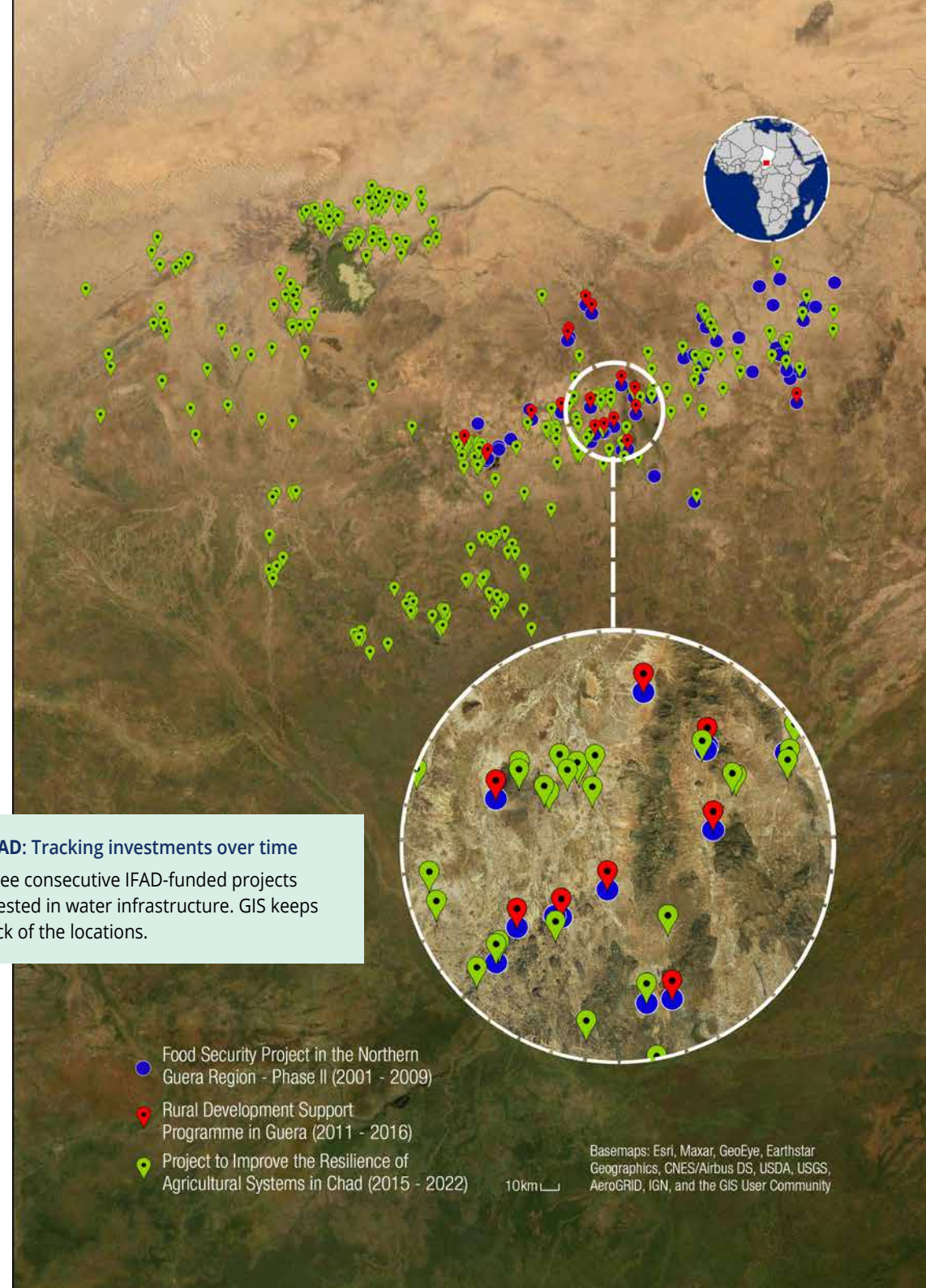
5 km

○ Demarcated land plots

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Geospatial tools, data and systems can help project stakeholders at all stages of the project cycle. Geospatial information helps in many ways:

- **Beneficiaries and other local people** can use data-enriched maps and satellite imagery to understand how the project is trying to support them. The maps can enable them to participate more effectively in project planning and implementation.
- **Project field staff** can use maps in their work with beneficiaries and other local people. They can more easily visualize the situation in the field and use the maps as a tool in their daily work. They can use maps both as a source of information and as a way to record new information to feed into the management and M&E system.
- **Project managers** can use maps to help decision makers, partners and new staff to understand the project quickly. Maps provide a common tool for visualization, a means to identify problems and opportunities, and a basis for discussion and decision-making.
- **IFAD staff and consultants** supervising projects can better understand the rationale and spatial extent of interventions, allowing them to provide better guidance and identify potential risks.
- **Evaluators** can obtain the data needed to assess current and future intervention impacts.
- **Innovators** can provide location-specific services such as precision agriculture or web-applications on weather and prices.
- **Project developers** can design activities informed by a track record of where interventions have taken place.
- **IFAD senior management** can make informed decisions and communicate successes of funded activities in a visually appealing way to the Fund's member states and cofinancers.
- **National governments and sub-national decision-makers** can easily see the value-for-money and results from their national operations. They can use this to guide future rural development interventions.
- **IFAD's member states and other donors** can more easily see the impact and effectiveness of their development finance and use this to guide future investments.



#### CHAD: Tracking investments over time

Three consecutive IFAD-funded projects invested in water infrastructure. GIS keeps track of the locations.

- Food Security Project in the Northern Guera Region - Phase II (2001 - 2009)
- Rural Development Support Programme in Guera (2011 - 2016)
- Project to Improve the Resilience of Agricultural Systems in Chad (2015 - 2022)

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

10km

## Inventory of mapped investment sites in IFAD

This manual is a product of the 2019 IFAD Innovation Challenge “Systematic integration of GIS in IFAD operations (GeoM&E)”. The initiative conducted an inventory of GIS datasets showing M&E indicators in IFAD-funded projects. Some insights:

- Many projects collect GIS data. In 2020, the GeoM&E initiative received data from a sample of these – over 60 projects.
- IFAD-funded projects collect data differently – from simple coordinates in a Word file to GIS-supported M&E systems.
- Many projects did not use data standards. Understanding the data was at times challenging.
- Data are mostly used for M&E but not for impact analysis.
- A lot of project data was linked to procurement procedures. Service providers of projects are valuable sources of data.
- Project areas defined at the design change during implementation. Perhaps 50% of the initial areas need adjustment during the project lifespan.



© Pictures: Engr. F. O. Ugbenyo and Robert Ekwule

### **NIGERIA: Mapping mission**

Two teams of surveyors mapped over 280 sites of the IFAD-funded Value Chain Development Programme (2013 – 2024) in 2020.



## 2. How can GIS be used in M&E?

**SENEGAL:** Investment sites of the IFAD-funded Agricultural Value Chains Support Project (2010 – 2016) and its successor project (2014 – 2020)



Base maps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

## 2. How can GIS be used in M&E?

Maps are very valuable at all stages in a project, from conceptualization and planning to implementation and follow-up. Here we focus on GIS applications used in monitoring and evaluation. These applications are useful both for a project implementation team, as well as IFAD staff and consultants providing technical support and advice to a project.

### Improving monitoring and reporting

GIS data, maps and statistics can feed into reports and support the decision making of management and project supervisors. GIS data can help to fulfil the reporting requirements of line ministries and donors. Data can be used in the following ways:

**Measuring indicators accurately.** GIS techniques can be used to measure indicators with a spatial dimension (such as kilometres or hectares) in the “logical framework” (logframe) – the basic document that guides the project’s implementation.

**Tracking activities.** Several projects equip field staff and contractors with GPS technology and require them to record and report on their activities (e.g. the time and location of a training session). This can help the project manager and other project staff in the rollout of project activities.

**Planning field visits.** Field trips can be planned more strategically when the exact intervention sites are known. This helps to save time and to prioritise visits to the most appropriate sites. Geotagged M&E data can also help with remote supervision of investments that are difficult to visit (e.g. conflict areas or in times of travel restrictions).

**Revising targets and results.** Once locations are accurately recorded, project implementers have the data to monitor progress and revise targets as necessary. GIS can be a very useful tool for capturing the true extent of project activities.

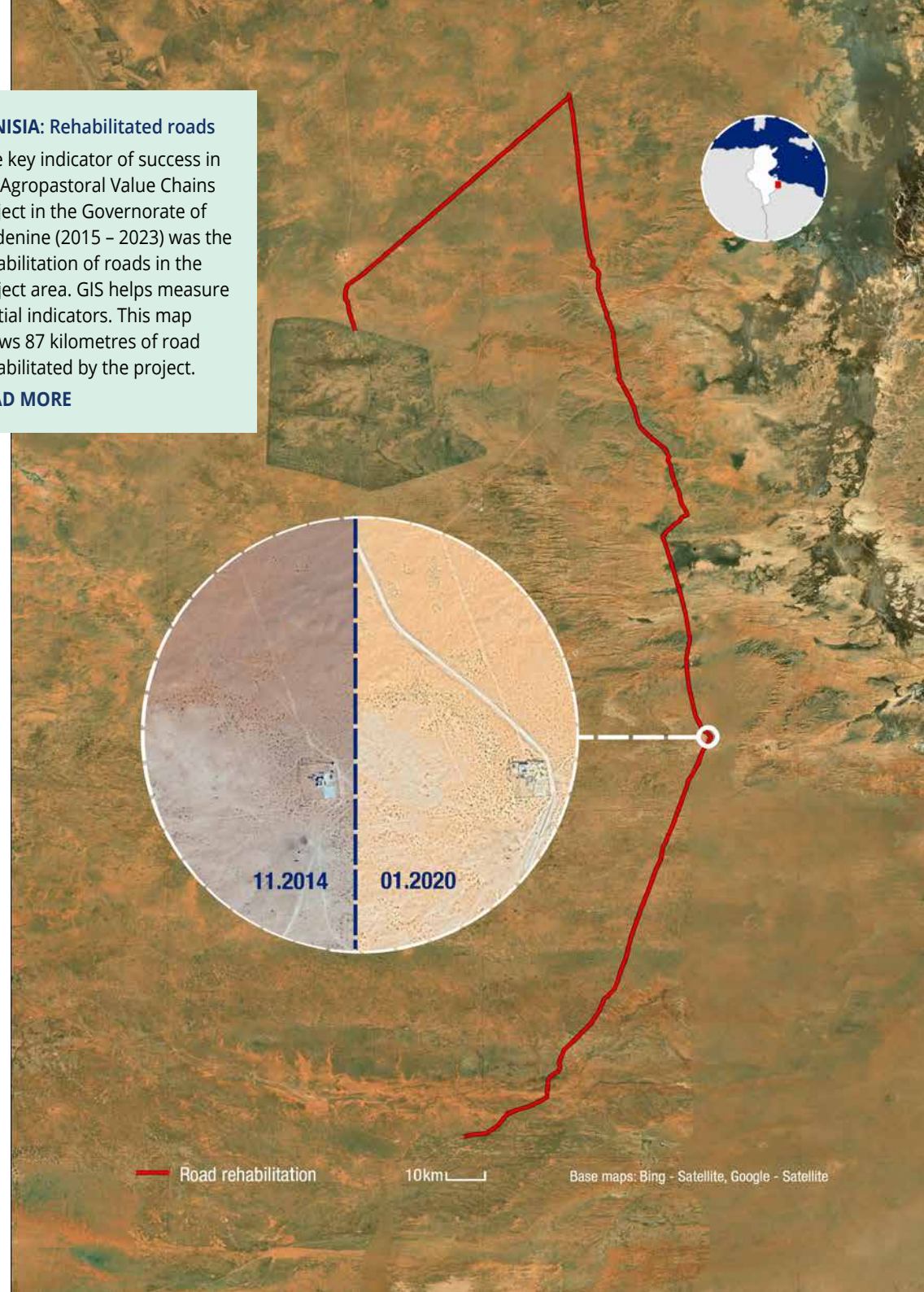
**Updating project area maps.** It is common for IFAD project areas to be refined during implementation. GIS maps of investment sites reveal where activities are actually taking place (and where not). This can help to update project area maps.



#### TUNISIA: Rehabilitated roads

One key indicator of success in the Agropastoral Value Chains Project in the Governorate of Médenine (2015 – 2023) was the rehabilitation of roads in the project area. GIS helps measure spatial indicators. This map shows 87 kilometres of road rehabilitated by the project.

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## Enhancing project effectiveness

Mapped M&E data allows project teams to make informed decisions about operations. It can help with the following:

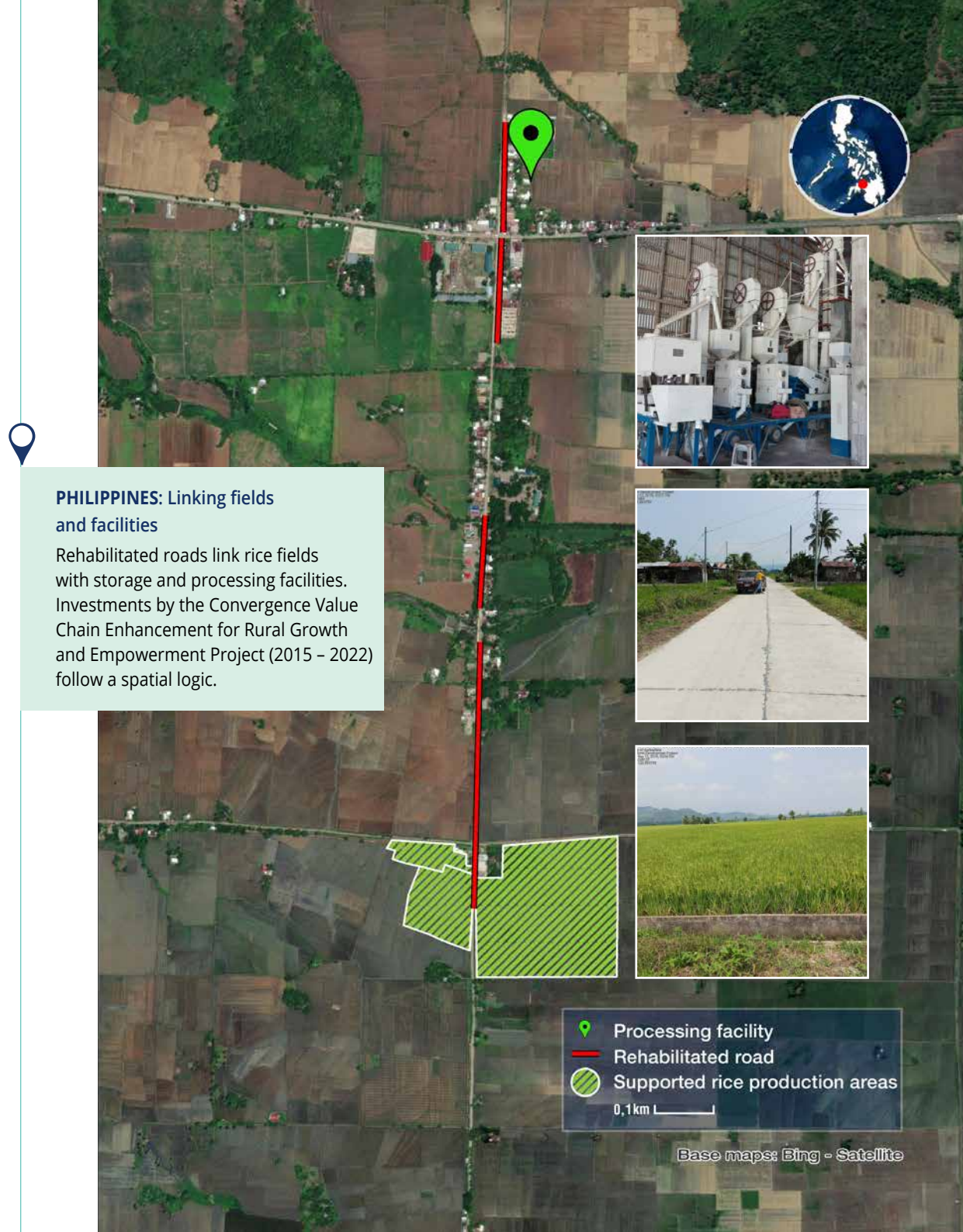
**Targeting.** Maps enriched with data can provide information about potential beneficiaries and show where specific project interventions are already taking place (and where not). This helps in the selection of beneficiary communities and in identifying potential gaps. Some data can be disaggregated by factors such as gender, age, presence of indigenous peoples, etc., helping IFAD and project staff to strategically allocate resources.

**Planning activities.** Project managers can allocate resources better and more cost-effectively if they know the exact location and full spatial extent of an intervention.

**Understanding the logic of interventions.** Many IFAD interventions have a spatial aspect. Spatial relationships (or the lack of them) can be displayed on maps. Dam locations, for example, are usually close to irrigation schemes, and rural roads should connect farmers to markets.

**Innovation.** Georeferenced data are also necessary to provide location-specific services. Geographical information technologies include precision agriculture and web-applications providing farmers with information on weather, commodity prices or agricultural inputs.

**Mitigating risks.** Analysing the overlap or proximity of project sites to legally protected areas (such as national parks), biodiversity hotspots and other areas of high environmental value can help the project to identify and mitigate risks of unintended adverse impacts. IFAD's Social, Environmental and Climate Assessment Procedures (SECAP) require the collection of GIS measurements of, for example, the construction of large irrigation schemes or roads.



## Assessing impacts

Knowing where interventions have taken place is necessary for many types of assessments, such as:

**Impact assessments.** Good data are a precondition for any rigorous impact assessment. Georeferenced monitoring is necessary to sample and match treatment and control sites, and control for confounding factors in order to identify impacts that can be attributed to the project.

**Environmental and climate assessments.** Location-specific data are needed to assess the impact of the project on the state of natural resources, land degradation, climate resilience and greenhouse gas emissions.

**Thematic assessments.** GIS data are also required for other types of assessments, for example on land tenure, supply-chain mapping, livestock-migration routes, water-related infrastructure, poverty maps and crop suitability.

**Change detection** with satellite imagery is a cost-effective option to monitor large areas and multiple sites. A precondition is to have location-specific data for analysts to know where to look for change. This may be the only alternative in conflict zones where access is restricted.

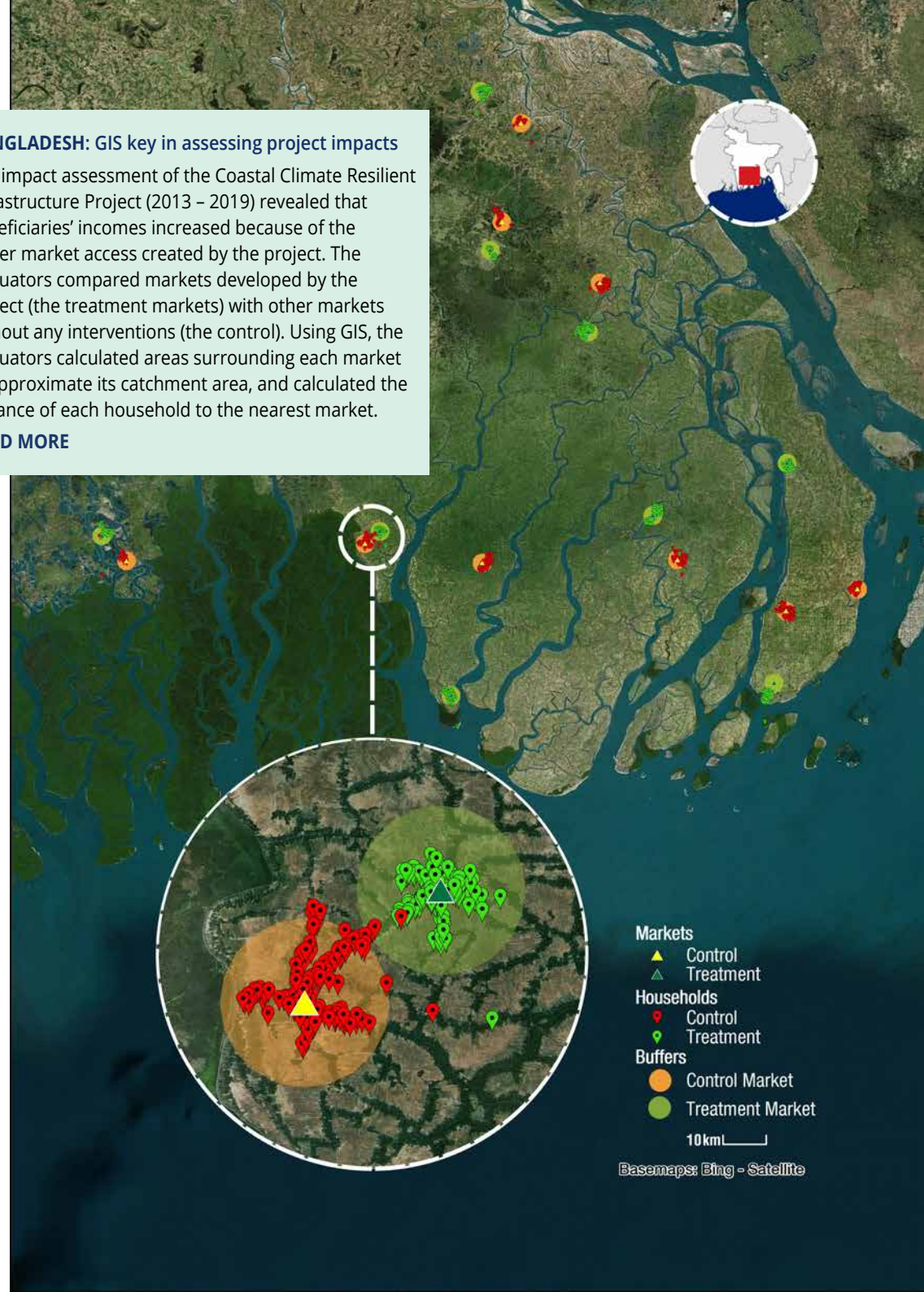
## Communication

Maps help to visualize plans and results. The extent of activities within a project area can be showcased to relevant government ministries, donors and project beneficiaries. This increases accountability and transparency. It supports better coordination and avoids duplicating efforts.

