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

Progress Report No. 2

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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.
See www.research4cap.org

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Acronyms, Units and Currencies

AfCAP	African Community Access Partnership
AfDB	African Development Bank
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
ESA	European Space Agency
GEM	Economic Growth through Effective Road Asset Management
GIS	Geographical Information System
GPS	Global Positioning System
HIC	High Income Country
ICTA	International Conference on Transportation in Africa
IoT	Internet of Things
IQL	Information Quality Level
IRI	International Roughness Index
LIC	Low Income Country
LIDAR	Light Detection and Ranging
LVR	Low Volume Road
MTRD	Materials Testing and Research Division
NRSC	National Remote Sensing Centre
PIT	Project Implementation Team
PMU	Programme Management Unit
RAMS	Road Asset Management System
RCMRD	Regional Centre for Mapping of Resources for Development
RDU	Research and Development Unit
ReCAP	Research for Community Access Programme
SAR	Synthetic Aperture Radar
SEACAP	South East Asia Community Access Programme
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UNRA	Uganda National Road Authority

Contents

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.

The main activities undertaken so far in Phase 2 are:

- The initiation of all partner countries: Uganda, Zambia, Ghana and Kenya, who have all committed to provide resources for the project, both in terms of staff time and logistics.

- Following on from the initial visits to Uganda and Zambia, visits have also been made to Ghana and Kenya to assess capacity, identify areas of interest for the surveys, commit resources, plan ground truthing surveys, assess and plan training, identify potential high-tech solutions and agree a way forwards.

- Imagery has already been procured for Uganda and Zambia, and the areas of interest have been logged for Ghana and Kenya.

- The methodology is in the process of being revised to suit the existing processes in each country.

- The Project Implementation Team (PIT) meeting in Caledon, SA, provided a good opportunity to disseminate information on the project amongst AfCAP and AsCAP country partners and others.

The project is still behind schedule, but it is hoped that some time can be made up over the next two months.

2. Introduction

The project started on 25th April 2016 and is due to complete in May 2017.

The confirmed partner agencies are:

- Uganda – Uganda National Road Authority (UNRA), with support from Makerere University

- Zambia – Research and Development Unit (RDU) of the Roads Development Agency (RDA), with support from the National Remote Sensing Centre (NRSC) Zambia

- Ghana – Ministry of Roads and Highways, with support from the Centre for Remote Sensing and Geographic Information Services (CERSGIS)

- Kenya – Materials Testing and Research Division (MTRD), with support from the Department of Resource Survey and Remote Sensing (DRSRS) Kenya and the Regional Centre for Mapping of Resources for Development (RCMRD)

The satellite assessment aspect was borne out of the research undertaken in Nigeria to map and assess the condition of rural, unpaved roads (Ref: Transport Infrastructure Monitoring Project, funded by Catapult). The main principle of that research was to test the feasibility of using satellite imagery as a way to avoid on-the-ground surveys in an area that is heavily involved in conflict and where many areas are too dangerous to visit. This research builds on that by testing the

methodology in the real world situation using local systems and processes, with the aim to produce a guideline to the most cost effective methodology for carrying out this methodology for road condition assessment.

The high-tech solutions aspect is designed to identify a small number of technologies that can be researched with the aim of increasing knowledge of rural road networks.

This progress report sets out the status of Phase 2 of the project beyond the progress reported in the first report; this is the trials phase where the methodology is being tested in the field.

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, following on from previous research undertaken in Nigeria in 2013. We have liaised with the other regional AfCAP projects on asset management and climate resilience and recommendations are made later in this report.

The project objectives as stated in the ToR are to provide a cost-effective and reliable high-tech solution for the capture of management data related to inventory and condition of a country's rural road network. The project is also expected to enhance the capacity of relevant partner-country road and transport ministries, departments and agencies in the key areas covered by the project. In line with the ReCAP guiding principles the project is expected to incorporate a process for keeping relevant agencies fully informed on project outcomes and how these outcomes can be cost-effectively utilised in normal practice.

An extensive literature review has been undertaken which has uncovered a large amount of previous research in the areas of remote sensing to establish knowledge on rural road networks, as well as research and practical experience in other high-tech areas of road knowledge and management that could be applied in the African context. This is shown in the desk study.

4.   Progress to date

4.1   Summary

This is the second progress report for the pilot phase of the programme and covers the activities achieved since the last progress report in October 2016. There have been some delays in completing Phase 1; initially in finalising the Desk Study Report but mainly in the Peer Review and subsequent Progress Report No. 1. The Peer Review has been assessed and the Desk Study report has been revised in line with many of the comments in the Peer Review.

The initial country visits went ahead before the Peer Review was complete, in order to maintain progress. The activities carried out during this period are consistent with the revised Peer Review.

The main aims of Phase 2 are shown below in Table 1.

Table 1 - Summary of Phase 2 Aims

No.	Aims of Phase 2	Actions
1	Feedback from Peer Review	Adjust methodology based on feedback
2	Confirm partner countries	Gain firm commitment of partnership
3	Make initial visits to each country	Identify teams, areas to be surveyed, maps, other partners and training needs, identify high-tech solutions to be trialled
4	Pilot high-tech solutions	Countries to seek funding for research, undertake identified pilots
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.

4.2 Expected progress

By the second progress report date it was expected that the following activities would have taken place:

- Inception report submitted and approved
- Desk study report submitted and approved
- Partner countries confirmed and local resources committed.
- Peer review submitted and reviewed.
- Initial visits undertaken to all partner countries and geographical areas of research identified
- Some satellite imagery tasked/procured
- Some training in image interpretation carried out
- Some high-tech solutions identified and funding sought

4.3 Activities undertaken

The following activities have been undertaken since the start of the project.

4.3.1 Inception Report

This was submitted on time in May 2016.

4.3.2 Country Selection Report

This was submitted early in June 2016 so that the desk study could confirm the characteristics of the potential partner countries.

4.3.3 Desk Study Report

This was submitted two weeks later than scheduled in July 2017 and was revised based on the results of the Peer Review.

4.3.4 Peer Review

The first part of the Peer Review was completed on 20th September by the Satellite Applications Catapult, approximately 2 months behind schedule as explained in Progress Report No. 1.

