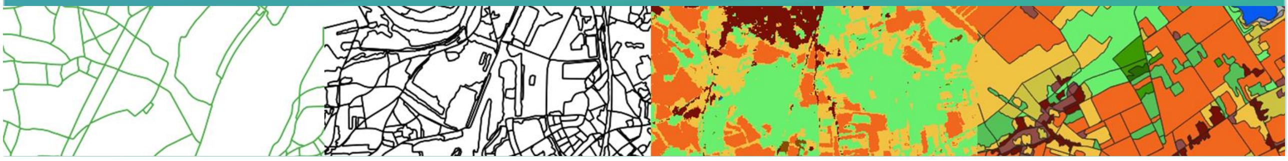
Service contract for the Copernicus Land monitoring services

Crop Mapping for GEOGLAM Country Level Support



Framework Contract N°939708-2020-IPR

First Specific Contract

D2.4 Field Campaign for Kenya – Methodology applied

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with support from:

Upande

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List of Abbreviations

AOI	Area of Interest
FAO	Food and Agriculture Organization
GeoODK	Geographical Open Data Kit
GPS	Global Positioning System
JRC	Joint Research Centre of the European Commission
OSM	Open Street Map
RGB	Red Green Blue
VHR	Very High spatial Resolution

1 Introduction

SIRS/CLS (Systèmes d'Information à Référence Spatiale/Collecte Localisation Satellites) and **TerraSphere** were selected in response to the Call for Tender for a Framework service contract in relation to Crop Mapping for Group on Earth Observations Global Agricultural Monitoring Initiative (**GEOGLAM**) Country Level Support as part of the Copernicus Global Land component.

The present document covers the D2.4 Deliverable focusing on summarizing the workflow and the changes between the actual field sampling and the planned one (as of the feasibility study) and the description of the impact of the changes in the following tasks.

Upande Ltd as a subcontractor to CLS was in charge of the field campaigns in Kenya, taking full profit of local knowledge regarding regulations, logistics and resources.

2 Objectives of the field campaign

The objective of the survey is to collect in the field harmonized training data (also called ground truth data) for 1) the classification of crop types and 2) the provision of unbiased crop area estimates and the validation of the crop type maps and crop mask.

So, 75% of the data collected in the field will be used as a training dataset. The image classification will involve Sentinel-2 at 10-meters resolution (with support of Landsat-8), and Sentinel-1 time series. Sentinel-1 will only be used in case of prolonged cloudiness. The remaining 25% of the data collected in the field will be used to evaluate the accuracy of the results (distinction between crop types mainly) and to obtain information on unbiased crop area estimates.

3 Specification of the Area Of Interest (AOI)

Following a discussion with the Head of Agricultural Statistics Unit of the Ministry of Agriculture Tom Dienya, there were changes in the definition of the AOI as described in the feasibility study for Kenya (D1.1) with the addition of 3 districts (Narok, Laikipia and Tharaka Nithi).

The AOI was expanded and finally the field campaign took place over the counties in the western highlands counties; central and northern rift valley and central highlands (Busia, Kakamega, Bungoma, Vihiga, Siaya, Kisumu, Homabay, Migori, Kisii, Nyamira, Narok, Nakuru, Nandi, Elgeyo Marakwet, Trans Nzoia, Uasin Gishu, Kiambu, Nyandarua, Muranga, Kirinyaga, Embu, Meru, Laikipia, Tharaka Nithi, Nyeri, Bomet and Kericho). The total area occupied by the AOI is covering approximately 98,690 km² representing 17% of the country. The AOI as described in the feasibility study for Kenya (D1.1) previously covered around 75,000 km² resulting in an extension of approximatively 23,500 km².

The three regions usually act as swing regions for food security and availability of data from these areas will be an important step towards food security forecast in the country. Most of the AOI is located in the Highland areas (elevation ranging from 1000 m to 2500 m with mountainous areas having elevation ranges between 2500 to >3000 m). Fertile soils are prevalent constituting of loams and clay/sandy loams (i.e., Phaeozems, Nitosols, Cambisols). Soils are deep and well drained, and as such highly suitable for agriculture. Figure 1 shows the extent of the area.

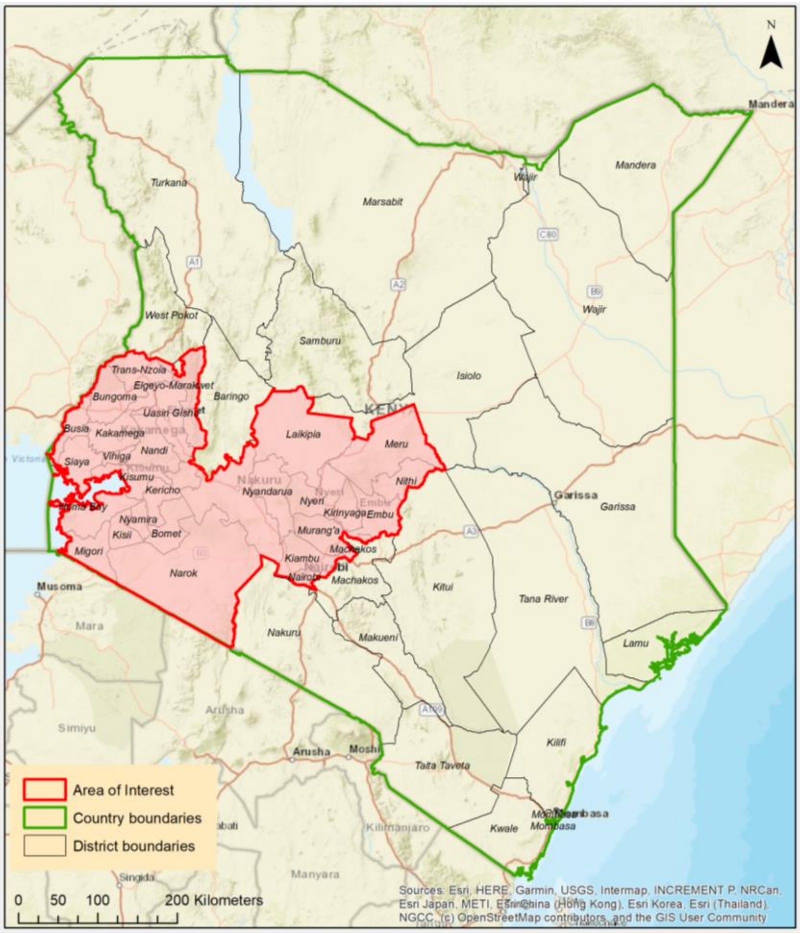


Figure 1: Area Of Interest (in red) in Tanzania

4 Review of the Stratification and Sampling Design implemented in the feasibility study

4.1 Stratification

The stratification applied was unchanged from what was proposed in the feasibility study (D1.1) but was expanded to the new districts added into the AOI as described in section 3. The stratification is summarised as follows based on a series of 6 strata and defined as follows (see Figure 2):

1. Irrigated crops (including rice fields);
2. Rainfed Lowlands;
3. Rainfed Highlands Sub-Humid/Humid;
4. Rainfed Tropical Highlands Humid;
5. Rainfed Tropical Highlands Sub-Humid;
6. Other areas (including areas ≥ 3,000 m and land cover classes different from cropland areas).

