Earth Observation for International Financial Institutions (EOFI)

Service Trial 2:
UN-IFAD – Development Planning

Final Report

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Submitted by:

GAFAG

Address: Arnulfstr.197 | 80634 Munich | GERMANY
Phone: +49 (0) 89 / 12 15 28 – 0 | Fax:+49 (0) 89 / 12 15 28 - 79
Email: info@gaf.de | Internet: http://www.gaf.de

Summary

This report summarises main activities and achieved results of the project Earth Observation for International Financial Institutions - Service Trial 2: Development Planning, which started in June 2010 and ended in March 2011. The report summarises the main elements of the Service Operations Report, the final Product Delivery as well as the Service Utility Report. Beginning with the Project Background and the regional situation in Madagascar, the Earth Observation data based service and products will be described in detail. The summarised service utility assessment and the description of service benefits/impacts conclude this report.

	Affiliation/Function	Name	Date
Prepared	GAF AG	Rainer Fockelmann Christopher Sandow	2011-02-28
Reviewed	GAF AG / Production Manager	Cornelia Storch	2011-03-02
Authorized	GAF AG / Project Manager	Rainer Fockelmann	2011-03-02
Accepted	ESA Project Manager	Benjamin Koetz	

Distribution

Affiliation	Name	Address	Copies
ESRIN	Benjamin Koetz	Via G. Galilei, Frascati (Rome), Italy	electronic copy

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List of Abbreviations and Acronyms

AD2M	Project to Support Development in the Menabe and Melaky Regions
ALOS	Advanced Land Observing Satellite
ALOS AVNIR-2	ALOS Advanced Visible and Near Infrared Radiometer
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ASTER-GDEM	ASTER Global Digital Elevation Model
BM	Baiboho Map
CIR	Colour Infrared
COTS	Commercial off-the-shelf
DEM	Digital Elevation Model
EO	Earth Observation
EOFI	Earth Observation for International Financial Institutions
ESA	European Space Agency
FR	Final Report
GAF	GAF AG
GIS	Geographic Information System
IFAD	United Nations International Fund for Agricultural Development
IFI	International Financial Institutions
LCM	Land Cover Map
LU	Land Use
OD	Operational Documentation
QC	Quality Control
SoW	Statement of Work
SRR	Service Readiness Report
SRTM	Space Shuttle Topography Mission
SUR	Service Utility Review
UN	United Nations

1 Scope of Document

This report summarises main activities and achieved results of the project Earth Observation for International Financial Institutions - Service Trial 2: Development Planning, which started in June 2010 and ended in March 2011.

The document describes the background of the project and the regional situation in Madagascar including the user and its information demand. Subsequently, all provided products are presented in detail, including their EO data sources. A review on the service utility assessment and the identified benefits/impacts of the projects conclude this report.

2 Background of the EO Service

2.1 EOFI Initiative

International financial institutions (IFI) provide financial support and professional advice for development activities on local to regional scale in developing countries. Their activities are generally organized in dedicated projects financed by long-term loans or grants covering social and economical development aspects in a wide range of fields. For certain fields EO (Earth Observation) products and services have been identified as a useful tool to support the monitoring and management of IFI projects, to improve the efficiency of the investments made and finally to assess the impact and social benefits of the financed development activity.

The European Space Agency (ESA), as part of its Value Adding Element (VAE) programme, has been interacting with the IFI and their stakeholders to understand their working environment and information requirements in particular for EO services. This process has resulted in service specifications for one specific user UN-IFAD (UN International Fund for Agricultural Development), which have been put out for tender. The main purpose of this procurement, called Earth Observation for International Financial Institutions (EOFI) is to demonstrate and validate the utility of currently available EO information services in support of selected IFI projects. In the scope of EOFI, GAF AG has been awarded with Service Trial 2: Development Planning in the Menabe region in Madagascar.

2.2 IFAD and Project Objectives

The International Fund for Agricultural Development (IFAD), a specialized agency of the United Nations, was established as an international financial institution in 1977 as one of the major outcomes of the 1974 World Food Conference. IFAD is dedicated to eradicating rural poverty in developing countries.

Working with rural poor people, governments, non-governmental organizations and many other partners, IFAD focuses on country-specific solutions to improve agriculture production, which can involve increasing rural poor peoples' access to financial services, markets, technology, land and other natural resources.

With a focus on developing countries, Madagascar certainly is an important country for IFAD, and IFAD is actively working for many years within. Since 1979, IFAD has funded thirteen rural development projects in Madagascar for a total of US$156.9 million. Currently in 2011, IFAD runs several large projects in Madagascar to improve the situation for rural population. The service area of Trial 2 (Menabe region) is subject to the Project to Support Development in the Menabe and Melaky Regions (AD2M project), which aims to make poor rural people's access to land and water secure through the productive development of arable land and the sustainable management of valley bottoms and micro-catchment areas.

As specified within the SoW, aim of the products from Service Trial 2 is the support of general development planning in this specific region in Madagascar (Menabe region) with a focus on the identification of suitable sites for development planning. For this purpose, the products have been provided not only to IFAD's headquarter in Rome but also have been transferred to Madagascar directly, supporting local users within development planning processes with recent information.

3 EO service: Trial 2 – Development Planning

Referring to the AD2M project, this Service Trial 2 focus on the identification of suitable sites for development planning within the UN-IFAD funded ADM2 project - in this case for implementation of irrigation schemes. From the user required information is:

- Current land cover maps required for general planning purpose
- Digital Elevation Model (DEM)
- DEM based information layers ready for GIS (Slope, Aspect and Basic Drainage System Layers)

Within the following sub-chapters, the general service operation is described, followed by the presentation of the individual projects.

3.1 Service Operation

3.1.1 Service Area

The service area is located in the mid-west of Madagascar (Menabe region) and comprises a total area of nearly 14 000 km² (see Figure 1).

The area is characterised by great plateaus with less vegetation, savannah-like plains, barren hills and valleys traversed by rivers. Agricultural activity is mostly connected to the rivers (irrigation), but also some rain-fed and shifting cultivation exists. With increasing distance to water bodies, the arable land changes to pasture and meadows. Forest occurs mainly in the northern part of the area and within the river valleys, mostly as Dry Forests. Sparsely populated, the region is represented by fewer infrastructures.

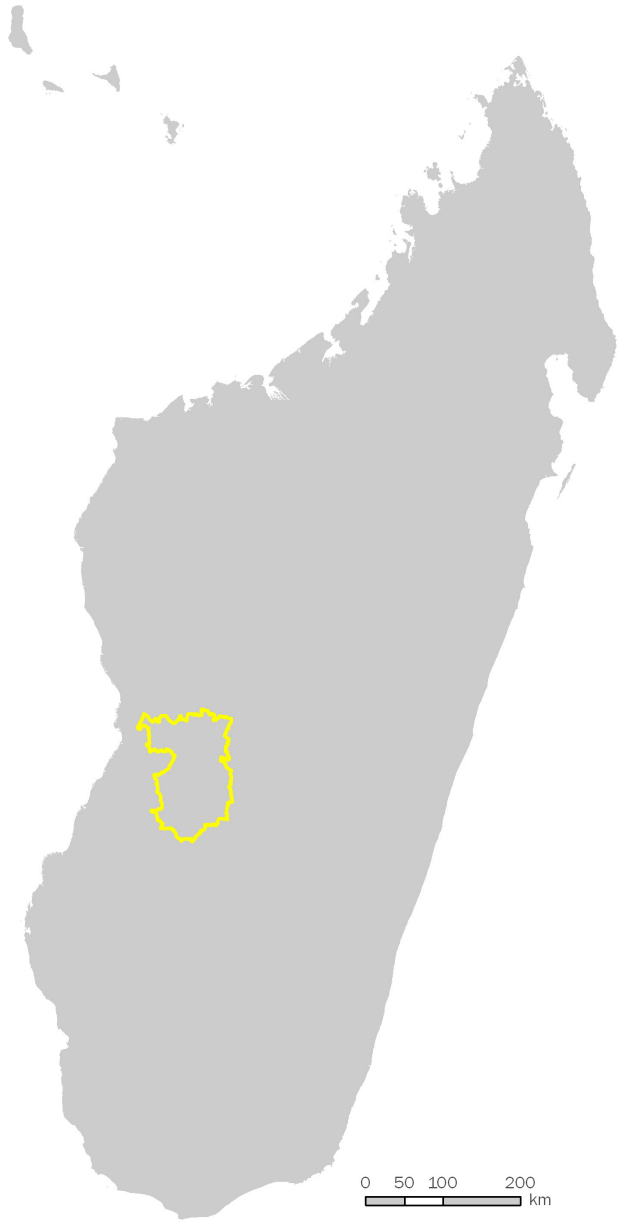


Figure 1 Madagascar - Service Area

3.1.2 Service Production

The Service for Trial 2 encompasses the following technical production steps in general:

- Acquisition of input data (EO data and DEM)
- Acquisition of in-situ and other data
- Pre-processing (data input check, ortho-correction)
- DEM-Processing: Production of the DEM of the region
- DEM derived information layers (Aspect, Slope, basic Drainage System)
- EO-data Processing: Mapping of the recent land use/land cover
- Generation of the specific Baiboho Map

Each processing step is listed in detail within the Project Service Operations Report [D3], including the production quality assessment protocols.

