

→ E04SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Agriculture and Rural Development | Ethiopia

Sustainable land management and food security



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1. INTRODUCTION

Ethiopia is the second-most populous country in sub-Saharan Africa with a population that surpassed 100 million in 2015. The country has a highly diverse agroecological environment, spanning tropical highlands and hot, arid lowlands, matched by an equally diverse socio-cultural setting, which makes it environmentally fragile. According to IFAD estimates agriculture is the primary source of income for more than 85 per cent of Ethiopia's population with smallholder farmers producing 90 to 95 per cent of the country's agricultural output. About one third of rural households cultivate less than 0.5 hectares of farmland. The population that depends on rain-fed agricultural and pastoral activities is particularly vulnerable to climate impacts, land degradation, drought, and flooding, which are each expected to have a negative impact on livestock, farmland, and overall nutrition. In addition, these smallholders are often weakly integrated into markets and have limited access to finance and modern agricultural technology.

Agricultural growth is a major driver of poverty reduction in Ethiopia. Yet agricultural productivity is low as a result of land degradation, poor water management, low technology use and an underdeveloped marketing system, among other factors. Population pressure has led to natural resource degradation, which is exacerbated by climate change and increasingly frequent extreme weather events, including drought, floods and heatwaves. The country is still very dependent on rain-fed agriculture and, given the variable rainfall, increasing temperatures and recurrent droughts, achievement of full food and nutrition security for all is becoming difficult.

Various programs and projects address these issues in the country. E04SD (Earth Observation for Sustainable Development) initiated partnerships with IFAD's Participatory Small-scale Irrigation Development Programme – Phase II (PASIDP II), the World Bank's Sustainable land management project – Phase II (SLMP II) and the UNDP-implemented Integrated Landscape Management to Enhance Food Security and Ecosystem Resilience project. Figure 1 shows the project areas with E04SD mapping activities.

E04SD (Earth Observation for Sustainable Development) "Agriculture and Rural Development Cluster" is a European Space Agency (ESA) initiative developed to encourage the uptake of Earth Observation information and services in international development projects on a large scale. In Ethiopia, E04SD provided satellite-based data and capacity training to the teams of the WB SLMP II, IFAD PASIDP II and UNDP IAP Food Security child projects.

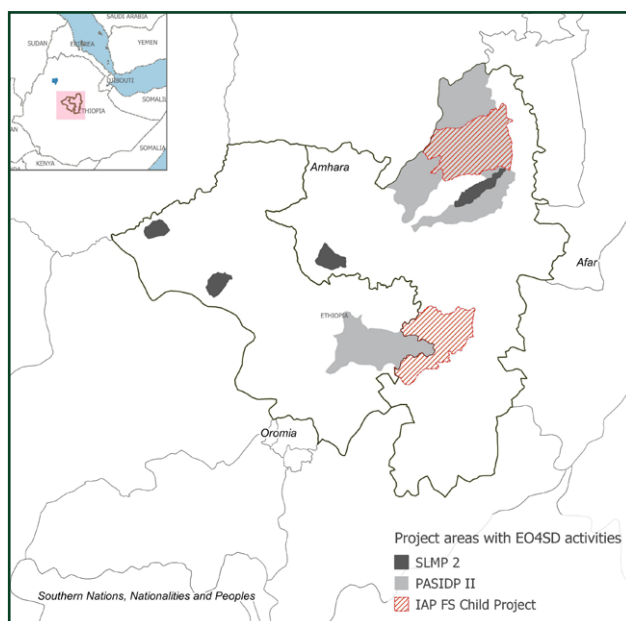


Figure 1 Overview of the project areas of the IFAD, WB and GEF IAP projects with E04SD activities.

Credit: E04SD Agriculture Cluster (DHI GRAS for ESA/IFAD/UNDP/WB, 2018).

Development priorities for the agriculture sector in Ethiopia range from preventing and reversing land degradation to increasing land and water productivity. In this context reliable evidence-based tools and information systems are essential to support the planning of sustainable food security interventions and to track the progress and impact of investments over time.

Currently, data are fragmented and generated by a variety of measurement methodologies and tools making results seldom comparable. Earth observation technology is one important part to that puzzle together with ground surveys and traditional statistics complementing the picture and helping standardisation of methodologies and coordination of data acquisition between and within countries on the way.