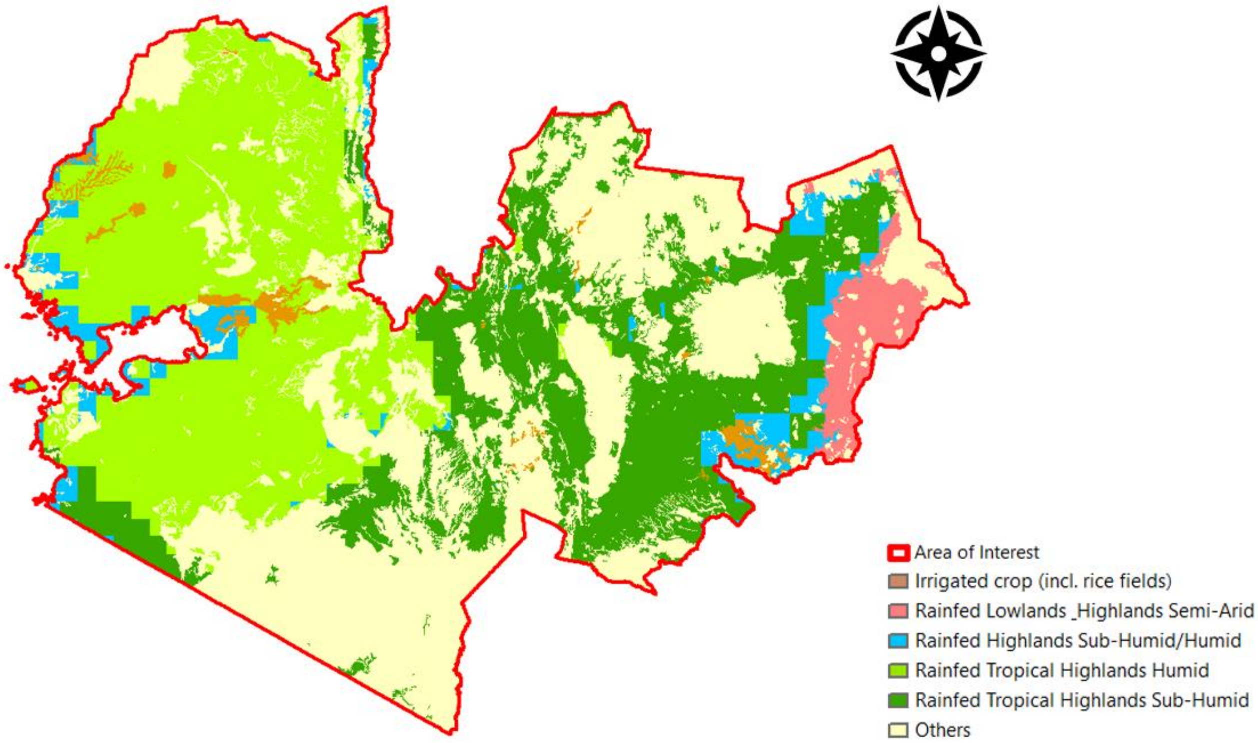


Figure 2: Derived AOI stratification

These strata are based on a combination of physical information (like the Copernicus Digital Elevation Model (DEM) at 30-meter spatial resolution[1] and the FAO's AFRICOVER dataset at 30 m for the Period 1995-2002) or the agro-climatic conditions (Agro-Ecological zones (AEZ) for Africa South of the Sahara at 10 km for the reference year 2015), so the resulting strata are homogeneous regarding both climate and agro-ecological conditions (relief, soil, etc.), and agricultural practices.

4.2 Sampling Design

Due to the modification of the AOI, the sample was modified from what was proposed in the feasibility study (D1.1) and delivered in D1.2 as a as a georeferenced vector file.

The approach is summarised as follows based on the new definition of the AOI.

The selection of sample units was still based on a stratified systematic and random sampling selection (two stage approach). The first stage was implemented by applying the same 20 x 20 km grid over the overall new area of the AOI. In a second stage, multiple sample units were still randomly selected in sequence for each grid cell based on the 500 x 500 m sub-grid as illustrated in Figure 3; but the protocol of the second stage was adapted.

Thus, the first replicate is in any case surveyed on the fields following the protocol described in the feasibility study (D1.1). But if the first replicate in the block is sampled in the cropland stratum, the second replicate is no longer included in the sample (whether it falls in the cropland or "other areas" strata). As

1 https://spacedata.copernicus.eu/web/cscda/dataset-details?articleId=394198

described in D1.1, if the first replicate falls in the “other areas” stratum, the second replicate is still included only if it falls in a cropland stratum as there should only be one replicate in the “other areas” stratum per block.

The sample design finally resulted with 271 segments selected.

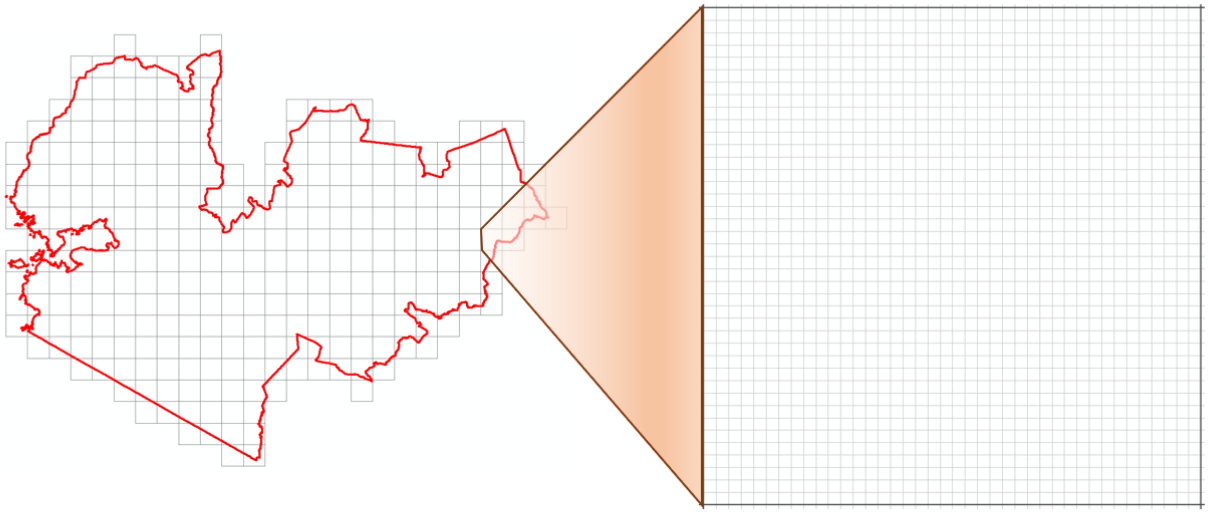


Figure 3: Two-stage stratified random sampling design: 1) 20 x 20 km grid applied on the AOI and 2) 500 x 500 m sub-grid used for the random selection of square segments as sample units

The spatial distribution of the sample units over the crop and non-crop strata are shown in Figure 4