3.1.3 Input Data

For the land cover mapping, nine absolutely cloud-free ALOS AVNIR-2 scenes have been procured through ESA. Ranging from May 2008 to July 2009, the selected scenes form an optimised coverage with homogeneous acquisition dates (see Figure 2). The ALOS AVNIR-2 data, with the spatial resolution of 10 m on ground and a radiometric resolution of four spectral bands in the visible and near infrared, offers a good basis for the detection of land use/land cover. The dataset provided very good quality; no data problems or artefacts have been detected within this high resolution optical satellite dataset.

Figure 2 ALOS AVNIR-2 CIR Mosaic of the Service Area

Besides this multi-spectral AVNIR-2 data for the thematic mapping, additional datasets have been included for the production.

- SRTM C-Band and ASTER GDEM data for the DEM production
- Landsat GeoCover: Ortho-rectified Landsat ETM+ compressed image mosaics, available for entire Madagascar.
- LANDSAT TM: A set of two additional Landsat TM 5 multi-spectral scenes has been acquired (acquisition date: May 2009).
- Topographic Maps: For ~60% of the Service Trial 2 area, maps with 1:100 000 scale had been available.
- GPS points: GAF owned GPS point measurements for the geometric accuracy
- GPS points from IFAD local stakeholders: IFAD provided additional GPS points directly from within the service area, focussing on different crop types. Figure 3 presents some image examples from the field which are taken at the GPS points to support the thematic classification.
- Aerial imagery: Received directly from the local IFAD Monitoring & Evaluation Officer of the AD2M project in Madagascar, aerial images from August 2010 with a spatial resolution of 50cm have been used for the QC processes.

Summarising, the situation regarding EO and non-EO data was excellent for the production. Each used dataset had been passed through an intensive quality assessment prior to the processing, according to well established Quality Management Standards. The quality assessment procedures as well as the assessment results are given within the Service Operation Report [D3].

Example tobacco

Example maize

Example haricot beans

Example Irrigated Rice, harvested

Example irrigated rice

Figure 3 Crop type examples in Western Madagascar (all photos © IFAD 2010)

3.2 Validated EO Products

This chapter presents the validated EO products of Service Trial 2. For each product, explanatory information is given in terms of overview images, visualisation and a brief description. All products cover the complete Service Trial 2 area with 13 387 km², as presented in Figure 1. Table 1 presents the product overview.

Table 1 Product list

Product code	Product Description	Product Type
D2-LCM2009	Land Cover Map 2009	Raster Data
D2-LCM2009-BM	Map of the Baibohos based on the LCM2009 and the slope layer.	Raster Data
D2-DEM	Digital Elevation Model	Raster Data
D2-DEM-Slope	Slope layer, derived from the produced DEM	Raster Data
D2-DEM-Aspect	Aspect layer, derived from the produced DEM	Raster Data
D2-DEM-Basic Drainage System	Vector layer with the basic drainage system, derived from the produces DEM	Vector Data

3.2.1 DEM and derived GIS Information Layers

The first main product within Service Trial 2 is a high resolution DEM of the service area, which forms also an important basis for the land cover maps. Supplementary to the DEM, three additional GIS layers have been derived on basis of the newly generated DEM, after finalisation of the DEM production. The production and all related technical processes have been conducted using the ESRI ArcGIS 9.3 software package (COTS software).

3.2.1.1 DEM

For the Service Trial 2 area, the DEM has been produced by combining the ASTER GDEM data with the SRTM C-Band data. Figure 4 presents the final DEM, derived after the combination of both datasets. In order to provide a more realistic view on the service region, Figure 4 includes the standardised hill shade effect which considers the illumination angle and shadows while displaying. Finally, Figure 5 provides a 3D view on the service area, viewing direction South to North, including a small superelevation to accentuate the existing relief.

The DEM is very valuable for various planning tasks, such as infrastructure planning (the construction of roads or bridges for instance).