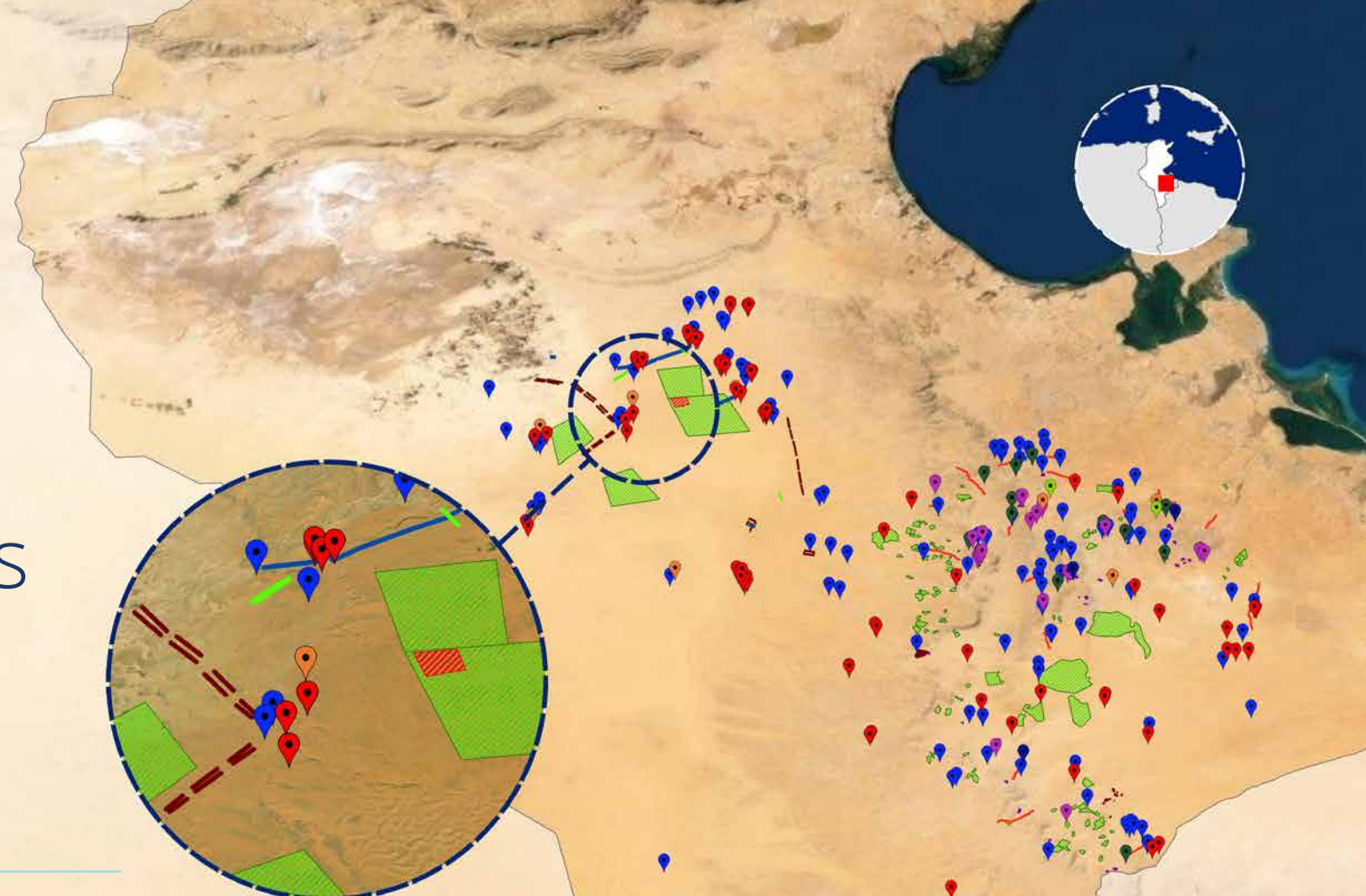
### BANGLADESH: GIS key in assessing project impacts

The impact assessment of the Coastal Climate Resilient Infrastructure Project (2013 – 2019) revealed that beneficiaries' incomes increased because of the better market access created by the project. The evaluators compared markets developed by the project (the treatment markets) with other markets without any interventions (the control). Using GIS, the evaluators calculated areas surrounding each market to approximate its catchment area, and calculated the distance of each household to the nearest market.

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### 3. What do project teams need to map investment activities?



**TUNISIA:** Investment sites of the Agropastoral Development and Local Initiatives Promotion Programme for the South-East - Phase II (2014 - 2020)



Base maps: Esri, Maxar, GeoEye, Earthstar, Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

### 3. What do project teams need to map investment activities?

IFAD projects are implemented by project teams that may include the staff of government, NGOs, consulting firms and others. It is these project staff who are the main collectors and users of spatial M&E data.

This section lays out what capacities and considerations are needed to map investment activities as part of M&E. A summary can be found in Annex 1 that presents the minimum requirements for IFAD-funded projects to map investment sites.

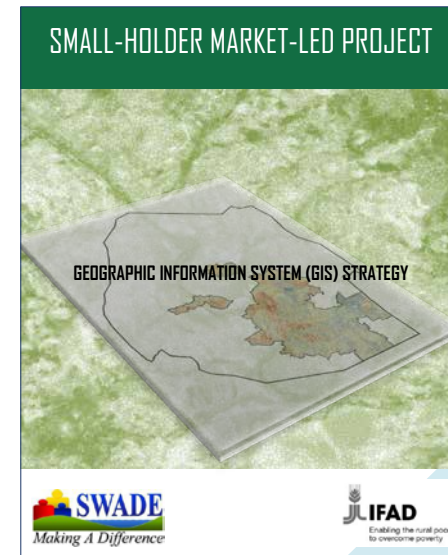
#### Strategy: What is the main objective?

As a first step, an overall concept should be developed determining the major objectives of GIS activities for a project. This could be captured for example in a **GIS strategy** or **operational manual**. Such a document should answer the following questions:

- What are the main **project activities** to be supported by GIS?
- What mapping **data** is needed to guide project planning, M&E and reporting?
- Who are your main data **users** (e.g. project management or field officers)?
- How will the data be used (simple visualizations and/or more advanced analysis)?
- What **capacities** (expertise, software and hardware) are needed to map and analyse data?
- What **procedures** for data collection, analysis and usage are needed?

Ideally, GIS should not be a separate activity, but be embedded in the project's M&E approach so it fully supports planning, monitoring and reporting.

When developing a strategy, find out what geospatial datasets and standards already exist externally or within a country. Contact government and international agencies and ask what data they have. A lot of data already exists and can be used to support decision making in the project.



### 6 - DATA ASSESSMENT

Considering SWADE's mandate and its project activities, more data is being generated than ever before, and much of it is location-based. The rise of the Internet of Things (IoT) is continuously creating an abundance of new data streams that need to be captured, processed and analysed on a regular basis to achieve operational and strategic organisational goals. This chapter highlights the existing data and database conditions, defined data users, and departmental concerns in regards to data. This chapter also includes a comprehensive digital data assessment of key base layers. Data in the backdrop of a GIS. Without comprehensive and reliable data, GIS of little use. GIS data should be seen as a very valuable organisational asset. The data discussed throughout this chapter has taken decades to compile and represents millions of Eswatini's effort and capital outlay. Therefore, the organization should take great care to maintain, improve, disseminate, and document this asset. Not only does the data serve to allow users to view and analyze facets of the organization, it allows users to create derivative (new) data sets that reveal patterns and intelligence that can in no other way be revealed. The following table is a summary of major findings in regards to data that have been discovered as part of this analysis.

KEY SWADE/SMLP DATA/DATABASE FINDINGS
Lack of standards – no organization-wide standards for data collection and maintenance have been established and no data standard operating procedures (SOPs) exist.
Redundancy of data types – the majority of data is unorganized and unstandardized.
Most of SWADE's GIS data is in shapefile and geodatabase format. This is a positive for the organization, because once it moves to ArcGIS Online based internet portals, the data will already be standardized. New data created should continue to be configured to the geodatabases, to ensure standardization and continuity for future GIS staff.
Need to improve data creation/collocation procedures across the enterprise – there is an opportunity to improve and standardize data collection procedures. Additionally, there is an opportunity to change organizational operations so that a coordinator and collector on staff gathers information in the field, giving data a geospatial component that it currently does not have.
Need to incorporate non-spatial data – organization-wide there are multiple spreadsheets and Access databases. Where applicable, location data needs to be captured or geotagged in these databases so they can readily be assimilated in the GIS.
The customer approach to Mobile GIS – data collection and maintenance of the field has become more important as technology has advanced. It is important that the organization invests in GPS and a uniform approach to mobile GIS efforts.

Since the organization is still at its infancy, very few datasets exist. Currently, data is stored in project-specific computers with copies saved in the GIS Server at the head office in Mbabane. Most of the data is in shapefile format and efforts have been made to migrate all the GIS data within the organization to the central server with a view of centralizing it. Currently available data for the SMLP is still being populated and includes the following:

- Digital orthophotos (DIOs)

### ANNEX B – SMLP SPATIAL METADATA GUIDELINES

The SMLP Spatial Metadata Guidelines are an adaptation of the National Standards from the Swedish Standards Authority (SIS) 2012. The SMLP officers or anyone assigned through the SMLP project should use these guidelines in preparing metadata as a bare minimum.

Category	Metadata element	Definition and allowable values
	Identifier	Unique identifier assigned by SMLP. This may be assigned by the metadata author in consultation with the SMLP GIS Officer.
<b>General Information</b>		
Title	Including alternative title/creation details	The ordinary name of the dataset. This should clearly and concisely indicate the content of the dataset.
Key Dates and Language	Resource creation date	Date that the dataset was first created or the date of the first record.
	Resource last updated date	Latest date in which the dataset was revised or verified. This date represents the reliability date of the dataset.
Abstract and Purpose	Metadata language/Resource Language	
	Abstract Purpose	A brief narrative of the purpose and content of the dataset. Purpose for which the dataset was created, including the project it was created for.
Metadata author	Metadata role Author	
	Author's details	The name and contact details of the responsible party completing the metadata record for the dataset.

#### ESWATINI: GIS strategy to guide operations

The Small-holder Market-Led Project developed a comprehensive strategy to guide the project on how to use GIS. It lays out guidelines for data handling, soft and hardware requirements, operational procedures, and training needs. It also provides guidance on how GIS data is recorded, stored and spatially projected.

## Measuring impact

**Start with the end in mind.** Projects need to measure the impact that can be attributed to their activities. Collect the data needed to help to measure impact. Collecting data for a map won't answer all your questions, but is necessary for more advanced analysis.

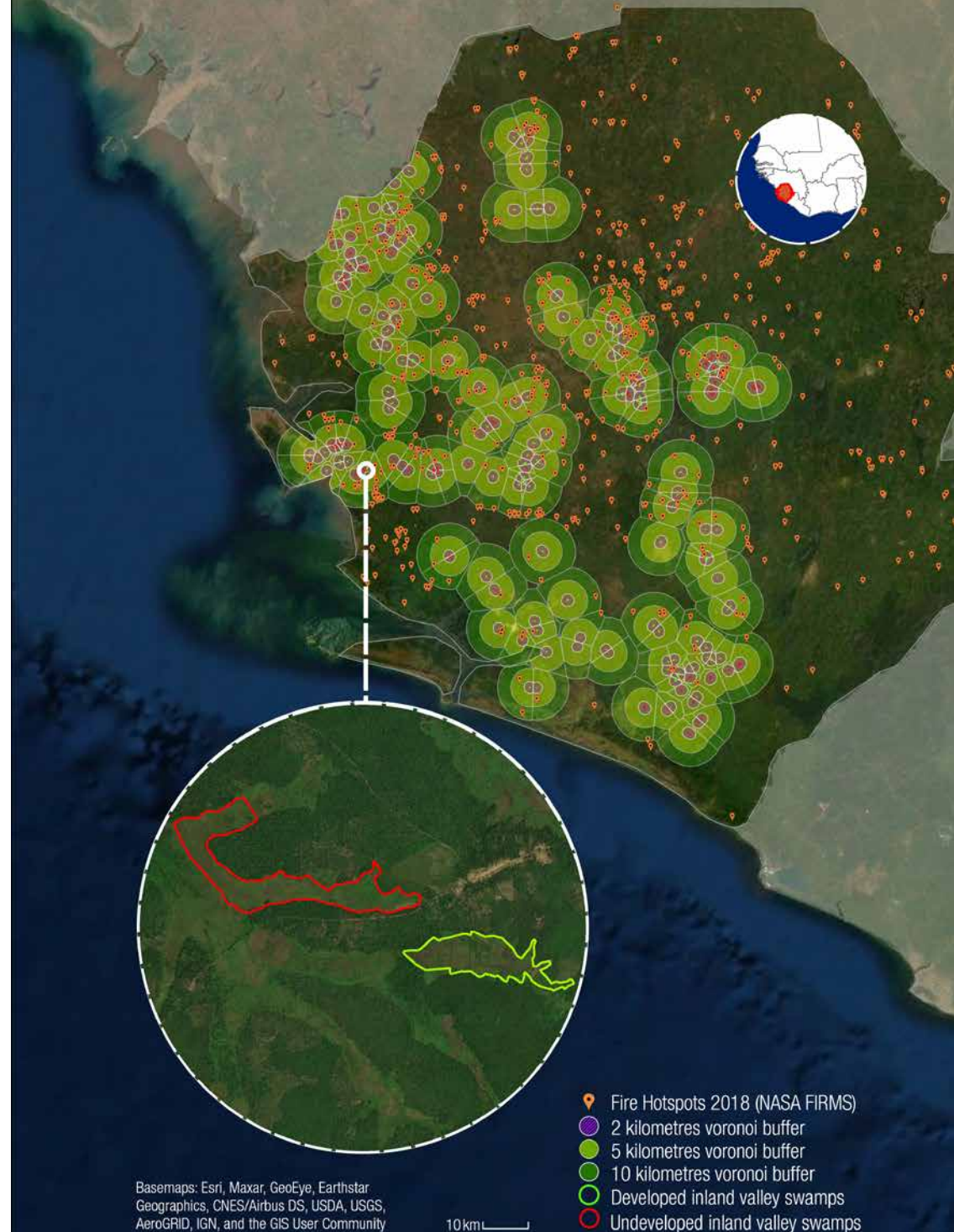
A good method to assess impacts is by comparing a representative sample of project beneficiaries (the treatment group) with a similar group of individuals not exposed to the project intervention (the control group). By comparing the two groups, it is possible to assess the changes that are attributable to a project. Geospatial data can help select suitable control groups and areas.

In most cases, the assessments compare households that have and have not received support by a project, but the unit of observation may also be small-scale businesses or producer organizations. Selecting the right control group is essential. The control must resemble the treatment groups in as many aspects as possible at baseline.

### SIERRA LEONE: Fighting fires with rice paddies

The IFAD-supported Smallholder Commercialization Programme, that finished in 2019, helped farmer groups develop low-cost irrigation systems in swamps which allowed them to grow irrigated rice three times per year as opposed to just once. Farmers now concentrate on producing rice in the developed swamps and practise less upland slash-and-burn to clear land in the surrounding higher lying areas. Burning the upland in the dry season harms the environment and is a major contributor to land degradation. Thanks to the thorough georeferencing of rice paddies by programme staff, IFAD's GeoM&E team were able to compare swamps developed by the programme with other swamps that remained undeveloped, and mapped these against satellite imagery on fires. On average there were 60 per cent fewer fires per year around the swamps developed by the project during the duration of the programme: a positive outcome for the environment.

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## People: What expertise is needed?

A project needs sufficient GIS expertise. GIS is a specialization and can be very technical. Experts should have a GIS background with appropriate technical knowhow, software skills, and working experience in the field. Consider the following points:

- Projects should employ a GIS specialist to support the M&E team. Annex 2 presents model terms of reference for a GIS expert to support M&E.
- Experts may also be external, and consultants can be sourced to support the project.
- Project staff may need to be trained, e.g. on how to use a GPS device for mapping points or measuring land area. It may also be useful to train staff on how to view GIS data against satellite imagery and to do basic calculations.
- Service providers often use GIS (such as engineering firms designing infrastructure). Projects can benefit from their expertise and request and store the data they produce.

## Procedures: What are the steps to collect and use geodata?

Mapping investment sites is not difficult in most cases. Often the bottleneck is not technology but coordination. Projects will require workflows to cover data collection, analysis, dissemination and usage.

**Collection.** This is the most challenging part. Develop a plan and protocols for data collection (who, what, when, where and how). Logistics may be challenging, as certain sites may be very remote. Develop detailed instructions on how to collect data. Staff will need training on how to collect data. Ways to collect information include:

- **Regular M&E and implementation activities.** Many projects equip their field staff with handheld devices to record the locations of investment sites during their regular site visits. This is a very cost-effective way to collect data.



© Community Development and Investment Agency (ARIS)

**KYRGYZSTAN:** The Livestock and Market Development Programmes I and II (2013 – 2021) employed a GIS expert who trained over 150 field staff to collect geolocations of project investment sites. The expert also gave 118 training sessions to over 2600 community members on how to use simple GIS mapping tools.



- **Mapping missions.** A project may wish to dedicate a standalone field mission to systematically record investment sites. This might be necessary, for example, to quantify farmland areas and roads.
- **Surveys.** Surveys of households, businesses, producer organizations, and communities should also collect their geolocations.
- **Service providers.** They help implement project activities and are an important source of data. Ensure that they provide the project with geodata on their activities.
- **Extracting data from external sources.** A lot of geodata already exists. Governments and development agencies often hold relevant data. For example, villages or roads can be extracted from geographic databases such as openstreetmap, or field boundaries may be extracted from cadastres.
- **Participatory mapping.** Communities can also be engaged in collecting M&E data. GIS can be combined with participatory planning methods to engage with communities.