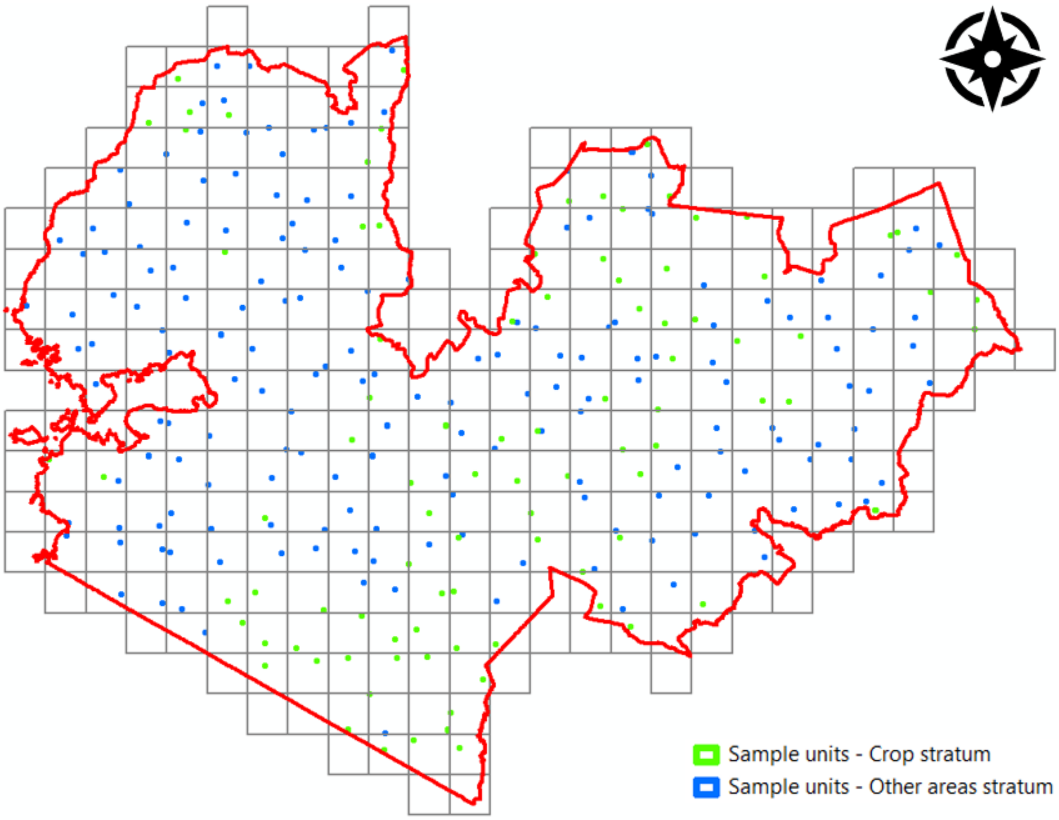


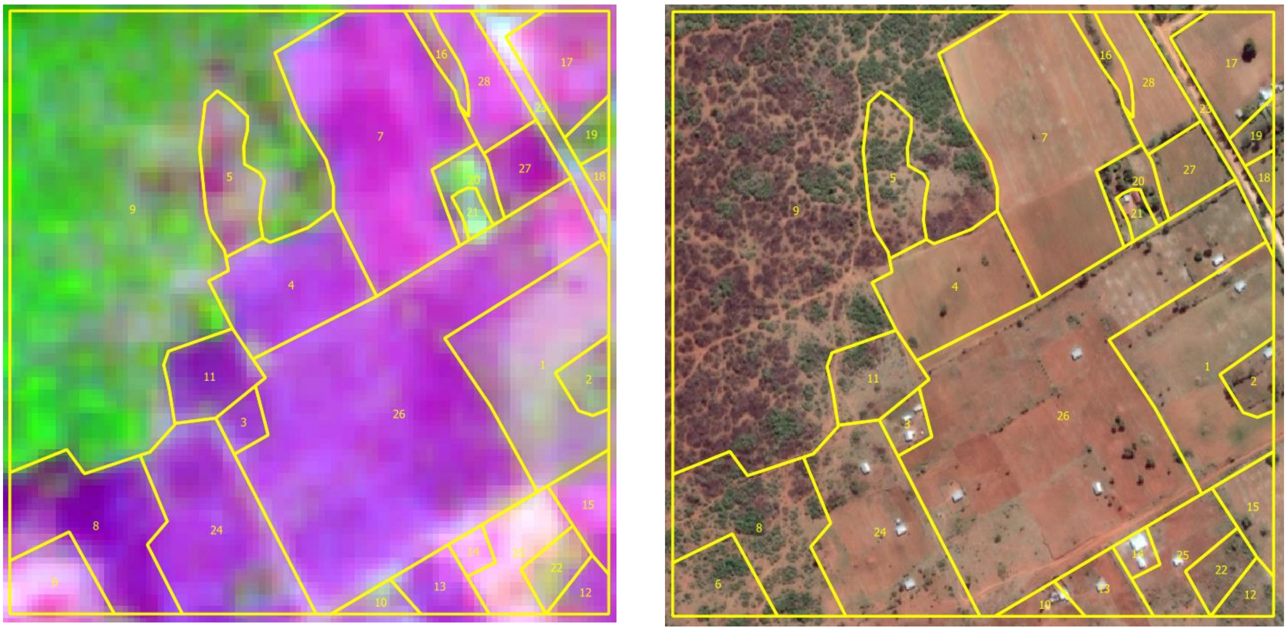
Figure 4: Spatial distribution of the sample units per aggregated stratum

However, a visual assessment of some of the selected segments was made during the feasibility study and showed that some crops were also sometimes present in the other areas stratum. Therefore, this assessment was conducted based on available imagery from Google Earth / Bing Maps over all segments to identify, from the overall samples, the segments without any crops present. This information was used to determine the number and location of the segment to be surveyed as an input to the contract for Upande Ltd. In total out of the overall sample of 271 segments, 201 segments were identified to contain field parcels and therefore were to be surveyed.

5 Field campaign

5.1 Segment survey protocol

Prior to the field campaign, each segment has been visually interpreted by CLS using a combination of the most recent available Very High Resolution (VHR) imagery from Google Earth/Bing Maps, Yandex, Planet and Sentinel-2 imagery from the current season. All field boundaries (including cropland parcels) were digitalised, resulting in polygons that constitute the segment. Figure 5 shows an example of a square segment interpreted and digitalized overlaid on a Sentinel-2 image (16 April 2021) and a VHR Google satellite image (Actual date unknown). Both the square segments and the associated fields are numbered with unique identifiers. These identifiers correspond with the form to be filled by the enumerators. The hardware and software tools used by the enumerators to collect the information in each sample is described in the following section.



Sentinel-2 imagery from 16/04/2021 (False color composite B11/B8/B4)

VHR Google imagery (date unknow)

Figure 5: Example of samples digitalized prior to the fieldwork

After digitalising the fields, the land cover is determined. Based on the VHR and Sentinel-2 imagery a land cover is assigned following the "Main Land Cover" nomenclature presented in Table 1.

Table 1: Main Land Cover nomenclature

1	Forest
2	Grassland
3	Cropland
4	Bare soil
5	Urban
6	Shrubland
7	Water
8	Wetland

Standard definitions for Land Cover are applicable such as:

- Forest: areas covered by woody species capable of exceeding 5m height tree crown and area > 10%
- Grassland: areas where the vegetation is dominated by grasses with a maximum of 10% of tree cover
- Cropland: land devoted usually to agriculture (temporary or permanent) in case of doubt if there was not a clear distinction between e.g. grassland or cropland, the parcel was classified as cropland
- Bare soil: areas with a minimum of 50% bare ground
- Urban: human settlement with high population density and infrastructure of built environment
- Shrubland or bushes: where the vegetation is dominated by shrubs (small to medium sized perennial woody plant) >20% cover of woody plants < 5m high
- Water: areas covered with permanent water surfaces (canal, rivers, water bodies, etc.)
- Wetland: a distinct ecosystem that is flooded by water, either permanently or seasonally, may include vegetation.

Only segments for which cropland is detected were surveyed. In cases of doubt, the segment was included in the survey. As a result, based on the new AOI and the modification of the sampling design protocol, **201 cropland segments were identified (out of 271) from which cropland parcels have been detected and potentially to be surveyed,** as is shown in Figure 6.

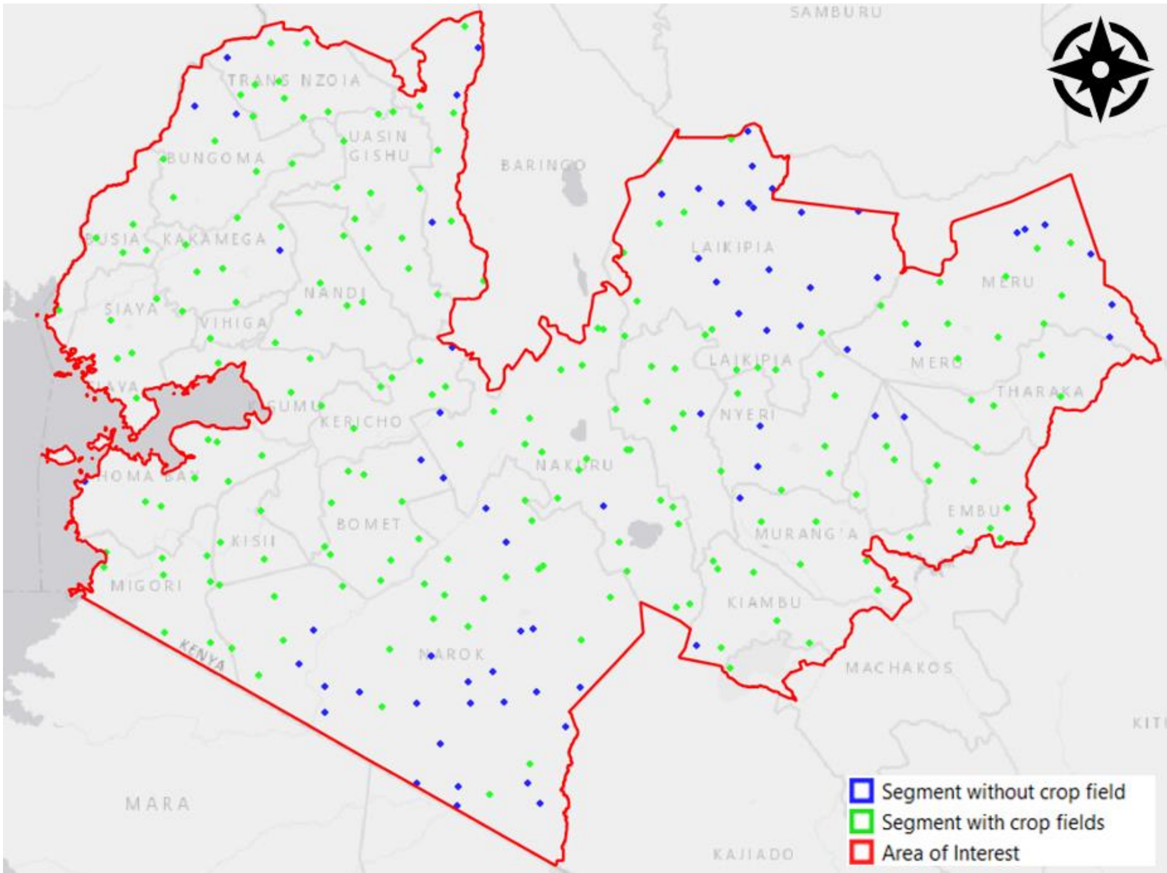


Figure 6: Spatial distribution of the 247 segments where crops have been identified

5.2 Adaptation of the field protocol and description of the impact of the resulting changes

All the 201 segments where crops have been identified were not surveyed in the field. During the field campaign, the enumerators faced some difficulties accessing the segments due to multiple causes such as:

- Segments not accessible due to the landscape (e.g. located in mountainous areas, without road/track network)
- Local people/farmers denying the access to their private land, getting even sometimes violent.
- Segments located in Government's properties (access denied despite the official support letters made available with enumerators holding in custody for several hours)

So, for the safety of the enumerators, it was decided not to survey those segments. Finally, only 175 cropland segments were visited as shown in Figure 7.