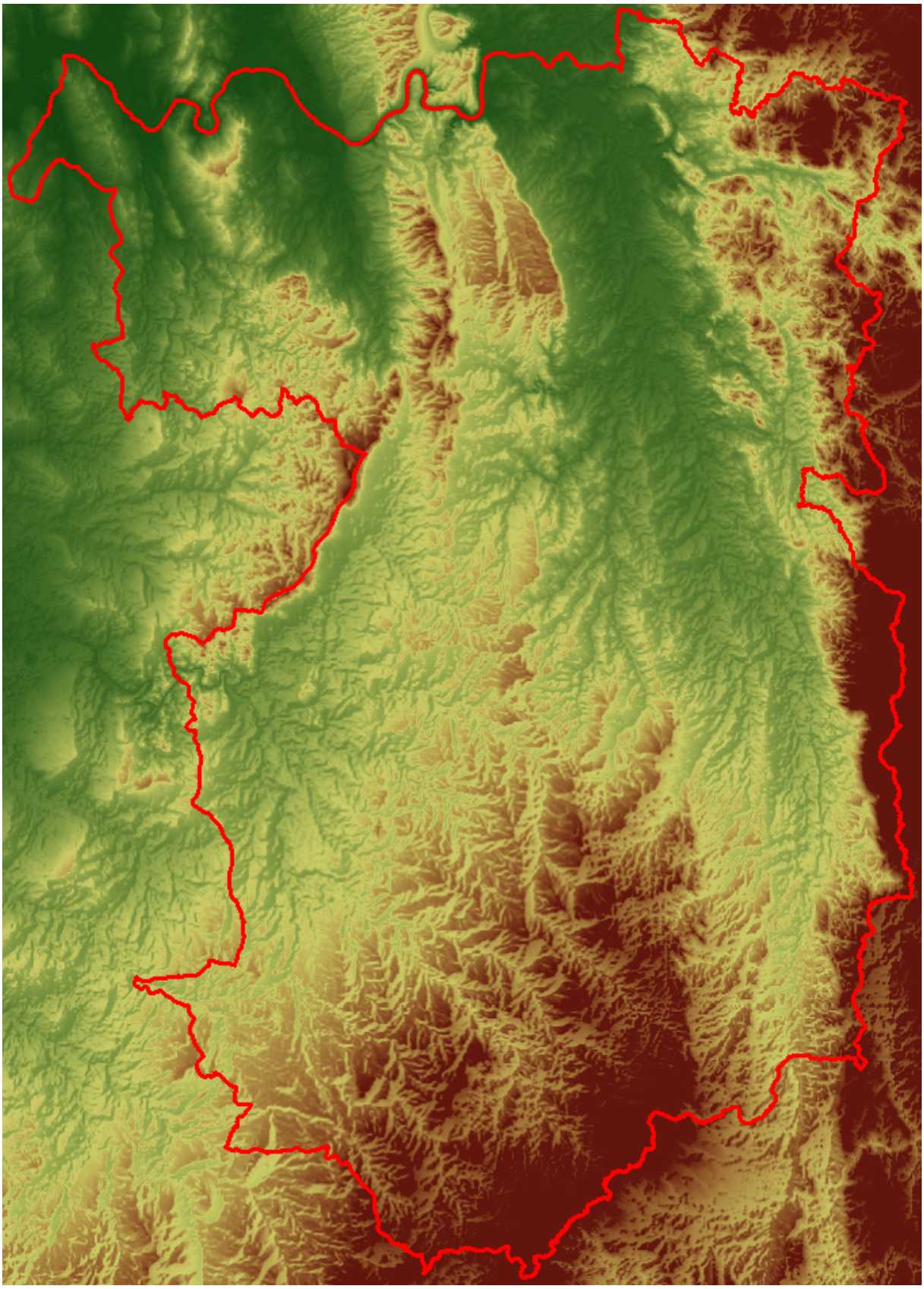


Figure 4 DEM for Service Trial 2, visualised with hill shade effect

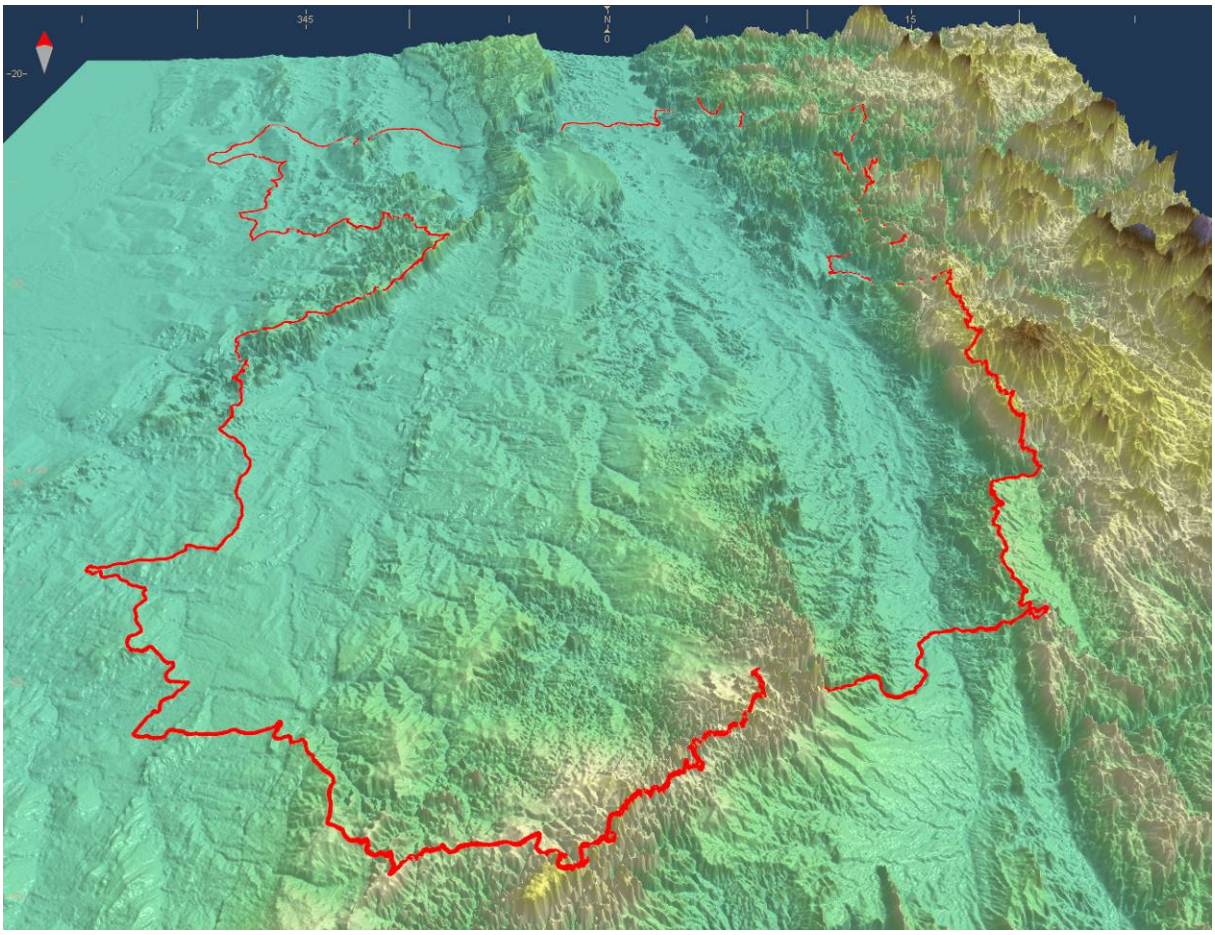


Figure 5 3D view on the processed DEM

3.2.1.2 Aspect Layer

Generally, aspect identifies the slope direction of the maximum rate of change at a location on a surface. It can be thought of as slope direction or the compass direction a hill faces.

Calculating the aspect for a certain region generates additional information which is useful for various tasks. For example, aspect is important to calculate the solar illumination for each location in a region. The degree to which sunlight strikes a hillside depends on its aspect. Because aspect affects the amount of sunlight striking the land's surface, aspect can be an important metric that aids in the siting of buildings to maximize or minimize solar gain or in improving agricultural production for instance. Aspect also can be one of a number of determinants of vegetation communities, habitat, soil moisture, evapotranspiration and other biological and physical landscape characteristics.

Figure 6 presents the aspect layer for Trial 2 area, using the Colour Ramp defined in Table 2. Grey areas are regions where the slope is zero; the pixels have been assigned here with -1.

Table 2 Aspect Legend

Direction	Colour
North	Red
Northeast	Orange
East	Yellow
Southeast	Green
South	Cyan
Southwest	Light blue
West	Dark blue
Northwest	Pink
Flat	Gray

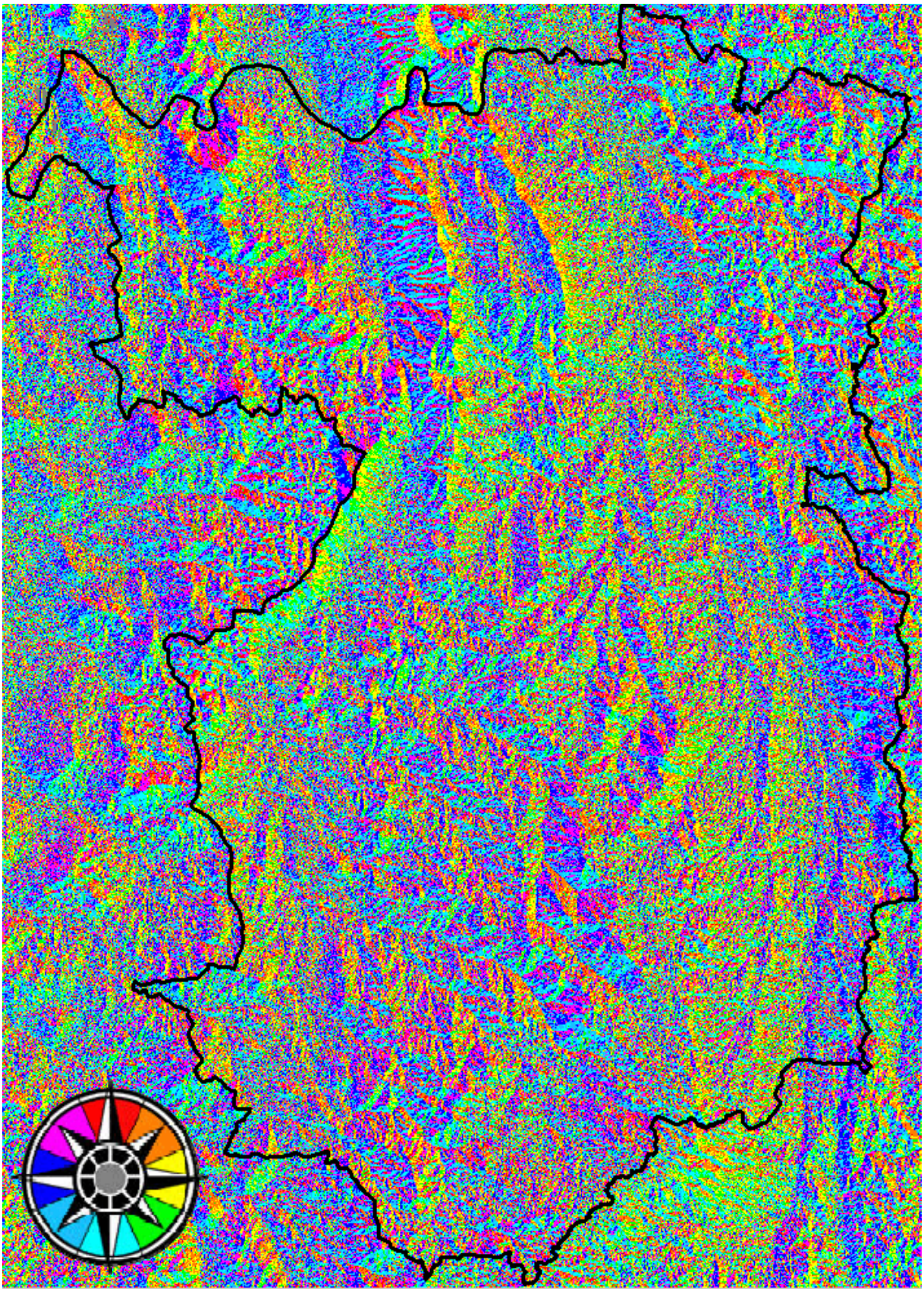


Figure 6 Aspect layer of Trial 2 area

Analysing the aspect layer, it is obvious that Dark Blue, Light Blue and Pink are dominant within Trial Area 2. Therefore the majority of the slopes within the region face a western direction, which characterise the landscape considerably. Looking at the statistics in Table 3, it becomes also evident that only a minority of the slopes faces a northern direction.

Table 3 Aspect Analysis

Direction	Colour	Count	Rank
North	Red	2084403	8
Northeast	Orange	3333773	4
East	Yellow	3181923	5
Southeast	Green	3036097	7
South	Cyan	3127750	6
Southwest	Light blue	3675118	2
West	Dark blue	3932480	1
Northwest	Pink	3493037	3
Flat	Gray	91666	9

3.2.1.3 Slope Layer

Slope can be defined as the angle, inclination, steepness, or gradient of a straight line. Slope often is used to describe the steepness of the ground's surface. Slope can be measured as the rise (the increase in elevation in some unit of measure) over the run (the horizontal distance measured in the same units as the rise).

