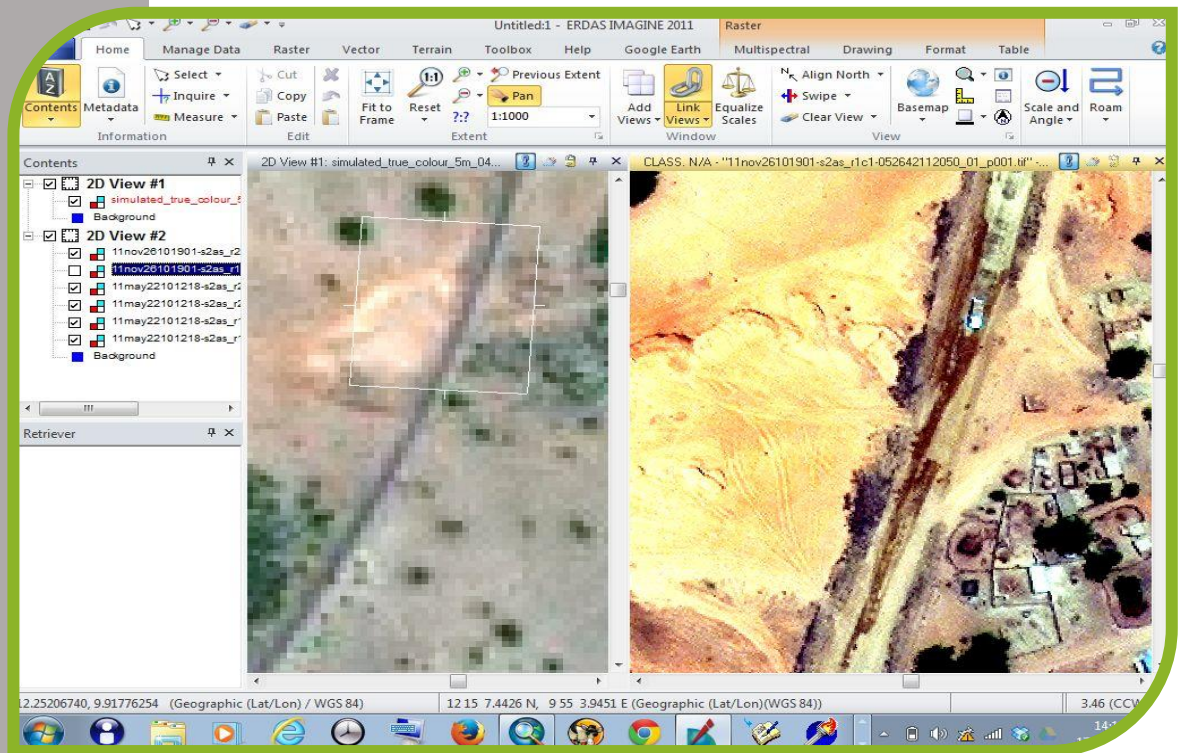




The use of appropriate high-tech solutions for road network and condition analysis, with a focus on satellite imagery

Interim Progress Report No. 3



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AFRICA COMMUNITY ACCESS PARTNERSHIP (AfCAP) ***Safe and sustainable transport for rural communities***

AfCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa. The AfCAP partnership supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The programme follows on from the AFCAP1 programme that ran from 2008 to 2014. AfCAP is brought together with the Asia Community Access Partnership (AsCAP) under the Research for Community Access Partnership (ReCAP), managed by Cardno Emerging Markets (UK) Ltd.