The 26 cropland segments that were not visited are scattered over the entire AOI as shown in Figure 7 below and therefore the surveyed sample should be representative of the overall AOI and the resulting crop area estimates should not suffer from any substantial bias.

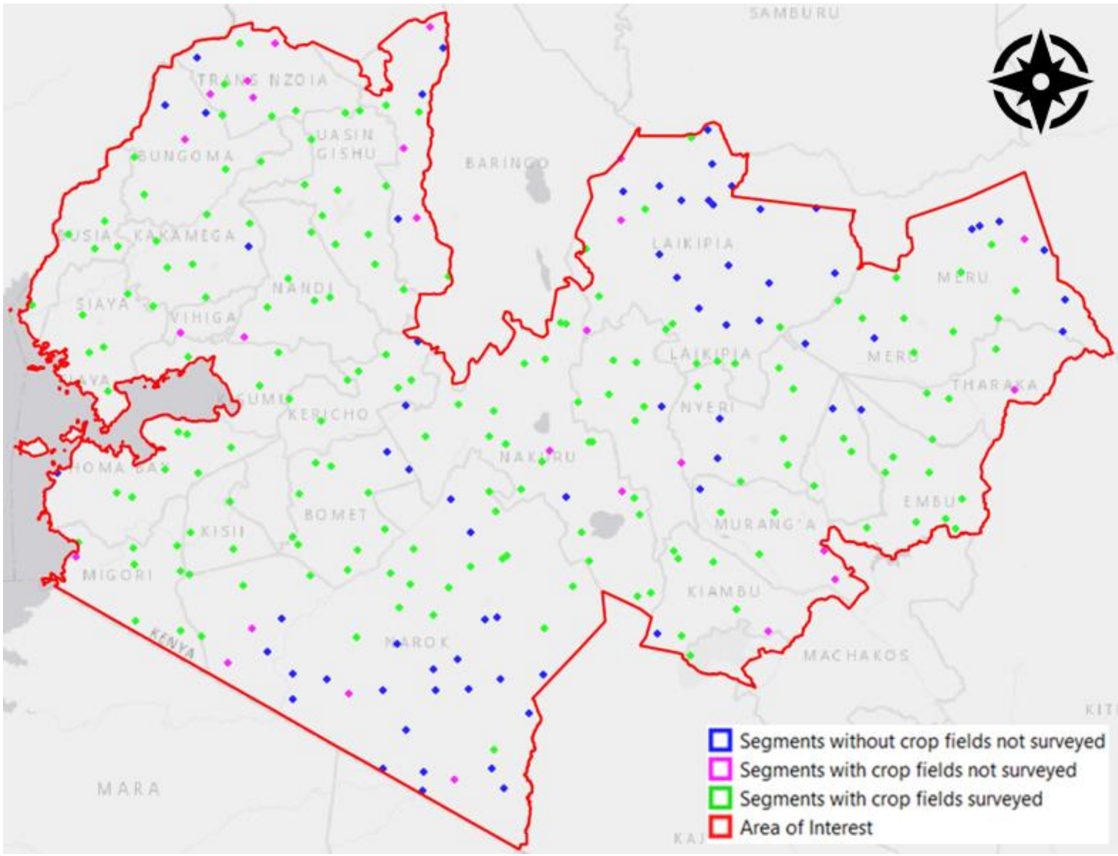


Figure 7: Final Spatial distribution of the surveyed segments

Moreover, all the parcels where crops were identified within a segment were not surveyed. This was due to the fact that it had been agreed that a maximum of 50 crop parcels within a segment were to be surveyed to avoid spending too much time on one segment. Indeed, as described in the feasibility study (D1.1), most of the farmers in the AOI are small holder farmers with land sizes ranging from 0.4 to 2 hectares often resulting in more than 50 crop fields per segment in some cases. In addition, to save time during the survey and considering the spectral heterogeneity of field parcel less than 1,000 m², it was also decided not to survey the crop parcels less than 1,000 m² with a maximum of 50 fields to be survey inside a segment.

5.3 Information collected in the field

The information collected was performed as planned in D1.1 with some minor adjustment as detailed below.

For each field id the enumerators have to collect data grouped in two categories:

1. First, the context of the sample with **field characteristics.** The geolocation of the position where the enumerators collect the data, and the time of visit were collected. The field characteristics to be collected in the field and to be reported in the form are shown in Table 2. Finally, the field characteristic irrigation/rainfed type was captured as intended. Nevertheless, based on the feedback and knowledge of the local fieldworker partner, almost the entire AOI was rainfed.
2. Secondly, the **crop characteristics** were be captured including especially the identification of the crop type for each field that is identified as cropland. The crop characteristics to be collected in the field are shown in Table 4.

Table 2: Information to be collected and documented in the application.

Additional information	Definition	Possibilities
Cropland presence	Presence of crop fields	Yes / No
Crop identifiable	Is a crop identifiable in the field?	Yes / No
Irrigation type	Identification of the irrigation type	Rainfed / Irrigated / Unidentified
Cropping pattern	Identification of the cropping pattern	Mono-culture / Mixed cropping / Agroforestry
Crop in monoculture	Identification of the name of the crop	Maize / Beans / Potatoes / see Table 3
Crop stage	Crop stage	bare soil / crops in ridges / ridges closed / field covered
Overview photo of the field	Photo indicating the field	
Detail photo of the field	Photo indicating details like crop stage or field preparation	Text

Especially, the enumerators identified the correct crop type for each field identified as cropland using a predetermined nomenclature shown in Table 3.

Table 3: Crop Type Nomenclature

301	Maize
302	Beans
303	Potatoes
304	Rice
305	Wheat
306	Peas
307	Potatoes
308	Banana
309	Tea
310	Coffee
311	Groundnuts
312	Sorghum
999	Other

This list has been derived from the crop typology to be covered by the mapping services listed in the "Information sheet" document provided by the Joint Research Center (JRC) of the European Commission. Other significant crops can also be expected in the field, so the other types of crops are derived from the list of main significant crop types in Kenya listed by the Food and Agriculture Organization (FAO) in "Country report on the state of plant genetic resources for food and agriculture" – Kenya[2]).

If the observed cropland is not listed, the code 999 "Other" selected in the smart form. The enumerator identified the observed crop type in the "comment" section.

5.4 Survey logistic and implementation

The survey logistics was performed as anticipated in D1.1 with some minor adjustments as detailed in the following sections.

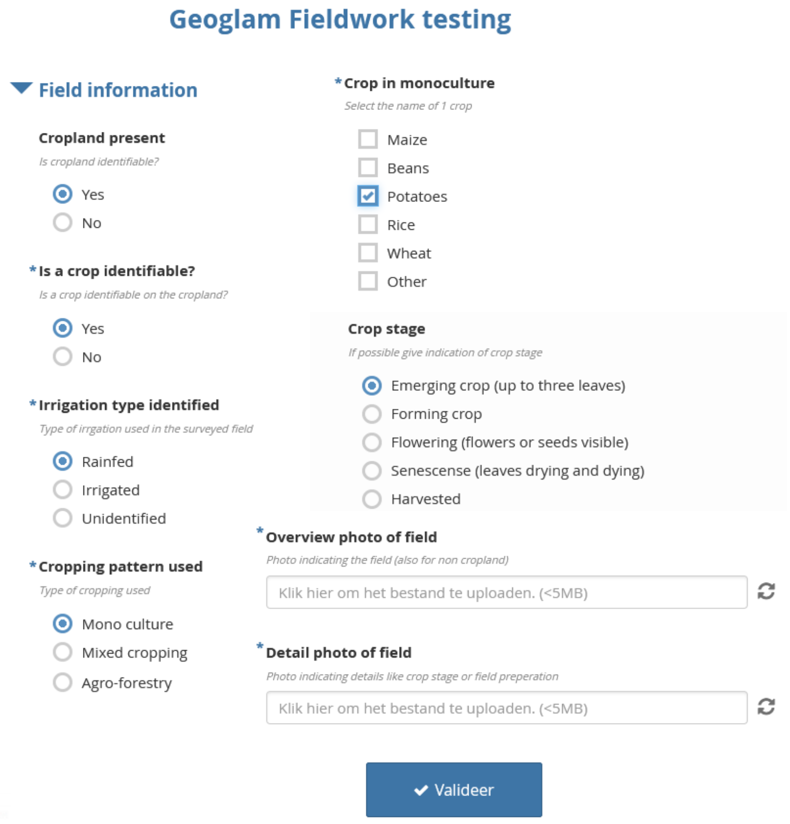
5.4.1 Equipment in the field

Before performing the fieldwork, the team installed all the equipment and software tools mentioned below.