Slope is an important landscape metric. Some examples of its applications include:

- to help describe landforms,
- to model surface runoff,
- to characterize habitat,
- to classify soils,
- to assess the potential for development and
- to model wildfire risk.

Slope identifies the steepest downhill slope for a location on a surface, calculated for each raster cell (it is the maximum rate of change in elevation over each cell and its eight neighbours).

Figure 7 presents the slope layer for Trial area 2. The legend shows 8 different slope classes, which have been defined in order to visualise the slope within the Service Area best possible. Horizontal areas without any slope (slope angle = 0°) have been assigned with 0, while areas with really high slope values (slope angle with max. 90°) reach values up to the maximum of 90. The colours of the slope classes have been defined in this way that the class without any gradient has the brightest colour, while all classes with higher slope values have been visualised with darker colour shades.

Thus the slope layer can be interpreted as followed:

- The lower the slope value, the flatter the terrain, the brighter the visualisation.
- The higher the slope value, the steeper the terrain, the darker the visualisation.

Analysing the Service Trial area 2, only the north-eastern part shows real steep slopes, followed by the southern border region. Within the major parts of the landscape, the slope values range between 1 and 15 degrees; therefore the landscape of Service Trial 2 is predominately rather flat.

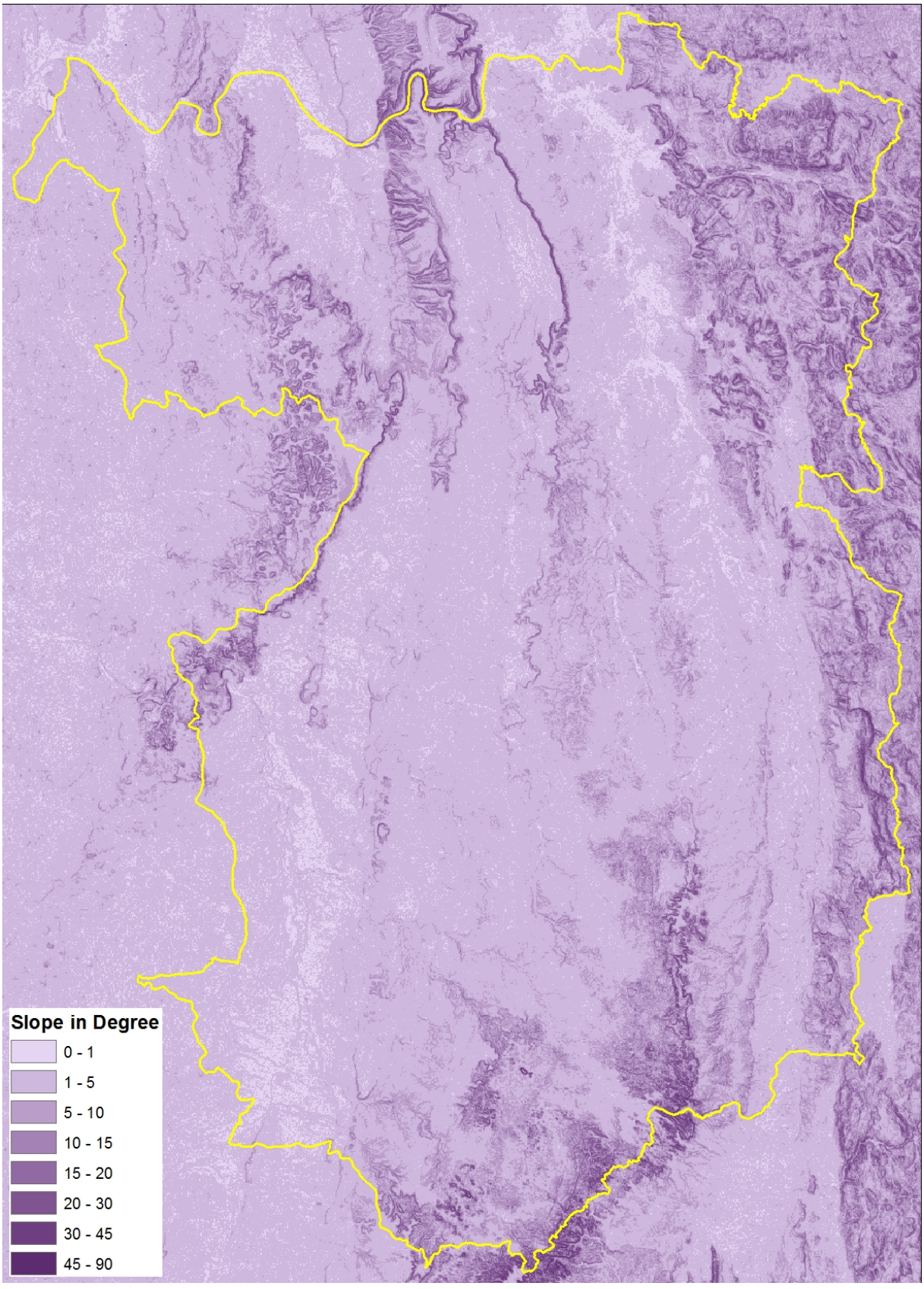


Figure 7 Slope layer of Trial 2 area

3.2.1.4 Basic Drainage System Layer

Generally, a drainage system is the pattern formed by the streams, rivers and lakes in a particular drainage basin. They are governed by the topography of the land and the gradient of the land. Drainage systems can fall into one of several categories, depending on the topography and geology of the land (e.g. dendritic, parallel or radial systems for instance). The calculation of a streamnet in very flat regions can give an impression where water could accumulate or flow. Gaps inside the datasets represent calculated sinks.

Within hydrology, the Strahler stream order values are established as standard description of rivers and streams. In the application of the Strahler stream order to hydrology, each segment of a stream or river within a river network is treated as a node in a tree, with the next segment downstream as its parent. When two first-order streams come together, they form a second-order stream. When two second-order streams come together, they form a third-order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream.

The Strahler stream order has its classic application within general hydrological cartography, where the systematic detection of river classification systems also provides important clues for the unique identification and allocation of waters. Particularly for modelling analysis of river systems (e.g. time-related rainfall-runoff models), the Strahler order is very useful as it describes individual river sections rather than complete stream courses. Especially for flood modelling and analysis, the stream order is important to identify the main rivers, for the analysis of the river catchments and the river valley forms.

Figure 8 presents the derived drainage system for the service area. The interpretation of the drainage system reveals a dendritic pattern of the network. Based on this first observation, it's very supposable that the underlying rock formation is rather homogeneous. According to references (LÖFFLER, 1994 and PRESS&SIEVER, 1995), this indicator is an evidence for horizontal sediments or massive ingneous rocks/metamorphic rocks. The dendritic pattern is also an indicator for an area with only marginal slope rates (e.g. a hilly/rolling country), which is confirmed through the produced DEM also. Through the applied Strahler Number, three main river networks can be identified within the Service Trial 2 area (North-West, South-West and East). In the domain of flood events, these three main rivers with their runoff have to be monitored closely.