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Airbus DS

Acronyms, Units and Currencies

AfCAP	African Community Access Partnership
AoI	Area of Interest
ARTReF	African Roads and Transport Research Forum
AsCAP	Asia Community Access Partnership
CERSGIS	Centre for Remote Sensing and Geographic Information Services
DRSRS	Department of Resource Survey and Remote Sensing
GEM	Economic Growth through Effective Road Asset Management
GIS	Geographical Information System
GPS	Global Positioning System
ICTA	International Conference on Transportation in Africa
IRI	International Roughness Index
LIC	Low Income Country
LVR	Low Volume Road
MTRD	Materials Testing and Research Division
PIT	Project Implementation Team
PMU	Programme Management Unit
RAMS	Road Asset Management System
RCMRD	Regional Centre for Mapping of Resources for Development
ReCAP	Research for Community Access Programme
SAR	Synthetic Aperture Radar
UK	United Kingdom

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1. Executive Summary

This project is designed to look to the future of road management in Africa and to explore innovative solutions to known problems. It is a regional project and is designed to consider high-tech solutions and road condition monitoring through satellite imagery across the range of conditions and environments found in Africa.

This report shows the progress on deliverables during Phase 2, which is the research trials part of the project. This report focuses on activities achieved since the Interim Trials Report was submitted.

The main activities undertaken so far in Phase 2 are:

- Imagery has been procured for all countries. In Ghana it was difficult to acquire all of the imagery due to persistent cloud cover and haze caused by the Harmattan winds from the Sahara, which bring dust into the atmosphere during the dry season. Consequently part of the area of interest was covered by archive imagery.
- Zambia, Uganda and Ghana completed their ground truthing within 2016. Kenya is still to complete this task.
- Training has been carried out in Zambia, Uganda and Ghana. These countries have all completed the condition assessment by satellite imagery, although not all of the results are processed yet. The results from Ghana are likely to be more accurate than other countries as they use a three level assessment system, rather than a five level, although some of the imagery was archive and therefore less recent.
- The methodology is in the process of being revised to suit the existing processes in each country.

The project is still behind schedule, due to delays in ground truthing and arranging the training.

2. Introduction

This interim progress report sets out the status of Phase 2 of the project beyond the progress reported in the first two progress reports and the Interim Trials report. This is currently the trials phase where the methodology is being tested in the field. In the Interim Trials Report Zambia and Uganda were covered as they had completed their training and condition assessment by satellite.

This report focuses mainly on Ghana, where the Ministry of Roads and Highways is leading the project, with support from the Centre for Remote Sensing and Geographic Information Services (CERSGIS). Since the Interim Trials Report this has been the main activity.

3. Background

This project is expected to lead to alternative, cost-effective methods to support asset management through enabling countries to gain a better understanding of their rural road networks and to be able to make more informed decisions on the funding for maintenance and management of those networks. In addition to this the project is expected to develop a method for using cost-effective satellite imagery to assess the condition of roads.

4. Progress to date

4.1 Summary

This report covers the period from 28th February until 31st March 2017.

The main aims relevant to this interim progress report are shown below in Table 1.

Table 1 - Summary of Phase 2 Aims

No.	Aims of Phase 2	Actions
5	Ground truthing condition surveys	Confirm maps, carry out condition surveys
6	Background training in country	Train all team members to be competent with GIS
7	Revise methodology	Establish rules and criteria for condition assessment
8	Identify imagery required	Identify satellite imagery and start to procure from various sources
9	Train in image interpretation	Airbus DS to carry out specialist training to partner country teams, regionally. Local training providers selected to learn from this training and replicate where possible.
10	Carry our condition assessment from satellite imagery	Local teams to carry out assessment, using the training they received.
11	Analysis of results	Countries supported by TRL.

4.2 Expected progress

By this date it was expected that all of the ground truthing and satellite assessment activities would have been completed, and the Final Trials Report would have been submitted. However, these activities are still outstanding for Kenya, whilst Ghana completed their assessment in March 2017.

4.3 Activities undertaken

The following activities have been undertaken since the Interim Trials Report was submitted:

4.3.1 Procurement of Imagery

The imagery has now been procured for all countries. This included a range of imagery including tasked Pleiades, archive Pleiades, SPOT 7 and SAR. In Ghana the imagery procurement was an issue due to persistent cloud cover and haze caused by the Harmattan winds from the Sahara, which brought dust into the atmosphere, meant that archive imagery had to be used for part of the Aol.