5.4.1.1 Mobile devices and software tools

The fieldwork was carried out predominantly with **mobile devices** (e.g., an android smartphone or a tablet) using a dedicated **Open Data Kit (ODK) Collect** application customized by Upande to store the collected information in a uniform way using a smart form. ODK Collect is an open-source application which is usable offline but can communicate with a central database to retrieve forms and upload information. The information was stored in the form as numeric fields, text fields, photographs, and geolocation. Figure 8 presents an earlier example of a smart form which was used to test the fieldwork procedures in December 2020.

[2] http://www.fao.org/3/i1500e/Kenya.pdf


Geoglam Fieldwork testing

Field information

Cropland present
Is cropland identifiable?
Yes
No

*Is a crop identifiable?
Is a crop identifiable on the cropland?
Yes
No

*Irrigation type identified
Type of irrgation used in the surveyed field
Rainfed
Irrigated
Unidentified

*Cropping pattern used
Type of cropping used
Mono culture
Mixed cropping
Agro-forestry

*Crop in monoculture
Select the name of 1 crop
Maize
Beans
Potatoes
Rice
Wheat
Other

Crop stage
If possible give indication of crop stage
Emerging crop (up to three leaves)
Forming crop
Flowering (flowers or seeds visible)
Senescense (leaves drying and dying)
Harvested

*Overview photo of field
Photo indicating the field (also for non cropland)
Klik hier om het bestand te uploaden. (<5MB)

*Detail photo of field
Photo indicating details like crop stage or field preperation
Klik hier om het bestand te uploaden. (<5MB)

Valideer

Figure 8: Screenshot of the GEOGLAM fieldwork data form for Kenya.

Data was captured locally and transmitted to secure cloud servers once internet connectivity became available.

Because the capture of geolocation is dependent on the Global Navigation Satellite System (GNSS) available on the mobile device like smartphone or tablet), it is important that the device is capable of getting an accurate measurement and quick fix of available satellites during sampling. The most ideal situation is when the chip of the device is capable of receiving multiple constellations such as GPS and GLONASS.

Beside the application needed for data collection, the application **Avenza maps** were installed on mobile device and used for convenient navigation from one sample unit to the next one (see Figure 9). Avenza Maps allows the display of basemaps like Open Street Map (OSM). To facilitate navigation from one sample to the next one, custom maps were provided in MBtiles format. These maps combine Red Green Blue (RGB) or False Color mosaicked Sentinel-2 images with vector overlays of the square samples and a selection of OSM elements (roads and waterways). Each team of enumerators were provided with an indicative optimal route.

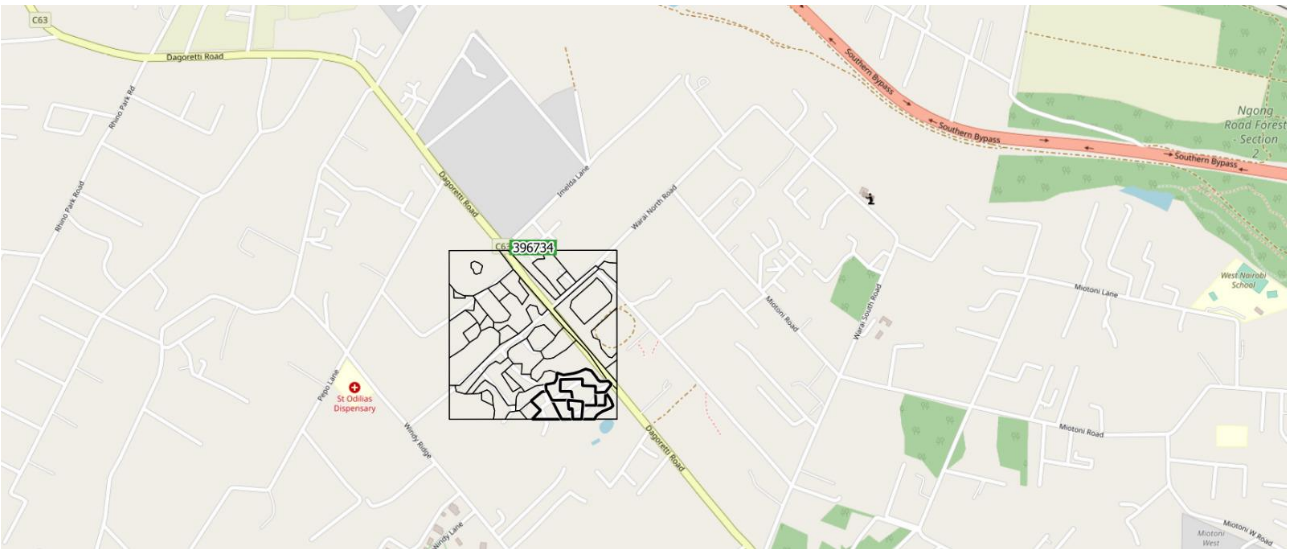


Figure 9: Situation map with segment squares and OSM network

Figure 10 shows a general example of visualization possibilities with Avenza Maps.

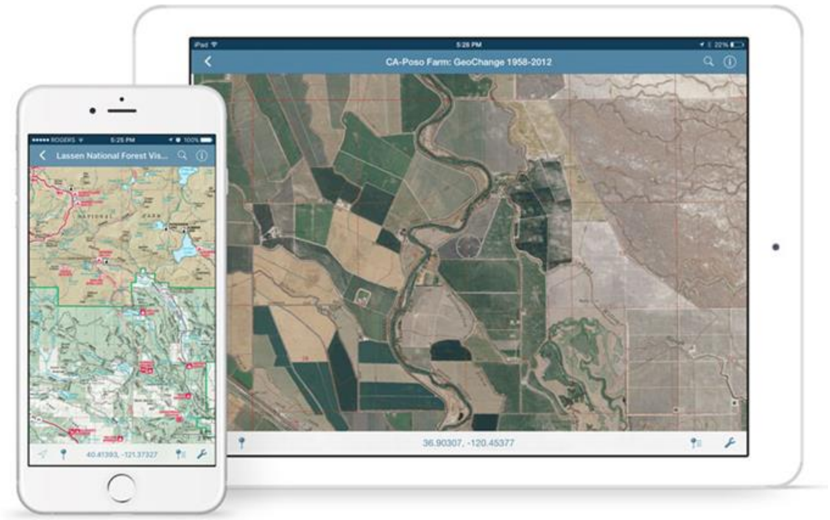


Figure 10: Avenza Map mobile app examples

Beside navigation the application was also be used to collect additional ground-truth data by the quality control team. See chapter 5.4.3 for a further description of the collection methodology for this additional data collection.

5.4.1.2 Additional instruments and equipment

Although fieldwork can be performed with the mobile devices and tools mentioned above, additional equipment can be used during fieldwork. Especially to mitigate failure of the mobile devices or provide a cross-check. Enumerators were advised to equip themselves with hardware to mitigate problems with the mobile devices like spare memory cards, sufficient cables, chargers and power banks.

To cross-check the accuracy and mitigate errors with capturing geolocations on the mobile device an additional navigational device like a GPS receiver can be used in the field. An additional photo camera can be used to mitigate failures of the camera in the mobile device. It also helps to collect additional pictures during sampling to provide more context for those processing the fieldwork data.

T-Shirts, Baseball caps or umbrellas with logos from the European Union (EU) made available by the EU Delegation in Kenya were worn by enumerators during the field campaign to facilitate contacts with local farmers. These were considered particularly useful and even essential.

5.4.2 Field work methodology and orientation in the field

5.4.2.1 Guidelines

Every evening, the team prepared the routing to reach samples that they plan to do the day after. Each team of enumerators prepared an indicative optimal route to reach the segments to visit.

The following guidelines were applied:

- Maximize the use of public rights of way;
- Visit the local community leader office to ask permission where possible to get permission of carrying out the field visit in those areas
- Do not damage;
- If challenged, explain mission (show the official support letter from the country contact), be polite, and apologise if necessary.

5.4.2.2 Orientation

As mentioned, the software Avenza maps were used for navigation from one sample to the next one. Within the application distinct types can be used to navigate and orientate. Both OSM basemaps (see Figure 11) and custom made RGB or false color satellite imagery (see Figure 12) were provided. Overlays were available of the digitalized samples and fields in combination with OSM vector networks like roads and waterways. This routing was advised to be planned at least one day before visiting the sample.

