



# LIFT Imagery Strategy

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## Contents

Contents .....	1
Acknowledgements.....	2
Executive Summary.....	3
Introduction and Context .....	3
What are the Government of Ethiopia's requirements for SLLC imagery? .....	4
New Option for Satellite Imagery .....	4
Recommendations.....	5

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## Executive Summary

The Second Level Land Certification (SLLC) process in Ethiopia is reliant on the use of remotely sensed imagery to provide a base map for parcel demarcation. Satellite imagery has recently become available which meets some of the 'de facto' standards for imagery used for SLLC purposes. This presents a potential opportunity for the Government of Ethiopia to procure cheaper imagery for SLLC purposes in the long term.

This report summarises the findings of the independently conducted study "*Analysis of Satellite Imagery to Meet the Requirements of the Land Investment for Transformation (LIFT) Second Level Land Certification Activities*" and subsequent discussions with federal and regional level officials. It makes recommendations for how the Government of Ethiopia, with the support of LIFT, can make informed decisions about the procurement of remotely sensed imagery for the future roll-out of SLLC and Rural Land Administration System (RLAS) activities in Ethiopia.

The principal recommendation is for RLAUD to lead a pilot exercise to determine whether satellite imagery is now a 'fit-for-purpose' source of imagery for SLLC.

## Introduction and Context

The Second Level Land Certification (SLLC) process in Ethiopia is reliant on the use of remotely sensed imagery to provide a base map for parcel demarcation. After a number of trials were conducted, the Government of Ethiopia settled on the use of orthophotography captured by aircraft. Satellite images were unable to provide the required resolution to enable parcel boundary features to be identified on the ground.

Subsequently, US military restrictions on the quality of satellite imagery available for civilian use were relaxed, allowing imagery with a spatial resolution of 31cm to be available commercially. This prompted the LIFT Internal Technical Service Provider (ITSP) to consider the possibility of using satellite imagery for SLLC purposes.

Imagery of this quality is only available from one supplier (DigitalGlobe), so in the interests of impartiality, the LIFT team and DFID Ethiopia commissioned an independent assessment via DFID's LEGEND programme. The resulting report, *Analysis of Satellite Imagery to Meet the Requirements of the Land Investment for Transformation (LIFT) Second Level Land Certification Activities*. While the study was inconclusive about the suitability of this newly available satellite imagery, it outlined recommendations for a pilot exercise to determine whether the imagery is 'fit-for-purpose'.

Given the time constraints for the LIFT programme to meet its ambitious targets, it was decided to continue to augment the existing orthophotography inventory for LIFT SLLC purposes. The risk of a negative outcome of a pilot study would leave the programme without essential imagery and with no flying window for the capture of cloud-free imagery.

The Government of Ethiopia is committed to extending SLLC beyond the LIFT programme woredas. Understanding how newly available imagery data may or may not present a viable alternative to the existing approach is essential to planning and costing any future SLLC roll-out. This report summarises the findings of the independently conducted study and subsequent discussions with federal and regional level officials. It makes recommendations for how the Government of Ethiopia, with the support of LIFT, can make informed decisions about the procurement of remotely sensed imagery for the future roll-out of SLLC and Rural Land Administration System (RLAS) activities in Ethiopia.

The report was presented to RLAUD and Regional Land Bureau officials at a workshop on 29<sup>th</sup> September 2017 and has been finalised based on input from the workshop participants.

## What are the Government of Ethiopia's requirements for SLLC imagery?

The Government of Ethiopia trialled a number of approaches to spatial data capture for SLLC, eventually deciding on the use of remotely sensed imagery in an approach based on that deployed in Rwanda by the DFID-funded Land Tenure Regularisation Programme. The Ethiopian Minister of Agriculture determined that high spatial resolution (25-30cm and up to 40cm in some cases) images collected from satellite or aircraft could be used for field demarcation as part of a fit-for-purpose approach to SLLC.

The exact standards for SLLC imagery have not been formally established. The table below summarises the imagery already procured for SLLC purposes:

Region	Area Name	Funded by	Flown by	Processed by	Spatial Resolution
Amhara	LIFT	DFID	INSA	INSA	30cm
Amhara	OP	Regional Land Office	INSA	INSA	25cm
Oromia	LIFT Block 3	DFID	INSA	INSA	30cm
Oromia	LIFT Blocks 1 & 2	DFID	INSA	INSA	30cm
Oromia	LIFT Block 4	DFID	Not yet acquired		
SNNPR	Regional	Region Land Office	INSA	INSA	Being processed
SNNPR	SLMP2	World Bank	INSA	EMA	Being processed small pilot
SNNPR	SLMP1	World Bank	INSA	EMA	15cm small pilot
Oromia & SNNPR	EMA	Regional Land Offices	Unknown	EMA	40cm
Tigray	Tigray OP	Regional Land Office	INSA	INSA	30cm
Tigray	LIFT	DFID	INSA	INSA	30cm

### Definitions:

**Spatial Resolution:** this is the area on Earth represented by one pixel on the image. This determines the size of the objects on the Earth which are easily visible to the eye from the image.