PASIDP II is designed to enhance resilience against external shocks and those induced by adverse weather and climate conditions, enhance economic growth and reduce rural poverty. The programme will improve the access of farmers to a secure irrigation production system and enhance water efficiency through climate-smart agriculture in the adjacent watersheds and thus aims to improve farmers' prosperity, food security and nutrition. The executing agency is the Ministry of Agriculture and Natural Resources.

SLMP II had the objective of reversing land and environmental degradation. in selected watersheds in targeted regions in Ethiopia. Focused of the project has been watershed and landscape management, institutional strengthening and rural land administration and certification. The executing agency was the Ministry of Agriculture and Natural Resources. The project concluded in December 2018. The SLMP project team profited from E04SD capacity development and information was used for final project reporting. The Resilience Landscapes and Livelihoods Project is the continuation of the SLMP II.

Earth Observation technology is exceptionally well suited to support the implementation of long-term and large scale development programs that aim to resolve the data and information gaps concerning the status and change in land cover and land use, land productivity and agricultural production. The fleet of Sentinel satellites as part of the European Copernicus program makes an unprecedented amount of free and open access data available. The Sentinel satellites carry both optical and radar sensors and provide images at multiple spatial scales, ensuring adequate access to timely information. Especially when coupled with appropriate ground information and local expertise, Earth Observation is a powerful tool to support and inform statistics and comply with reporting obligations.

This document presents the potential of EO-based geo-information products and services to contribute in an effective way to sustainable land management and food security in Ethiopia. The purpose is to demonstrate and raise awareness among MDBs and their local stakeholders of the important added value of EO information products and services for international development projects.

"Integrated Landscape Management to Enhance Food Security and Ecosystem Resilience in Ethiopia" is the Ethiopian child project of the Global Environmental Facility "**IAP Food Security**" program. The project aims to enhance long-term sustainability and resilience of food production systems by addressing the environmental drivers of food insecurity in Ethiopia. The overarching focus is on integrated landscape management (ILM) to achieve food production resilience in landscapes under pressure. ILM combines land management choices and Integrated Natural Resources Management with water- and climate-smart agriculture, value chain support and gender responsiveness.

2. OBJECTIVES

The E04SD Agriculture and Rural Development Cluster project demonstrated the benefits of EO-based information and services to support agricultural monitoring and management tasks including agriculture production assessment, land degradation monitoring, soil erosion risk mapping and irrigation management.

Generating environmental information over large areas based on satellite data will catalyse evidence-based implementation of the projects by providing a concrete and operational contribution to the program-level monitoring and evaluation (M&E) tools and a cost-effective system for scaling up successful initiatives. These services can provide independent and authoritative environmental variables that build a stronger indicator framework. Indicators can demonstrate how different program investments are addressing drivers of environmental degradation and agro-ecosystem resilience, as pursued by the Sustainable Development Goals (SDGs), including target 15.3 on Land Degradation Neutrality.

E04SD - Agriculture and Rural Development Cluster project aims to demonstrate the benefits of EO-based geo-information products and services to support agricultural monitoring and management tasks including:

- agriculture production assessment,
- land degradation monitoring,
- soil erosion risk mapping,
- identifying food security, and
- irrigation management.