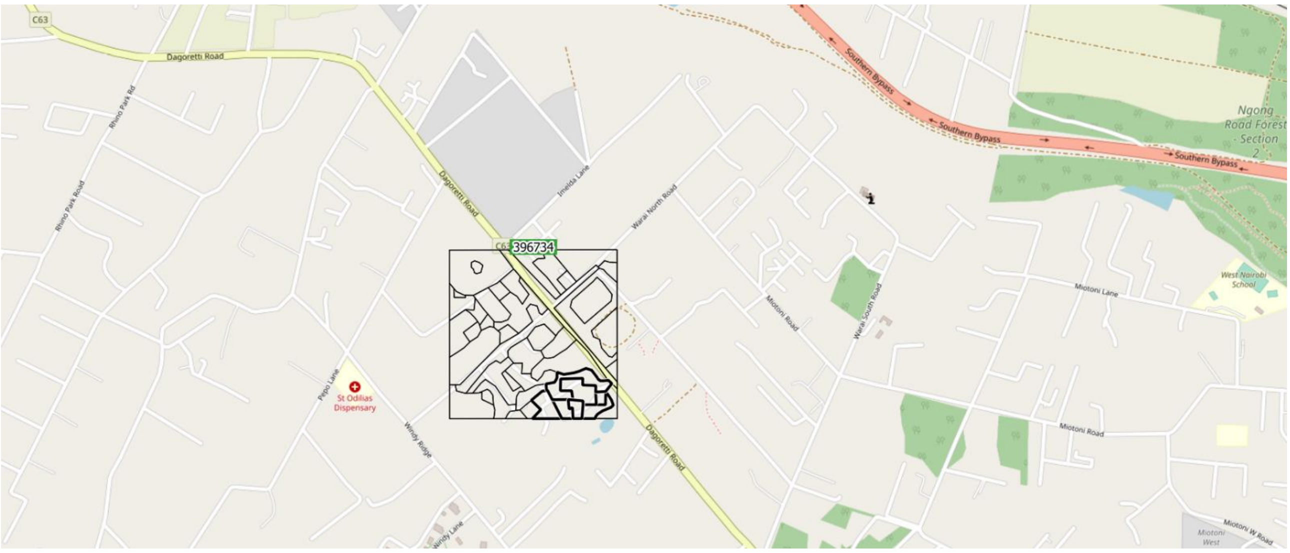


Figure 11 Orientation using OSM with overlayed sample unit 396734

Figure 12 Recent satellite imagery (S2) in natural colours with sample fields and routing overlays

Within the ODK Collect the same maps were made available through MBtiles. When taking a geolocation the enumerators could see a point on top of the selected basemaps with vector overlays. This helps 1) to visualize the geolocation is currently correctly measured and as such reduces the errors that might result of a lower quality satellite fix and 2) to capture locations in the app from a distance. This is possible because the location can be selected by tapping a location on the map and confirm the pinpoint. This type of orientation in the ODK collect app will be used when the enumerators are in the field.

5.4.2.3 Field survey protocol and data collection

When the team reaches the segment, enumerators filled in the smart form stored on the mobile device with ODK Collect. This form ensures a quick, intuitive and uniform collection of field data. The enumerator is asked to identify field information on crop type and crop stage, as well as meta information on the country, the surveyed sample unit, and the field_id. A detailed description of the form is presented in ANNEX I – Description of form used for segment survey.

Figure 13. Illustration of the field data collection process

5.4.2.4 Photography

In order to cross-check the results, geolocated pictures of the crops (close-up for crop phenology and more distant for crop type and condition) were captured to assess the quality of the collected fieldwork. If needed it will help to augment the results with the help of a trained agronomist.

So, enumerators were requested to take 1) an overview picture of each field present in the segment from their selected vantage location and 2) a close-up picture of the present crop.

Overview pictures provide an overview of the fields with clear features of the visible landscape. These pictures will support spatial orientation at a later stage, using *e.g.,* Google Earth.

5.4.3 Collection of extra ground-truth data

To collect additional ground-truth data besides the samples from the square samples the quality control team was asked to collect extra ground truth data along the route. The hardware consists of two Sony action cameras (HDR-AS300R) with 128GB miniSD-card, capturing an image every second at both sides of the car along the whole route ad shown in Figure 14.

Figure 14: Set-up of the Street Level Imagery camera's by Upande in Kenya.

The use of Street Level Imagery (SLI) was implemented as a test to investigate the feasibility to be used as source of additional fieldwork data with thousands of geotagged photos of crops available for training of satellite data classification algorithms and validation of the results. Having SLI available would also be useful as a fail-safe in the case that field work would not sufficient. Additional field data like crop type and crop stage can be generated behind the desk by visual interpretation. The tests showed that the fields and the associated crop types could be clearly identified based on the SLI. As an example, a maize parcel can be found in Figure 15.

Figure 15: Example of Street Level Imagery

The extra ground truth data collected during the exercise are shown in Figure 16.

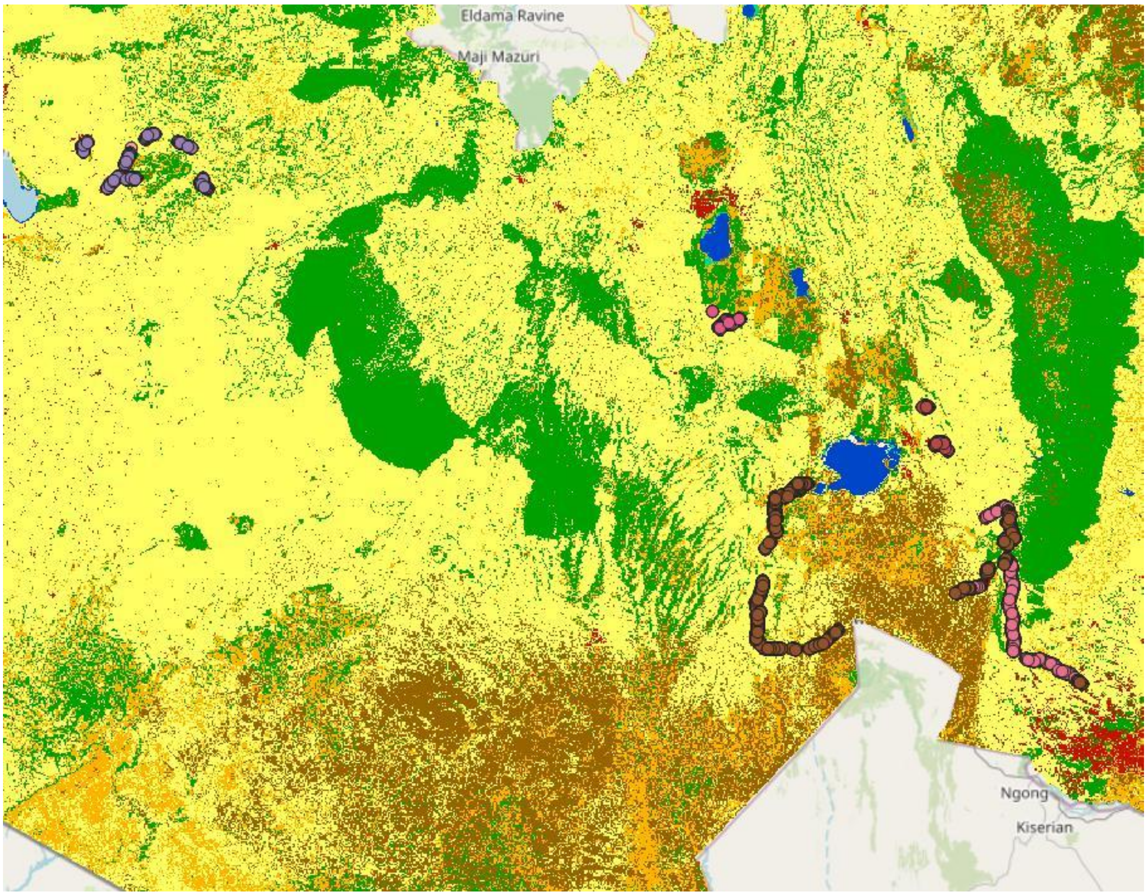


Figure 16: Extra ground-truth data collected during the SLI field work

5.5 Specification of the local fieldwork partner and organization

The Kenyan company Upande Ltd has been selected as partner of the consortium to conduct the fieldwork for both growing seasons in 2021. Upande Limited is a private Kenyan social enterprise founded in 2009 in order to provide Internet, web mapping and Geographical Information Systems (GIS) services to a variety of clients including private sector, governments, multilateral and bilateral agencies. Customers are primarily based in Kenya, but they serve several other clients across Africa and beyond. During the last few years Upande has moved from a services provider to developing its own products. All products share that they facilitate data centric decision-making and have sensor data integration. The Upande team consists of a group of experts in GIS, Internet mapping, environmental and social academics, software developers and business practitioners.