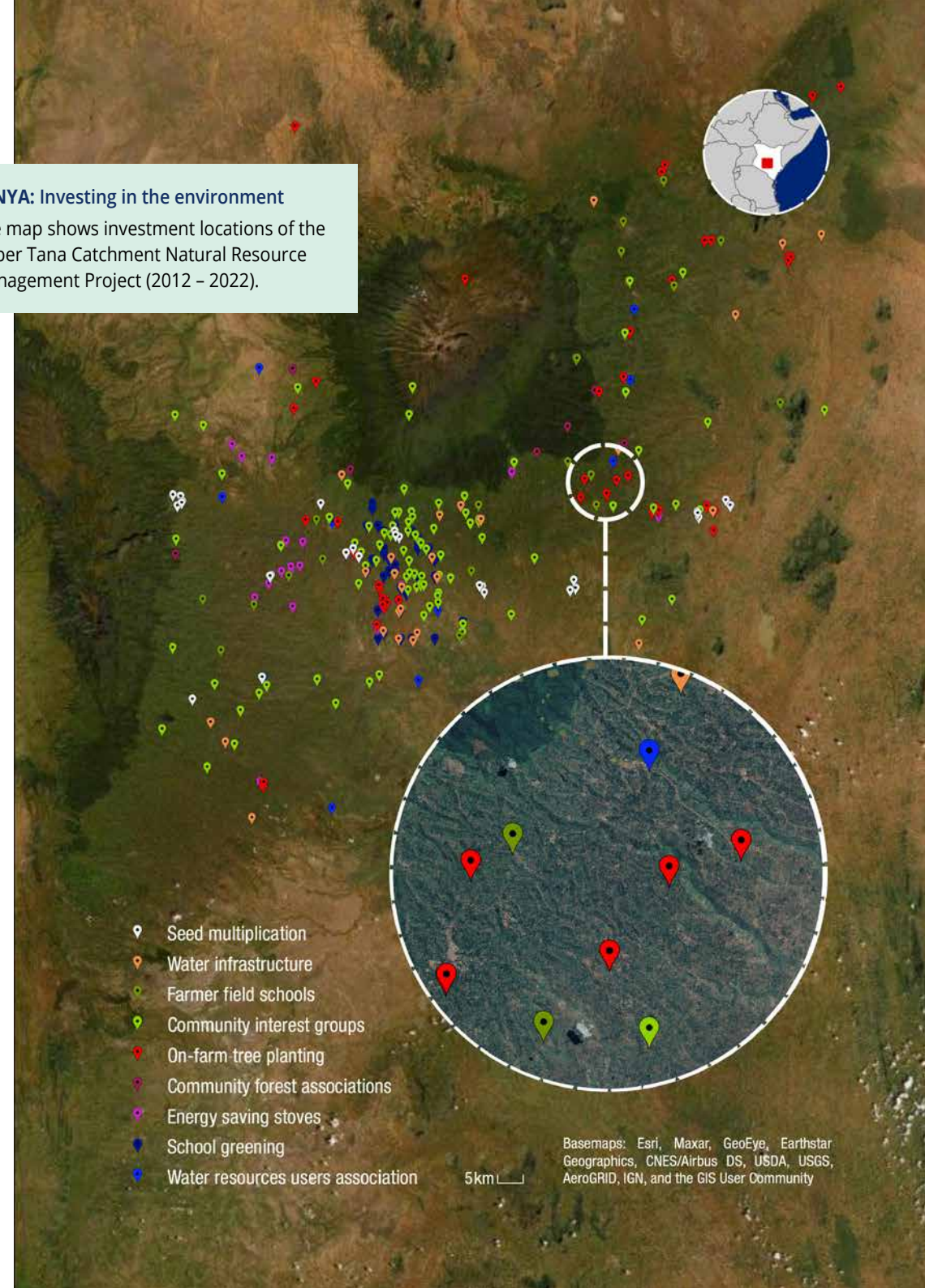
Some tips for data collection:

- **Accuracy.** For most purposes the approximate location of an investment site is fully sufficient for IFAD. Inaccuracies of 5 to 10 metres are not a problem in most cases.
- **Coordinate formats.** A common problem projects face is different coordinate formats. Specify the coordinate format and be consistent in using it when you collect point locations. We recommend using decimal degrees (e.g. -17.8632480963; 47.6763893702).
- **Frequency.** Some sites only need to be geotagged once. In other cases, projects might want to record an investment site twice (before and after) for planning purposes and to check if the activity has been successfully completed.



### KENYA: Investing in the environment

The map shows investment locations of the Upper Tana Catchment Natural Resource Management Project (2012 – 2022).



- Seed multiplication
- Water infrastructure
- Farmer field schools
- Community interest groups
- On-farm tree planting
- Community forest associations
- Energy saving stoves
- School greening
- Water resources users association

5km

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

**Cleaning and quality check.** The data need to be assembled and checked for correctness. Do not underestimate the time it takes to clean and check data.

**Analysis and visualization.** This includes producing descriptive statistics and simple maps. Consider placing the data on a web-map or dashboard. This manual features examples of how IFAD-funded projects display their data. The data can also be the basis for more advanced analysis using other data sets such as population estimates and accessibility maps.

**Storage.** The project team must determine where to store data. Ideally the data should be accessible to project staff, and regular backups should be made. Projects should comply with national data-privacy regulations. Be sure to protect sensitive data.

**Dissemination and usage.** The data are of value for project management and should be featured in official reports, not only for reporting to the project manager, but also for technical staff and staff working in communications. They are also valuable for publications, websites and public-awareness materials. Cater also for the reporting requirements of IFAD.

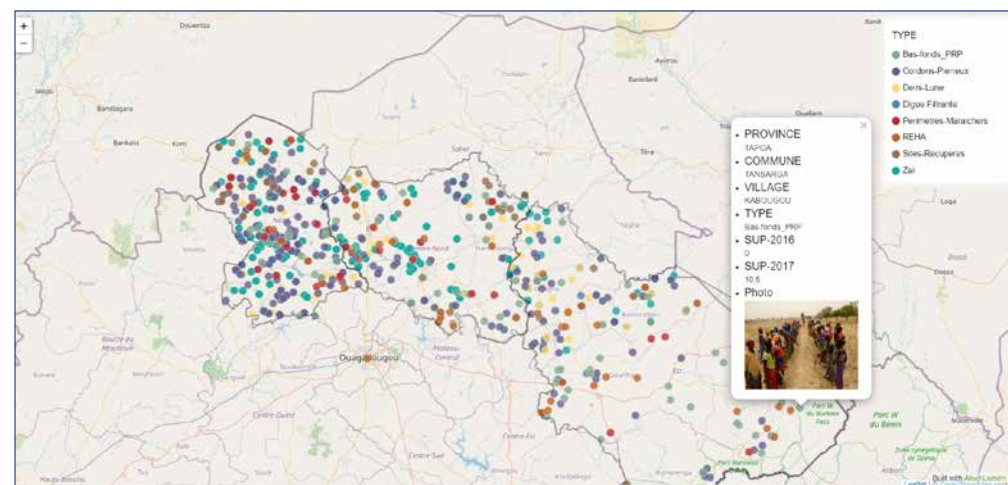
## Indicators: What data to collect?

Determine what spatial data are to be captured. The best entry point is the logical framework of a project. Find out which indicators have a spatial dimension and whether geographically referencing them would support the project M&E.

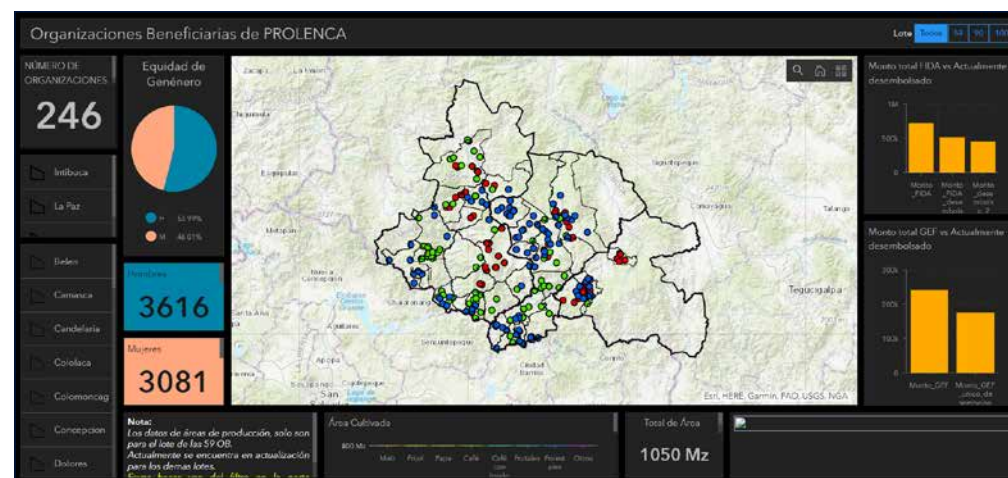
Be specific in defining the unit of observation (the object about which information is collected) to avoid confusion later. Spatially explicit indicators that should be georeferenced include:

- **Infrastructure** such as markets, processing facilities, roads and water points.
- **Organizations** such as farmer associations and rural finance institutions.
- **Land areas** such as irrigation schemes, afforested areas and land under improved tenure.

## Online maps of IFAD-funded projects



**BURKINA FASO:** Participatory Natural Resource Management and Rural Development Project in the North, Centre-North and East Regions (2013 – 2022) ([VIEW SITE](#))



**HONDURAS:** Project for Competitiveness and Sustainable Development in the South Western Border Region (2014 – 2023) ([VIEW SITE](#))

Do not collect GIS data for everything. Collecting GPS coordinates has a cost. The project has to reflect where it makes sense to collect data and how the data is to be used. Consider the following:

- Map investments that are costly (e.g. buildings costing over US\$10,000).
- Map investments that have a high environmental and social risk (e.g. dams and roads).
- Map investments that are necessary to measure impact (e.g. the boundaries of irrigation schemes are needed to estimate yields).
- Integrate the collection of georeferenced data during regular project activities.
- Map indicators that are IFAD core indicators (e.g. rural roads or processing facilities).
- Points are easier to collect than transects or areas, as you only need latitude and longitude coordinates that most smartphones can determine.

### Environmental indicator maps

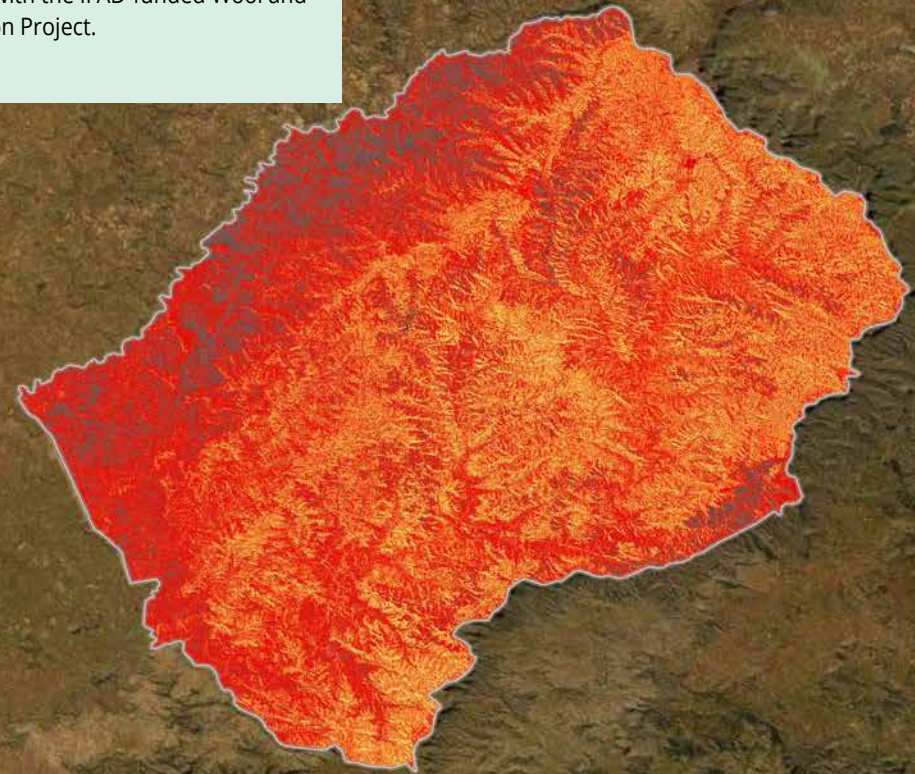
Indicator maps (e.g. on soil erosion, vegetation health or soil organic carbon) might help detect changes attributable to a project. The maps might be modelled using satellite imagery and field measurements, and take into account seasonality and other factors such as rainfall. Going into the details on how to produce indicator maps requires another manual and is not featured here. Important is that these maps are the most effective if the boundaries of the intervention (e.g. afforestation) are known.



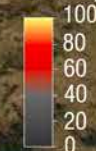
#### LESOTHO: Erosion modelling

This map on soil erosion can help identify locations for investments to restore rangelands, and to monitor the success of such interventions. It was produced by the World Agroforestry Centre in collaboration with the IFAD-funded Wool and Mohair Promotion Project.

[READ MORE](#)



Erosion prevalence (%) 2019-2020



Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

10km

## Household locations

Ensure that all household surveys undertaken are geographically referenced, particularly at baseline, mid-term and completion surveys. Smartphones or GPS devices can help do this. Having a representative sample of households is enough to monitor project impacts. It might be unrealistic (and unnecessary) to georeference every single household that might benefit from a project.

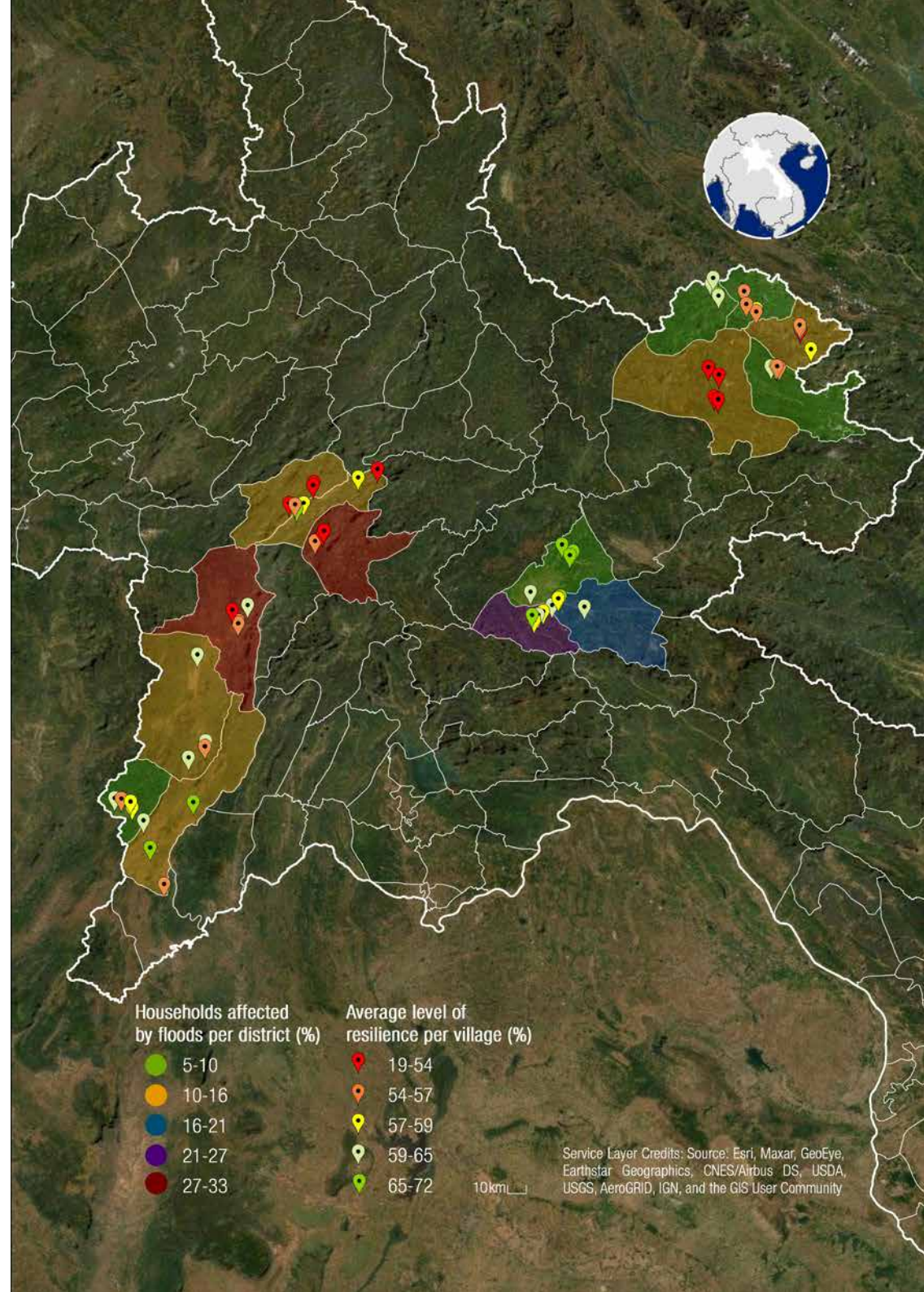
IFAD-funded projects use a questionnaire on core outcome-indicators for baseline, midterm and completion surveys. IFAD is also piloting survey methods to measure household resilience (their capacity to respond to shocks).

Once a household location is mapped, analysts can associate it with additional information for this location. For example, they can check the climatic data for the location, or detect if the household is located in a flood plain. The survey data can also be aggregated at different levels (e.g. village, district or watershed). This makes it possible to map vulnerable areas, identify needs and measure changes over time.

### LAO PEOPLE'S DEMOCRATIC REPUBLIC: Measuring household resilience

This map shows the results of a survey with 1,500 households in 60 villages undertaken by the Partnerships for Irrigation and Commercialisation of Smallholder Agriculture Project (2019 – 2025). The survey builds on IFAD's Resilience Design and Monitoring Tool – a methodology that identifies multiple risks (environment, climate, social, economic) and measures the level of resilience (a household's capacity to respond to shocks and stressors).

Data can be aggregated at different levels. This map shows the percentage of households reporting to be at risk from floods in a district. It also shows the average level of resilience at village level. Such data help project implementers to identify the most vulnerable households and appropriate measures to address climate risks (such as flooding).



## Hardware: What devices are needed to collect data?

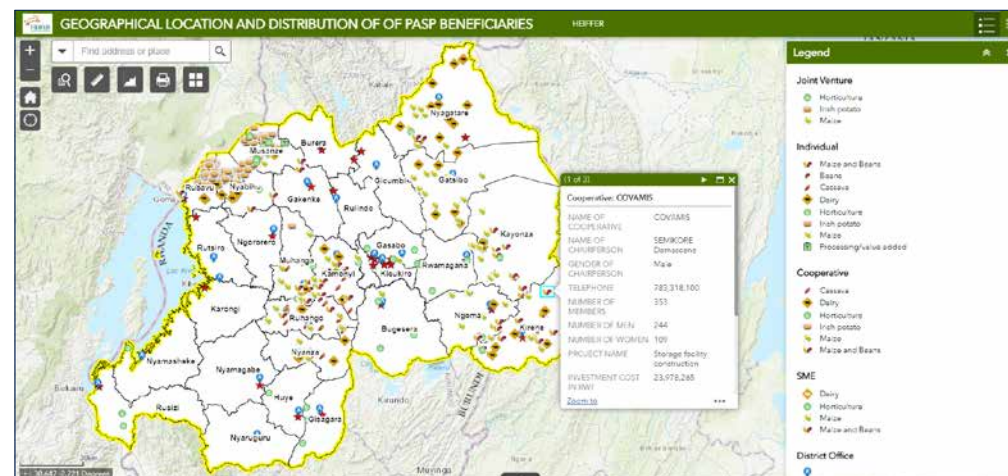
Hardware considerations include the following: servers/cloud, desktops, laptops, mobile devices, stand-alone GPS devices, drones, plotters, large-scale printers, etc. The points below give an overview of the different types of devices to collect georeferenced data.

- **Smartphones and tablets.** These devices are easy-to-use and relatively efficient for collection of GPS coordinates, basic analysis and viewing of maps. They are widespread, low-cost, portable and have multiple uses (including for communication, photography and video recording). They readily lend themselves to georeferencing project sites, but depending on the device, may not be very accurate.
- **Specialized GPS handheld devices.** These record GPS coordinates more accurately than smartphones. Projects should preferably use these devices to record geographical locations. They can also capture transects and areas precisely. Various brands and models have different costs and specifications in terms of accuracy and versatility.
- **Drones (unmanned aerial vehicles).** Drone cameras can quickly take a large number of images or video, showing both the GPS coordinates and the time and date. They may also show the accuracy of the coordinates. The coordinates can be linked to aerial photographs, videos and satellite images. Drones can be especially useful for georeferencing rural roads, water bodies and topographic features.