4.3.5 Initial partner country visits

Initial visits have been made to all countries, Uganda and Zambia were reported in Progress Report No. 1 and a detailed report of the Ghana and Kenya visits can be seen in Annex G. These visits took place on the following dates:

- Ghana was visited between 26th and 30th September 2016
- Kenya was visited between 17th and 21st October 2016

These visits involved meeting the main stakeholders in the project, for example:

- AfCAP coordinator
- Project team in the host organisation
- Remote sensing specialist partners who will be involved in the training
- Other potential partners or donors

The main aims and progress of the initial visits are shown in Table 2:

Table 2 – Aims and Achieved Actions

Aims of initial visits	Achieved actions
Present details of the project and meet the main stakeholders	This was achieved in all countries.
Become familiar with the existing system of condition assessment in each country	This was achieved in all countries through the field visits and by consulting local staff responsible for condition surveys.
Assess the existing system against that proposed in the desk study report	This process has started and is ongoing
Carry out a field visit to assess potential roads/networks for the study	This was undertaken in all countries
Identify the geographic area to be trialled in the pilot phase	This has been identified for all countries
Plan ground truthing/condition assessment in line with country practices	This has been completed for Uganda and Zambia and is planned for Ghana and Kenya.

Determine background training necessary to be carried out by local partners	This has been initiated in all countries and will be finalised by the partners themselves
Identify suitable organisations to carry out background training	Local partners have been identified for all countries
Identify an image interpretation team and assess their capacity.	This has been finalised in Uganda, Zambia and Ghana, and is almost complete for Kenya.
Identify a potential date for specialist training by the consultants	Dates have been agreed for Zambia and Uganda and are pending for Ghana and Kenya
Initiate a search for available imagery or plan a tasking mission to collect imagery for the trial area.	Imagery has been procured for Uganda and Zambia and searches have been initiated for both areas in Ghana and Kenya

4.4   Challenges

- There have been delays due to the Airbus DS trainer being taken ill, so a temporary replacement, Ned Chisholm, was agreed. He will carry out the training in Uganda and Zambia during November 2016.

- There have been some delays in implementing the ground truthing in Ghana and Kenya. Ghana are carrying out re-training of their staff who do the condition assessments, so it was seen as sensible to wait until this re-training was complete in November. The ground truthing for Ghana should take place in late November or early December. Kenya are allocating resources for ground truthing and it is hoped that it will also be completed within November 2016, or at the latest December 2016.

- Our proposal specified regional training with countries coming together for two regional training events between the four countries. Unfortunately the countries are unable to fund their teams to travel for regional training, so training will need to be carried out in each country. It has been agreed that RCMRD will attend the Uganda training, then replicate that training for the Kenya team. However, an additional training date will be necessary for Ghana as the specialist SAR training will be carried out there as well. We will therefore be requesting an additional 5 days input from Airbus DS, plus associated travel to cover this additional input.

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.

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, in order to disseminate information on the project and

gain feedback on the potential high-tech solutions. The audience included transport and roads practitioners from Africa and elsewhere and the workshop was received well.

The TL 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. This workshop was attended by 20 countries and provided an excellent opportunity for dissemination.

The TL has also applied to make a presentation at the T2 conference in Zambia in May 2017, although it is hoped that this will be delivered by one or more of the partner country staff.

5   Budget Against Actual Expenditure

5.1   Summary

The first three invoices for the Inception Report, Desk Study Report and Progress Report No. 1 have been submitted. The next invoice is due when this Progress Report No. 2 is approved. An invoice will also be submitted for Provisional Sums for the dashboard cameras and part of the satellite imagery.

6   Next Steps

The planned next steps are:

- To carry out the training in Zambia and Uganda.

- To carry out ground truthing in Ghana and Kenya.

- To procure the satellite imagery for Ghana and Kenya.

- To identify and plan the training for Ghana and Kenya.

- To encourage partner countries to identify the high-tech solutions that they are interested in researching and seek funding, with the assistance of ReCAP and the project team.

- For countries to start the actual assessment of condition from the imagery, analyse the results and compare to the ground truthing.

7   Lessons Learnt

In some cases it is difficult for the partner country staff to relate the high-tech solutions to their work and therefore to find an innovative application. So far interest has been shown in the social media application and back analysis, but funding is yet to be sought or identified. It will be difficult for countries to undertake such research without dedicated funding and significant support, given that the technologies involved are not their core business and external inputs will be required.

All countries have established condition assessment regimes, but few carry them out strictly in accordance with the regulations, mainly due to a lack of resources. The resources needed for traditional condition assessments seem to be those most difficult to manage, such as vehicles, trained staff and equipment. This identifies a gap in the process that could provide an opportunity for condition assessment by remote sensing.

8   Conclusion and Recommendations

The Peer Review motivated a revised version of the Desk Study Report. It is recognised that this review has improved the report and will have a positive impact on the research.

All countries have now been visited and have shown good cooperation. All have faced challenges for funding, but all are now fully committed to the project, although their funding resources did not allow them to travel regionally for the specialist training. The issues related to high-tech solutions raised in Chapter 7 may restrict the amount of research that can be carried out in this phase, but recommendations will be made in the final report detailing which technologies have the potential to be successful and what the funding implications would be to implement them. The funding for such research will be challenging, given the coordination that will be necessary between sectors.

The ground truthing programmes have been delayed, partly due to local issues. The ground truthing in Uganda and Zambia has been carried out largely during the dry seasons, and it is hoped that the onset of the wet season in Kenya will have minimal impact as the area selected is in a desert region which receives very little rain anyway. In Ghana we expected to test the system with the presence of cloud, so the timing in terms of seasons is not so critical.

In terms of the proposed high-tech solutions, the countries have been asked to define exactly what they would like to research and to cost the potential research. Due to the short timeframe it may be necessary to outline the processes involved in researching these issues and take further time to seek funding and scope the research for future projects beyond the current project.

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 and specialist training courses developed to suit. The specialist training will be undertaken by Airbus DS and TRL, with RCMRD being the surrogate trainers for Kenya.