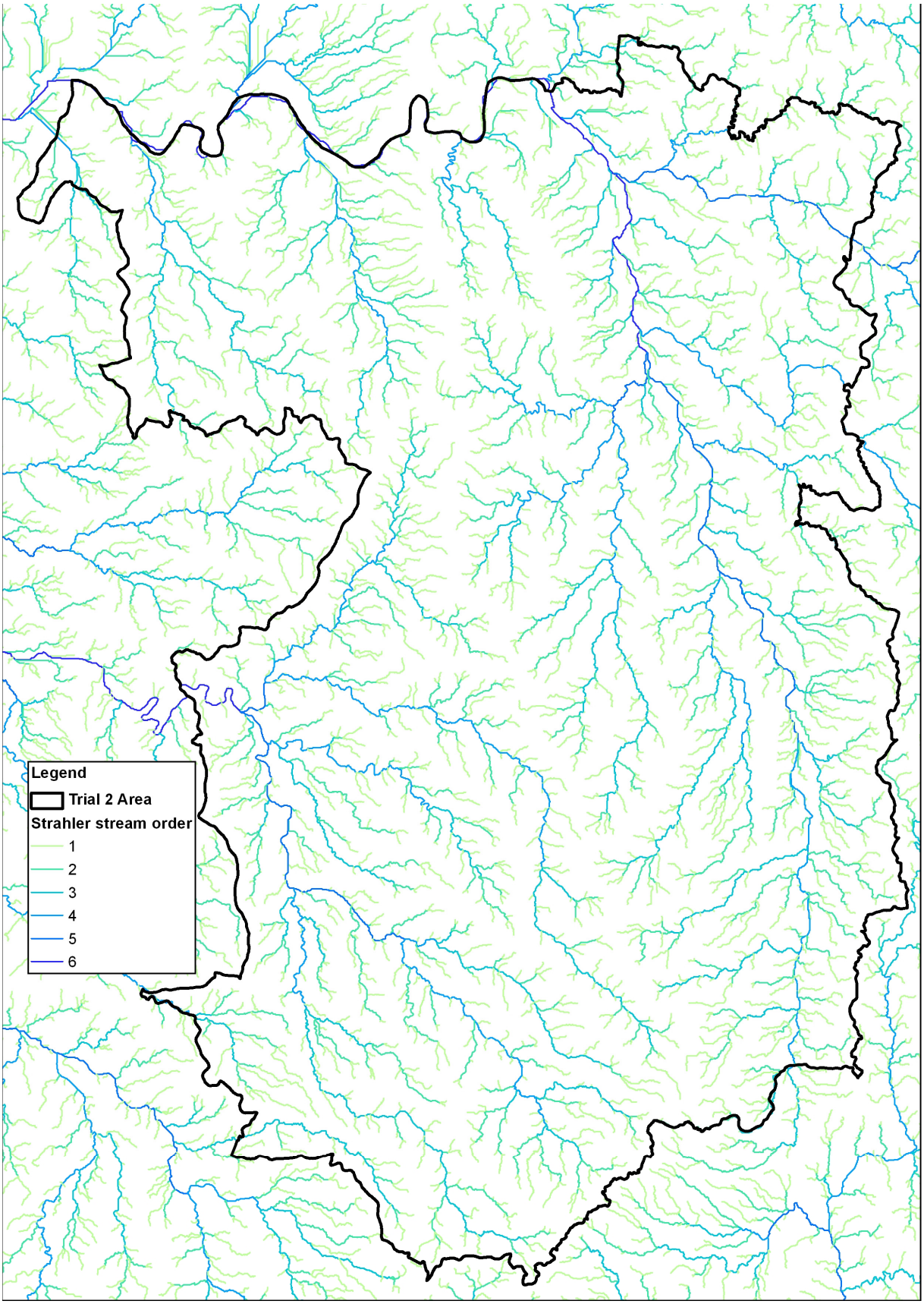


Figure 8 Basic Drainage System of Trial 2 area

3.2.2 Land Cover Map 2009 and Baiboho Map

The second main product within Service Trial 2 is a recent Land Cover Map of the service area for general planning purposes. Based on ALOS AVNIR-2 scenes from 2009, twelve classes have been defined in agreement with the user (see Table 4).

Table 4 Land Cover Map - thematic classes

No.	English Class Name	French Class Name
1	Urban areas	Zones urbaines
2	Roads	Routes
3	Water bodies	Plan D'eau
4	Forest – dense	Forêt dense
5	Forest – degraded	Forêt dégrade
6	Bare soil	Sol nu
7	Tree savannah	Savane arborée
8	Shrub savannah	Savane herbeuse
9	Sand	Sable
10	Wetlands	Zones humides
11	Irrigated cropland	Terres agricoles irriguées
12	Rain-fed cropland	Terres cultivées non irriguées

The production and all related technical processes have been conducted using the ERDAS Imagine software package (COTS software) as well as GAF tools. The produced LCM2009 with 10m spatial resolution is presented in Figure 9. The area statistics of the final product are given in Table 5.

Figure 10 and Figure 11 provide a detailed view on two regions within the service area to visualise the product quality. The examples also show some seasonal difference between the AVNIR-2 data and the reference data (aerial imagery).

Table 5 Area Statistics for the LCM2009

No.	Thematic class	Area in km²	%
1	Urban	3.04	0.02%
2	Roads	5.77	0.04%
3	Water bodies	175.93	1.31%
4	Forest - dense	379.04	2.81%
5	Forest - degraded	862.10	6.40%
6	Bare soil	146.06	1.08%
7	Tree savannah	1730.44	12.85%
8	Shrub savannah	9729.39	72.24%
9	Sand	159.63	1.19%
10	Wetlands	9.44	0.07%
11	Irrigated cropland	153.59	1.14%
12	Rain-fed cropland	113.19	0.84%
	Total Area	**13 467.61**	**100.00%**