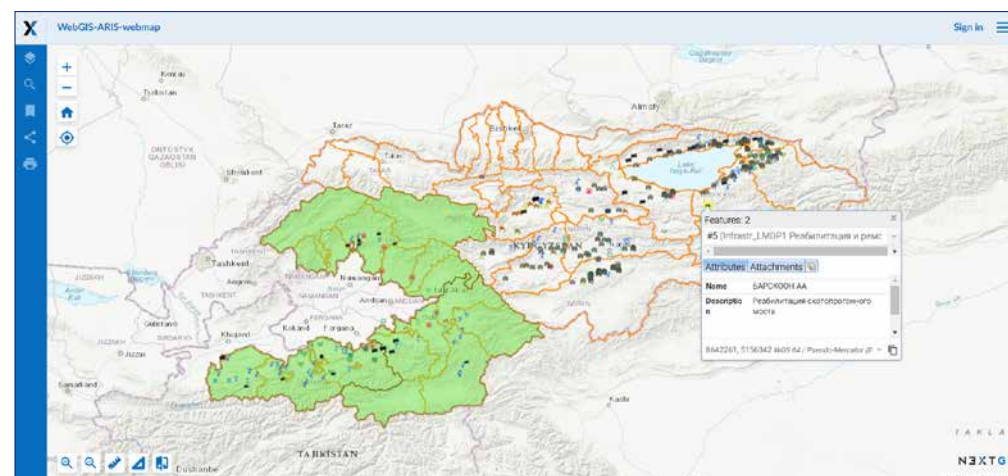
An important hardware consideration is the cost and the number of units required. Consider the following points:

- Handheld devices are sufficient for most IFAD projects. Medium-sized projects typically have around 20 to 30 GPS devices. Higher-accuracy GPS data are needed only in specialized contexts such as the construction of dams.
- Think twice about procuring devices that require a monthly or annual subscription, or if you do, ensure that licence fees are low. Some high-quality devices seem not to cost much, but the monthly licence fees may be very expensive.

## Online maps of IFAD-funded projects



**RWANDA:** Climate-Resilient Post-Harvest and Agribusiness Support Project (2014 – 2020) [\(VIEW SITE\)](#)



**KYRGYZSTAN:** Livestock and Market Development Programmes I and II (2013 – 2021) [\(VIEW SITE\)](#)

- GPS receivers can store geographic coordinates in various numeric formats ('sexagesimal degrees' vs 'decimal degrees'); and it is crucial to stick with one system to avoid confusion and errors later.
- Software to take geographical measurements is often already provided by the manufacturer of GPS handheld devices.

See the Annex 7 for technical details on GIS equipment.

## Software: How is data managed, analysed and stored?

Various software applications are available. In most cases a combination of different programmes for different purposes is used.

### Data management

The most commonly used GIS software in IFAD and IFAD-funded projects are the following:

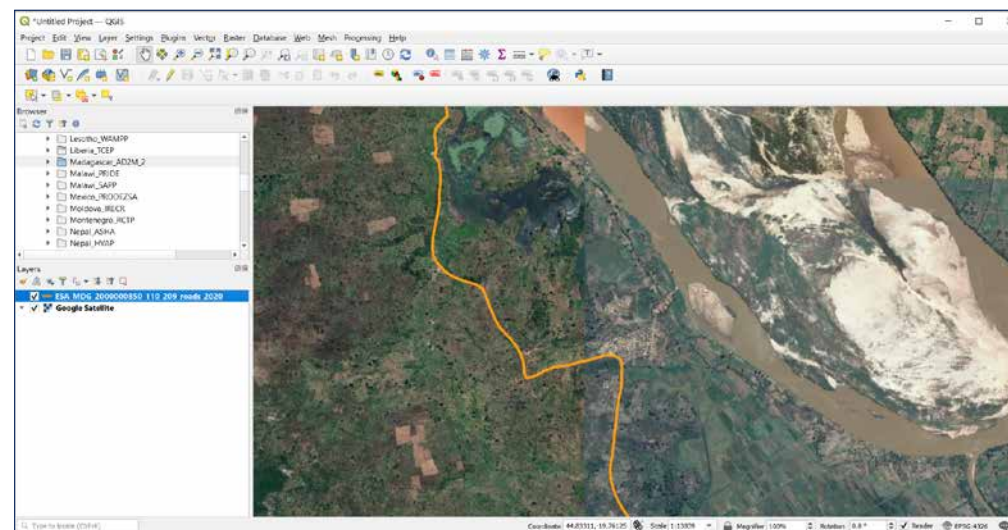
- **QGIS** is a free and open-source cross-platform desktop geographic information system application that supports viewing, editing, and analysis of geospatial data ([learn more](#)).
- **ArcGIS** is a commercial geographic information system for working with maps and geographic information maintained by Esri. The software package also allows users to create online dashboards and story maps ([learn more](#)).
- **Google Earth Pro** is a freely available computer programme that renders a 3D representation of the Earth based primarily on very high resolution and multitemporal satellite imagery. It is an excellent tool to visualize data ([learn more](#)).

The best software packages to handle, manage and analyse GIS data are ArcGIS and QGIS. IFAD projects should use one of these packages. Google Earth Pro is ideal to visualize data, but not to manage and analyse it.

## Comparison of commonly used GIS software

	QGIS	ArcGIS	Google Earth Pro
Level of GIS expertise	High	High	Low
Data management	Advanced	Advanced	Challenging
Data analysis	Advanced	Advanced	Basic
Licence fees	No	Yes	No
Map creation	Yes	Yes	No
Visualization with satellite imagery	Plugins available	Basemaps provided	Set of high resolution data available

## Software interface of QGIS



Visualizing a rehabilitated road against satellite imagery

## Data collection

The following **data-collection applications** are mainly used for household surveys and allow the capture of geographical coordinates of visited sites:

- **KoBo Toolbox** is a toolkit to collect and manage data in challenging environments. The software is free and open-source ([learn more](#)).
- **Open Data Kit** is a free and open-source software for collecting, managing, and using data in resource-constrained environments ([learn more](#)).
- **SurveySolutions** is a free data-collection software developed by the World Bank ([learn more](#)).

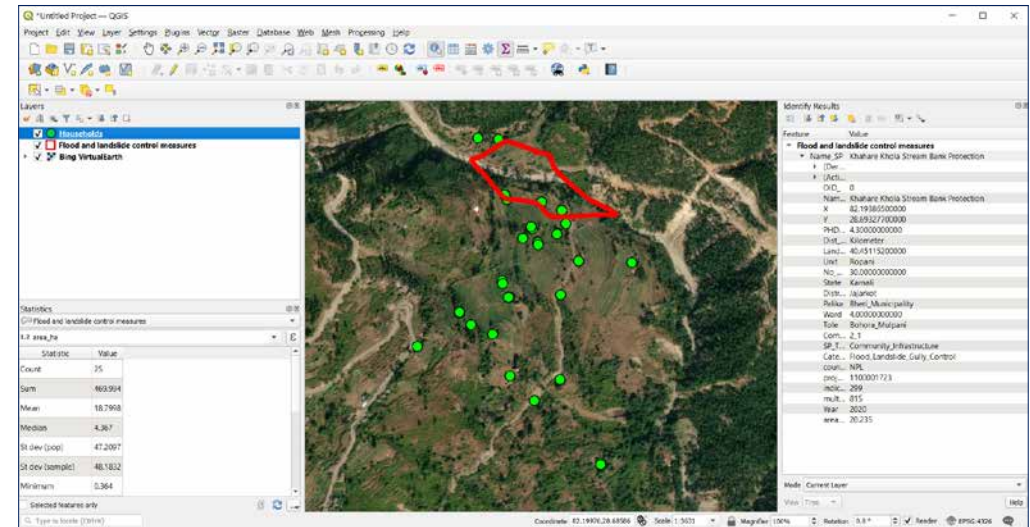
## Data platforms

There is a trend towards using online GIS platforms to store and visualize data. While the setup of online GIS systems used to be technically demanding a few years ago, it has become much more easy nowadays. A variety of options exist. Check what options exist in a country.

QGIS cloud as well as ArcGIS Online offer readily possibilities to process and publish spatial data layers or even maps directly online, which allows users to integrate these easily into reports or share them online with ease. Basic hosting plans are for free, but for additional features such as access restrictions or large data volumes, fees may apply.

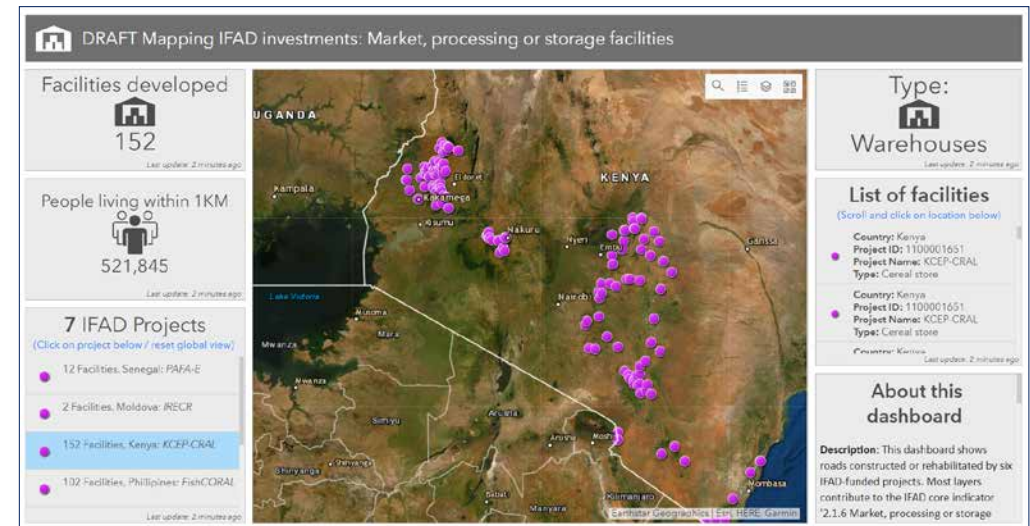
Many different web-based spatial content management systems exist. GeoNode, an open-source solution, can be extended and modified, or integrated into existing platforms. IT expertise is needed to set up GeoNode.

## Software interface of QGIS



Each feature has attributes that specify the details of an investment site. QGIS can easily compute summary statistics.

## ArcGIS dashboards



This web-application shows market, processing and storage facilities developed by several IFAD-funded projects. Once the data is in the right format and standardized, it can be visualized easily.

## Data analysis

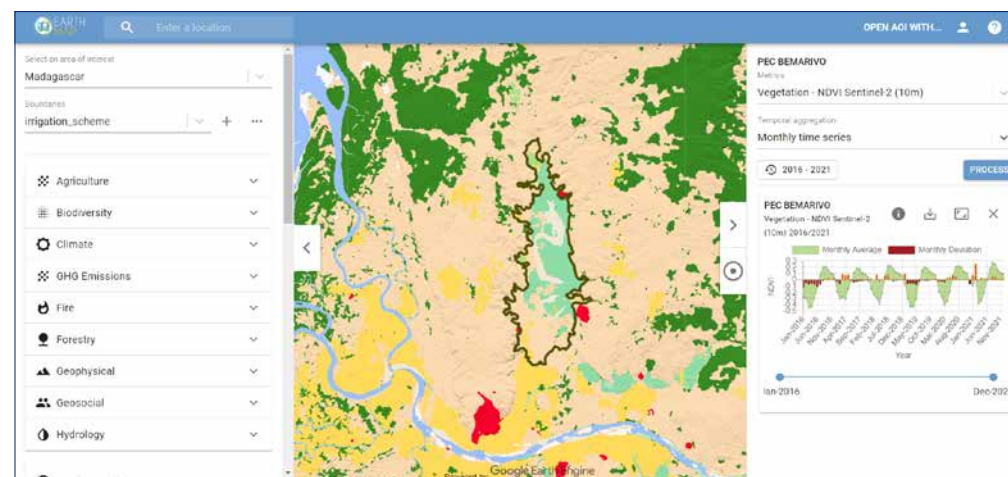
When the M&E data is ready for analysis, continue using ArcGIS and QGIS. These softwares can conduct most types of spatial data analysis.

The following user-friendly **web-applications** give access to a number of environmental and socio-economic datasets and are especially useful for environmental analysis. They allow users to determine or upload their areas of interest for analysis:

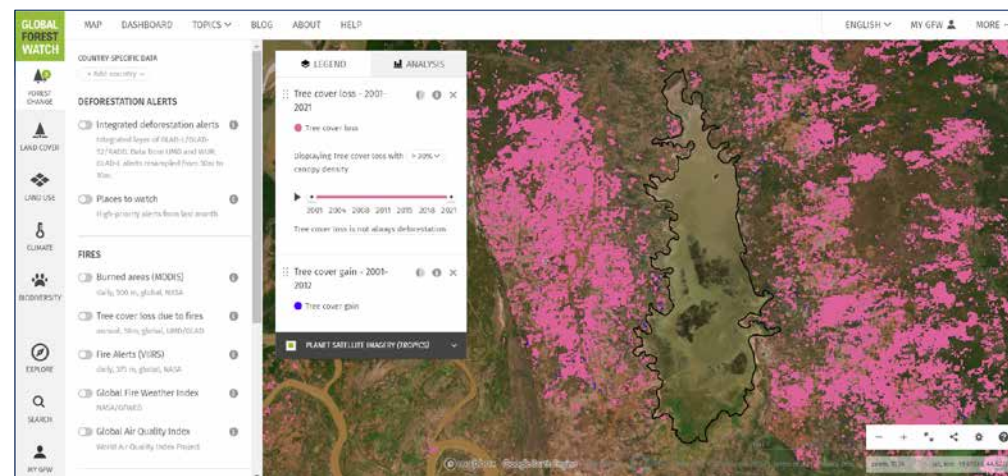
- **Earth Map** is an innovative online tool hosts a repository of models allowing users to analyse the status and trends of e.g. vegetation, climate, fires, land cover, biodiversity and water ([learn more](#)).
- **Global Forest Watch** is a online forest-monitoring system that allows users to measure and visualize changes to the world's forests. It also hosts useful layers on e.g. indigenous peoples' territories, land cover, climate and biodiversity ([learn more](#)).
- **SEPAL** or – System for Earth Observation Data Access, Processing and Analysis for Land Monitoring – is a cloud computing-based platform that allows users to access and process satellite imagery without having to download any data ([learn more](#)).
- **Geofolio** is a simple web-application. Draw an area of interest, and this tool generates a factsheet for that area showing land cover, watersheds, climate, topography, soils, etc. ([learn more](#)).

**Google Earth Engine** is a powerful processing platform that hosts a wide range of datasets and draws on enormous computing power. Users do not have to download or process any data on their own computers. Analysis is done in the cloud. JavaScript or Python programming skills are needed ([learn more](#)).

## Web-applications to help analyse an area



**EarthMap:** Upload an irrigation scheme area as a zip file and view e.g. how the land is used and analyse vegetation health trends.



**GlobalForestWatch:** Upload the same area and analyse deforestation trends within and around it.



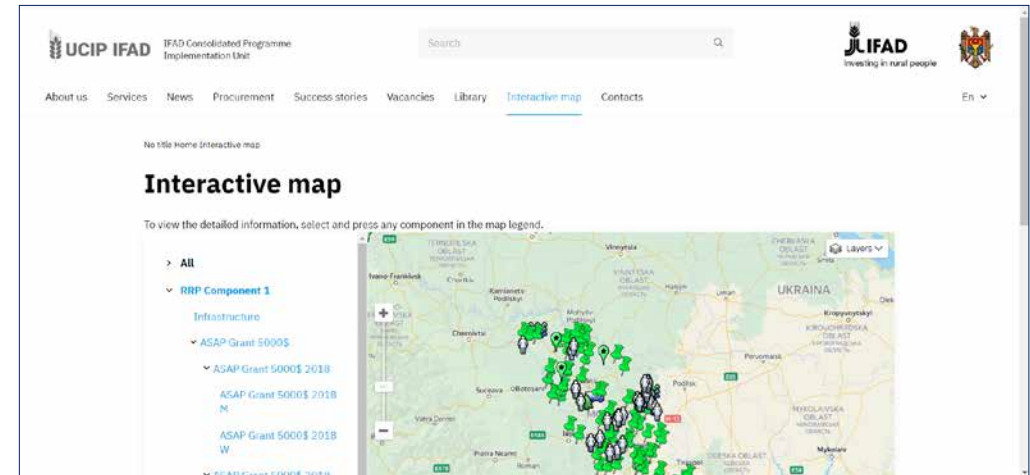
You might want to consider using **statistical and econometric software**. Here are two options:

- **STATA** is a commercial software package allowing users to conduct spatial econometric analysis. They can link GPS coordinates with remote-sensing data in order to rigorously analyse project impacts (learn more).
- **R** is a free open-source software environment that can be used for statistical computing and graphics. It allows users to conduct geospatial statistical analysis and mapping. R requires the user to get familiar with its programming environment, which offers powerful analysis tools, but can be daunting at first (learn more).

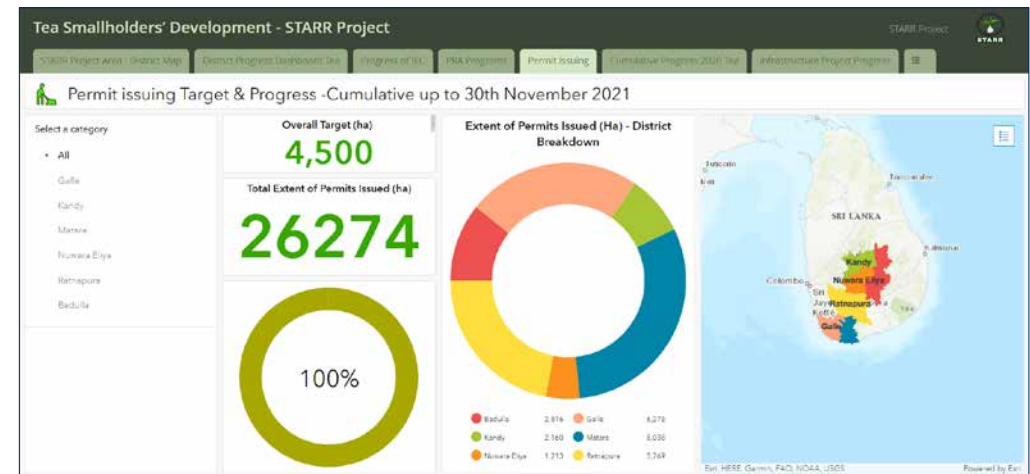
### Open-source vs. licences?

Should projects use open-source or paid GIS software? Both have advantages and disadvantages. Open-source solutions tend to be scalable, cost little, are easy to use and have equivalent functionality to proprietary software. Paid software has better user support and tends to be more user-friendly.

### Online maps of IFAD-funded projects



**REPUBLIC OF MOLDOVA:** Inclusive Rural Economic and Climate Resilience Programme (2014 – 2021) ([VIEW SITE](#))



**SRI LANKA:** Smallholder Tea and Rubber Revitalization Project (2016 – 2023) ([VIEW SITE](#))

## Using GIS to support M&E of project activities in Sierra Leone

The Smallholder Commercialization Programme (2011 – 2019) systematically used GIS in its M&E. Collecting the exact coordinates and area calculations of project activities allowed the project managers to ensure that service providers and other implementing partners had carried out field activities.

**People.** A GIS expert was a member of the M&E team. This expert coordinated georeferencing activities and took care of the software aspects of data collection. The expert trained a range of people in the use of GPS and data collection, including all project staff, M&E officers, agricultural engineers, and service providers.

**Hardware.** The project procured 32 handheld GPS devices (model Garmin GPSMAP 64s). Five were located in headquarters and two were located in each of the nine district offices for M&E staff. Nine devices were given to agricultural engineering officers. The project also procured 100 smartphone tablets to do surveys.

**Software.** The M&E unit used ArcGIS to handle spatial data and mapping. It used Open Data Kit, a free application, to collect data. ONA (a cloud service provider) was used to host the project's database as well as the data-collection platform.

**Data.** The project georeferenced in particular:

- Warehouse and drying-floor locations;
- Areas of developed inland-valley swamps used mainly for rice production;
- Locations of sites where farmers planted tree seedlings (3,000 for oil palm and 3,200 for cacao);
- Locations where training took place, including the Gender Action Learning System methodology; and
- Locations of 52 agribusiness centres.

**Procedures.** District agricultural officers and service providers were required to collect and submit GPS data to the GIS expert as part of their regular reporting. Enumerators were hired to map rice-production areas and tree-crop facilities. This was done by walking around each area with a GPS.

*Provided by Abu Bakarr Sidique Bangura, GIS officer of the project.*



Pictures: Brima Kamara (top) and IFAD/Oliver Mundy (bottom)

## Standards: How should data be described and recorded?

**Data standards** are rules by which data are described and recorded. They make it possible to share, exchange, and understand data. Consider the following points.