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

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?
- Inception Report	Completion by 9th May 2016	Completed by 6th May, final revision 16th May 2016	None	None	Small revisions to report	RW
- Country selection report	Completion by 4th July 2016	Completed by 22nd June 2016	Two weeks early at the request of PMU	To get countries on board before desk study complete	Minor revisions, some countries still to commit fully	RW
- Desk Study Report	Completion by 4th July 2016	Completion by 22nd July, final revision 27th July 2016	2 weeks late	Some issues with getting info. from countries and commitments	Minor revisions to report	RW
- Peer Review	Completion by 20th July 2016	Completed by 19th September 2016	2 months.	Desk study late, also issues with contracting peer reviewer and their availability	Revision of desk study necessary, to involve Airbus and TRL	RW, AO, AI

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[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.

-	Initial country visits	August-September 2016	Started in September, completed in October 2016	1 month	Delays in report and peer review, necessary to start in dry season	Visit programme adjusted to take account of delays and seasons	RW
-	Visit to Uganda	August 2016	September 2016	1 month	Delays as above	Necessary to start in dry season	RW
-	Visit to Zambia	August 2016	September 2016	1 month	Delays as above	Necessary to start in dry season	RW
-	Visit to Ghana	August/September 2016	September 2016	1 month	Delays as above and waiting for re-training of condition assessment staff	Not necessary to start in dry season due to different methodology	RW
-	Visit to Kenya	August/September 2016	October 2016	2 months	Late commitment and resources only available from November 2016	Training can be funded from the provisional sum	RW, AFCAP

Annex B: Steps for Next Reporting Period to 3rd January 2016
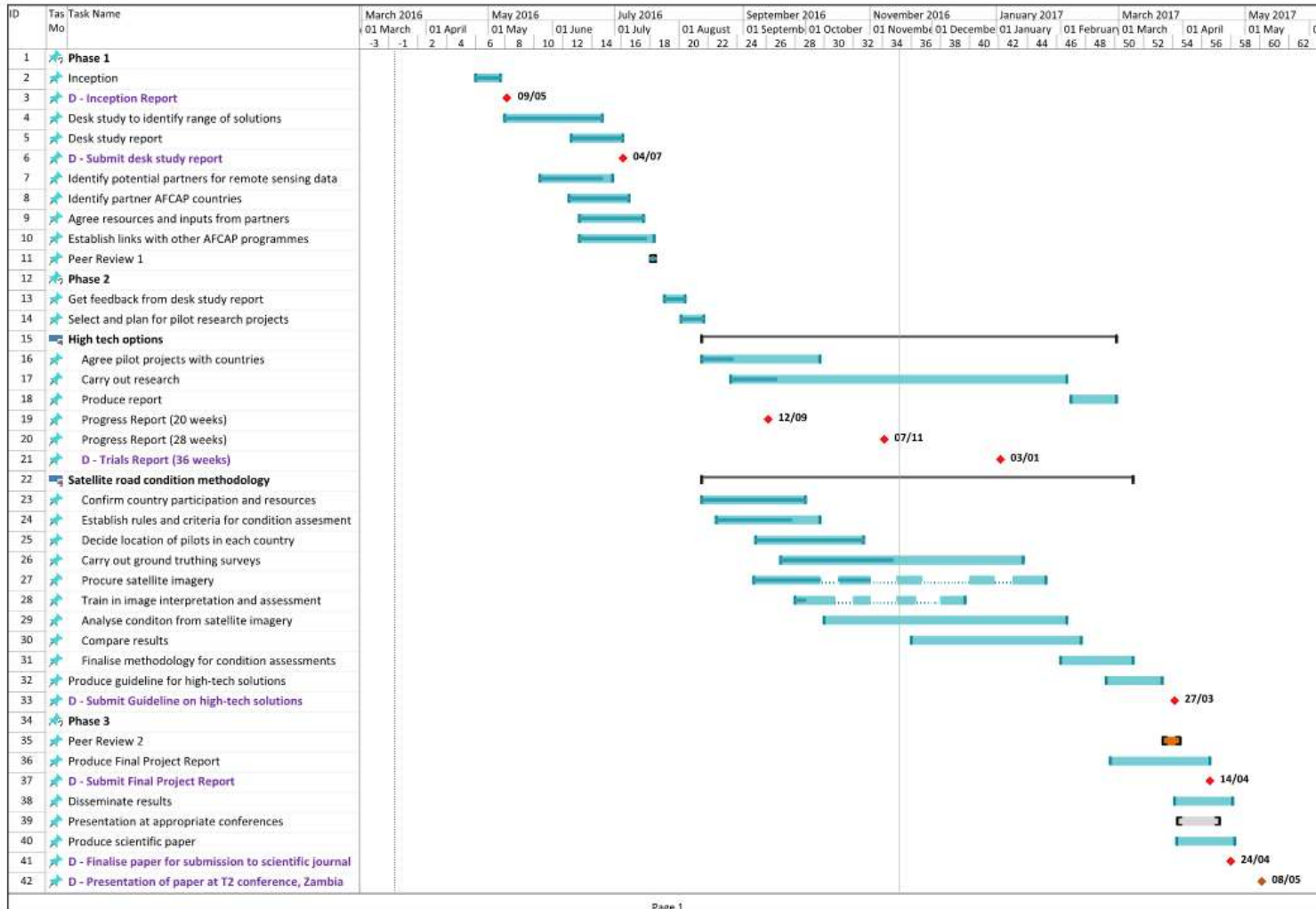
Workplan for next reporting period.

Activity	Expected Progress for Reporting Period	Planned sub-activities[2]
- Ground truthing	Complete all ground truthing in Ghana and Kenya before the next reporting period	Ground truthing will consist of: • Carrying out condition surveys on the trial roads • Collating the data • Analysing the data and producing it in a format that is easy to compare to the image interpretation
- Specialist Training	It is expected that all specialist training in image interpretation will be carried out during the period	Airbus DS will be carrying out the specialist training in two countries, with RCMRD staff taking on this role in Kenya as a way to test the replicability of the training. If successful this methodology may also be used in Ghana. There are two levels of training: • Background training to get all team members to a similar level of competence in GIS and other necessary computer skills, to be carried out locally • Specialist training to be carried out by the consultants
- Image interpretation	It is expected that the image interpretation will be started in all countries, but some may not be completed by the next reporting period	Image interpretation will be carried out by the local teams themselves. This task will include: • Assigning conditions to each length of road in line with the criteria set • Comparing this to the ground truthing and analysing the results
- High-tech solutions	All countries should have identified the high-tech	These sub-activities will depend on the solutions selected by the countries themselves and whether they manage to secure funding for them. There has been interest so far

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[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.

	solutions they are interested to research and should have started to explore potential sources of funding, with assistance from AfCAP.	mainly in the social media app for reporting maintenance or safety issues with the road. It would require external funding to produce the app. UNRA are also in the process of procuring a UAV for use in Uganda, so some research may be possible using that.