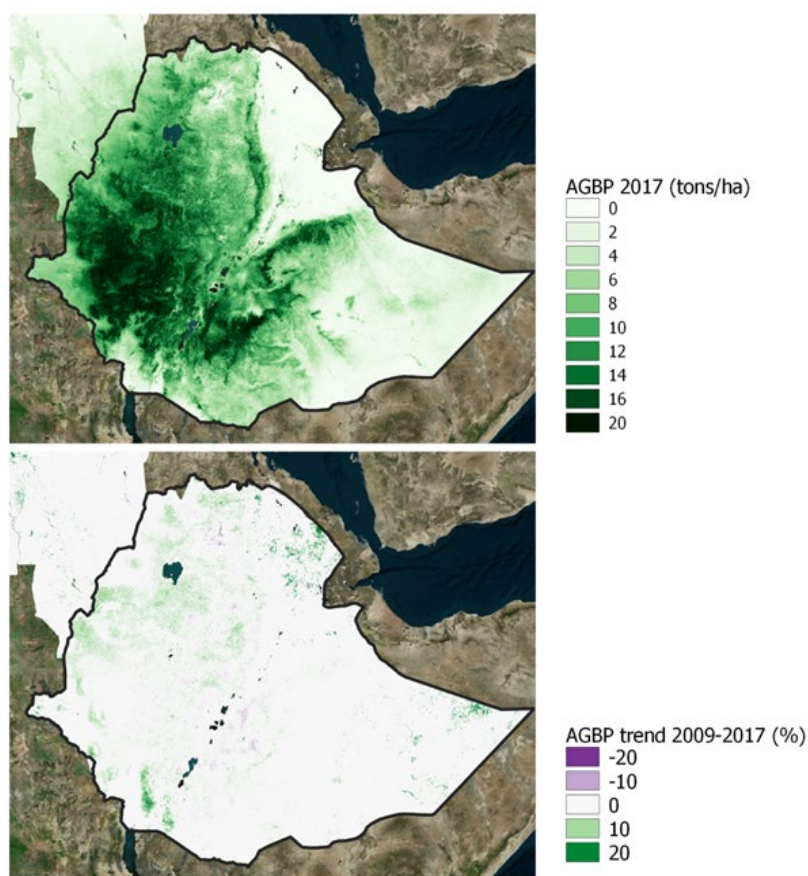


Figure 2 Above Ground Biomass Production (AGBP) in Ethiopia for 2017 (top) and trends from 2009-2017 (bottom) based on data from the FAO WaPOR portal.

Credit: E04SD Agriculture Cluster (eLEAF for ESA/IFAD/WB, 2019)

3. OUTCOME

The collaboration between E04SD and the three Ethiopian project teams led to the production of a series of EO data products covering the Ethiopian project areas, such as annual and monthly biomass production (Fig. 2), land use and land cover maps (Fig. 3), long-term vegetation trends (Fig. 4), annual and monthly water productivity, a rough soil erosion risk assessment (Fig. 5) as well as irrigation suitability maps for various crops (Fig. 6). Earth Observation data, information products and services, available at the appropriate scales and timeframes, were made accessible to the users through the E04SD data and information delivery platform (E04SD.lizard.net). The Lizard site will go offline in October 2019, but most data will continue to be available through our partners ICRAF (<http://landscapeportal.org/projects/11>) and Conservation International's Food Resilience Atlas (<https://foodsecurityiap.resilienceatlas.org/>).

"E04SD introduced the satellite-based information collection and analysis to our project and partners. That was an eye breaker for me to think about the use of such information to document our base line and develop a monitoring system. I am still using the sample data E04SD gave me for 2 districts as an example while I present the value of satellite-based information for our monitoring system. These data I got helped me to demonstrate how satellite data, analyzed and interpreted can have a meaningful information for policy makers. " Tesfaye Haile, UNDP IAP FS Project Manager, Ethiopia.

In addition to the E04SD generated data, the Lizard system also included open access data (for a data overview see Table 1) such as datasets developed under ESA Climate Change Initiative (CCI+), including high resolution land cover dataset (prototype) for the entire Africa continent which was produced in the framework of the ESA and Copernicus Program Initiatives. The FAO Water Productivity Open-access database - WaPOR- which provides open access to the water productivity database and underlying map layers such as the Above Ground Biomass Production (AGBP) product which is also assimilated on the relevant data portals. Besides data provision, the teams were invited to two capacity development workshops which took place in February 2018 and 2019, respectively (see chapter 4).

Table 1 Available data layers in the E04SD Lizard portal for regional service level and Ethiopia.