5.6 Summary of the field campaign

Starting date: 2021-05-19

Ending date: 2021-07-16

Upande Ltd were responsible for all practical local fieldwork and data acquisition. In total 8 enumerators were hired supported by another 4 enumerators focusing on QC activities. A dedicated team took in charge the overall management of the campaign.

Initially set up to be completed in a 21-day period, the project activities were delayed due to the impact of covid-19 and other challenges experienced during the field campaign such as:

- Access denied to privately owned lands due to the fear of insecurity in certain areas or some local chiefs which were against the field campaign exercise even after being presented with the introductory letter supporting the exercise from the National government. Some enumerators were held hostage for a couple of hours before being released by the local community members/farmers such as in Thika Kiambu County, Elgeyo Marakwet.
- Segments inaccessible by means of vehicle or "bodaboda" (motorbikes) because roads were closed (not updated on map). Narrow, rocky, and hilly routes in some parts which could not be accessible by motorbike, forcing data collectors to walk long distances in order to cover crop parcels, whereas some areas could not be covered on foot.
- Severe rains affecting the survey on some regions.

6 Conclusion and recommendations

Overall, the field data collection in Kenya was performed as planned even though there was a 4-5 week delay primarily due to the impact of covid-19 and the hostile reception of the local community chiefs and members. The field campaign lasted for about nearly 1.5 months but the delay was not really problematic as most crops were still in their vegetative state.

However, the preparation of the field campaign took considerably more effort than initially anticipated. In particular, the digitising of the segment was far more complex than envisaged and it appears that the agriculture in the area is very dynamic and requires the use of the latest imagery available. This meant that the number of segments was initially underestimated because the initial assessment made during the feasibility study was performed on historical imagery.

Interaction with local team was very good and the quality of the work was also very good once some minor adjustments were made.

Some recommendations based on feedback from the Upande can be made in case of a future campaign:

- Engaging local community leaders (chiefs, village elders, nyumba kumi leaders), a month before the start of the field campaign in areas to be visited.
- Organizing small tokens for local authorities and farmers such as EU branded pens, baseball caps, shirts to allow smooth operations of our teams.
- Receiving EU materials for enumerators and QC team on time. This first round, the materials were only availed two weeks into the project.
- Involving police officers in regions identified as risky areas
- Analysis of all the segments prior to the field campaign to flag areas that cannot be accessible

8 ANNEX I – Description of form used for segment survey

This annex describes the structure of the smart form and what kind of information it retrieves in the field and how to deal with issues when surveying in the field.

Within each segment each field/landuse is digitalized and all croplands should be surveyed. When the surveyor is in the field the first step is to pinpoint the current geographical position **in** the field. The application will automatically use the coordinates given by the smart device. If the device is giving a wrong location or enumerator is not in the field, the point should be moved to make sure the point is clearly in the field. (See also section dealing with issues below).

The first part of the form is focused on retrieving meta information concerning the fieldwork; country,id of sample id and field id (see Figure 17). For each segment of 500x500 meters a MBTile is created and the sample_id is given in the top middle of the MBTile.

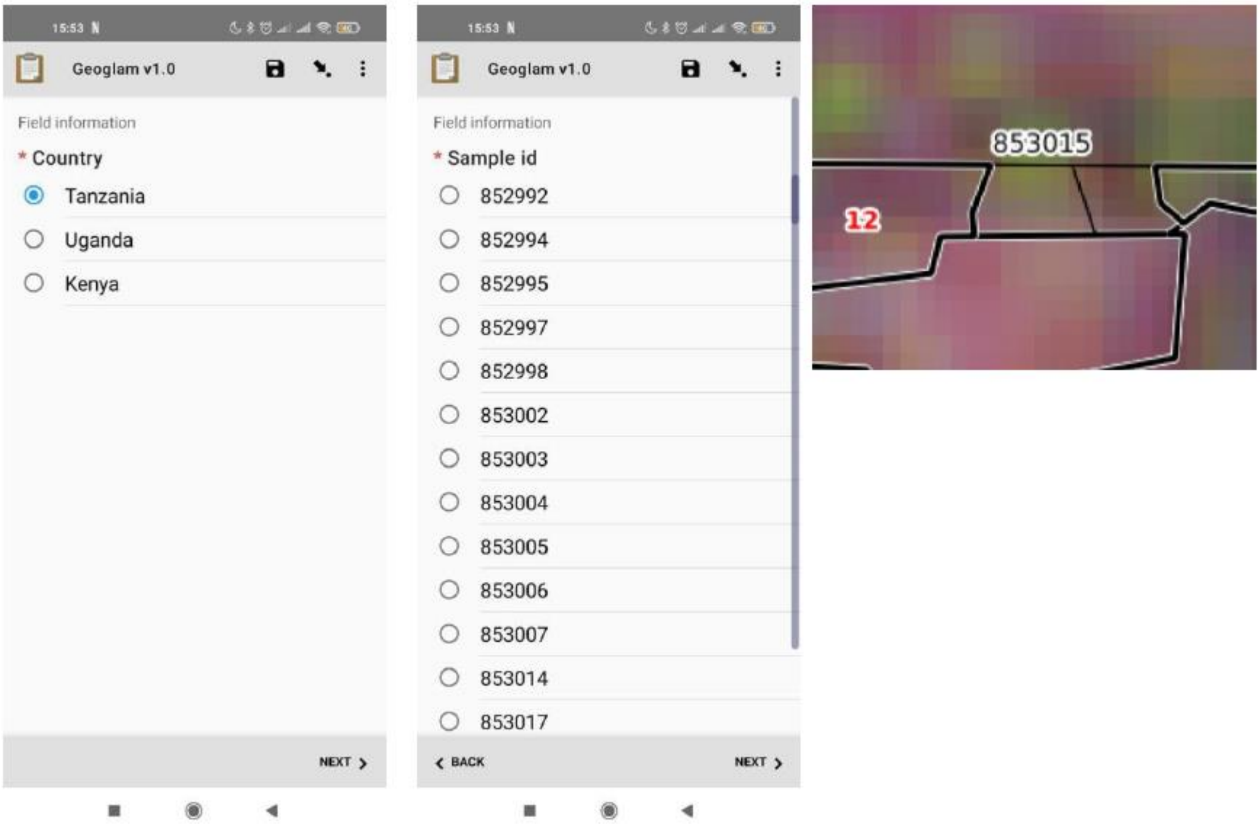


Figure 17 Collecting meta information

Each field has a unique id and ranges from 0 to the number of fields in the segment (see Figure 18). The combination of segment_id and field_id creates a unique combination for later data analysis. Each field_id which is indicated as potential cropland **should be** surveyed. (Unless the total amount exceeds the contractual amount agreed upon). In the MBTile these fields are indicated with a **red number**. Other digitalized fields with landuse like homesteads, water and forest etc. **do not** have to be surveyed and are indicated with black numbers and have parenthesis. The field_id number can be selected from a pull_down list in the form.

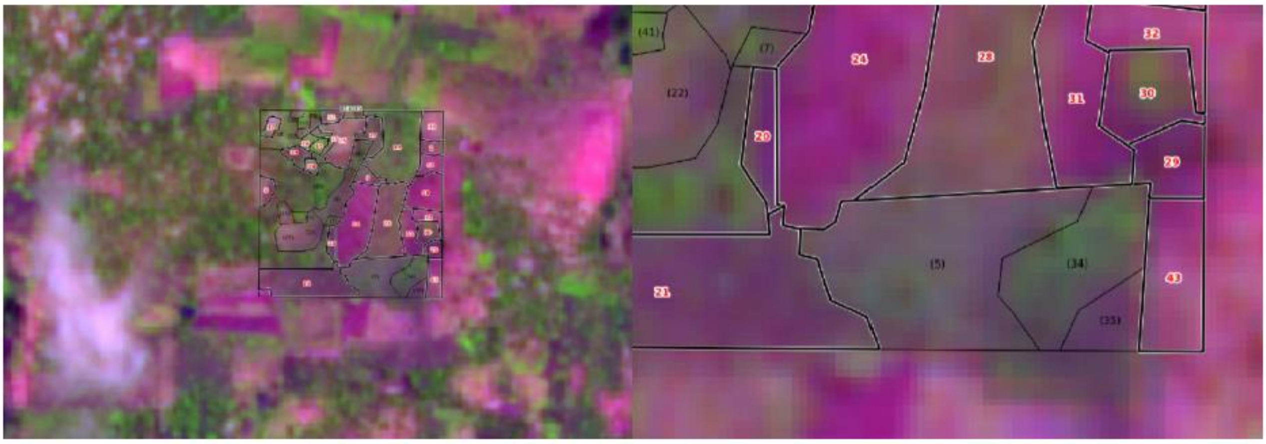


Figure 18 Digitalized sample with field IDs

For each field id the enumerators have to collect data grouped in two categories:

1. First, the context of the sample with **field characteristics.** The geolocation of the position where the enumerators collect the data and the time of visit will be automatically collected. Different field characteristics must be captured such as irrigation/rainfed type. The field characteristics to be collected in the field and to be reported in the form are shown in Table 4 and Figure 19.
2. Secondly, the **crop characteristics** have to be captured including especially the identification of the crop type for each field that is identified as cropland. The crop characteristics to be collected in the field are shown in Table 4 and a small excerpt is shown in Figure 19.