The team are in constant contact with the partner countries and will monitor progress up to the start of the holiday period in UK. It is expected that the countries themselves will also be on holiday at this time, so any significant activities should be completed before the 16th December 2016. Training is taking place during November in Zambia and Uganda, so targets will be agreed with those countries. Kenya and Ghana are expecting to complete ground truthing in November/December, so when this is complete targets will be agreed with them for training and condition assessment.

Annex C: Updated Workplan

ID	Tas Mo	Task Name	March 2016 – May 2017 Gantt chart
1		Phase 1	
2		Inception	
3		D - Inception Report	◆ 09/05
4		Desk study to identify range of solutions	
5		Desk study report	
6		D - Submit desk study report	◆ 04/07
7		Identify potential partners for remote sensing data	
8		Identify partner AFCAP countries	
9		Agree resources and inputs from partners	
10		Establish links with other AFCAP programmes	
11		Peer Review 1	
12		Phase 2	
13		Get feedback from desk study report	
14		Select and plan for pilot research projects	
15		High tech options	
16		Agree pilot projects with countries	
17		Carry out research	
18		Produce report	
19		Progress Report (20 weeks)	◆ 12/09
20		Progress Report (28 weeks)	◆ 07/11
21		D - Trials Report (36 weeks)	◆ 03/01
22		Satellite road condition methodology	
23		Confirm country participation and resources	
24		Establish rules and criteria for condition assesment	
25		Decide location of pilots in each country	
26		Carry out ground truthing surveys	
27		Procure satellite imagery	
28		Train in image interpretation and assessment	
29		Analyse conditon from satellite imagery	
30		Compare results	
31		Finalise methodology for condition assessments	
32		Produce guideline for high-tech solutions	
33		D - Submit Guideline on high-tech solutions	◆ 27/03
34		Phase 3	
35		Peer Review 2	
36		Produce Final Project Report	
37		D - Submit Final Project Report	◆ 14/04
38		Disseminate results	
39		Presentation at appropriate conferences	
40		Produce scientific paper	
41		D - Finalise paper for submission to scientific journal	◆ 24/04
42		D - Presentation of paper at T2 conference, Zambia	◆ 08/05

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Annex D: Progress towards ReCAP logframe outputs

Intervention Logic	Indicator	Next Milestone Target Date (from Inception Report)	Next Milestone Target (from Inception Report)	Comment. (Risks, challenges, will Targets be achieved, and on time?)	Achievement[3]	
Outcome: Sustained increase in evidence base for more cost effective and reliable low volume rural road and transport services, promoted and influencing policy and practice in Africa and Asia	1. SUSTAINABILITY: Partner Government and other financiers co-funding research with ReCAP. Contributions in kind (K) and Core Contributions (C)	October 2016	4 countries committed and engaged	Kenya has a lack of funds and AfCAP have agreed to supplementary funding for training	This reporting period	4 countries committed and funding
					Cumulative to date	As above
	2. Concrete examples of change (applied or formally adopted), influenced by ReCAP research that will be allied to #km of road in focus countries.	Too early to identify change	December 2016, ground truthing should be complete	Ground truthing is delayed in 2 countries, local resource arrangement is a challenge, despite funding being confirmed.	This reporting period	Some countries have started to allocate resources
					Cumulative to date	As above
	3. Number of citations in academic articles of ReCAP peer reviewed articles and/or working papers, conference papers etc.	Not due until end of project			This reporting period	None
					Cumulative to date	None

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[3] Evidence to be attached to the report submission.

Intervention Logic	Indicator	Next Milestone Target Date (from Inception Report)	Next Milestone Target (from Inception Report)	Comment. (Risks, challenges, will Targets be achieved, and on time?)	Achievement[3]	
Output 1: RESEARCH and UPTAKE: Generation, validation and updating of evidence for effective policies and practices to achieve safe, all-season, climate-resilient, equitable and affordable LVRR and transport services in African and Asian countries. (Low Volume Rural Roads : LVRR / TS – Transport Services)	1.1 LVRR: Number of peer reviewed papers generated from ReCAP supported or related LVRR research projects made available in open access format.	May 2017	May 2017		This reporting period	None
					Cumulative to date	None
	1.2. TS: Number of peer reviewed papers generated from ReCAP supported or related LVRR research projects made available in open access format.	May 2017	May 2017		This reporting period	None
					Cumulative to date	

Intervention Logic	Indicator	Next Milestone Target Date (from Inception Report)	Next Milestone Target (from Inception Report)	Comment. (Risks, challenges, will Targets be achieved, and on time?)	Achievement[3]	
	1.3 Engineering Research: National policies, manuals, guidelines and/or research outputs that have been fully incorporated into Government/Ministerial requirements, specifications and recommended good practice as a result of ReCAP engineering research (including climate change adaptation and AfCAP and SEACAP adaptations). To include introduction of new policies and modification to existing policies.	May 2017	May 2017	Guidelines will be complete by May 2017, but it will take a lot longer for them to be incorporated into government policy.	This reporting period	None
					Cumulative to date	None
	1.4 TRANSPORT SERVICES Research: National policies, regulations and/or practices for rural transport services	May 2017	May 2017	This depends on what high-tech solutions are taken forwards by the countries. Even after the research it will take time to	This reporting period	None