Service level	Data	Spatial coverage	Temporal coverage	Spatial resolution	Description
Regional	Land cover	Continental Africa	Yearly, 1992-2015	20-300m	ESA Climate Change Initiative datasets, including first continental Prototype Map for Africa based on Sentinel-2 at 20 m (CCI+) as well as annual land cover change products from Copernicus Global Land Cover (100m) based on ProbaV
	Land productivity	Continental Africa	Yearly, 2009-2017	250m	Above Ground Biomass Production (AGBP), in kg/ha/year, as available in the FAO Water Productivity Open-access portal WaPOR
	Biomass water productivity	Continental Africa	Yearly, 2009-2017	250m	Net Biomass Water Productivity (NBWP), in kg/m ³ , as available in the FAO WaPOR database
	Water consumption	Continental Africa	Yearly, 2009-2017	250m	Actual evapotranspiration (AET), in mm, as available in the FAO WaPOR database

Service level	Data	Spatial coverage	Temporal coverage	Spatial resolution	Description
Ethiopia	Land cover/ land cover change	(part of) North Shewa	2016/2018	10 m	Customised land cover map based on Sentinel-2 data with detailed information on the land cover in 2016 and seven land cover classes (water, build-up, bare soil, agriculture, grassland, shrubs, forest.) Baseline mapping for 2016 followed by near real time change mapping in 2018 with the aim to set up a Sentinel-2 based high resolution hotspot monitoring system.
	Vegetation cover dynamics (trends)	(part of) North Shewa	1999- 2018	30 m (National trends for 2000-2017 at 250m)	Long-term trends of vegetation cover showing areas of significant increase and decrease. Break points can be set at project start to see impact of intervention on vegetation development.
	Land productivity (biomass production)	(part of) North Shewa	2013 & 2017	30 m	Biomass production over time, in kilograms per hectare to derive input to carbon assessment product (combining carbon sequestration in biomass and in the soil).
	Potential soil erosion risk	(part of) North Shewa	2017	30 m	Potential soil erosion risk (long-term average) by water linked to environmental factors of a site, such as terrain slope, soil type, land cover/use and amount of precipitation.

Service level	Data	Spatial coverage	Temporal coverage	Spatial resolution	Description
Ethiopia	Irrigation suitability	(part of) North Shewa	2018	30m	Mapping of suitable areas for irrigation development. A first rough screening is performed which is helpful for areas where no information is available yet.
	Irrigation performance and timing	(part of) North Shewa	2013/2017	30m	Estimates of water consumption and water stress combined with biomass production and/or yield data provide estimates of irrigation performance, including water productivity in kg per ha per m3.
	Roadless areas	(part of) North Shewa	One coverage, date depending on road input data (2017/2018)	Depending on input data	Highlighting areas in need of rural infrastructure development or as input to irrigation scheme development. This information can be refined with in situ information on storage facilities and other key parts of the supply chain.
	Support to MDBs environmental and social safeguard frameworks / M&E service	(part of) North Shewa	2018	10-30m	Area statistics for areas of interest for parts of North Shewa based on land cover/land use and change, vegetation trends, biomass productivity and potential soil erosion risk.