**Metadata.** Datasets should be accompanied by information about the dataset. Users should understand, for example:

- What exactly the data shows (e.g. indicator name and description);
- To which project it belongs;
- When and how it was collected; and
- Who collected it (person and contact details);

**Format.** The **shapefile vector** format is the most common format used. In principle, one indicator should be displayed as one shapefile. ArcGIS and QGIS are both able to create, display and process shapefiles. Each shapefile holds one of the three basic geometries:

- **Points**, which are single locations that have latitude and longitude coordinates (e.g. a warehouse).
- **Polylines** indicate transects (e.g. roads); and
- **Polygons** capture areas (e.g. irrigated farmland).

Google Earth's KMZ format, which is often used in IFAD projects, is good for visualizations in Google Earth Pro, but the format is not suited well for data management and analysis because it lacks an attribute table, and geometric calculations with many layers are cumbersome. Projects managing data in the KMZ format should convert it into shapefiles. Other GIS data formats exist, but they are not very common for M&E in IFAD projects.

The screenshot displays a GeoNode interface for a dataset titled "Market facilities supported by KCEP-CRAL, Kenya". The main content area features a satellite map of Kenya with numerous orange triangle markers indicating the locations of market facilities. To the right of the map, there are several interactive elements: a "Download Layer" button, a "Metadata Detail" button, and a "Download Metadata" button. Below these is a legend showing a single orange triangle labeled "point". Further down, there are sections for "Maps using this layer" (listing "Mapped activities of KCEP-CRAL, Kenya") and "Create a map using this layer" (with a "Create a Map" button). The "About" section identifies the owner as "m.latham" from "IFAD".

Info	Attributes	Share	Ratings	Comments
Title	Market facilities supported by KCEP-CRAL, Kenya			
Abstract	The data set shows 107 locations of physical markets supported by the Kenya Cereal Enhancement Programme Climate Resilient Agricultural Livelihoods Window (KCEP-CRAL) (11000016551). Moses Abukari and Ndavazhile Kaluwa from IFAD received the data from the project in July 2020. Acknowledgement: This data set has been added to IFAD Geonode as part of the IFAD Innovation Challenge "GeoM&E" funded by CDI.			
Publication Date	Aug 28, 2020, 2:33 a.m.			
Type	Vector Data			
Category	Structure			
Regions	Africa, East Africa, Kenya			
Owner	m.latham			
More info	-			

**Metadata:** GeoNode – IFAD’s repository for geospatial data – enables users to understand what the data is showing and where it comes from.

**Attribute table.** The shapefile vector format makes it possible to attach an attribute table to each feature mapped. This table is similar to a spreadsheet file in Excel. It contains **fields** that store information about the **feature**. The attribute table is the best way to record details of an investment such as its name, cost and type of intervention. Projects should specify the fields a shapefile should contain. The most common fields are the following:

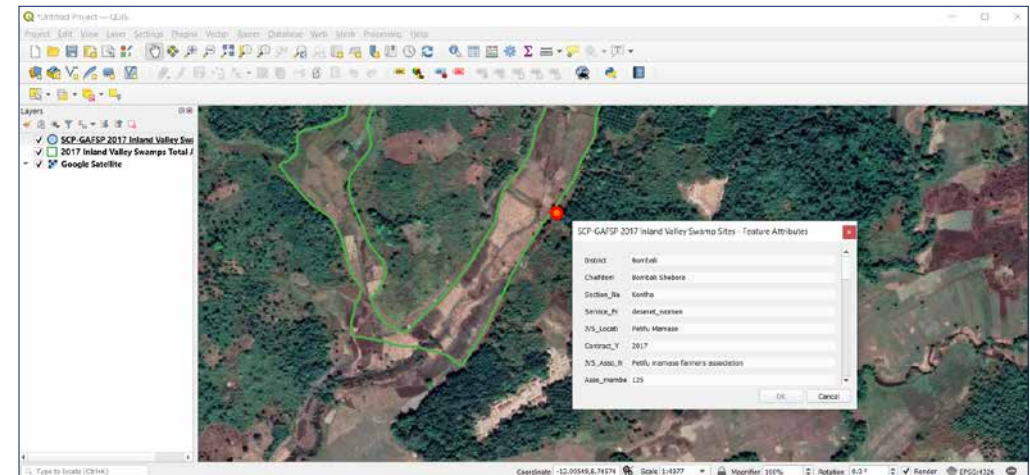
- Unique identifier (ID);
- Name of infrastructure/organization;
- Type (e.g. market, processing or processing facility);
- Intervention (e.g. construction or rehabilitation);
- Status (e.g. planned, under implementation, or completed);
- Dates of measurement and of completion/support; and
- Geometry (x and y-coordinates, area size in hectares or length in km).

Fields such as dates, x and y-coordinates or types of interventions should be standardized. A standardized attribute table is necessary for analysis and to showcase data on dashboards.

**Coordinate reference system(s).** Using different map projections can complicate geometry calculations. A project should use one only reference system and ensure that all datasets correspond to this system. IFAD uses the World Geodetic System 1984 (WGS84) to display data on web-applications and “Universal Transverse Mercator” for area and length calculations.

Annex 4 recommends data standards for IFAD. These standards can be adapted for a project.

## Managing an indicator layer in QGIS



	District	Chiefdom	Section_Na	Service_Pr	IVS_Locati	Contract_Y	IVS_Asso_N	Asso_membe	Asso_femal
1	Bombali	Bombali Shebora	Koniba	deseret_women	Petifu Mamaso	2017	Petifu miamaso farmers as...	125	49
2	Bo	Bagbo	Tissana	community_action_for_rural_t...	Manibo	2017	Making IVS	100	44
3	Bo	Bagbo	Tissana	community_action_for_rural_t...	Manibo	2017	Making IVS 2	100	44
4	Bo	Bagbo	Niagorehun	community_action_for_rural_t...	Niagorehun	2017	Nyi	30	12
5	Bo	Bagbo	Niagorehun	community_action_for_rural_t...	Kpetewoma	2017	Muyorhoma	50	20
6	Bo	Bagbe	Nyawa	interlinks_investment_limited	Njala Kaibema	2017	Amuloma	35	20

This layer shows low-cost irrigation schemes. The attribute table of a shapefile captures the features of each scheme.

## Budget: What are the costs?

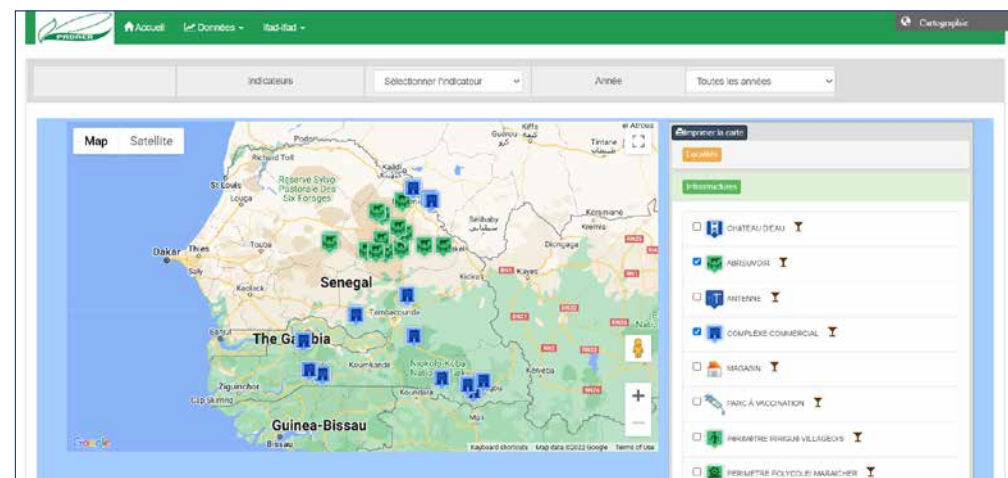
Collecting GPS coordinates has a cost. The project has to reflect where it makes sense to collect data and how the data is to be used. Ideally, the costs of georeferencing investment sites should be part of the project's M&E or implementation budget. Some costs occur only once, while others will be necessary to incur for every data-collection exercise. Consider the following cost items:

- **GIS expertise.** Projects may wish to employ an expert or procure external expertise, either through a service provider or an independent consultant.
- **GIS equipment.** This includes smartphones, tablets, GPS devices, or simple GPS trackers.
- **Software licences.** Open-source solutions may require set-up costs. The annual subscription fees of commercial software solutions (e.g. ArcGIS) vary depending on how many licences and what software packages are needed. A standard licence usually starts from US\$1,500 a year.
- **Training on GIS.** Training may be needed for staff on new software packages or on data collection.
- **Surveys.** The costs of travel and accommodation for data collection missions need to be factored in.

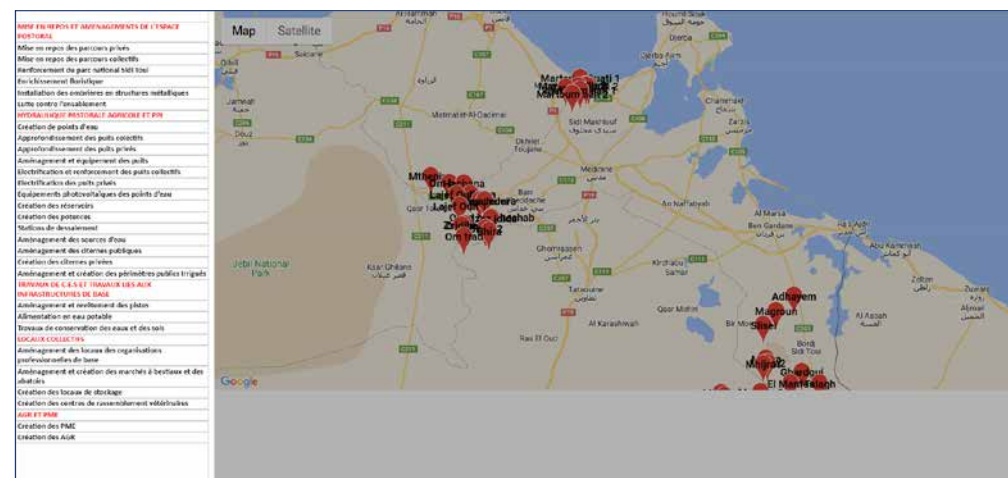
Based on the actual expenditures of a number of ongoing projects in the current portfolio, it is estimated that between US\$30,000 and US\$40,000 is typically needed per year to support GIS data collection activities, and about twice these amounts for very large projects. While factoring in costs, consider the following points:

- **Avoid standalone mapping activities.** Costs for example for logistics can be reduced if georeferencing activities accompany and feed into ongoing M&E activities.
- **Source data from service providers.** In many cases, GIS measurements may already be available. Contracted engineering firms for example may use GIS in the design of infrastructure.

## Online maps of IFAD-funded projects

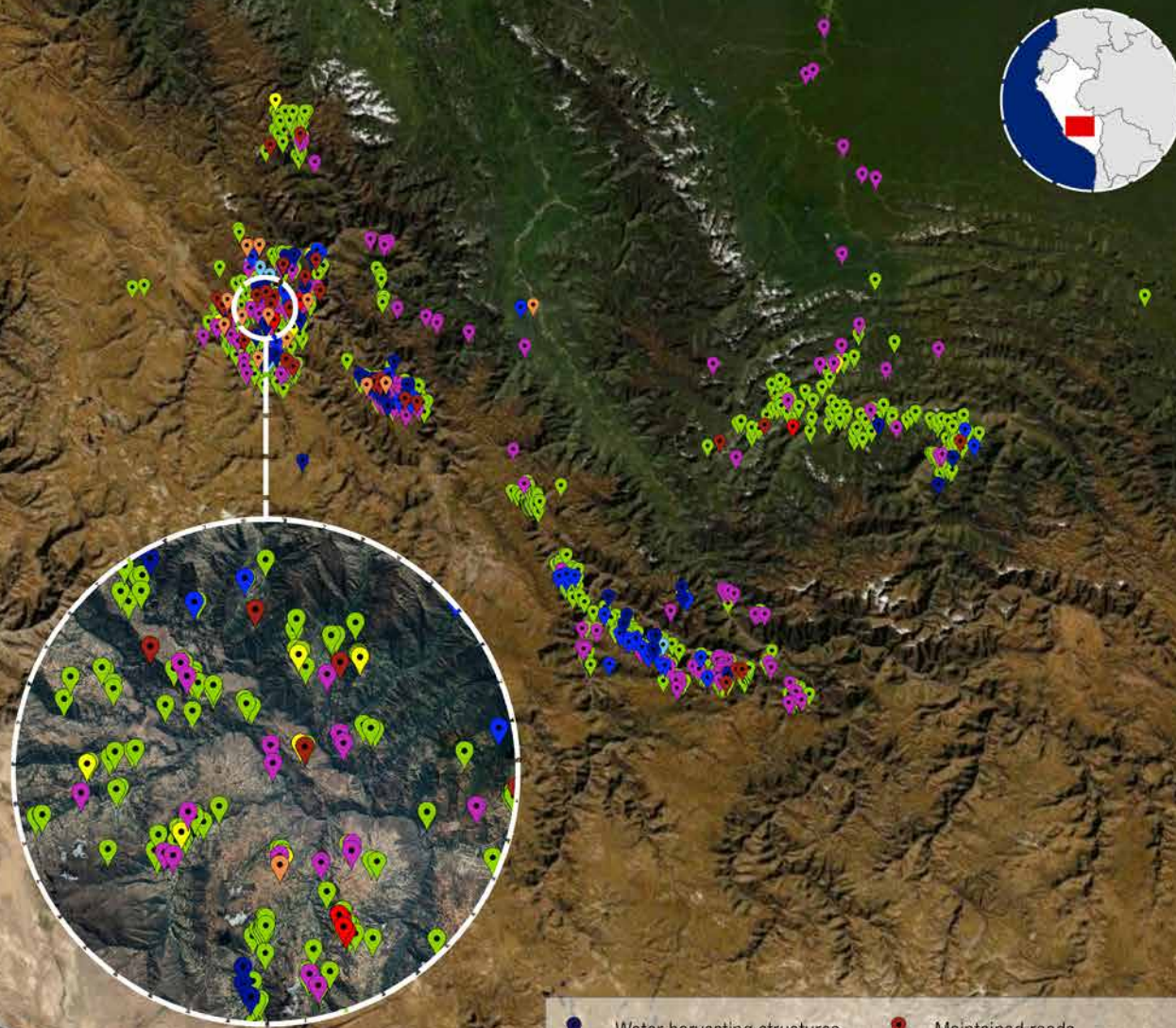


**SENEGAL:** Support to Agricultural Development and Rural Entrepreneurship Programme (2011 – 2019) (login required)



**TUNISIA:** Agropastoral Value Chains Project in the Governorate of Médenine (2015 – 2023) (VIEW SITE – see geolocalization tab)

# 4. How can IFAD help its project teams map investments?



Water harvesting structures	Maintained roads
Irrigation equipment	Community development plans
Irrigation works	Storage facilities
Market facilities	Indigenous community development plans
Investment plans	

10km



**PERU:** Investment sites of the IFAD-funded Public Services Improvement for Sustainable Territorial Development in the Apurimac, Ene, and Mantaro River Basins project (2016 – 2022)

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

## 4. How can IFAD help its project teams map investments?

This section is for IFAD staff and consultants designing, supervising or evaluating projects. If you fit in this role, consider the following ways to help projects map their activities.

### Allocate budget and expertise in projects

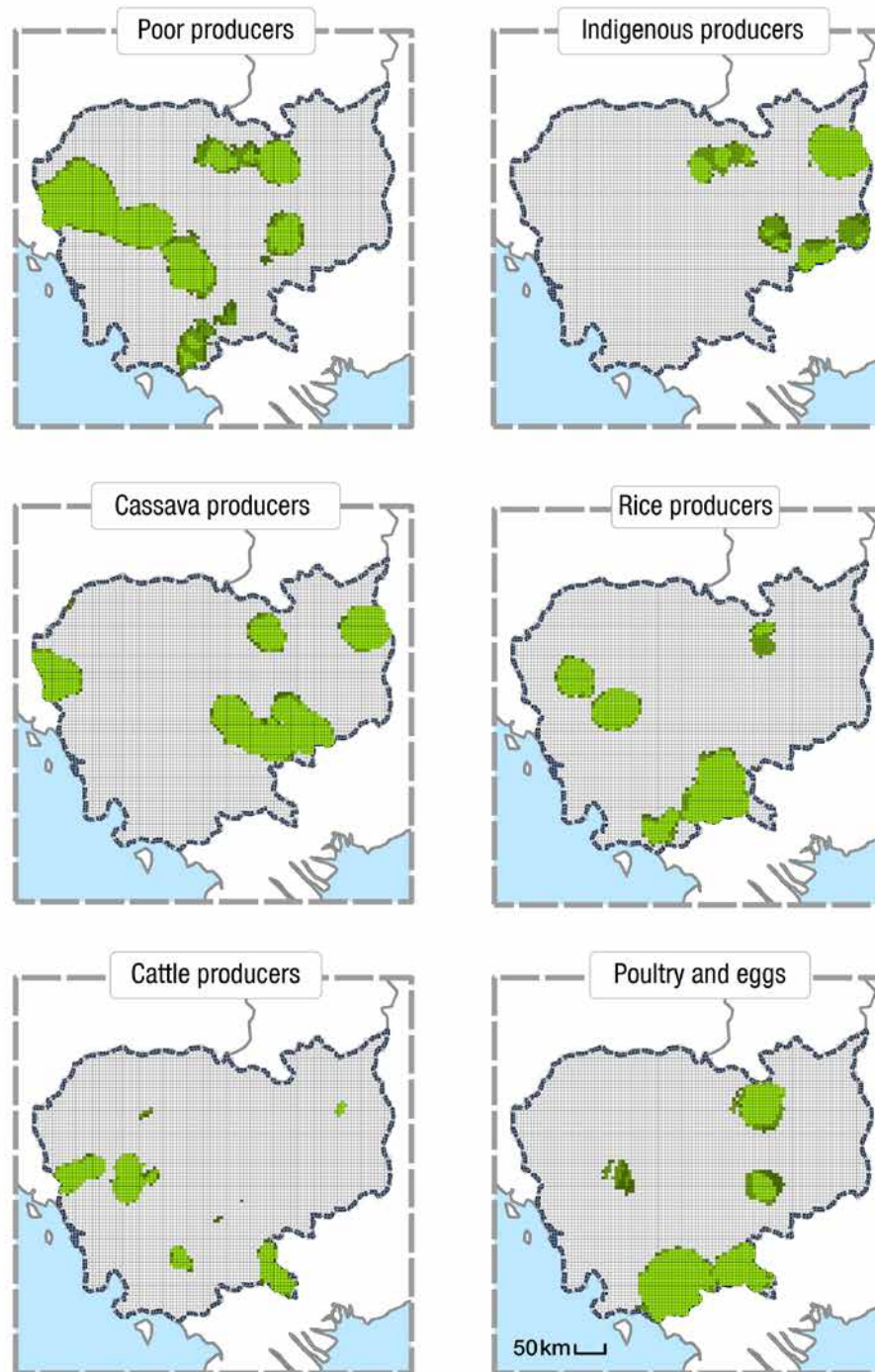
GIS expertise, software and hardware should be present in a project right from the start. If you are involved in the design of a project, make sure to allocate budget towards GIS-supported M&E (see section 3, “Budget: What are the costs?” above). It is also possible to do this at a later stage in the annual workplan and budget during project implementation. Consider providing budget for the following items:

- GIS expert or consultant to support the M&E team;
- One-off costs such as tablets, smartphones or GPS;
- Field missions for data collection (e.g. for area measurements); and
- Studies that include the collection of geotagged M&E data.

Annex 2 provides model terms of reference for a GIS expert supporting the project M&E unit. Ideally, a project should have a GIS strategy or operational manual to guide the usage of GIS in its operations.

#### **CAMBODIA:** Hotspot maps of agricultural producers

The Agricultural Services Programme for Innovation, Resilience and Extension project and the Accelerating Inclusive Markets for Smallholders project rigorously collected data of over 140,000 producer households. These rich datasets made it possible to do hotspot analysis: to create maps suggesting where support to indigenous and poor producers should be concentrated, prioritize where best to provide extension services for different commodities, and find ideal locations of agricultural extension centres.



## Collect locations of surveyed households

Make sure that all household surveys (including baseline, midterm and completion surveys using the questionnaire to measure IFAD core outcome indicators) capture the GPS coordinates of households in order to conduct spatial analysis. Respect privacy issues, and keep sensitive information secure.