Intervention Logic	Indicator	Next Milestone Target Date (from Inception Report)	Next Milestone Target (from Inception Report)	Comment. (Risks, challenges, will Targets be achieved, and on time?)	Achievement[3]	
	modified or introduced as a result of ReCAP research (including road safety and gender and AfCAP and SEACAP research) To include introduction of new policies and modification to existing policies.			incorporate into government policy	Cumulative to date	None
	1.6. LVRR and TS information generated for dissemination, and disseminated, that is not peer reviewed. Total to include research papers, final research reports, workshop reports, manuals and guidelines.	Trial report due in January 2017	January 2017		This reporting period	Trials are approximately half way through so nothing to report yet
					Cumulative to date	As above
Output 2: CAPACITY BUILDING: The building of sustainable capacity to carry out research on low volume rural roads, and rural	2.1. African / Asian experts or institutions taking lead roles in ReCAP Research Projects.	May 2016	October 2016	Local partners have been brought in, but funding may be an issue.	This reporting period	From all partner countries there are other institutions who have been brought in to partner the local team, either Universities or Remote Sensing Centres. They will play a key role in the project. RCMRD training in Kenya is an example of this, which is expected to happen in

Intervention Logic	Indicator	Next Milestone Target Date (from Inception Report)	Next Milestone Target (from Inception Report)	Comment. (Risks, challenges, will Targets be achieved, and on time?)	Achievement[3]	
transport services in African and Asian countries.						December 2016.
					Cumulative to date	
	2.3. Research projects with female researcher inputs at senior technical level.	October 2016	October 2016	Involvement of women is dependent on availability, but Uganda have shown good initiative in identifying women in senior roles.	This reporting period	In Uganda four of the team of six are women and three will play a senior technical role. In Zambia there is one woman on the team and in Ghana two. The Kenya team is expected to have at least one woman member.
					Cumulative to date	As above
Output 3: KNOWLEDGE: Generated evidence base of LVRR and transport services knowledge is widely disseminated and easily accessible by policy makers and practitioners (including education and training institutions).	3.2. ReCAP generated knowledge presented and discussed at high level international development debates and conferences	April 2017	April 2017	If project is delayed the T2 conference may be missed	This reporting period	None
					Cumulative to date	None
	3.3.ReCAP generated knowledge disseminated through significant workshops and dedicated training, virtually or physically, that are rated by participants as effective.	April 2017	Recently held workshop at ICTA conference in October 2016		This reporting period	None
					Cumulative to date	None

Annex E: Participant Data

There have been no formal training events to date. The first training events are scheduled for November 2016.

Name	Position	Organisation	Gender	Contact details

Capacity Building Recipients

Name	Position	Organisation	Gender	Contact details

Annex F: Partner Contribution

Surveys and Assessment:

There are no constructed trial sections within this project. The trials consist of carrying out condition surveys and assessing the road condition from a satellite image of the same area. Condition surveys are planned for October and November 2016. However a site visit was arranged during the initial visit of the Team Leader, which required the following resources:

Uganda	Duration	Number	Total	Cost	Total
Vehicle	1 day	1	1		
Equipment	N/A	N/A	N/A	N/A	N/A
Staff	1 day	4	4		

Zambia	Duration	Number	Total	Cost	Total
Vehicle	1 day	1	1		
Equipment	N/A	N/A	N/A	N/A	N/A
Staff	1 day	4	4		

Ghana	Duration	Number	Total	Cost	Total
Vehicle	1 day	2	2		
Equipment	N/A	N/A	N/A	N/A	N/A
Staff	2 day	3	6		

Kenya	Duration	Number	Total	Cost	Total
Vehicle	N/A	N/A	N/A	N/A	N/A
Equipment	N/A	N/A	N/A	N/A	N/A

Staff	1 day	2	2		

Training

No training has yet taken place, training is planned for November and December 2016. Local partners have also been engaged for the training.

Staff Time

During the visit of the Team Leader several staff were made available to attend the initial presentation and to facilitate the visit by providing information and making introductions to different departments or other stakeholders. There were approximately 15 staff in attendance at each presentation, for approximately 2 hours. In each country the main coordinator spent approximately 2 days with the consultant, in addition to the site visits. Other key staff were consulted as necessary.

Other costs

No other costs were utilised.

Annex G: Country Reports

Summary of TRL initial Visit to Ghana – GEN2070A

26th - 30th September 2016

Background

- RW became familiar with institutional structure of the Ministry of Roads and Highways (MRH) and ownership of the road network, which is as follows:

  – Ghana Highways Authority (GHA): Trunk and Main roads

  – Department of Feeder Roads (DFR): Feeder roads and all smaller roads, managed by the Regional offices, including engineered and non-engineered roads.

- No formal asset management system exists, but HDM4 is used by some departments (GHA). Ministry is considering installing a system, perhaps that covers all modes of transport, such as HIMS. This could be in association with a locally developed asset management system.

- Condition surveys are undertaken on feeder roads by regional and district teams, with training by DFR.

- RW has obtained a copy of condition assessment forms, guidelines etc. from DFR.

Mapping

The level of existing GIS mapping within DFR is very good. It was established with help from DFID from 2001 to 2005. The videos taken by the team using the satellite project video camera are GPS enabled, we are exploring the possibility of extracting the GPS track from the .mov files.

The team used these maps and compared them to existing Google earth imagery to select the area of interest.

Ground Truthing

- The defined area to be used for the trials is in the central region, this area is shown in Fig. 1a and was assessed during the initial field visit. There are a range of unpaved roads, as well as a paved main road. Although the majority of roads were found to be in fair to poor condition, there was one in good condition, so a full range is possible. The polygon in Fig. 1a is approximately 10km by 10km, and includes:

  - Approximately 10km of Trunk road (under rehabilitation)

  - Approximately 45km of engineered feeder roads

  - Approximately 35km of non-engineered feeder roads

  - Approximately 30km of semi-engineered feeder roads

- It may be necessary to provide an area closer to Accra for training purposes, and an area has been identified to the north in the Eastern Region, see Figure 1b. The training can probably be carried out using a small area of archive imagery, as the terrain, vegetation and rainfall is very similar to the proposed area in Central Region. The consultants will check the availability of archive imagery in advance to see if this is possible. Archive imagery has the advantage of being cheaper per km^2 and it is also

possible to procure areas of just 25km^2, instead of the set minimum for tasked imagery of 100km^2.