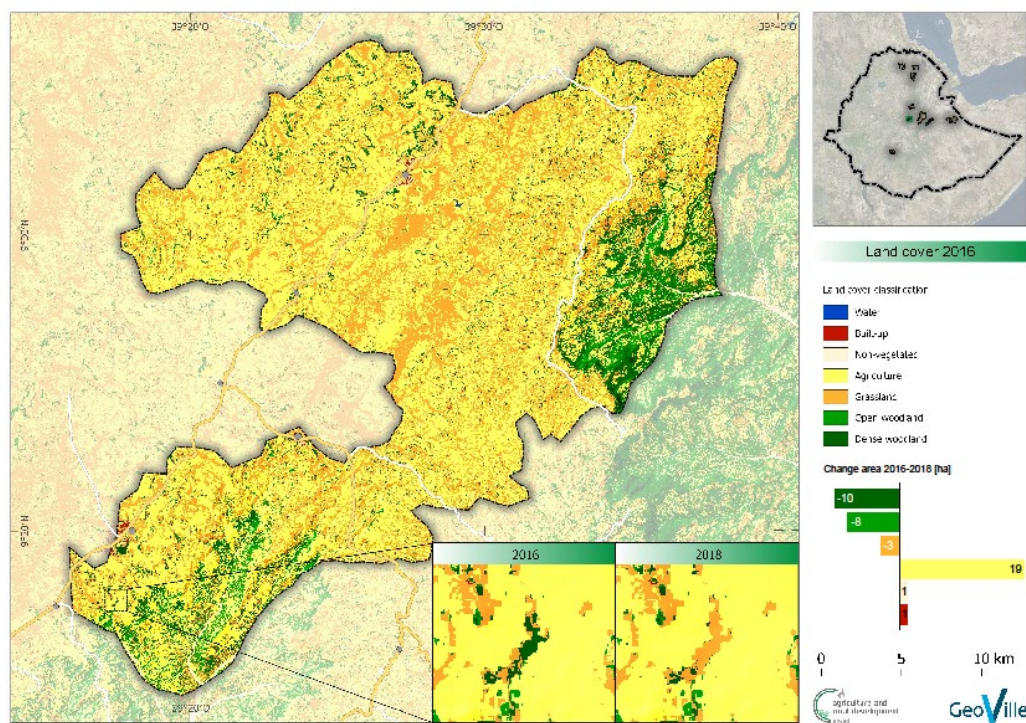


Figure 3 Land cover/use map of the IAP FS project area Angolelana Tera for 2016. Showing land cover changes between 2016 – 2018. Sentinel 2 time series were used for the mapping. Main identified changes are from forested areas to cultivated land. This trend can be observed throughout all areas of interest in Ethiopia. Credit: EO4SD Agriculture Cluster (GeoVille for ESA/UNDP, 2018).

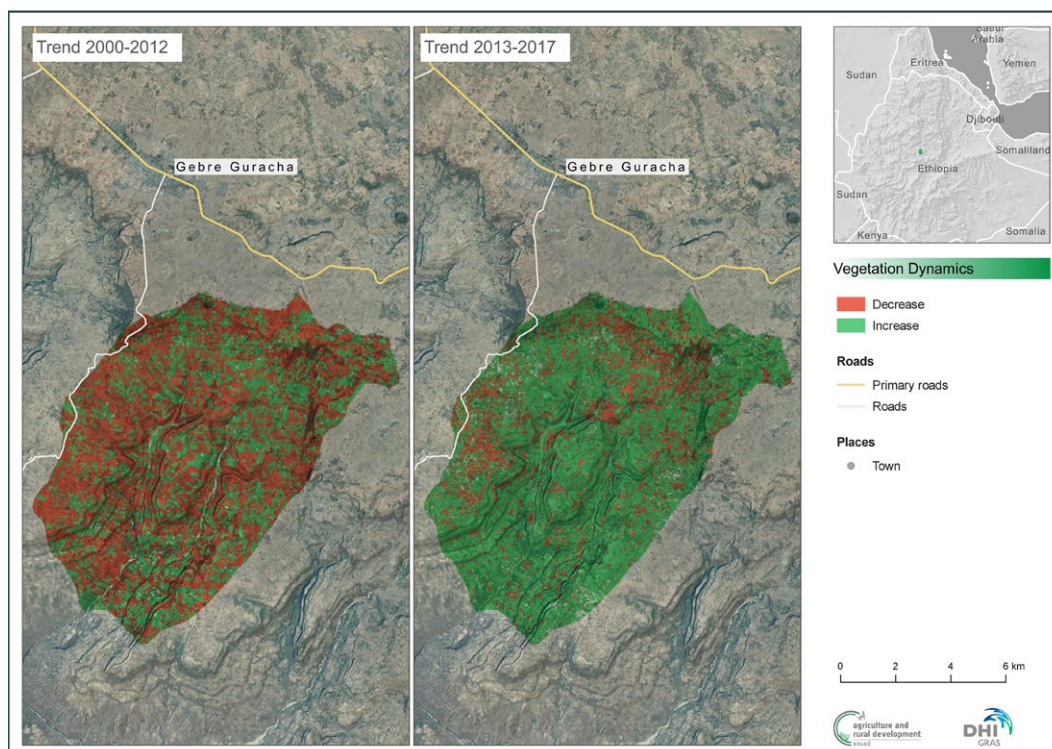


Figure 4 Assessment of the changes in vegetation cover in a SLMP-2 project watershed between 2000 and 2017. Time series analysis can support the evaluation of impact of project interventions by looking at trends before and after interventions. Knowing the exact project implementation area together with local knowledge is vital for the interpretation of the results.

Credit: E04SD Agriculture Cluster (DHI GRAS for ESA/WB, 2017).