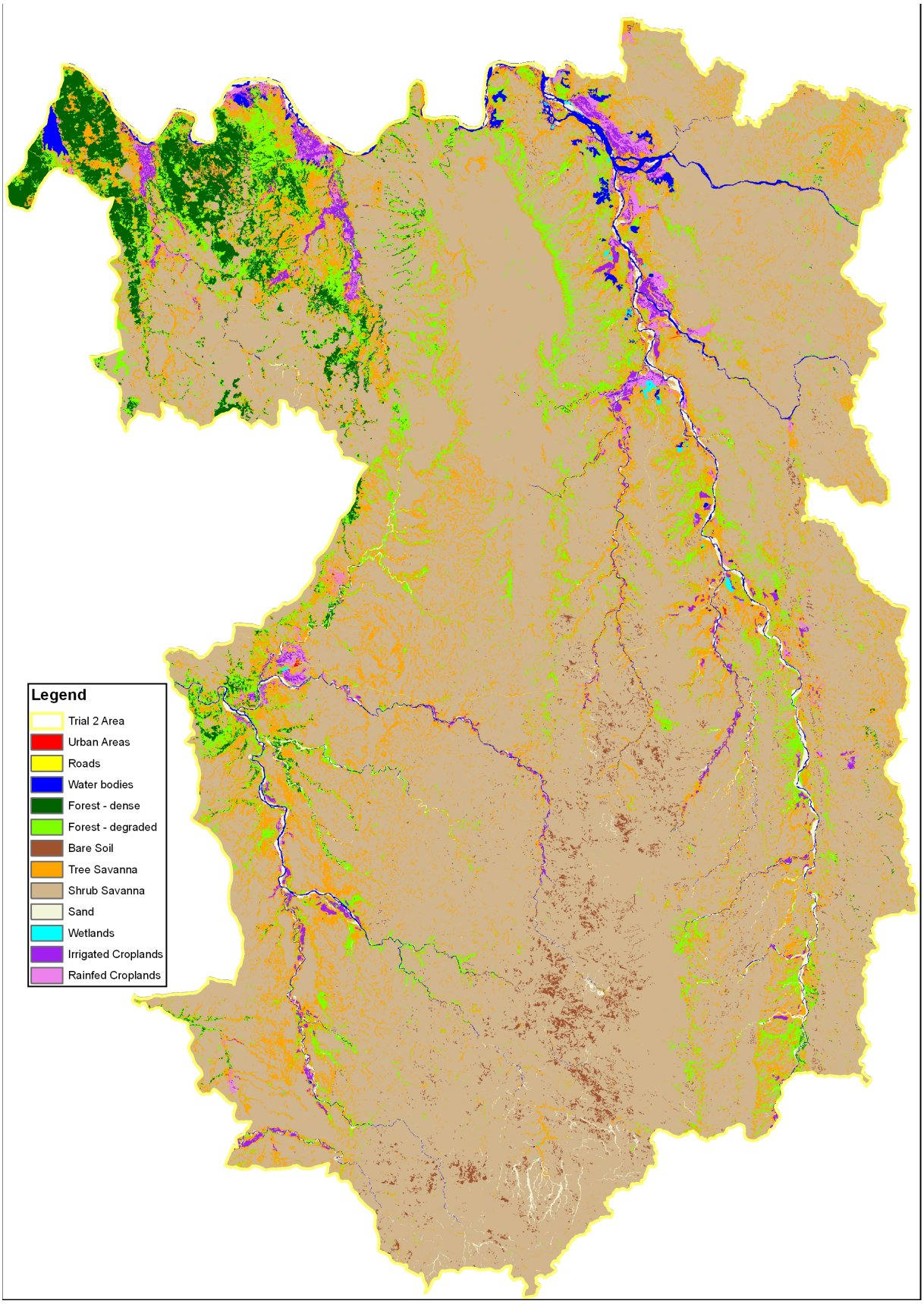


Figure 9 Land Cover Map 2009

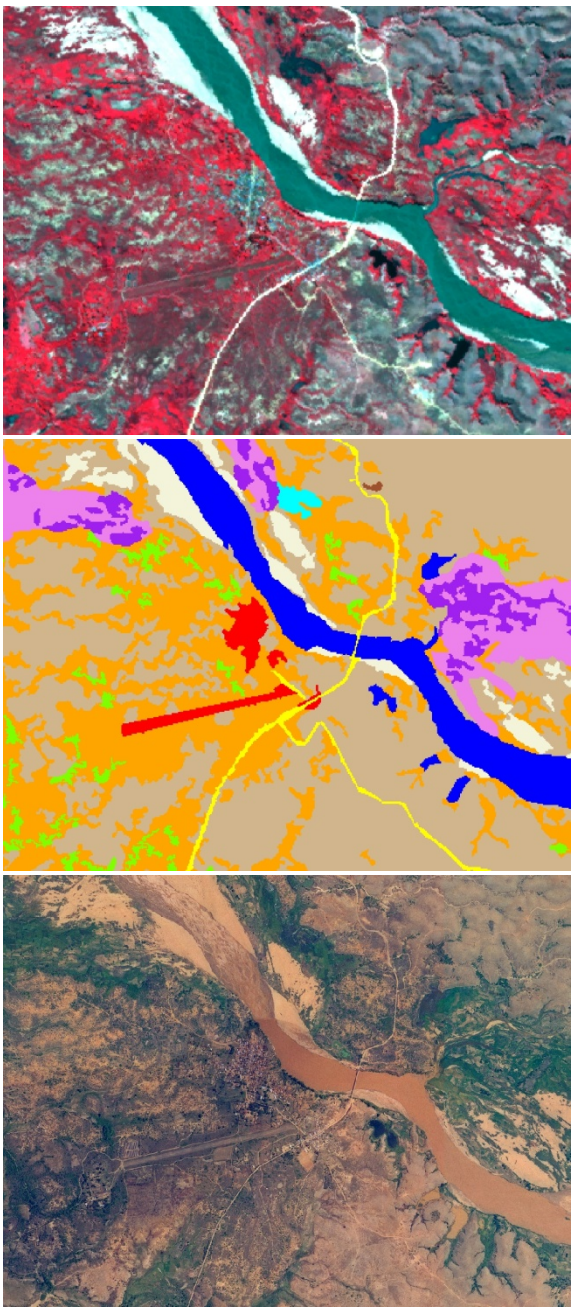


Figure 10 Example LCM2009 Amatolahy

The example presents the City of Amatolahy and surrounding area incl. airport. Within this subset the city, road network, river and the agricultural areas are clearly visible.
(Top: AVNIR-2 data, 10m resolution; center: Final Product, LCM2009; bottom: Reference data - Aerial Photography, 0.5m resolution)

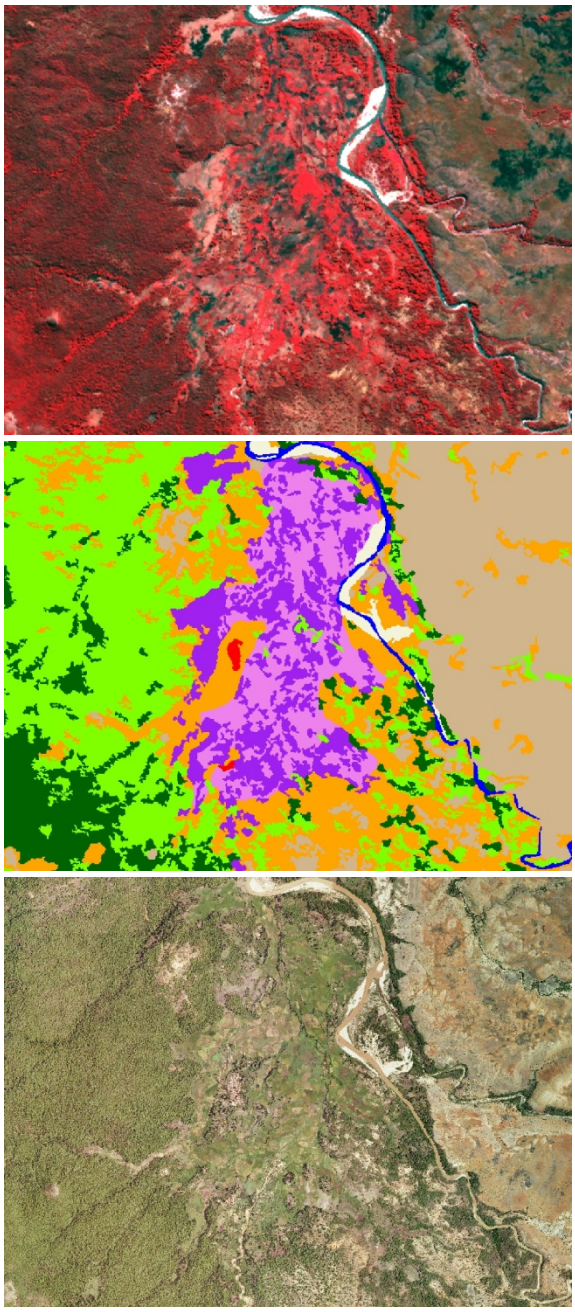


Figure 11 Example LCM2009 Belinta

The example presents the Village of Belinta and nearby cropland. (Top: AVNIR-2 data, 10m resolution; center: Final Product, LCM2009; bottom: Reference data - Aerial Photography, 0.5m resolution)

Based on this derived Land Cover Map, an analysis for the Trial 2 Service Area based on the statistics has been executed. The overall statistic in Table 5 shows, that over 73% of the service area is covered with no or only sparse vegetation (Thematic class: Shrub Savannah). Figure 12 clearly points out the dominance of this single class.

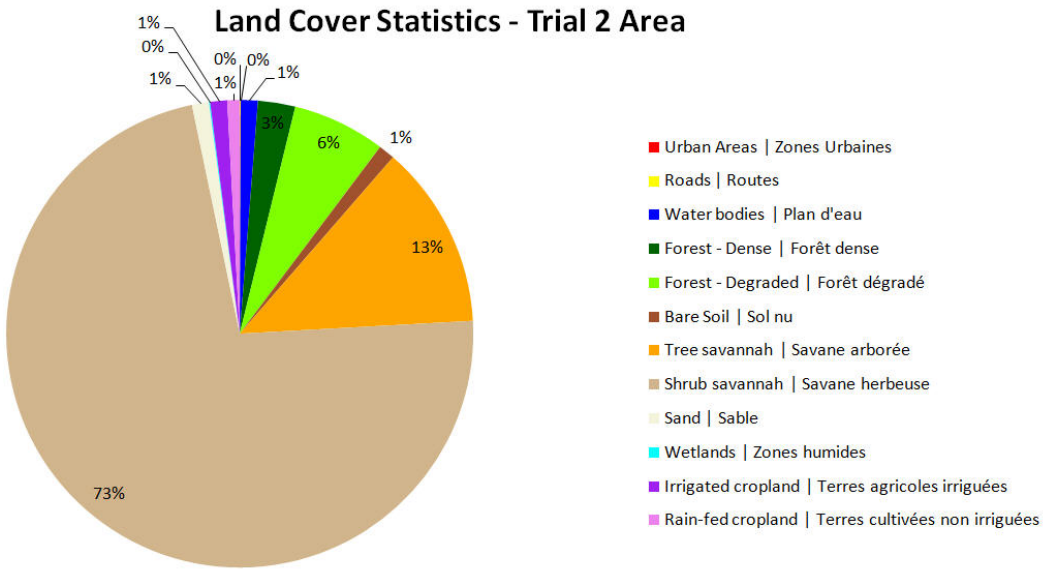


Figure 12 Visualised Land Cover Statistics of Service Trial 2

To provide a more detailed view on the region, the analysis was broken down on communities which are part of the service area (see Figure 13).

Figure 13 Community borders within Service Trial 2

Table 6 Area Statistics in km² for the Communities within Service Trial 2, based on the LCM2009

	Class Number and Name											
	1	2	3	4	5	6	7	8	9	10	11	12
Community within the Service Trial 2 area [Area in km²]	Urban Areas	Roads	Water bodies	Forest - Dense	Forest - Degraded	Bare Soil	Tree savannah	Shrub savannah	Sand	Wetlands	Irrigated cropland	Rain-fed cropland
Ambatolahy	0.33	0.69	14.71	0.21	38.04	1.4	97.8	713.97	7.85	1.12	13.68	14.97
Ambia	0.13	--	9.37	0.43	37.59	32.1	134.46	783.61	12.19	0.06	10.05	1.69
Ankilizato	0.59	1.32	14.27	30.09	137.61	16.27	343.17	1793.63	21.36	0.36	14.9	15.98
Ankiroroky	0.16	0.02	7.42	22.89	44.88	--	64.24	154.43	3.63	0.01	18.34	8.37
Ankotrofotsy	0.09	0.76	31.1	0.04	56.22	0.8	98.08	492.85	5.5	1.49	17.44	21.05
Atsoha	0.08	--	0.81	36.08	39.09	0.14	50.98	304.81	1.2	--	2.07	2.67
Belinta	0.08	--	1.66	43.51	79.92	0.08	101.41	448.1	1.82	--	10.61	5.34
Berevo	0.08	--	9.51	103.41	84.2	0.92	64.12	54.96	5.84	--	4.91	6.99
Beronono	0.18	--	5.46	2.62	29.42	22.61	101.93	1139.56	19.33	0.45	8.24	2.52
Isalo	0.11	0.33	24.1	0.11	30.7	0.77	52.89	139.62	6.39	0.44	9.07	7.13
Malaimbandy	0.57	1.54	16.79	1	112.46	40.76	282.69	1752.61	31.31	1.7	19.91	9.14
Manambina	0.01	0.47	6.69	0.26	48.45	0.47	81.36	428.43	7.76	3.41	9.39	10.41
Tsaraotana	0.46	0.19	5.73	91.99	30.27	0.09	43.98	9.06	3.83	0.27	8.57	4.4
Tzimazava	0.07	--	5.96	3.13	68.36	29.45	137	1218.51	25.39	0.07	5.75	0.66

As requested by IFAD, the Road Network is of special interest within this service area. In order to provide additional information about the detected roads, the thematic class No.2 Roads has been converted from raster into vector format in order to calculate road lengths.