4.3.2 Training in QGIS and image interpretation

Training for Ghana was carried out within March 2017. The training was carried out by Airbus DS and was attended by a total of 10 participants, five from the Ministry and five from CERSGIS. The training was successful and included a half-day field trip to the Aol in the Eastern Region.

4.3.3 Assessment of road condition using satellite imagery

Immediately following the training in Ghana the assessment was carried out with staff from the Ministry of Roads and Highways, Department of Feeder Roads and CERSGIS. The digitisation of the Ground Truthing was completed and a team who was not involved in the ground truthing then used the satellite imagery to assess the road condition on all roads in the AoI. They used the digitised roads to create a separate map for the satellite condition assessment so that the two could be compared.

4.3.4 Analysis of results

Some initial assessment of the results has been possible. Ghana uses a three level condition assessment system, with roads being divided into 'Good', 'Fair' and 'Poor'. The overall network was approximately 97km, two thirds of which is unpaved, and the rest paved with a bituminous surface. Initial results show that the overall correlation between ground truthing and satellite assessment is between 78% and 100%, although the 100% is for a small sample ('Poor' paved roads, 2.85km only). Also the proportion of assessments that were more than one condition level out (i.e. Good assessed as Poor, or vice versa) was less than 1%. More analysis needs to be done on this data, but the results are encouraging and appear to be more consistent than the five level condition assessment, where it is far easier to be more than one condition level out.

4.3.5 Tanzania scoping study

The Team Leader visited Tanzania to make a scoping study on how Tanzania could be involved in this project, both in the current phase and in the longer term. The results of this are contained in a separate report.

4.4 Challenges

There have been some delays in implementing the ground truthing in Kenya due to funding issues. TRL have liaised with Kenya to arrange the ground truthing and training, which is now scheduled for the first two weeks in April 2017. This has delayed the whole programme, as the Kenya results are integral to the overall research, but it is hoped the final deliverable dates will not be delayed further.

There have been some minor difficulties in procuring the satellite imagery, and there have also been some logistical challenges during the ground truthing process. These issues have been noted and will be accounted for in the final methodology.

4.5 Gender

The consultants have encouraged the partner countries to involve women as much as possible in this project. All countries will include at least one woman in their assessment teams, with as much as 66% in some teams.

4.6 Capacity Building

Local institutions have been used to carry out the background training in each partner country, as a more cost effective and sustainable solution. The specialist training from Airbus DS is considered as a 'training of trainers' so that the knowledge is retained in country and can therefore be passed on in the future. RCMRD have been procured to carry out the training in Kenya, although this has not yet been arranged.

4.7 Uptake and Dissemination

The Team Leader facilitated a workshop at the International Conference on Transportation in Africa (ICTA) conference in Ghana in October 2016 and was also invited to the PIT workshop for the Economic Growth through Effective Road Asset Management (GEM) project in South Africa, where a

presentation was made on the project to all AfCAP and the African Roads and Transport Research Forum (ARTReF) members.

The Team Leader has also applied to host a workshop at the T2 conference in Zambia in May 2017, although it is hoped that this will be co-delivered by one or more of the partner country staff. TRL have proposed that a representative for each partner country attends.

5 Budget Against Actual Expenditure

5.1 Summary

Invoices for the Inception Report, Desk Study Report, Progress Reports 1 & 2, and Interim Trials report have been submitted and paid. The next invoices will be for the Tanzania scoping study and this interim progress report. An invoice will also be submitted for Provisional Sums for the remainder of the satellite imagery.

6 Next Steps

The planned next steps are:

- To carry out ground truthing in Kenya. This has now been confirmed by MTRD to happen from 31st March to 4th April 2017.
- To identify and plan the training for Kenya. This has now been confirmed by MTRD to take place from 5th to 7th April 2017.
- For Kenya to start the actual assessment of condition from the imagery, analyse the results and compare to the ground truthing. This is planned for the week commencing 10th April, with the Team Leader and Researcher staying in country to assist in the process.
- For all countries to finalise the analysis of data, with the support of the TRL team. The Team Leader is travelling to Uganda from 9th to 11th April to finalise this process.
- To finalise the Trials Report. This should be finalised by the 17th April 2017.
- To start the revision of the methodology and initiate the guideline.