Table 4: Information to be collected and documented in the application

Additional information	Definition	Possibilities
Cropland presence	Presence of crop fields	Yes / No
Crop identifiable	Is a crop identifiable in the field?	Yes / No
Irrigation type	Identification of the irrigation type	Rainfed / Irrigated / Unidentified
Cropping pattern	Identification of the cropping pattern	Mono culture / Mixed cropping / Agroforestry
Crop in monoculture	Identification of the name of the crop	Maize / Beans / Potatoes / see Table 3
Crop stage	Crop stage	bare soil / crops in ridges / ridges closed / field covered, d
Overview photo of the field	Photo indicating the field	
Detail photo of the field	Photo indicating details like crop stage or field preparation	Text

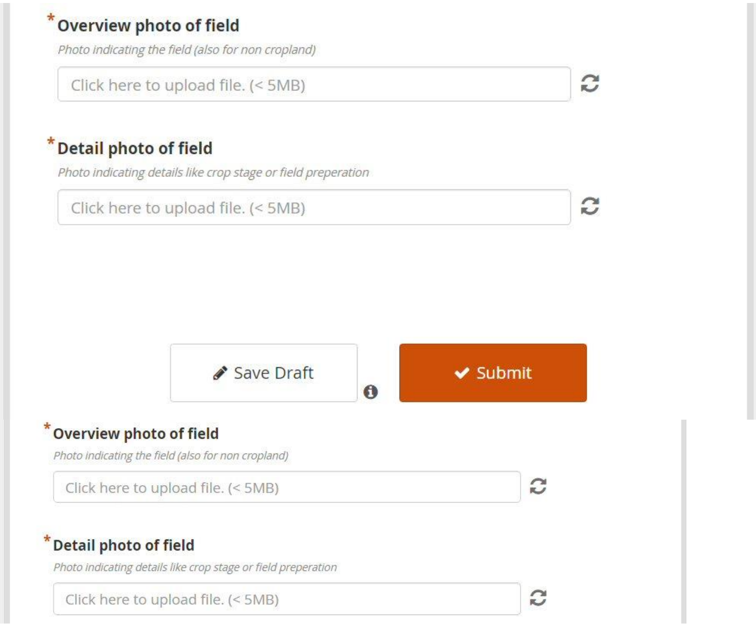


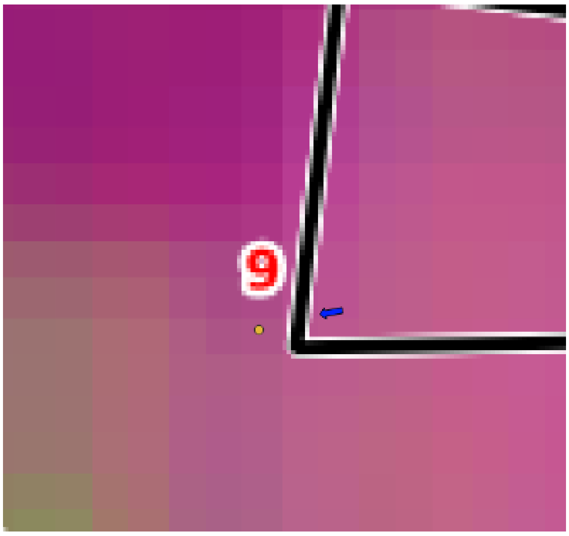
Figure 19 Example of characteristics captured with the form

Dealing with issues

Field cannot be accessed

Case 1

If the field cannot be accessed BUT all the information concerning the cropland can be identified from a (small) distance the form can be filled in. In this case the pinpoint should be dragged **within** the field. (See mock-up below with location and view of the enumerator as a blue error and the dragged point to survey field 9).



Case 2

Many events like prohibition by owners or local governments or accessing issues due to heavy rain etc. can cause that a field can permanently not be accessed by the enumerator. If the field cannot be accessed permanently and no information can be retrieved we still like to have a filled in form, so that for the data-analysis it is clear that no data is to be expected in a later stage and that the field is not 'forgotten'.

In this case the enumerator can fill in the form by 1) **dragging the pin-point** and 2) indicate **OTHER** with the question Is the field correctly segmented with the desk digitization? and note 'Field cannot be accesed due to ' with the reason. 3) Indicate cropland present with No > Landuse Other and note that the field could not be accessed 4) make a mock-up picture and send the form.

Field is not a cropland

Although the identification of possible cropland is done as precise as possible other landuse can be present in the field. In this case just indicate that the field is not cropland and fill in the correct landuse. The field should be surveyed and a form send to the server.

Field is not correctly digitalized

Although the digitalization is done as precise as possible and using the most recent imagery the parcels in the samples can be different. In this case discrepancies will be noted and described as a comment by the enumerator.

Case 1 – Field is aggregated with other fields
If a field is aggregated and no distinction can be made concerning boundaries, croptype and cropstage this can be simply indicated in the form. In the note the numbers of the other fields can be mentioned e.g. '6,,8 and 7 should be aggregated as one field'. For the other fields the forms should be filled in as well in similar fashion. This to avoid any possible doubt and to perform spatial joins during data analysis.

Case 2 – Field is split
If a field is split this can be indicated in the form as well. In the notes remarks concerning the split and the other crop(s) can be given. Filling in additional forms for the additional fields is **not** needed

Example of good overview pictures
Crops are clearly visible, field characteristics can be inspected and the crop phenology is clearly derivable from the close-up picture.

End result

After reviewing a complete segment, the data-analysis team expects to see a filled in form for all croplands (red numbers) in the segment. The pin-points should match as much as possible the location of the enumerator, but sould be completely in the the field_id polygon and match the field-id given in the form.

Below in Figure 20 some examples of incorrect placement of pin-points are given. In the left image field 21 and 12 have two forms filled in, whereby one form is meant for other fields. In the right image a pin-point is given outside the segment below and two fields below do not seemed to be surveyed.

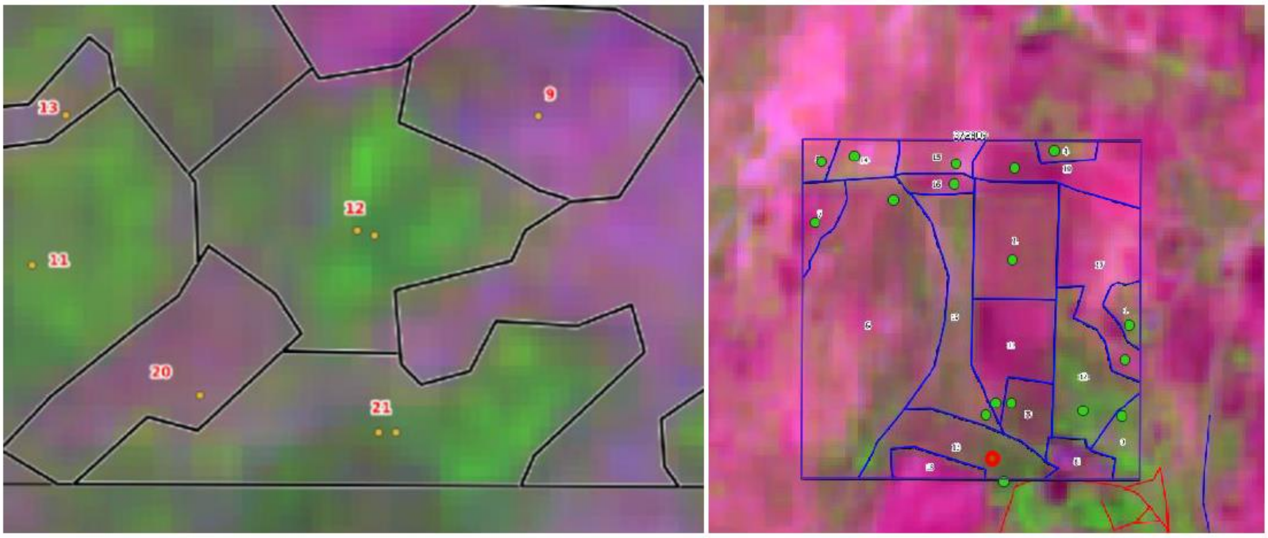


Figure 20: examples of incorrect placement of pin-points