Depending on the 10m spatial resolution of the AVNIR-2 data only major roads within the service area could be detected. Smaller roads could be detected partly in some communities, but they do not form a coherent road network

In total, the detected road network has a length of 222.21 km within Service Trial 2. The statistic of the length of the road network per community is given in Table 7. Around 17 km of roads lie outside of the listed community borders but within Trial 2 Area.

Additionally, customised map layouts have been created for the LCM2009 dataset, which are presented in Figure 14 and have been delivered to Madagascar as well.

Table 7 Road Network Statistics

Community	Road length [in km]
Ambatolahy	25.018
Ankilizato	57.698
Ankiroroky	0.663
Ankotrofotsy	27.976
Isalo	12.849
Malaimbandy	59.687
Manambina	15.155
Tsaraotana	6.078

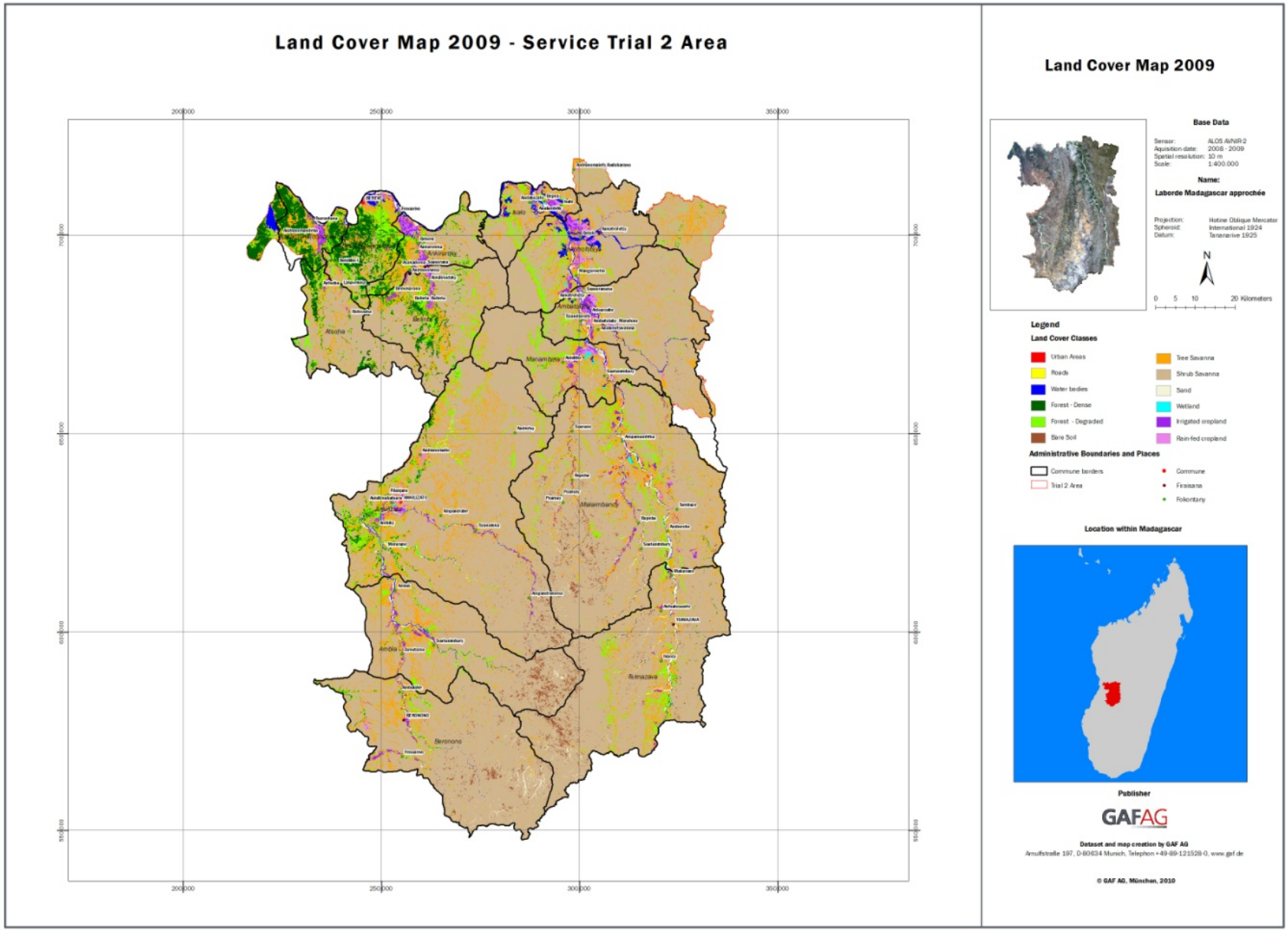


Figure 14 LCM2009 including Community Borders and Village Labels

Following the user demand regarding in-depth information on the Baiboho areas, which are of high interest regarding agricultural development planning in Madagascar, a newly developed Baiboho Map has been produced to provide additional information of these specific areas.

The final map product highlights areas with high and low potential for agricultural activities within the Baibohos and gives a first indicator for regions which are of interest for further investigations regarding additional/extended agricultural activities. The map was created by combining the Land Cover Map 2009 and the produced Slope Layer from the DEM. Areas with low slope values and suited thematic classes have been labelled with potential for expansion of agricultural activity, additionally referring to the location within the Baiboho and moisture values. Figure 15 presents the created Baiboho map, including a map layout. A detailed view is given in Figure 16, complemented with an interpretation example. A first analysis on community basis is provided in Table 8.

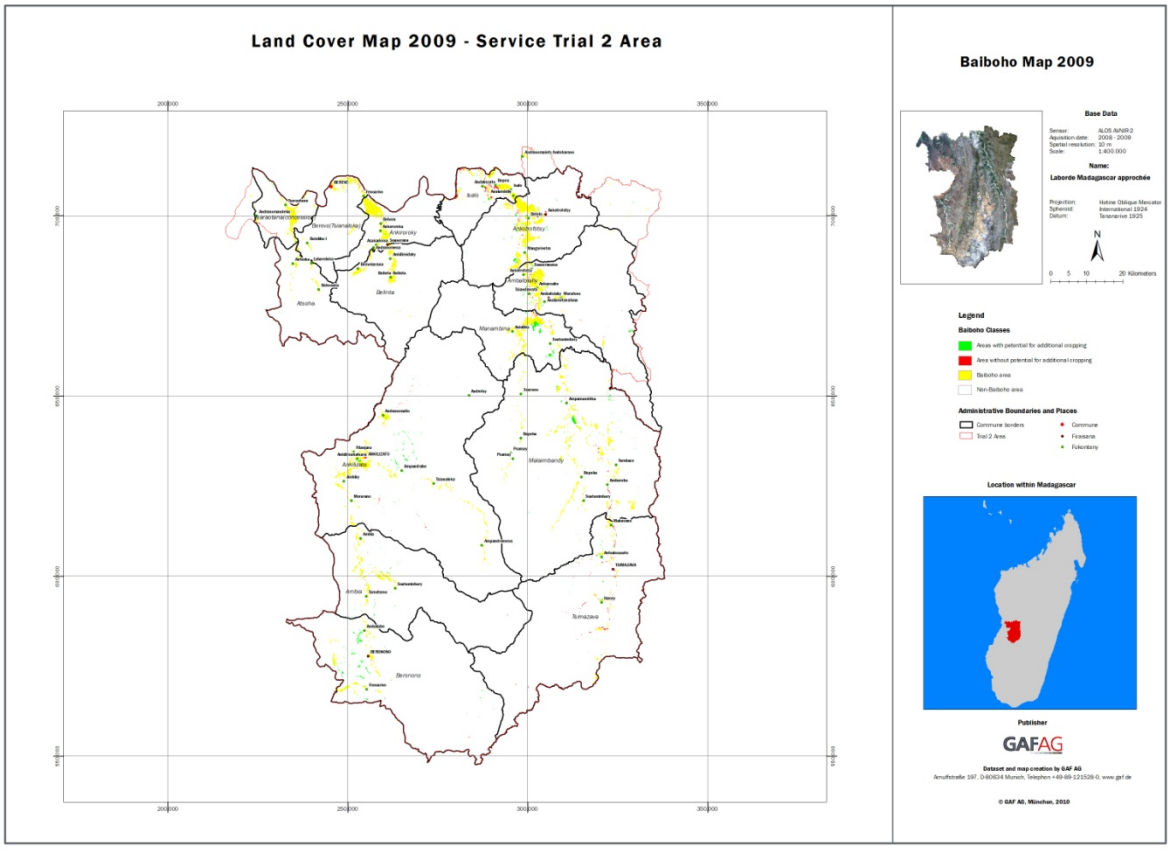
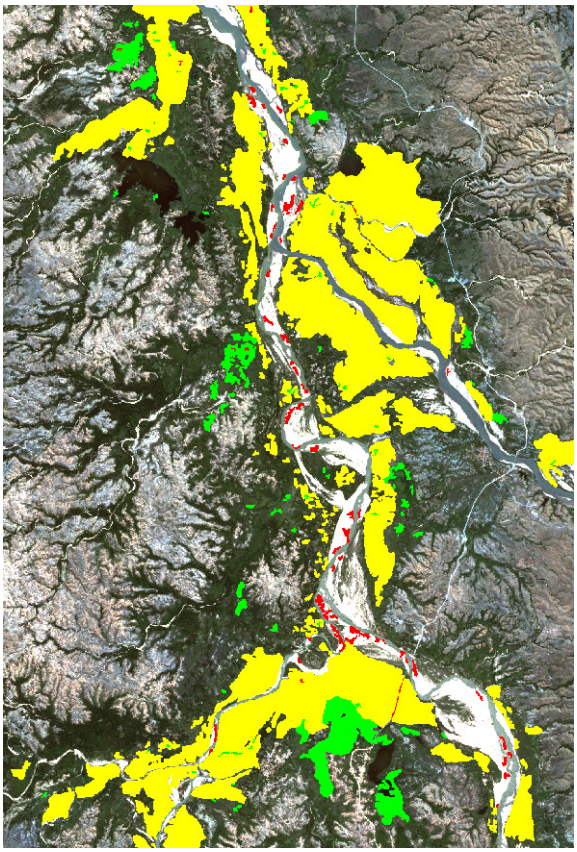