**Spatial accuracy:** this refers to how close the co-ordinates of the pixel are to the corresponding area on the ground.

A 'de facto' standard for spatial resolution is currently being observed of between 0.25m and 0.40m resolution. This is being used satisfactorily in the field for demarcation purposes. The LIFT ITSP Registration Specialist notes that it is 'fit-for-purpose' and that the range of spatial resolution is consistent with the types of imagery used for similar demarcation activities in other countries (for example, Rwanda and Tanzania).

While the spatial resolution has a 'de facto' standard, no equivalent exists for the spatial accuracy of imagery. For the LIFT procurement, imagery is specified at 73.2cm at the 95% confidence level. This has not been independently verified.

Previous pilots in Ethiopia have discounted the use of satellite imagery for SLLC on account of the lower spatial resolution, and perceived lower spatial accuracy standards.

### New Option for Satellite Imagery

At the time of the SLLC pilot activities, satellite imagery was only available for civilian use at a spatial resolution of between 0.45m and 0.65m – regarded as unsuitable for SLLC application. In early 2016, imagery from the Worldview-3 satellite (and the subsequently launched Worldview-4) became available for civilian use at a resolution of 0.31m.

This product is only available from a supplier called DigitalGlobe. With satellite imagery now available which fits the Government of Ethiopia's 'de facto' standards, LIFT requested an independent comparison of the imagery specifications.

## Comparison of Imagery Options

Requirement Comparison of Imagery Specifications:	LIFT Requirement Orthophotos	DigitalGlobe Offering Product Characteristic
Spatial Resolution	30cm	31cm
Spatial Accuracy	CE 73.2cm at 95% confidence level	RMSE 2m, CE 3.035m at the 90% confidence level, and 3.462m at the 95% confidence level
Source of DEM	Stereo airborne imagery	Off the shelf 5m DEM from JAXA ALOS stereo satellite imagery
GCP collection	EMA (cost included in price below)	EMA (cost included in price below)
Imagery Collection	New	New and archive from no older than two years
Cloud cover	Less than 5%	Less than 5%
Spectral Resolution	Three bands: red, green, blue, infrared (not delivered to LIFT)	Four bands: red, green, blue, infrared
Cost	£21.00/km2 (630 ETB)	£19.16/km2 (575 ETB)

While it is clear that the orthophotography currently in use offers a higher standard of spatial accuracy, there are other considerations:

- Is this standard of spatial accuracy 'fit-for-purpose' for the SLLC and RLAS general boundaries approach? Lower standards may be acceptably accurate
- Satellite imagery is currently 9% cheaper, and the price is likely to reduce with volume
- Satellite imagery offers greater flexibility of acquisition. Archive imagery can be combined with newly captured imagery in order to create cloud-free coverage on demand. Image capture is not restricted by aircraft flying conditions and availability
- Satellite imagery allows areas closer to the border with Eritrea to be safely imaged, if this becomes a requirement.

DigitalGlobe have expressed a willingness to participate in a pilot study to assess the suitability of their product. They will provide sample imagery and processing without charge.

## Recommendations

While LIFT must continue to procure orthophotography in order to ensure that imagery is available to meet the programme's SLLC targets, there is now an opportunity to examine whether newly available satellite imagery presents the Government of Ethiopia with an opportunity to reduce the cost of future imagery procurements.

It is recommended that the Government of Ethiopia lead a short pilot study to determine the suitability of the DigitalGlobe Worldview-3 / -4 products. DigitalGlobe have offered to support this without charge. LIFT can support this process through assistance with the design of the pilots, relevant introductions to DigitalGlobe, map production, and provision of SLLC data for analysis.

The pilot exercise should:

- Perform a comparison of parcel boundary data captured using 31cm satellite imagery with data already captured by SLLC under LIFT (like for like parcels). This should be conducted across a variety of terrains. A combination of desk-based capture and field-based capture can be used;
- The above analysis could be supported by an independent quality verification of the spatial accuracy of both the INSA-procured orthophotography and the 31cm satellite imagery. This verification could be performed by EMA or by an independent third party.

The results for the pilot exercise will allow a better understanding of whether the current spatial accuracy standards are realistic and 'fit-for-purpose' for the SLLC approach. This will allow an informed decision to be taken on whether 31cm spatial resolution satellite imagery is suitable for SLLC, and allow the Government of Ethiopia to plan and budget continued SLLC operations outside of the LIFT programme.

The results of the pilot should be shared widely, as they will be of value to similar systematic registration programmes in Africa and elsewhere.

It is proposed that RLAUD take the lead on this pilot exercise, nominating a small team internally. LIFT will provide support as described above. It is proposed that the LIFT ITSP commence design work on the pilot in November 2017, with a view to rolling out the pilot in early 2018.