7 Lessons Learned

The lessons learned shown in the previous progress report are still valid. Ghana has provided a lesson in procuring imagery, which has been difficult due to the environmental conditions. This would mean that the condition assessments would be restricted to a small window each year when the imagery could be procured with sufficient clarity. This was to some extent expected in Ghana as it was chosen due to the tropical climate and high levels of vegetation.

8 Conclusion and Recommendations

All countries have now been visited at least three times. Most have shown good cooperation, despite challenges for funding.

The ground truthing programmes have been delayed, partly due to local issues. The ground truthing was completed in Ghana, Uganda and Zambia largely during the dry seasons, and it is hoped that the

climate in Kenya will have minimal impact as the area selected is in a desert region which receives very little rain anyway.

Appropriate local partners have been identified in each country so far. These partners are all specialists in remote sensing and have agreed to assist with training of local staff to bring all team members up to the required level. These partners will be the focus of producing a sustainable base for this technology into the future.

The methodology for condition assessment is being refined following the results so far. The specialist training undertaken by Airbus DS and TRL was successful in providing sufficient skills in QGIS and imagery interpretation for the participants to make the assessments. RCMRD attended the training in Uganda and will manage the training in Kenya on a similar basis.

Partner country contributions are being assessed and will be reported to AfCAP on completion of the trials period.

The interim recommendations made in the previous report are still valid and no more have been identified.

It should be noted that the submission date for the Final Trials report in the Updated Workplan in Annex C has been moved back to 17th April, due to the delays in Kenya. This date is dependent on the ground truthing and training being carried out in early April, as is being negotiated with Kenya at the present time. It is hoped that this will not have a significant effect on the overall project duration and that the project can still complete by the end of July 2017.

Annex A: Results Achieved in Reporting Period (Date)

Progress against workplan.

Activity	Expected Progress for Reporting Period	Actual Progress for Reporting Period	Deviation	Challenges	Corrective Action / Comment ¹	
					Action	By Whom?
Carry out ground truthing	Complete	All complete except for Kenya	Delayed by 2 months	Funding locally to carry out ground truthing	Chasing Kenya management	R Workman
Carry out training in QGIS and image interpretation	Complete	All complete except for Kenya	Delayed by 2 months	Waiting for ground truthing before training can be delivered	AfCAP agreed to assist with training costs, TRL to arrange	R Workman
Assessment of road condition via satellite imagery	Complete	All complete except for Kenya	Delayed by 2 months	Dependent on ground truthing and training	Pending	R Workman
Analysis of results	Complete	Countries and TRL are still working on the analysis	Delayed by 2 months	Dependent on assessment	R Workman has visited Zambia, Uganda and Kenya to assist with the analysis	R Workman

¹ If appropriate (i.e. if planned activities were not implemented) then signal what actions will be taken by whom to address deviations from the work plan.

Annex B: Steps for Next Reporting Period to 15th May 2017

Workplan for next reporting period.

Activity	Expected Progress for Reporting Period	Planned sub-activities ²
- Ground truthing, training and assessment in Kenya	Complete	Team to visit Kenya to support training and assessment of condition via satellite imagery
- Analysis of data in all four countries	Complete	Support country teams as necessary, visit planned to Uganda and Kenya, others will be supported remotely
- Finalisation of Final Trials Report	Complete	TRL to manage with information from country teams
- Development of methodology and guideline	Complete	Ongoing
- Hold workshop at T2 conference	Complete	TRL to submit proposal to AfCAP detailing costs and inputs. Proposal for workshop already submitted.

² If planned activities were not implemented in the period covered by this report, then the actions proposed in Annex 1 to address this should also appear in this column.