Figure 15 Baiboho Map



Yellow Areas represent areas which are already used for agricultural production. Green areas highlight potential areas which are actually not used for agricultural purposes featuring low slope rates and suitable thematic classes (for this example: shrub savannah, tree savannah and wetlands). Red areas indicate regions which are not usable for additional agriculture activities. Although the slope rate would be suitable, the land cover class is not applicable for further agricultural activities. (e.g. road network and sandy areas among the river are not applicable). Analysing this example, the large green spot in the south would be probably the first area where additional investigations regarding additional agricultural production areas should be conducted.

Figure 16 Example Baiboho Map

Table 8 Baiboho Map - Statistics on Community Level

Community within the Service Trial 2 area	Area with potential for additional agricultural activities (Class No.1)		Area without potential for agricultural activities (Class No.2)		Area already in agricultural use (Class No.3)		Overall
	km²	%	km²	%	km²	%	km²
Ambatolahy	2.56	7.39%	0.83	2.41%	31.22	90.20%	34.61
Ambia	1.16	7.74%	0.11	0.73%	13.77	91.53%	15.05
Ankilizato	3.64	8.93%	0.7	1.71%	36.44	89.36%	40.78
Ankiroroky	0.65	2.15%	0.3	1.01%	29.21	96.84%	30.17
Ankotrofotsy	2.56	5.69%	1.34	2.98%	41.13	91.33%	45.03
Atsoha	0.17	2.84%	0	0.00%	5.85	97.16%	6.02
Belinta	0.14	0.79%	0	0.00%	17.62	99.21%	17.76
Berevo	0.55	3.49%	0.43	2.76%	14.67	93.75%	15.65
Beronono	5.11	28.26%	0.2	1.13%	12.75	70.60%	18.07
Isalo	1.74	6.97%	5.23	20.91%	18.04	72.12%	25.01
Malaimbandy	4.04	9.94%	1.55	3.81%	35.08	86.25%	40.67
Manambina	4.28	16.07%	0.58	2.16%	21.78	81.77%	26.64
Tsaraotana	0.71	4.61%	0.09	0.56%	14.52	94.83%	15.31
Tzimazava	1.23	10.12%	3.1	25.43%	7.85	64.46%	12.18

3.2.3 Product Validation

In general, intensive quality monitoring has been applied throughout the production process. All verification exercises and accuracy assessments during the production process are carried out in comparison to the specified measures in the Service Readiness Report [D1]. Following well established quality assessment standards, the products have been validated against:

- Geographical coverage
- Geometric accuracy (Positional and vertical accuracy)
- Geometric reference system
- Image quality and acquisition
- Minimum Mapping Unit and spatial resolution
- Thematic accuracy
- Metadata standard (INSPIRE conformity)
- Completeness (Product format and delivery)

Documented in the Service Operations Report [D3] in detail, all product specifications as defined in the Service Readiness Report [D1] have been met.

4 Impact and Benefits of the EO Service

The service utility assessment has been the important task within this Service Trial 2 after product delivery. The general procedure for the service assessment is given in Figure 1. Focussed on impact and benefits of the service, supplementary value statements of the user have been collected, including recommendations for future service improvements.

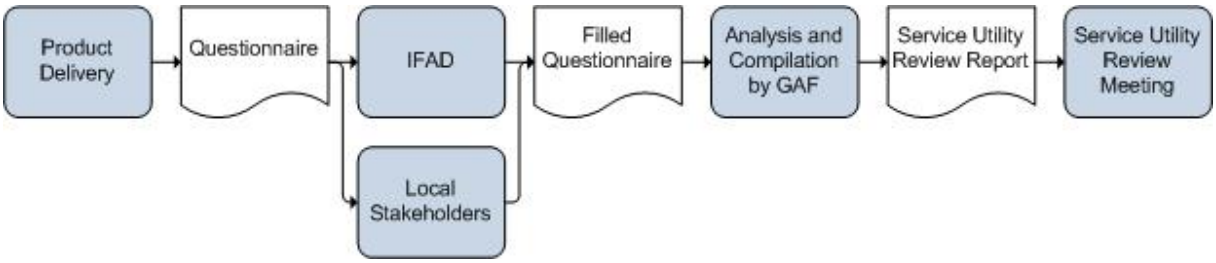


Figure 17 Assessment Procedure

The complete assessment is given in the Service Utility Report [D4], which contains statements not only from IFAD but also from local users in Madagascar. In total, four independent statements from users have been received.

The assessment has addressed firstly Service Quality, which covered topics such as service integrity, accuracy, maintainability and others. In summary, the quality has been evaluated as being *compliant* to the user expectations. Exceptional case was the thematic accuracy, where the user demanded the mapping of roads with higher resolution, which was technically limited by the provided ALOS AVNIR-2 imagery.

Several improvements have been stated by the users, including:

- Improved spatial coverage
- Improved spatial resolution
- Improved accuracy
- More efficient development planning

Regarding service benefits, especially the user statement, that the benefit of the service for Improved Development Planning has been evaluated with *very good*, gives a strong commitment from the user for the initial task of this Service Trial 2. Other benefits have been mentioned, such as

- Improved monitoring capabilities
- Improved objectivity/consistency/reliability
- Cost saving

Several recommendations regarding the service have been provided, from the users as well as from the service provider. The main topics have been:

- Training, Capacity Building and local visit

  During the service/product assessment, the users clearly mentioned within their feedback that capacity building and training would be crucial for them to raise the Integration Potential of the products, especially for the local users in Madagascar. The Service Provider added in his recommendation that the maximum benefit of EO data and product towards Development Planning certainly will be achieved through combined application with other data sources. EO can build an excellent information basis for rapid situation awareness over large areas in Madagascar, which then should be integrated within a GIS Environment for further analysis. The capacity of GIS analysis, application and data integration is cardinal to exploit the information of EO data and products to a maximum extent. Both IFAD and GAF agreed that a local visit/technical workshop in Madagascar should be foreseen in a future service.

- Higher spatial resolution:

  The users stated that they would appreciate if a future service could be based on EO data which features a higher spatial resolution. The reason for this demand is the need of a more detailed mapping of the road network of the region which is considered to be essential for further development planning in the region. The currently used ALOS AVNIR-2 data allows road mapping only to a certain extent, based on their 10m spatial resolution.

Value statements from the user have been collected regarding several topics. For the overall utility, the user commented that the service "*Promote land consolidation, efficient strategic planning and proper land allocation for agriculture*". The accordance with the success criteria has been evaluated with "*HIGH*", and also he stated regarding willingness to use that he is "*Motivated and excited for further up-scaling*" of the service.

The overall evaluation of the service had been labelled with GOOD by the user.

Acknowledgments

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