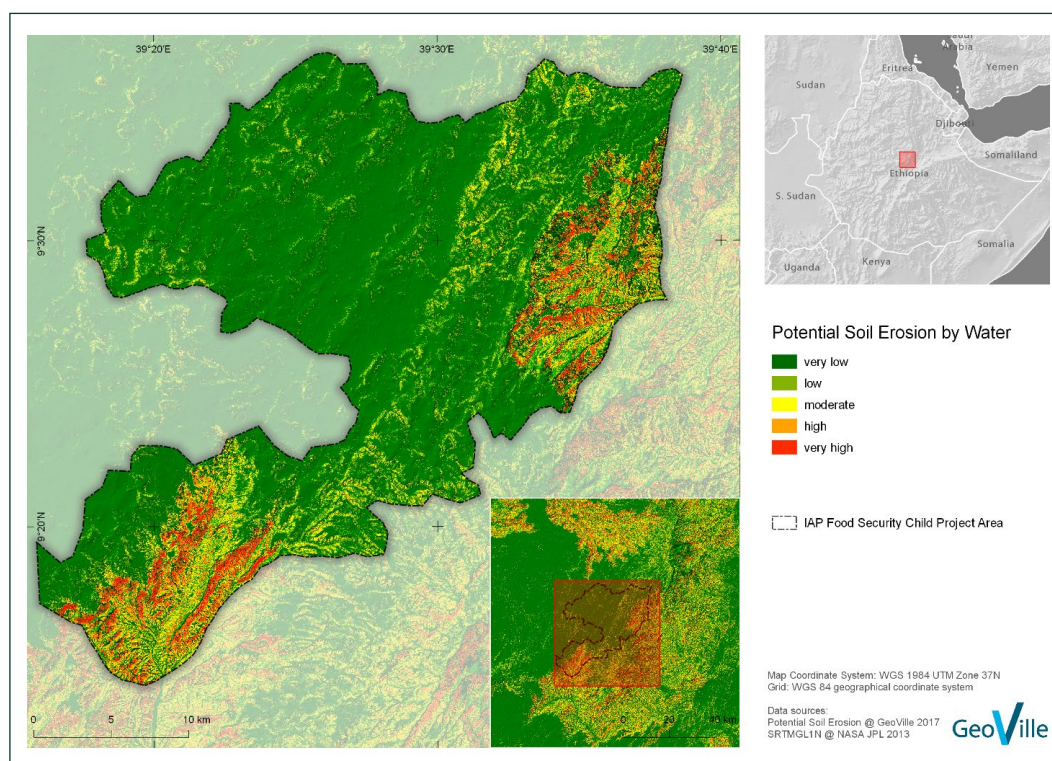


Figure 5 Soil erosion potential by water for selected Woredas in Ethiopia. The potential is linked to environmental factors of a site, such as terrain slope, soil type, land cover/use and amount of precipitation.

Credit: E04SD Agriculture Cluster (GeoVille for ESA/IFAD/WB, 2017).