- The consultant will make a field trip to assess the Eastern Region area during October. It may also be the case that this area could be used as the main pilot area if the range of road conditions is appropriate and it is found to be superior to the Central Region site.

- The ground truthing condition assessment team will be led by Edmond and Richmond, with the District office staff assisting, using the existing system used by DFR. Team will use the Dash-Cam whilst undertaking surveys, as well as the Road-Lab smartphone software. Edmond or Richmond to assist with the use and operation of the Dash-Cam. Roads will be sectioned into lengths of 1km for purposes of condition assessment (as per the existing system), each length of which will be allocated a condition from 'poor', 'fair' and 'good', as per the DFR categorisation. Drainage has four categories with the addition of 'critical'.

- DFR are planning to carry out training for local staff in how to conduct condition surveys, in November 2016, so it would make sense to carry out the ground truthing after this training has been completed.

- Ground truthing is programmed to start in early November 2016, when hopefully the wet season has abated. If possible the team should survey as many feeder roads within the selected area as possible, including engineered, non-engineered and semi-engineered. It is important that a full range of conditions is experienced.

- The DFR system of condition assessment has been compared to the outline methodology in the desk study report. The project categories will need to be adjusted to take into account the three levels of condition for the DFR surveys, compared to the five levels in the project methodology.

- Team should collect the data and record as per their usual procedures. If possible produce outputs, including strip maps with indications of condition using coloured scale (as per satellites desk study report). The coloured scale for DFR is opposite to that used in the project, in RoadLab and in the potential HIMS system. This should be easy to adjust in GIS. Condition will be consolidated on a 1km basis for all roads.

- Team should collate and store video imagery on a server. Review video images on computer to use as an audit/double check against the ground truthing.

- Collate and store Road-Lab results from smartphone. Review results on computer and use as audit/double check against the ground truthing.

Image interpretation
- Procurement of imagery is planned for November, based on the agreed area. It may be necessary to procure some archive imagery closer to Accra for training purposes as the selected site is at least a 3 hours' drive away, as mentioned above. There are similar areas in the Eastern region that can be reached within 2 hours.

- A team has been confirmed for image interpretation, including 3 from MRH and 3 from CERSGIS. Team identified so far are:
    - Edmond Balika/MRH

- Richmond Ankrah/DFR

- Juliet Amponsah/DFR

- Stella Ofori-Ampofo/CERSGIS

- Victor Guyir/CERSGIS

- Bashara Ahmed Abubakari/CERSGIS

- An outline training plan has been finalised, the final version is to be confirmed before the training visit of Airbus DS. Mr. Mensah has confirmed that CERSGIS would be able to supplement the training in GIS before the Airbus training expert arrives and can provide training facilities if necessary. The Ministry training base at Koforidua would also be appropriate and is close to the training site in the Eastern Region. MRH to arrange venue for training, in association with DFR and CERSGIS.

- There are good and accurate GIS maps within DFR. If the team are able to use a GPS during the ground truthing they would be able to check the accuracy of the mapping, which has not been updated since 2012. The existing maps are expected to be accurate, but additional roads may have been added.

- All training participants to be provided with laptops that have QGIS installed, currently the most up to date fully tested version is 2.14.5 and this is recommended, but all participants should have the same software. Airbus will check the latest release to see if it is fully tested.

- Training is expected to take place over 3 or 4 days towards the end of November 2016, but dates will be confirmed when the ground truthing is completed. This will also depend on weather. Training will be facilitated by Alex Irving of Airbus DS. This training should be regarded as a training of trainers so that the people trained will be able to pass on their knowledge to others in the future, especially within CERSGIS.

- The actual image interpretation should be carried out by someone who did not go on the initial site visit and is not familiar with the roads included in the area. This is to avoid any prejudices which could skew the results. If archive imagery from the Eastern Region is used for training this will not be an issue.

- When training is complete the staff trained can proceed to assess the imagery to define road condition on all identified roads.

Potential High-tech solutions

The following are potential technologies identified by MRH and DFR during the past week. This should be seen as a shortlist against which concept notes can be prepared and potential funders can be identified and approached. If any of these options are taken forwards MRH will need to explore possibilities for funding where appropriate, AFCAP and TRL will assist as necessary.

- UAVs / Drones – There is some interest in drones from Ghana, but a firm purpose would need to be identified as this is an expensive undertaking. This will be further discussed and may be of interest to other donors. Edmond will explore to see if it is possible to hire drones in Ghana.

- Archive imagery – The condition surveys on feeder roads are behind schedule. They are supposed to be carried out every year, but they were last undertaken 3 or 4 years ago. A question has arisen as to whether yearly surveys are really necessary and whether they can be less frequent. In this context archive imagery could also be used to determine the necessary frequency of condition assessments, by comparing the changes in condition over a number of years. Very high resolution imagery has been available for less than 10 years, but CERSGIS do not have a catalogue of very high resolution imagery, so this would require procurement. The imagery can also be used for back analysis, for example comparing a new system of maintenance to an old one.

- Climate resilience – It is possible that a project could be developed in this area, possibly through learning from the AFCAP regional climate resilience project. The consultant plans to explore opportunities for liaison in this area.

- Social Media – There is also some interest in developing the use of social media to involve the public more in road maintenance and road safety, and this has already been discussed with AFCAP separately. This will be further explored.

- Mapping of materials – Apparently the Ministry are already interested in this area and have been talking to AFCAP about it. There is experience in this area within Africa, including work carried out by TRL and under AFCAP projects. Some of this work has involved the use of satellite imagery or aerial imagery, for the location of materials such as calcretes, cinder gravels and laterites, all of which are being researched for use as road building materials.

Programming

- A programme for the pilot phase in Ghana has been produced, as shown below in Figure 2.