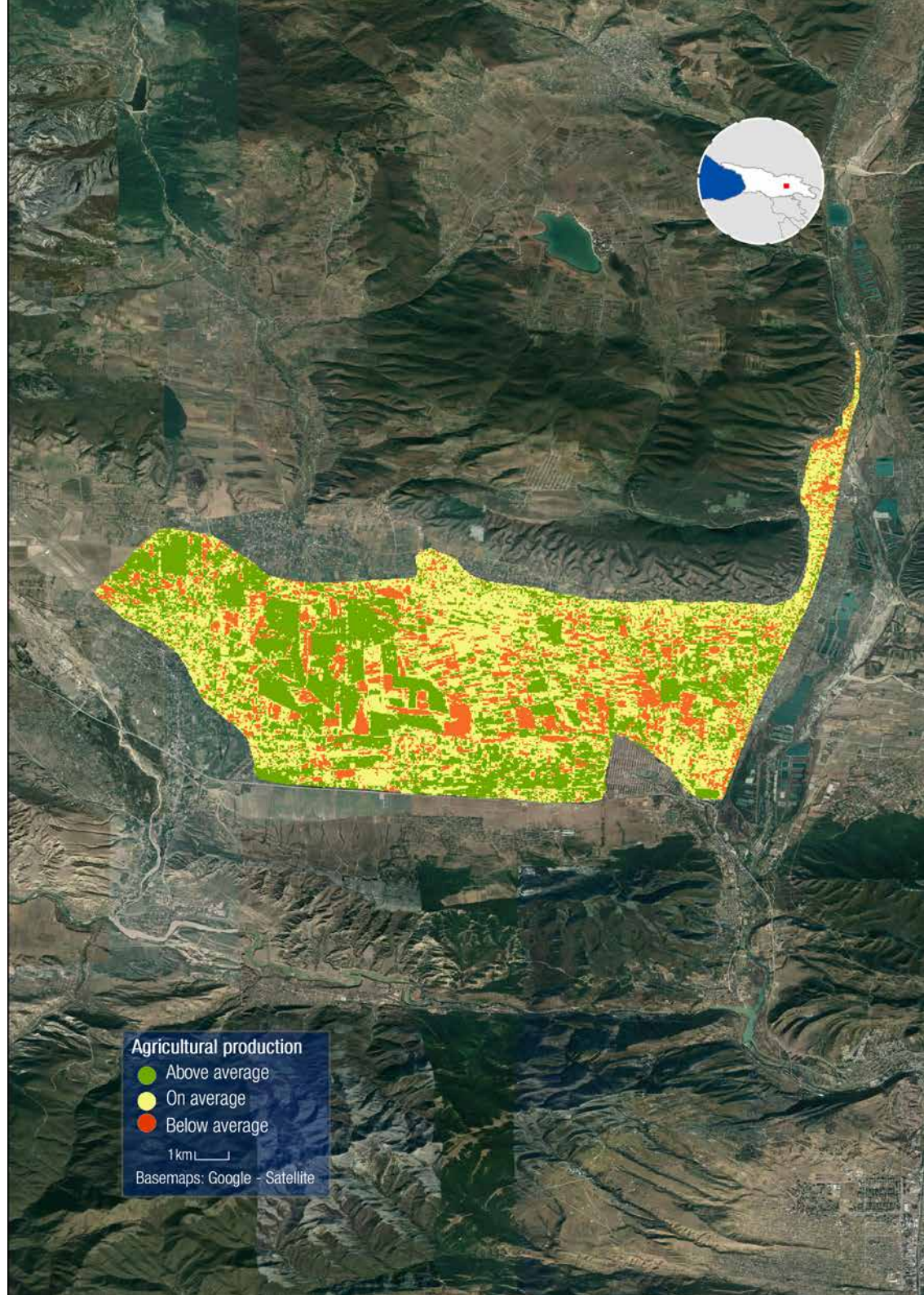
### GEORGIA: Geospatial analysis of irrigation schemes

The Independent Office of Evaluation of IFAD carried out an impact evaluation of the [Agricultural Support Project](#) in Georgia that rehabilitated six irrigation schemes from 2010 to 2015. In addition to regular household surveys and interviews, the evaluation team used GIS and Earth observation to see if irrigated farmland developed under the project had become more productive.

Georeferenced boundaries of irrigation schemes were obtained from the company that conducted the rehabilitation works. This allowed the evaluation team to identify and statistically compare 14 developed and undeveloped areas using the before/after control/impact contrast method. The normalized difference vegetation index (NDVI) was used as a proxy to measure vegetation development (in this case, agricultural production). NDVI values derived from satellite imagery (MODIS and Landsat 8) were calculated for all 14 sample areas for different points in time.

The geospatial analysis confirmed what the household surveys revealed: the rehabilitated irrigation schemes only had a minimal impact. Though half of the sampled areas showed an improvement in NDVI after the intervention, the difference was only 1.24 per cent. Among other reasons, farmers said they did not grow more because of a lack of market access. Many farmers' fields were next to secondary canals that were not subject to rehabilitation.

[READ MORE](#)





## Provide technical support to projects

IFAD staff can also provide technical support to projects (subject to availability). This may include, for example:

- **Supervision.** Deploy a GIS expert to partake in supervision missions. The expert can review and quality-check GIS data, map it against M&E figures, and provide recommendations on how to improve GIS usage in planning and monitoring. Annex 2 provides model terms of reference for GIS experts supporting supervision missions.
- **Grants.** In the past IFAD has often used grants to channel specialist knowledge on GIS and remote sensing from firms or research institutions to IFAD-funded projects.
- **Partnerships.** Foster partnerships with other donor-funded projects or international organizations. IFAD has a longstanding partnership on climate analysis with the World Food Programme, for example. Initiatives such as the *Global Development Assistance* of the European Space Agency have been launched to support operations such as those supported by IFAD. See Section 6, *Where to get help*, for more information.
- **IFAD's community of practice, GeoGroup.** Minor requests (such as on available datasets or open-source software) can be answered by IFAD's community for geospatial applications. See Section 6, for more information.

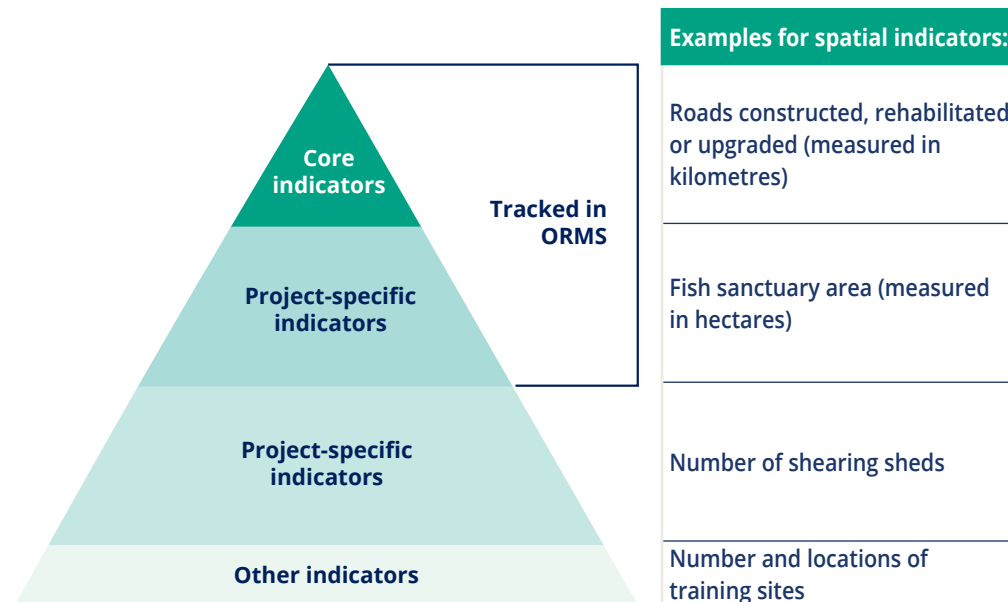
## Ensure spatial indicators are georeferenced

A good way of linking M&E and GIS is by measuring spatial indicators of a project's logframe with geospatial technologies.

Spatial indicators depict, for example, areas such as farmland measured in hectares, transects such as roads measured in kilometres, and buildings for which x and y-coordinates can be captured.

IFAD differentiates between **core indicators** that are aggregated for higher-level corporate and external reporting, and **project-specific indicators** that are used only in the project and are not aggregated for any other cross-project purpose. All core indicators and a selected number of project-specific indicators are tracked in IFAD's Operations and Results Management System (ORMS), which IFAD staff can access.

## Different types of indicators in IFAD projects



IFAD is particularly interested in collecting GIS data on core indicators that can be georeferenced and aggregated. Indicators with strong rationale for georeferencing include:

- **Rural roads** constructed or rehabilitated;
- **Irrigated farmland**;
- **Land area under improved management**;
- **Infrastructure** such as markets, processing and storage facilities;
- **Rural institutions and businesses** such as agribusiness centres, financial service providers or small processing facilities.

Each spatial indicator should be accompanied by one shapefile, documenting not only the location of an intervention, but also other attributes such as the type of intervention and when it has been completed. View Annexes 3 to 5 for more details.

## Ensure service providers map activities

Service providers (e.g. companies designing irrigation schemes) are important data sources as they can collect GIS data and then forward it to the project teams. It is best to include terms in the project procurement documents specifying that GIS data is to be collected and submitted to the project teams. IFAD's [standard bidding documents](#) for procurement specify that contractors designing infrastructure have to submit any GIS data to the project to be forwarded to IFAD.

## Map investments with high environmental and social risk

IFAD's [Social, Environmental and Climate Assessment Procedures \(SECAP\)](#) require mandatory collection of GIS measurements in projects having a high or substantial risk classification. Infrastructure that requires geographical referencing includes irrigation schemes, roads, agricultural facilities, electricity lines, dams, weirs, large earth works, community and health facilities, irrigation channels and bridges. Projects are required to submit geotagged data to IFAD on two occasions: (a) when the spatial measurements of a planned activity have been made and (b) once the activity has been completed.

### Key takeaways

- Make sure that projects have sufficient expertise and budget to conduct GIS supported M&E.
- Identify spatial indicators in the logical framework that should be mapped.
- Make sure that surveys also collect the locations of households.
- Service providers sourced through procurement are a great data source. Make sure that they collect and give you data in the format you need it to be.
- Make sure large investments such as medium-sized dams and irrigation schemes are mapped to comply with IFAD's safeguard rules.

# 5. How to review geotagged M&E data



**ESWATINI:** Investment sites of the IFAD-funded Smallholder Market-led Project (2016 – 2023)



- Ferrocement tanks
  - Community gardens
  - Earth dams and springs
  - Apiary sites and beekeepers
  - Wetland and rehabilitation sites
- 2 km

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



## 5. How to review geotagged M&E data

This section is for IFAD staff and consultants who have some GIS background. If you fit into this role, consider the following steps to review GIS data during project implementation.

### Request data

The first step is to request data from the project. This sounds easy, but may be difficult, because different people might have data and sometimes they don't know of each other. Data may have been collected by the following actors:

- M&E staff;
- Technical specialists (e.g. engineers, agronomists or agribusiness experts);
- District and field staff; and
- Service providers (firms that have built infrastructure, or research institutes that have conducted a study).

Inform the project team that IFAD treats the data confidentially and that it will be stored on IFAD's GIS platform. Requests should be done before the mission so that there is enough time to review it and use it to plan for field visits. Be aware of the time it takes for project staff to collect, clean and deliver the data.

### Clean and check the data

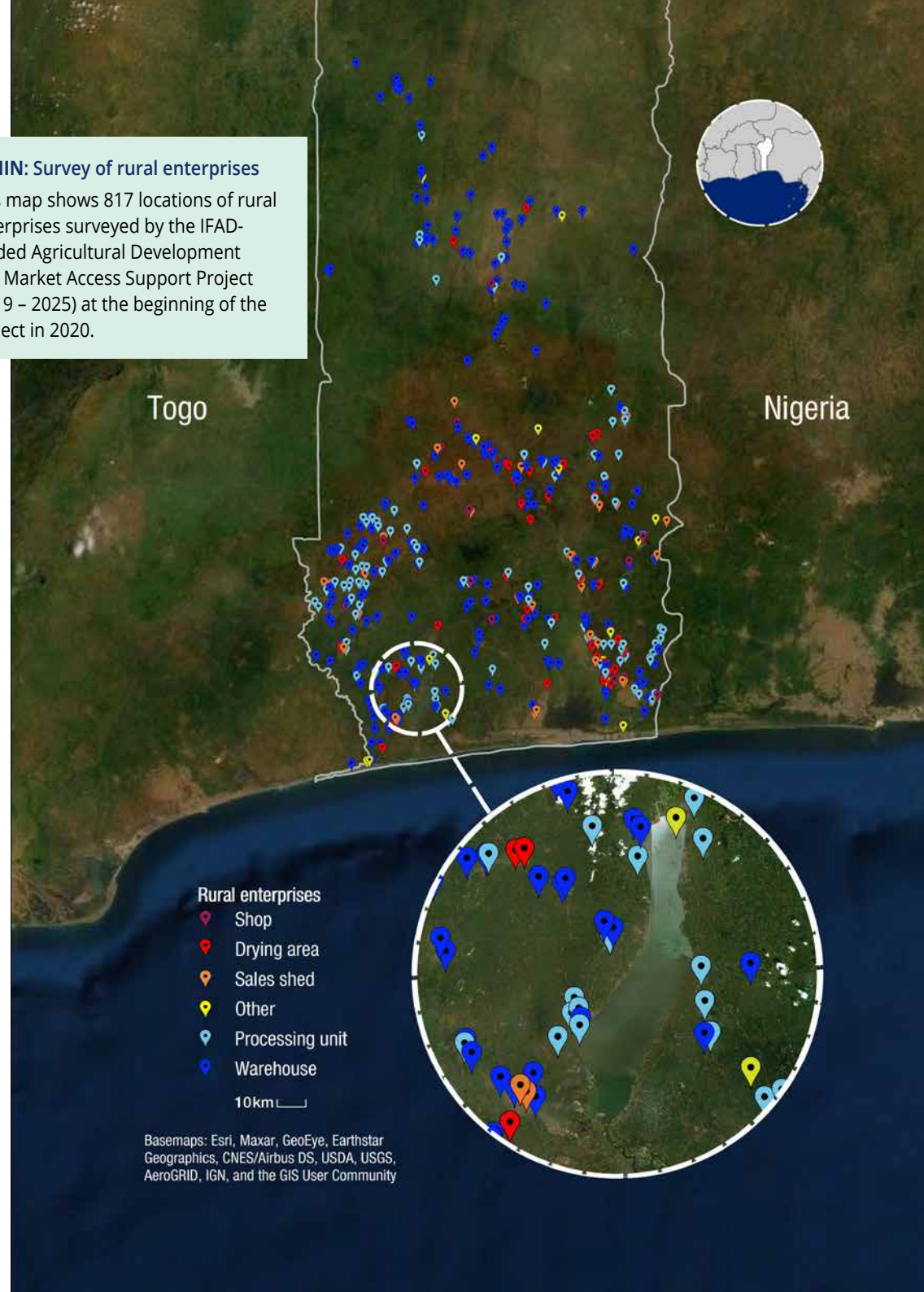
Review the data and check for its correctness. Annex 6 provides a useful checklist. Consider the following:

- **Format and geometry.** Ideally, data should be in shapefile format. Data might be different formats (even Word files!). You might spend some time converting the data into the right format. Then, check for data inconsistencies, duplications, and overlapping areas.
- **Metadata check.** Check if enough information is provided about a dataset to understand what the data are about. Understand what it is showing, who collected it, and when it was collected.



#### BENIN: Survey of rural enterprises

This map shows 817 locations of rural enterprises surveyed by the IFAD-funded Agricultural Development and Market Access Support Project (2019 - 2025) at the beginning of the project in 2020.



- **Correctness.** Make a random check to see if the geolocations make sense (e.g. agribusiness centres should be next to roads; infrastructure points should not be on lakes; bridges should be over waterways; markets should be near urban areas, etc.).
- **Data privacy.** Check for and remove any confidential information such as beneficiary names and contact details.
- **Project area check.** Check if all data points are within the country and project area. If outside the project area, flag this to the supervision mission team and discuss this with the project team. In most cases the project map should be updated.

## Analysis, discussion and recommendations

Your main task is to compare the submitted GIS data with the reported M&E data. Are the figures the same? If the project is over- or under-reporting, find out why. Geotagged M&E data should match (or be related to) results reports and targets specified in the logframe of the project design report. Find all indicator targets and results on IFAD's Operations and Results Management System.

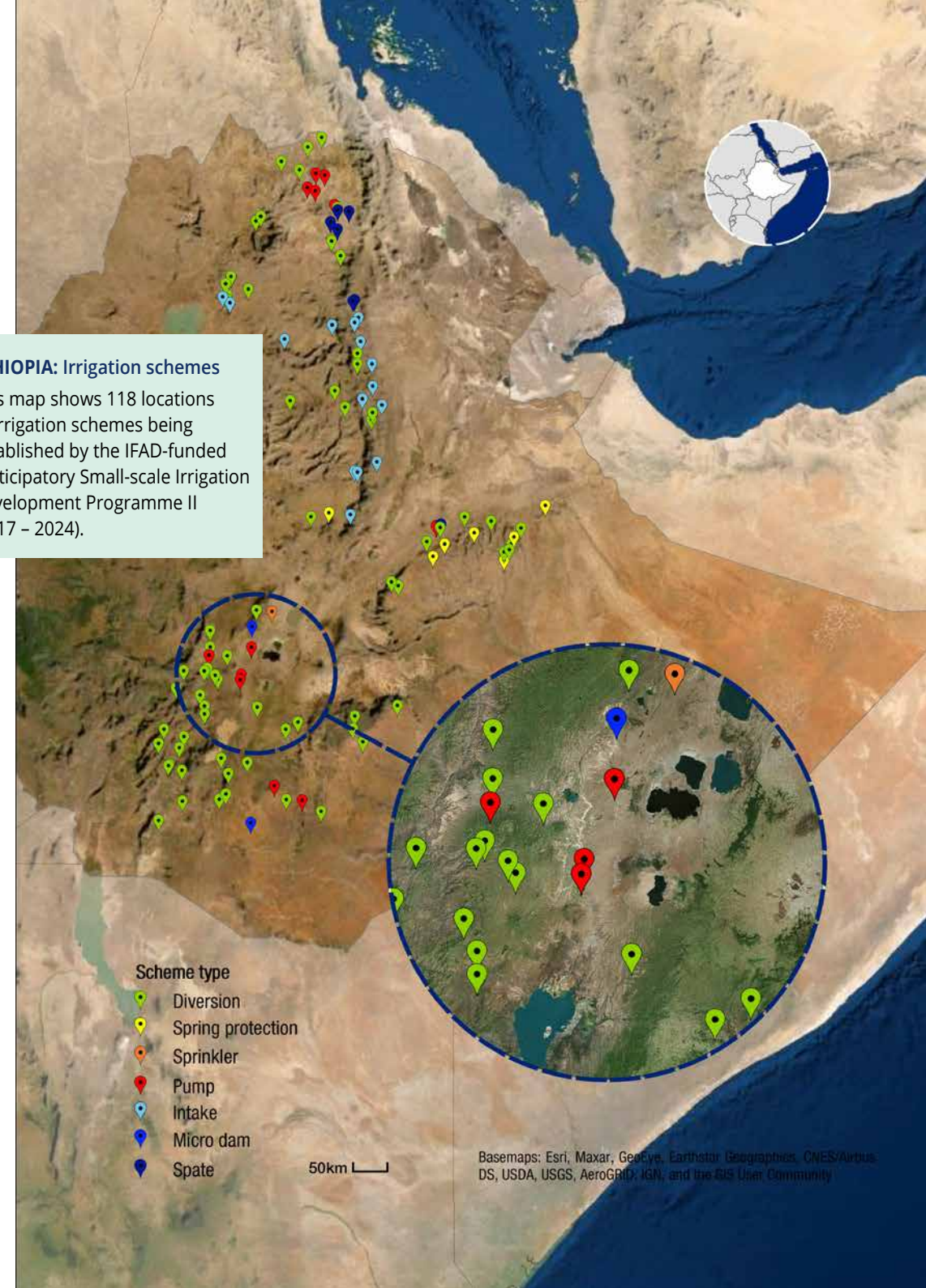
You may also want to do the following:

- Create simple maps and calculate summary statistics on the number of points, kilometres and hectares – this simple analysis and visualization are of great help for the team reviewing the project and in planning field visits.
- Engage with the project team to understand the data. Understand what GIS expertise the project has, which software and hardware it uses, and the procedures related to using geospatial data. Ask about gaps and for the reasons certain activities are taking place in an area.
- Cross-check if the spatial extent of activities (e.g. length of roads and land area sizes) correspond to the project's risk classification and management plans (e.g. environmental and social management frameworks or plans).
- Make recommendations on how to improve data quality and analysis, and check if any capacity-building measures are needed.
- Consider recommending the project area map to be updated if you discover interventions have taken place outside the original project area.