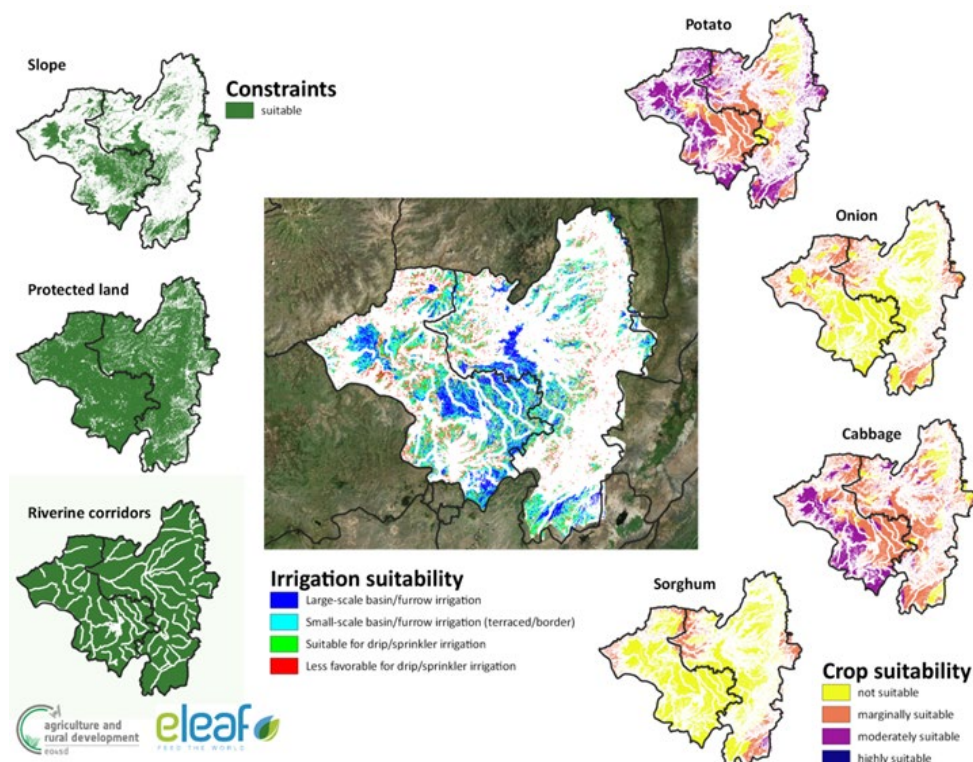


Figure 6 Irrigation suitability for the North Shewa region. Irrigation suitability classes take into account environmental constraints, opportunities for different irrigation techniques (e.g., sprinkler, furrow irrigation) as well as crop suitability (temperatures).

Credit: Credit: E04SD Agriculture Cluster (eLEAF for ESA/IFAD, 2018).

4. CAPACITY BUILDING

The amount of free and open-access satellite data has increased dramatically with the commissioning of the Sentinel satellites. However national GIS and remote sensing centres or user organisations often lack the capacity to develop and use the data for monitoring and reporting activities. Developing a portfolio of tailored information services and ad hoc capacity building activities would help them to sustainably build up their decision-making capabilities as well as skills in EO data exploitation.

The training under the E04SD umbrella aimed at demonstrating the opportunities and benefits of using EO-based information services so that they become an integral part of the planning, operational, monitoring and evaluation phases of projects. This plan was implemented with the technical support of the ITC Faculty of Geo-Information Science and Earth Observation of the University of Twente, a global leader in training and capacity building in the field of geo-information science, Earth Observation and GIS. It aimed at developing the skills set of the remote sensing professionals and the user organisations alike and included - as necessary - practical exercises concerning data application and use, lectures, and independent EO research by the participants. It also specifically leveraged free, open access Earth Observation data and programs.

This dedicated training component (see Figures 7 and 8) involved the organisation of awareness raising sessions with MDBs and other development partners and national training workshops. The national workshops gathered stakeholders from different targeted projects.