Figure 1a: Proposed area of investigation – Central region for tasked imagery

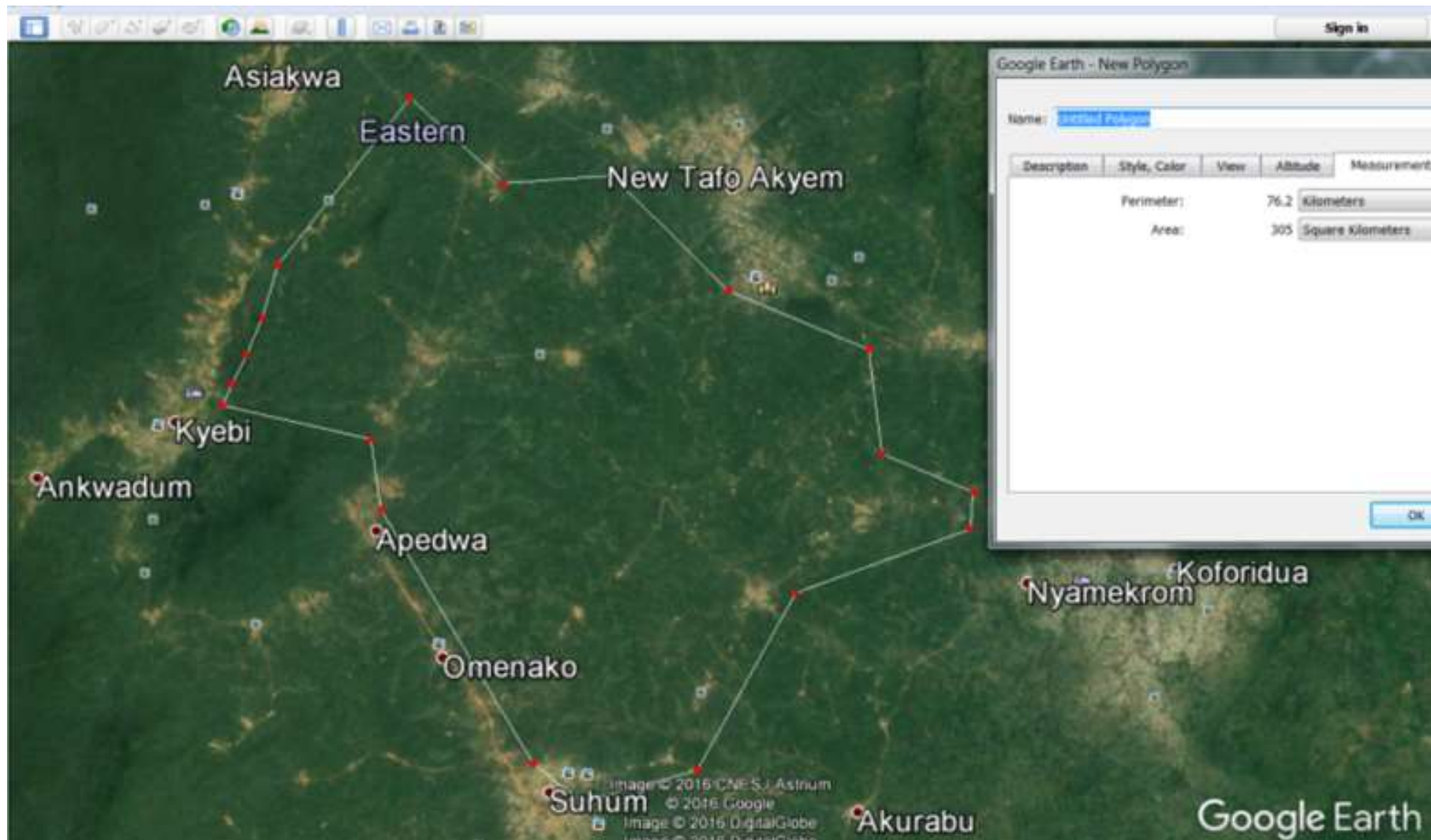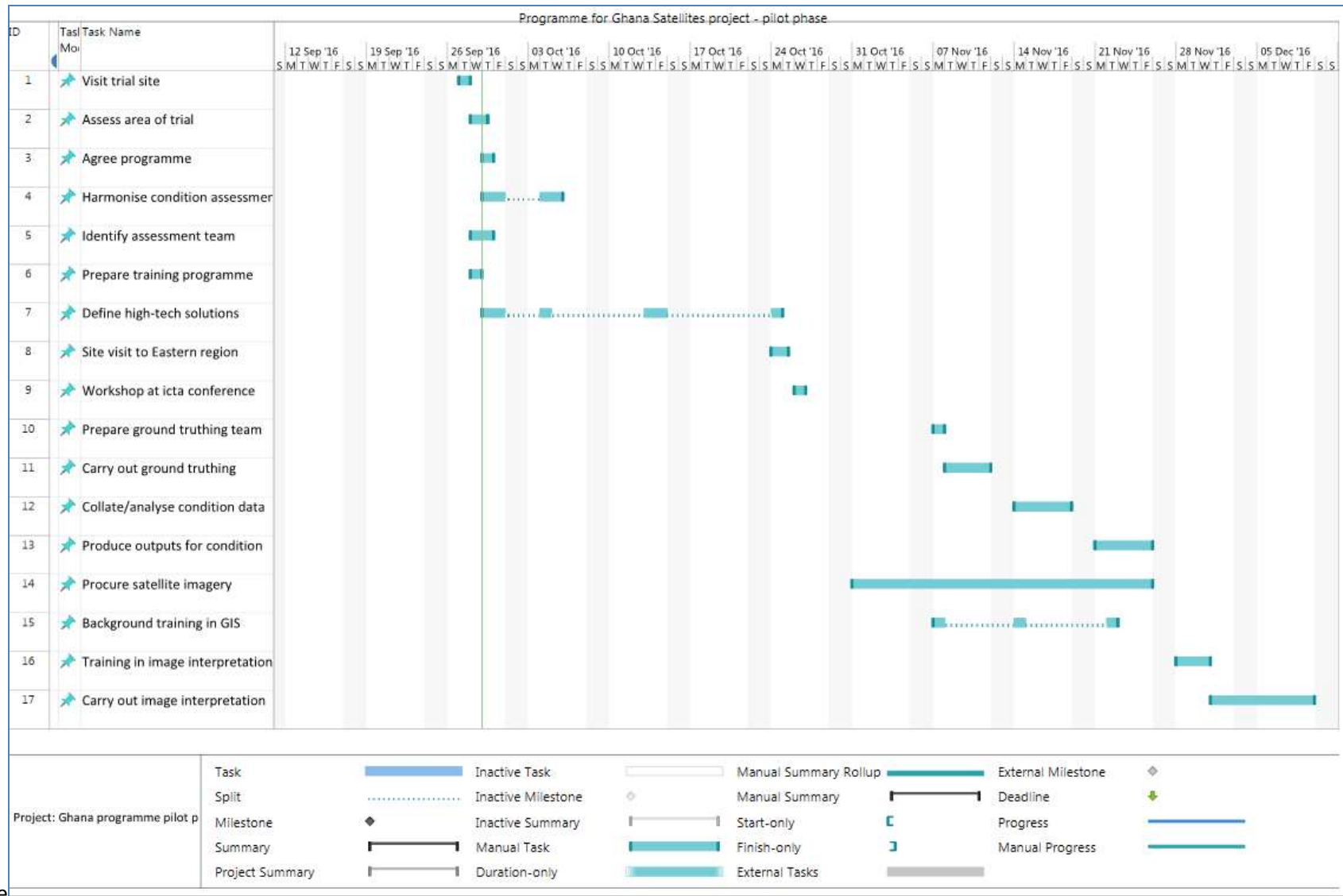Figure 1b: Proposed area of investigation – Eastern region for tasked and archive imagery