### ETHIOPIA: Irrigation schemes

This map shows 118 locations of irrigation schemes being established by the IFAD-funded Participatory Small-scale Irrigation Development Programme II (2017 – 2024).



Depending on the needs, further analysis may be required. Here some ideas:

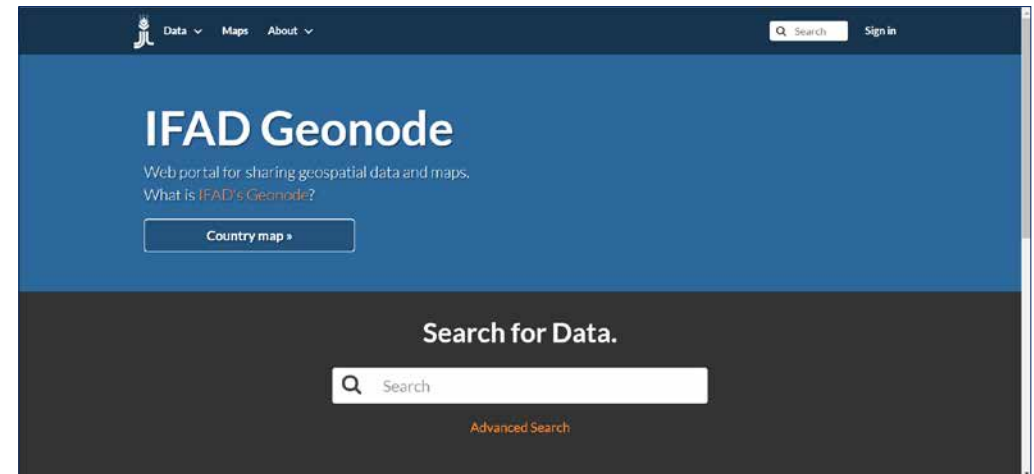
- Aggregate data at district level. Find administrative boundaries on IFAD's GeoNode.
- Fetch WorldPop or Meta population data and estimate the number of people (women and youth) living within or around an intervention area or site;
- Use FAO EarthMap or Global Forest Watch to analyse the overlap or the proximity of project areas to legally protected areas (such as national parks), biodiversity hotspots and other areas of high environmental value (e.g. wetlands or mangroves);
- Go to IFAD's GeoScan web-application and download a standardized set of more than 180 geospatial layers from reliable data sources. Display the M&E data against e.g. land cover, population or accessibility maps.
- Go to LandMark to check if operations are taking place on territories of indigenous peoples.

## Store the data

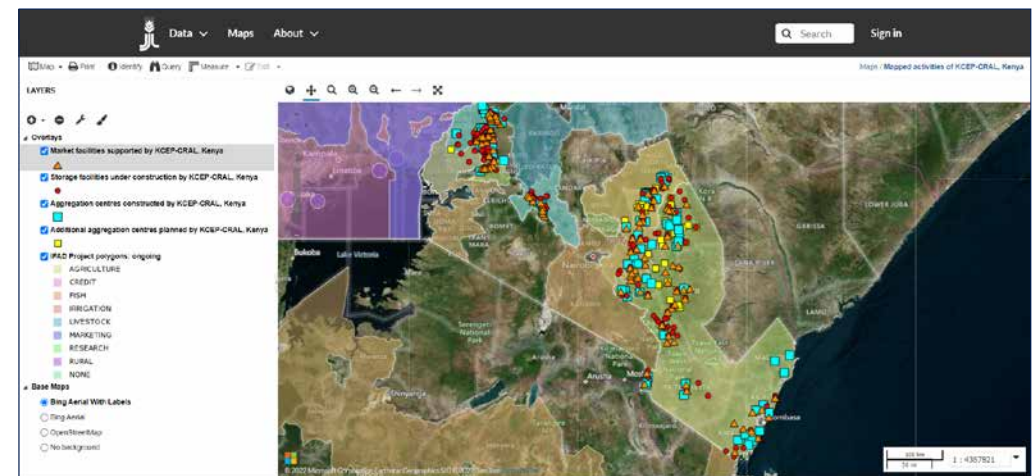
Upload the data on IFAD's GeoNode, IFAD's official system to store and visualize geospatial data. Follow the data standards for geotagged M&E data (see Annex 4). Only IFAD staff can upload data on GeoNode. Write to [geo@ifad.org](mailto:geo@ifad.org) if you need help.

IFAD treat data confidentially. Don't share any data without asking for permission from the project and the IFAD country team.

## GeoNode – IFAD's platform for geospatial data



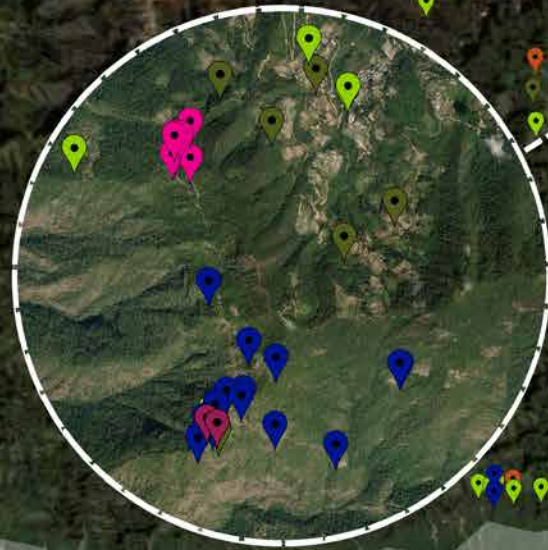
IFAD staff can find, access and upload geodata on GeoNode



Users can create maps to display project data on web-maps

# 6. Where to get help

**BHUTAN:** Investment sites of the IFAD-funded Commercial Agriculture and Resilient Livelihoods Enhancement Programme (2015 – 2025)



- Land development
  - Biogas units
  - Dairy value chain infrastructure
  - Vegetable value chain infrastructure
  - Irrigation infrastructure
  - Electric fencing
  - Market infrastructure
- 5km

Basemaps: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

## 6. Where to get help

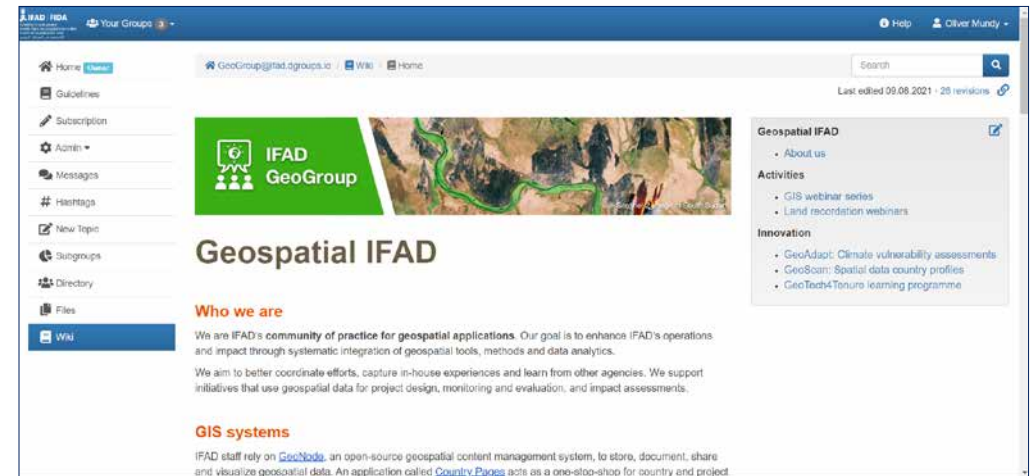
### Get advice

You can get advice on geospatial tools, data and methodologies from **IFAD's community of practice for geospatial applications** (or in short GeoGroup). This informal group is for IFAD colleagues, project staff and partners in research and the private sector. You don't have to be a GIS expert to be part of the group.

Members of the group have various areas of expertise and can give advice. The group also maintains a database of IFAD activities on GIS. It can advise on the following:

- Datasets on a wide range of themes (e.g. demographics, poverty, land cover, environmental hazards and climate datasets);
- Software and hardware considerations;
- Simple data visualizations;
- Big data analysis using Google Earth Engine;
- Data standards;
- IFAD's internal systems and procedures, including GeoNode;
- GIS consultants and companies;
- External initiatives that provide GIS and Earth-observation services free of charge.

Join the community by visiting its [webpage](#) or by writing to [geo@ifad.org](mailto:geo@ifad.org). The community uses an email-based platform to communicate. Share content or questions by e-mail to the community.



Register with the GeoGroup online platform



Lively discussions during a GIS workshop in Rome

© Oliver Mundy



## Find partners

Support can also be provided through IFAD's partners. Here are some of them:

- **WFP-IFAD Climate Analysis Partnership.** The partnership, established in 2014, builds on the World Food Programme's data and expertise. It provides geospatial analysis on climate risks and vulnerability for country and project designs, geographical targeting, and impact evaluations.
- **Food and Agriculture Organization of the United Nations (FAO).** FAO hosts an array of data and web-tools such as its Hand-in-Hand geospatial platform, Earth Map and SEPAL, allowing users to access a wealth of geodata on agriculture and to conduct analysis without needing programming skills.
- **European Space Agency.** IFAD projects have been benefiting from programmes of the space agency since 2009. Current programmes include the Global Development Assistance and EO Clinic initiatives. IFAD colleagues can request support.
- **Research centres.** IFAD projects collaborate with several CGIAR centres such as the GeoScience Lab of the World Agroforestry Centre, CGIAR Research Program on Climate Change, Agriculture and Food Security, and the International Livestock Research Institute.
- **United Nations Geospatial Network.** IFAD is a member of the UN network for geospatial applications, giving IFAD staff access to geospatial data, tools and expertise of other UN agencies.
- **Private sector.** Various service providers offer geospatial services. IFAD is also in contact with providers such as Airbus, Digital Globe and Planet, which offer very high-resolution imagery down to 30 cm. The costs of imagery depend on the scale, time and resolution.

Contact [geo@ifad.org](mailto:geo@ifad.org) to learn more and benefit from geospatial partnerships.



**GERMANY:** Side event at the Living Planet Symposium hosted by the European Space Agency

© Oliver Mundy



**LESOTHO:** Training from the World Agroforestry Centre on collecting field data

© ICRAF

## Find data

The best place to find data on IFAD projects is in [GeoNode](#), IFAD's database to store and visualize geospatial data. The GeoM&E Innovation Challenge initiative has uploaded datasets from 51 IFAD-funded projects. All datasets include a description with details of what the data show, when they were included, and who submitted the data. You require an IFAD e-mail address to access GeoNode.

Go to the web-application [GeoScan](#) to access a variety of external datasets on a wide range of themes (e.g. accessibility, land use, climatic data, or socioeconomic data) from different sources (e.g. NASA, European Commission's Joint Research Centre, and Openstreetmap).

## Publications

The IFAD publication "Catalogue of Geospatial Tools and Applications for Climate Investments" features innovative geospatial tools and IFAD case studies, some building on mapped project data.

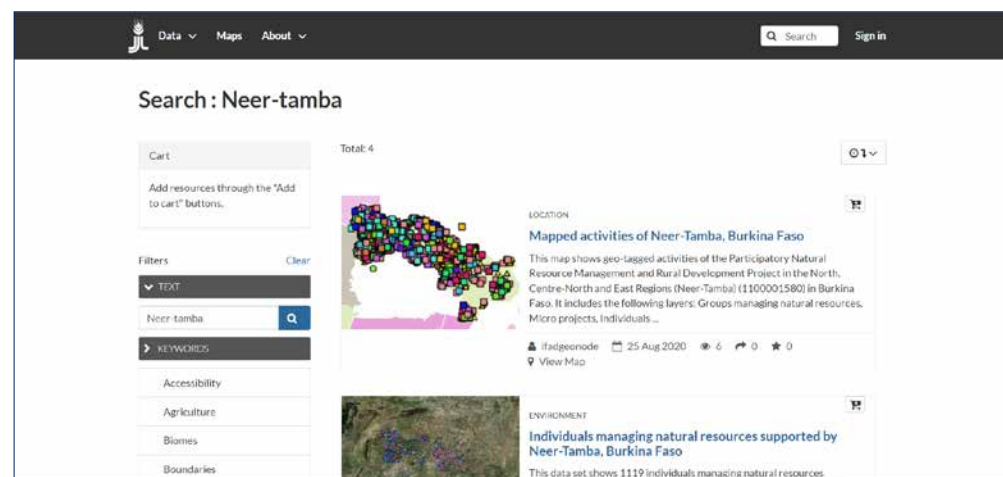
## Equipment

The GeoM&E Innovation Challenge initiative has procured equipment to support georeferencing of project activities. Gear can be lent to IFAD staff and IFAD-funded projects. IFAD has the following equipment:

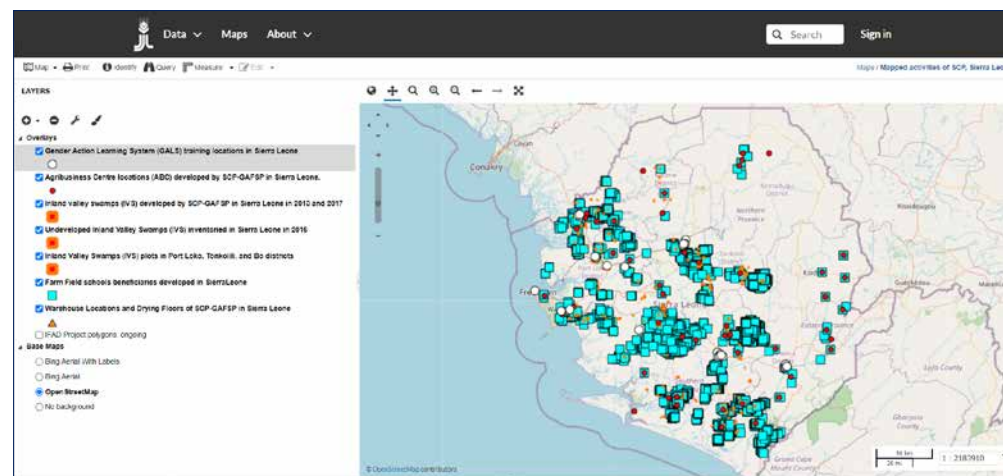
- **Specialized handheld devices.** Sets of Trimble Catalyst and TopCon HiPer with FC-5000 hardware and MAGNET software are available in IFAD headquarters, Nairobi and Johannesburg.
- **Drones.** DJI Mavic Pro drones have been procured and used by IFAD. They can be used for aerial video-recording and collecting GPS coordinates.
- **Microelectromechanical systems (MEMS) and Sensors.** Apart from GPS coordinates, these devices collect data on movement (e.g. of fishing boats or livestock and pastoral herds).

Contact [geo@ifad.org](mailto:geo@ifad.org) to request the equipment.

## Screenshots of GeoNode – IFAD's platform for geospatial data



Find and search data and maps from IFAD-funded projects



Explore investments sites of IFAD-funded projects

# 7. Annexes

**HONDURAS:** 24 out of 246 agri-businesses supported by the IFAD-funded Project for Competitiveness and Sustainable Development in the South-Western Border Region (2014 - 2023)

Agribusinesses	
	Coffee
	Organic fertilizer
	Poultry
	Fruit
	Basic grains
	Bakery
	Consumer shop
	Vegetables
	Supply store

1 km

Basemaps: Google Satellite

# Annex 1: Minimum requirements for an IFAD-funded project to map investment sites

Area	Requirements
Expertise	<ul style="list-style-type: none"> <li>• One GIS expert to support the monitoring and evaluation team</li> <li>• Field staff trained to collect GIS data</li> </ul>
Procedures	<ul style="list-style-type: none"> <li>• Operational guidelines explaining what data is collected, how it is collected, reviewed, stored and used</li> </ul>
Standards	<ul style="list-style-type: none"> <li>• Metadata (rules that describe data)</li> <li>• Format: shapefile vector format</li> <li>• Attribute table: standard fields for each indicator to record type of activity, status of activity or date of completion</li> </ul>
Indicators	<p>Indicators of the logical framework measured with GIS, e.g.:</p> <ul style="list-style-type: none"> <li>• Rural roads constructed or rehabilitated</li> <li>• Irrigated farmland</li> <li>• Land area under improved management</li> <li>• Infrastructure such as markets, processing and storage facilities</li> <li>• Rural institutions and businesses</li> </ul>
Data collection	<ul style="list-style-type: none"> <li>• Georeferenced surveys of households, businesses/producer organizations, and communities</li> <li>• As part of regular monitoring and evaluation activities</li> <li>• Standalone mapping missions e.g. of farmland and roads</li> <li>• Service providers</li> </ul>
Software	<p>In most cases a combination of different programmes to:</p> <ul style="list-style-type: none"> <li>• Collect data (such as KoBo Toolbox or SurveySolutions)</li> <li>• Data-handling software (such as QGIS or ArcGIS)</li> <li>• GIS platform to store and visualize data</li> </ul>
Hardware	<ul style="list-style-type: none"> <li>• Smartphones</li> <li>• GPS devices (e.g. a medium-sized project might require 20 to 30 GPS devices)</li> <li>• Drones (if necessary)</li> </ul>
Reporting	<ul style="list-style-type: none"> <li>• Reporting to IFAD once per year before project visits following standardized methodology</li> </ul>

# Annex 2: Model terms of reference for a GIS expert supporting M&E in a project

*To be adapted as required*

The GIS expert is part of the project management unit (PMU) and will support the project's monitoring and evaluation (M&E) through the usage of geographic information systems (GIS). The expert will help establish procedures and standards to support the monitoring of project activities with GIS tools and measure the progress towards achieving its deliverables that are specified in the project's logical framework (logframe). The expert will work in close collaboration with the M&E officer. The specific tasks include the following:

- (a) GIS data collection and usage manual.** The GIS expert will develop a manual specifying what GIS data are to be collected, how they are collected and how they are used for planning and reporting. The GIS manual should specify how the usage of GIS will support the project's M&E system. It should cover:
- GIS software and hardware requirements of the project;
  - Data layers to be collected;
  - Data standards (rules by which data are documented and recorded);
  - Procedures and workflows specifying the steps how data are collected, quality-checked, stored, analysed and used, as well as roles and responsibilities;
  - Data management, analysis and visualization for project planning and reporting as well as external communication.
- (b) Implementation plan and budget.** The expert will produce a detailed implementation plan for the application of GIS approaches in the M&E of the project. The plan will include a proposed budget for the work, specifying whether the costs are one-time-only or recurring on an annual basis.
- (c) Procurement of hardware and software.** The expert will support the project in determining the specific equipment that is needed (e.g. the number and type of GPS units that are needed). The expert will also specify the type of GIS software to be used and support its setup.
- (d) Support project M&E with GIS.** The GIS expert will support project M&E activities. The expert will make sure that geospatial data are collected during project field activities. The expert will help to monitor project activities and measure the progress towards achieving its deliverables that are specified in the project's logframe. The locations of agribusinesses, community-based organizations, as well as infrastructure and areas being developed have to be geospatially captured using GPS or by other means. The expert will calculate, for example, the number of hectares of farmland being developed and the number of kilometres of irrigation channels being constructed.

**(e) Conduct training on georeferencing and using GIS software.** The GIS expert will train field officers on how to operate a GPS, how to collect geospatial data correctly, and how to submit the data. The expert will develop training materials and a field manual/brochure. The expert will also train other technical specialists as required on how to use GIS for their work.

**(f) Coordinate georeferencing field missions.** The GIS expert will coordinate or conduct field missions to collect data that cannot be gathered during regular project field missions. These standalone missions may be necessary for example to georeference areas or transects. The mapping missions may include participatory approaches allowing community members to point out and validate which sites have been developed by the project.

**(g) Assemble GIS data from third parties.** The expert will ensure that GIS data from service providers who carry out project activities, such as the design of irrigation schemes, are collected and quality-checked. With the support of the project team, the GIS expert will also reach out to government agencies and research institutes to request geospatial data that can be of use for analytical and planning purposes of the project.