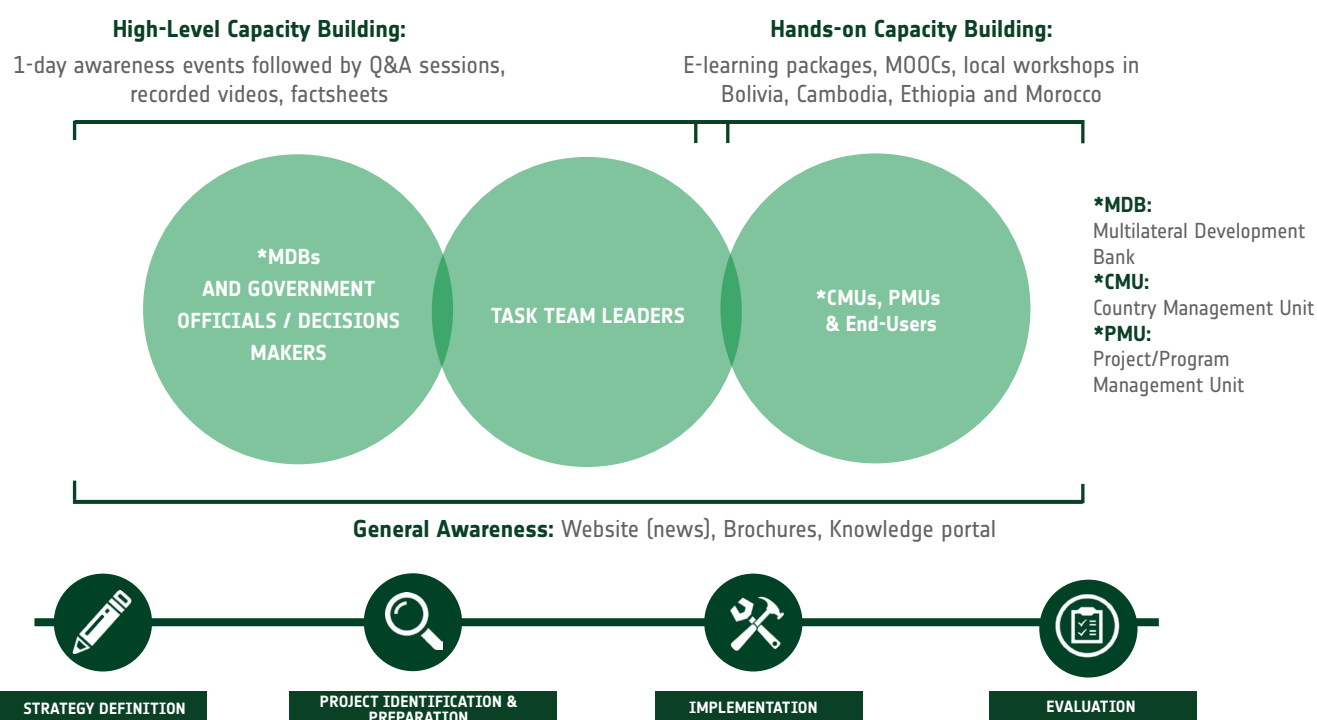


Figure 7 E04SD capacity building plan.

In Ethiopia, the Agriculture and Rural Development cluster organized two local workshops: February 5th to 9th, 2018 and February 10th to 14th, 2019. Both events were held in Addis Ababa at the International Livestock Research Institute (ILRI) campus. These workshops did not only present state-of-art EO capabilities for agriculture and rural development to local stakeholders, but it also provided the project implementation teams with a refresher training on GIS and EO technology and data. Moreover, these trainings were used to discuss a roadmap towards an integrated approach to the development of EO-based indicators for Monitoring and Evaluation purposes. More than 40 attendants from different backgrounds and with different roles in regional projects, organisations, and ministries benefited from the various components of the trainings.

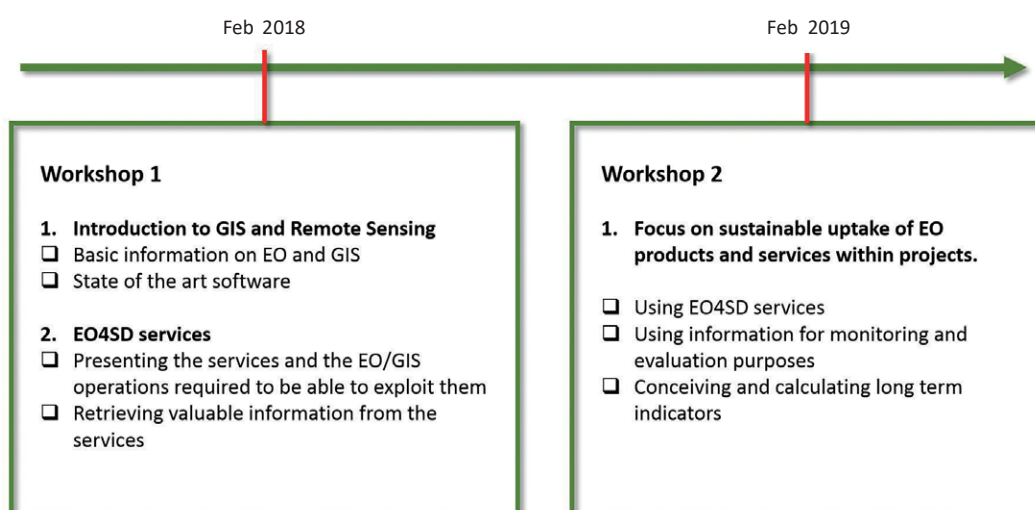


Figure 8 Outline of customised national training workshops.

Partners of the Agriculture Cluster



Nelen & Schuurmans



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