**(h) Data management, analysis, visualization and reporting.** The expert will manage GIS data, and produce analytical reports and maps to support the M&E unit and management to plan for and monitor the implementation of project activities. The expert will also provide IFAD with geospatial datasets in accordance with corporate GIS procedures that follow standard requirements with regards to naming conventions, attribute structure and records, and metadata.

**Education:** Advanced university degree (master's degree or equivalent) in geography, geospatial information, earth sciences, or other related field.

**Experience:** A minimum of five years of progressively responsible experience in geospatial information management, applied spatial analytics, earth observations, mapping, applications development, data visualization or related area are required. Proven experience in utilizing geospatial software (QGIS or ArcGIS, database management, spatial analysis or mapping) is required.



# Annex 3: Model terms of reference for a GIS expert supporting supervision missions

*To be adapted as required*

The geographic information systems (GIS) expert will participate in the supervision mission of the project. The expert will review the project's GIS capacities and usage, and will provide recommendations on how to improve the usage of GIS for monitoring and evaluation (M&E). The expert will work under the team leader in close collaboration with the other mission team members. The specific tasks include the following:

- (a) Data request and field visit planning.** Prior to the mission, the expert will access what geotagged M&E data is available in IFAD and in the project, and will ensure that a request for geodata is sent out to the project. The expert will do a first review of the data to provide the team leader and other mission members with online maps and data that can be used to plan field visits.
- (b) GIS capacity check.** The expert will interview project staff to assess the project's GIS capacities and usage. This includes looking into the number of staff collecting and handling geodata, their level of expertise, and software and hardware aspects. The expert will also assess procedures and data workflows, if any operational manuals exist, and how maps and data are used in the project.
- (c) Data quality review.** The expert will review the data and check for its correctness. Data should be in shapefile format and refer to the same coordinate system. The expert will check for data inconsistencies, duplications, overlapping areas, merged and hidden cells. The expert will check if the metadata provides enough information to understand what the data are about. The expert will also make random checks to see if the geolocations make sense (e.g. agribusiness centres should normally be next to roads; infrastructure points should not be in lakes; household survey sites should be random).
- (d) Project area check.** The expert will check if geotagged project activities are within the country and project area. The expert will also check if any activities are taking place on legally protected areas such as national parks, or on areas of high ecological value (such as mangroves or wetlands).
- (e) Logical framework check.** The expert will analyse which indicators can be measured with GIS. He/She will evaluate the extent to which GIS data corresponds to reported M&E figures of the project's logical framework, and structure the geodata accordingly. One indicator should be displayed as one shapefile.

**(f) Analysis and recommendations.** The expert will produce descriptive statistics and calculate the total number of hectares and kilometres. The expert will make recommendations on how to improve data quality and usage of GIS data, and check if any capacity-building measures are needed. Analysis details and any figures and statistics shall be added as an annex to the supervision mission report.

**(g) Upload and storage.** The expert will remove any confidential information such as beneficiary names and contact details and will upload geotagged M&E data on IFAD's geospatial repository following the data standards laid out in the manual "Mapping Rural Development: How to use GIS to monitor and evaluate projects".

**Education:** Advanced university degree (master's degree or equivalent) in geography, geospatial information, earth sciences, or other related field.

**Experience:** A minimum of two years of progressively responsible experience in geospatial information management, applied spatial analytics, earth observations, mapping, data visualization or related area is required. Proven experience in utilizing geospatial software (QGIS or ArcGIS, database management, spatial analysis or mapping) is required.



## Annex 4: Recommended data standards for geospatial M&E data in IFAD

The following standards describe how GIS data should be described and recorded in IFAD for a project. The standards help IFAD's systems and its users to share, exchange, and understand data.

Element	Requirements / Standard
Data request	The project management unit (PMU) is responsible for the collection of geospatial data for its own purposes and for reporting to IFAD. IFAD should request the data once per year prior to a supervision mission. Data should ideally be in shapefile format following the standards detailed here.
Data review	<p>The GIS expert in IFAD should check the following:</p> <ul style="list-style-type: none"> <li>• <b>Format and geometry:</b> Ensuring the right format and checking for correct geometry and coordinate reference system.</li> <li>• <b>Correctness:</b> Checking if locations are within the project area and making sure that the geolocations make sense (e.g. bridges should be over waterways).</li> <li>• <b>Logical framework alignment:</b> Checking if the GIS data corresponds to reported figures and targets of the project's logframe.</li> <li>• <b>Data privacy:</b> Removing all sensitive data such as names and contact details of beneficiaries.</li> <li>• <b>Metadata:</b> Adding a clear description of what the data shows, when it was recorded and who recorded it.</li> <li>• <b>Attribute table:</b> Ensuring that all necessary fields are included to capture, for example, country, project, and planning phase.</li> </ul>
Possible data uses	<p>IFAD can use the data in the following ways:</p> <p><b>At project level</b></p> <ul style="list-style-type: none"> <li>• Planning of field visits</li> <li>• Project supervision reports and logframe updates</li> <li>• Updating project areas</li> <li>• Investment maps on ifad.org</li> <li>• Safeguard compliance check</li> <li>• Impact assessments or evaluations</li> </ul> <p><b>At corporate level</b></p> <ul style="list-style-type: none"> <li>• Donor reporting (e.g. to ASAP+ donors)</li> <li>• Assessments of adaptation interventions at portfolio level</li> <li>• Core indicator dashboards and online maps</li> <li>• Communication products</li> </ul>
Data storage	GeoNode is where IFAD stores GIS data.
Format	IFAD saves GIS data showing M&E data in ESRI shapefile format composed of four individual files: .shp, .shx, .dbf, .prj. A shapefile can depict an area (polygon), a transect (polyline) or locations (points).
Coordinate reference system	IFAD uses the World Geodetic System 1984 (WGS84). If spatial processing is applied, metric coordinate systems (e.g. Universal Transverse Mercator) should be used. Datasets can easily be converted between these coordinate systems.

Element	Requirements / Standard
<b>Metadata</b>	<p>This provides information about the collected datasets. It enables users to understand what the data shows, who collected it and how and when it was collected. GeoNode provides fields where this information can be summarized (e.g. in the abstract). The metadata of project-level data should provide:</p> <ul style="list-style-type: none"> <li>• Brief description and descriptive statistics</li> <li>• Full project name, project abbreviation and ID</li> <li>• Country</li> <li>• Indicator and multiplier (if available)</li> <li>• Month and year reported</li> <li>• Data source (persons/institutions) and contact details</li> </ul>
<b>Naming of shapefiles showing a project indicator</b>	<p>The naming of shapefiles depicting data at project-level follows the following naming standard:</p> <ul style="list-style-type: none"> <li>• IFAD region (APR, ESA, LAC, NEN or WCA)</li> <li>• Country 3 letter ISO code</li> <li>• Project ID</li> <li>• Indicator ID</li> <li>• Multiplier ID</li> <li>• Keyword</li> <li>• Year reported</li> </ul> <p>Example: NEN_TUN_1100001622_110_209_roads_2020</p> <p>Indicator and multiplier IDs do not have to be featured if not available.</p> <p>Shapefile names have the following rules:</p> <ul style="list-style-type: none"> <li>• The name cannot be longer than 65 characters.</li> <li>• Do not use hyphens ( - ). Use underscores ( _ ) instead.</li> <li>• Capitalization doesn't matter. Letters can be uppercase or lowercase.</li> </ul> <p>Find country letter codes <a href="#">here</a>. Find IDs for indicators and multipliers on ORMS.</p>



Element	Requirements / Standard
Attribute table	<p>Information about a geographic feature is stored in the attribute table of a vector file. Columns in the attribute table are called fields. Ideally, every attribute should be self-explanatory. If not, a short description can be included. Shapefiles should include the following fields:</p> <ul style="list-style-type: none"> <li>• Unique identifier (ID)</li> <li>• Name</li> <li>• Type of activity (e.g. roads)</li> <li>• Type of intervention (e.g. construction, rehabilitation, grant)</li> <li>• Status (planned, in progress, completed)</li> <li>• Date when feature was geographically captured</li> <li>• Date of completion or provision of support</li> <li>• Geometry: <ul style="list-style-type: none"> <li>• Point: Decimal degrees (e.g. -17.8632480963; 47.6763893702)</li> <li>• Transect: Length in kilometres</li> <li>• Area: Number of hectares</li> </ul> </li> </ul> <p>Other fields can for examples include costs, the type of commodity or a description with additional information.</p> <p><b>Standard fields</b> that every shapefile should include are:</p> <ul style="list-style-type: none"> <li>• Country ISO code</li> <li>• Project ID</li> <li>• Indicator ID</li> <li>• Multiplier ID</li> <li>• Year reported</li> </ul> <p>Find country letter codes <a href="#">here</a>. Find IDs for indicators and multipliers on <a href="#">ORMS</a>.</p>

## Annex 5: Example for an indicator standard

The following two tables show recommended standards to record IFAD's core indicator on roads rehabilitated or constructed. You require the ArcGIS or QGIS software to work with the data. Feel free to adapt the table as required for other indicators.

Element	Example for roads
Indicator	Roads constructed, rehabilitated or upgraded
Format	<b>Polyline</b> (shapefile)
IFAD core indicator	Number of kilometres of roads constructed, rehabilitated or upgraded (Core indicator number 2.1.5; ID: 110)
IFAD multiplier	Length of roads (ID: 209)
Shapefile name	(IFADregion)_(project ID)_110_209_roads_(year reported)
Data collection	<p><b>Collector:</b> Project management unit</p> <p><b>Unit of measurement:</b> Road transects (kilometers)</p> <p><b>Measurement (e.g.):</b></p> <ul style="list-style-type: none"> <li>• GPS measurements are taken from the engineering company developing the roads.</li> <li>• Project staff take measurements with a GPS device by driving in the middle of the road from the beginning to the end.</li> </ul> <p><b>Frequency:</b> Measurements are taken twice: (a) once at the design of a road; and (b) once the road has been completed.</p>
Analysis (examples)	<p><b>Descriptive statistics:</b> Total length of roads; length of constructed roads by status and/or type; average cost per km</p> <p><b>Catchment area:</b> Number of people living near the road</p> <p><b>Connectivity:</b> Reduction of travel time/costs</p> <p><b>Remoteness:</b> Roads are located in areas far from large cities</p> <p><b>Intervention logic:</b> For example roads are connecting villages/production areas and markets</p>
Visualization (examples)	<p>Map (online) with roads</p> <p>Map with roads, villages and markets to show spatial relationships</p> <p>Map with distance as travel time</p>

## Attribute table of roads shapefile

Name	Expression	Value	Type	Description
<b>Mandatory indicator-specific fields</b>				
ID	id_ifad	Number	Integer	
Road name	rd_name	Free text	Text	This is the road name as defined by the local authorities.
Intervention type	interven	1-constructed 2-rehabilitated	Text	
Status	status	1-planned 2-under development 3-completed	Text	
Date measured	date_measu	dd.mm.yy	Date	Date of road measurement
Date constructed	date_const	dd.mm.yy	Date	Date of completed construction
Approximate length in kilometres	length_km	Number	Decimal (double)	
Costs of construction (US\$)	cost_const	Number	Decimal (double)	
<b>Optional indicator-specific fields</b>				
Original surface type	before_surf	1-Unimproved 2-Soil, gravel, or stone 3-Bituminous 4-Concrete	Text	Roadway surfacing type in pavement view before its development (more)
Developed surface type	after_surf	1-Unimproved 2-Soil, gravel, or stone 3-Bituminous 4-Concrete	Text	
Description and purpose	descrip	Free text	Text	i.e. farm-to-market roads
<b>Standard fields</b>				
Country ISO code	country	Free text	Text	Find three-letter codes here
Project ID	projectid	Free text	Text	
Indicator ID	indicid	110	Integer	
Multiplier ID	multipliid	209	Integer	
Date reported	year_report	Free text	Text	Year reported to IFAD

# Annex 6: Data review checklist for IFAD

This checklist is for IFAD staff or consultants reviewing geodata submitted by project staff.

General information		
<b>Reviewer:</b>	<b>Date:</b>	
<b>Country:</b>	<b>Project:</b>	
<b>Data received:</b>		
<ul style="list-style-type: none"> <li>(file name and format)</li> </ul>		
<b>Data updated on IFAD GeoNode:</b>		
<ul style="list-style-type: none"> <li>(file name and URL)</li> </ul>		
Standard checklist	Checked	Comments / Solutions
<b>Format and geometry</b>		
Data is in shapefile format.	<input type="checkbox"/>	Convert data into shapefile format.
Coordinate reference system is WGS84.	<input type="checkbox"/>	Reproject shapefile to WGS84.
Geometry is valid (allowing area sizes and transect lengths to be calculated).	<input type="checkbox"/>	Apply the "Fix Geometries" tool in QGIS.
Georeferenced sites are not overlapping. There are no duplicate entries.	<input type="checkbox"/>	Understand why records are overlapping. Check for duplicate entries and remove them.
<b>Correctness</b>		
Georeferenced sites are within the target country.	<input type="checkbox"/>	Remove sites outside of the target country and inform the project team of the incorrect entries.
Georeferenced sites are within the IFAD project area.	<input type="checkbox"/>	Find IFAD boundaries <a href="#">here</a> . If sites are outside of the project area, flag this to the project team and recommend them to update the project area.
Georeferenced sites are not located in water bodies or other unsuitable areas.	<input type="checkbox"/>	Remove data on water bodies (except if a port or fish protection area). Inform the project team of the incorrect entries.
Geolocations are logically correct (e.g. markets located in or close to urban areas; pasture survey points located on pastures; no activities located in legally protected areas; etc.).	<input type="checkbox"/>	Display data on openstreetmaps and on satellite imagery. Inform the project if data seems incorrect.
<b>Logical framework check</b>		
Shapefile corresponds to one logframe indicator and multiplier listed in IFAD's Operations and Results Management System (ORMS).	<input type="checkbox"/>	One shapefile shows one indicator. Visit ORMS and indicator reports to find project indicators.
Shapefile statistics match or relate to reported annual and end targets.	<input type="checkbox"/>	In cases of over- or under-reporting, find out if logframe figures should be adjusted or geotagged data needs adjusting or if any data is missing.

Standard checklist	Checked	Comments / Solutions
<b>Data privacy</b>		
Dataset contains no sensitive information (such as beneficiary names and contact details)	<input type="checkbox"/>	Remove all beneficiary names and contact details.
<b>Metadata</b>		
Metadata includes: <ul style="list-style-type: none"> <li>Project name and ID</li> <li>Description of what the shapefile shows and when it was collected</li> <li>Date the data was submitted</li> <li>Person and contact details who providing the data</li> </ul>	<input type="checkbox"/>	<b>Example:</b> This data set shows 6 livestock water points established by the Family Farming Development Programme in the Diffa Region (ProDAF-Diffa) (2000001810) in Niger. Water points may include a water tower, solar panels, generator, drinking troughs and taps for domestic water use. This data set contributes to the project-specific indicator «Nombre de points d'eau aménagés dans le cadre de l'hydraulique pastorale». Anne Givings Kuhnen from IFAD received the data from the project coordinator in August 2020.
Shapefile name captures: <ul style="list-style-type: none"> <li>Region code</li> <li>Country code</li> <li>IDs of project</li> <li>IDs of indicator and multiplier*</li> <li>Key word (e.g. waterpoint)</li> <li>Year reported</li> </ul>	<input type="checkbox"/>	<b>Example:</b> NEN_TUN_1100001622_110_209_roads_2020 Region codes: APR, ESA, LAC, NEN or WCA Find country letter codes <a href="#">here</a> . Find IDs of indicator and multiplier on <a href="#">ORMS</a> .
<b>Attribute table</b>		
Attribute table contains all mandatory fields: <ul style="list-style-type: none"> <li>Name</li> <li>Status (planned or completed)</li> <li>Country ISO code</li> <li>Project ID</li> <li>Indicator ID*</li> <li>Multiplier ID*</li> <li>Geometry (x and y-coordinates, kilometres or hectares)</li> <li>Year reported</li> </ul>	<input type="checkbox"/>	Find country letter codes <a href="#">here</a> . Find IDs of indicator and multiplier on <a href="#">ORMS</a> .
Optional fields include: <ul style="list-style-type: none"> <li>Type or category</li> <li>Date recorded</li> <li>Costs</li> </ul>	<input type="checkbox"/>	

\* For ORMS indicators.

## Annex 7: Technical note on GIS equipment

In general there are two types of GPS devices to consider: handheld and geodetic devices. The major difference between the two is the level of accuracy of data produced; handheld devices have a lower accuracy than geodetic.

**Smartphones and tablets.** Smartphones and tablets are easy to use and relatively efficient equipment for collection of GPS coordinates, basic analysis and viewing of maps. They are widespread, cost little, are portable and have multiple uses (including for communication, photographing and video-recording), they readily lend themselves for georeferencing of project sites. Smartphones and tablets will likely be the entry-level equipment that IFAD projects should consider for georeferencing project sites.

**Specialized GPS handheld devices** are dedicated GPS devices that offer greater accuracy. Various brands and models has different specifications that offer a range of versatility and accuracy requirements (and come at different prices).

Basic **Garmin** equipment, such as the Garmin GPSMAP 66, mostly designed for navigation rather than for georeferencing, have been used in some IFAD projects with good results.

More specialized equipment includes the handheld **Trimble** and **TopCon** devices (e.g., TDC 100 and T-18 Mobile Field Controller). They are significantly more expensive but are more rugged, versatile and accurate.

With the evolution of GPS technologies, handheld devices have become increasingly accurate, and they will suffice for most IFAD project applications. However, where higher accuracy is needed, high-accuracy GPS-receiver equipment with antennas can be connected to handheld smartphones and tablets to enhance accuracy. A smartphone or tablet that typically collects GPS coordinates using its internal chip can now be connected to Global Navigation Satellite System (GNSS) receiver equipment such as the **Trimble Catalyst** and **TopCon HiPer V** using a USB cable. This improves accuracy down to the nearest centimetre, depending on the service subscription.

Where high accuracy is needed, e.g. for civil works or to measure small land areas, more specialized equipment can be considered. But highly specialized equipment such as **LIDAR** (light detection and ranging sensors) is highly unlikely to be needed. Such equipment is very expensive and the cost cannot usually be justified in IFAD project settings.

**Drones (unmanned aerial vehicles).** Most reasonably priced drones have a maximum flying time of about 30 minutes as the batteries are often light and small. Having an extra battery pack can extend the flying time but will require a change of battery. The drone pilot must be trained to fly it and must be aware of the associated risks, including the danger of crashing into people, livestock, buildings

and trees. Ensuring safety is critical. In addition, issues of privacy invasion may arise if photographs or video are recorded while flying over private areas. It may be worth obtaining insurance for such risks. Certified or licensed drone pilots may be available for hire as consultants. In some countries it is necessary to obtain permissions and clearances before importing and flying a drone.

**GPS trackers.** These make it possible to collect data on mobile objects such as animals (as in projects on pastoralism) and boats (for fisheries). GPS tracking devices can collect accurate, high-frequency mobility data over time, which can be analysed for travel patterns and times.

**Microelectromechanical systems (MEMS) and sensors.** MEMS form the basis of the so-called “Internet of Things”. These nanotechnologies can detect motion or presence (e.g. the motion of vehicles over a road surface) and can simultaneously collect GPS coordinates. They can relay this information to a remote server via an internet connection. They are not yet widely applied but are expected to become more and more relevant in the future. IFAD has a solar-powered Houston radar sensor with related software that can be used for motion detection and enumeration of rural road infrastructure and market centres.

### Aerial image and GPS processing software

Several open-source packages are now freely available to develop flight plans for drones, which allows for the simultaneous capture of photographic images and videos and GPS coordinates of project sites.

**Pix4Dcapture.** This allows for drone flight planning and automated flight and image-data transfer. The app can also be used for optimal three-dimensional mapping and modelling ([learn more](#)).

**Open Aerial Map (OAM).** This can be used to obtain existing aerial images uploaded by other users and link them to project GPS coordinates. It also allows for uploading and sharing aerial images and related GPS coordinates collected from project sites. This enables geospatial analysis to be linked to imagery from multiple data sources and users, and to satellite remote sensing databases. Before uploading or downloading images and GPS coordinates data, it is important to consider all relevant data governance policies and whether you can legally make the GPS coordinates and imagery data publicly available ([learn more](#)).

Other mapping software for drones includes DroneDeploy ([learn more](#)) and OpenDroneMap ([learn more](#)), which is open-source.



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**SIERRA LEONE:** Staff of the Smallholder Commercialization Programme collecting GPS coordinates of an irrigation scheme developed by the project.



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