Figure 2: Programme for Ghana Satellites Programme – Pilot

phase

Summary of TRL initial Visit to Kenya – GEN2070A
17th – 23rd October 2016

Background

- The Team Leader is familiar with the institutional structure of the Materials Testing and Research Division (MTRD) and other institutions regarding ownership of the road network, which is as follows:

  - KENHA: A, B and C roads: Trunk and Main roads

  - KURA: Mainly B roads: Urban roads

  - KERRA: D, E and other roads: Rural

  - Counties: Assuming responsibility for many rural roads

- An asset management system exists and HDM4 is used.

- Condition surveys are undertaken on rural roads by MTRD.

- RW has obtained a copy of condition assessment forms, guidelines etc. from MTRD.

Mapping

Maps exist within MTRD, but soft versions are only available through KERRA. GIS maps of the proposed area have been requested. A handheld GPS will be used in the ground truthing to help establish up to date mapping for the area of interest. The team used available maps and compared them to existing Google earth imagery to select the area of interest, as shown in Figure 1a.

Ground Truthing

- The defined area to be used for the trials is in the Marsabit District, this area is shown in Fig. 1a and was assessed during the initial field visit. There are a range of D and E standard unpaved roads, as well as a paved main road, the A2. There was a good range of road conditions from very poor to very good. The polygons have been selected to cover the minimal area as the density of roads is very low and there is a need to maximise the procurement of satellite imagery:

  - Approximately 10km of Trunk road

  - Approximately 100km of D and E roads

- It is necessary to provide an area closer to Nairobi (south) for training purposes, see Figure 1b. The training can probably be carried out using a small area of archive imagery, as the terrain, vegetation and rainfall is similar enough to the proposed area in Marsabit District. The counterpart engineer will recommend an area for training.

- The ground truthing condition assessment team will be led by Joseph Gatimu and the MTRD team, with the other staff assisting if necessary, using the existing system used by MTRD. This system is based on roughness using a bump integrator and longitudinal profile, assessed manually.

- Team will use the Dash-Cam whilst undertaking surveys, as well as the RoadLab smartphone software. Joseph Gatimu is to assist with the use and operation of the Dash-Cam. If the team have available resources they should carry out a calibration of the RoadLab software and the bump integrator.

- Roads will be sectioned into lengths in line with the existing MTRD system for purposes of condition assessment, each length of which will be allocated a condition from 'very poor' to 'very good', as per the MTRD categorisation.

- Ground truthing is programmed to start in November 2016, whilst Kenya is still in the dry season. This will help with the procurement of satellite imagery due to the lack of cloud. If possible the team should survey as many rural roads within the selected area as possible, including engineered and non-engineered roads. It is important that a full range of conditions is experienced.

- The MTRD system of condition assessment will be compared to the outline methodology in the desk study report.

- The team should collect the data and record as per their usual procedures. If possible produce outputs, including strip maps with indications of condition using coloured scale (as per satellites desk study report).

- The team should collate and store video imagery on a server and review video images on computer to use as an audit/double check against the ground truthing.

- The team should also collate and store Road-Lab results from smartphone, review the results on computer and use as an audit/double check against the ground truthing.

Image interpretation

- Procurement of imagery is planned for November 2016, based on the agreed area. It may be necessary to procure some archive imagery closer to Nairobi for training purposes as the selected site is at least a 7 hour drive away, as mentioned above. There are similar areas south of Nairobi that can be reached within 2 hours. Archive imagery has the advantage of being cheaper per km^2 and it is also possible to procure areas of just $25km^2$, instead of the set minimum for tasked imagery of $100km^2$.

- A team has been confirmed for image interpretation, including four from MTRD and two from DRSRS. Team identified so far are:

  − Joseph Gatimu / MTRD
  − / MTRD
  − / MTRD
  − / MTRD
  − / DRSRS
  − / DRSRS

- It is proposed that RCMRD are the main training providers for Kenya, due to their proximity with their headquarters in Nairobi. It is the intention for them to attend the Uganda training to learn how it is carried out, then carry out similar training in Kenya. This is a sustainable solution, as well as providing RCMRD with the ability to carry out the training for other countries within east and southern Africa. AFCAP

have agreed that the cost of this training can be met from the Provisional Sum budget.

- An outline training plan has been finalised, the final version is to be confirmed before the Uganda training. It is hoped that DRSRS would be able to carry out the background training in GIS to MTRD staff who are not so proficient in this program, before RCMRD carry out the specialist training. The team will liaise with DRSRS to determine the costs of this training or whether it can be provided for free.

- There are reasonable GIS maps within KERRA. The team should aim to use a handheld GPS during the ground truthing in order to check the accuracy of the mapping. The existing maps are expected to be accurate, but additional roads may have been added and some alignments may have changed.

- All training participants should be provided with laptops that have the QGIS freeware installed; currently the most up to date fully tested version is 2.14.5 and this is recommended, but all participants should have the same software.

- Training is expected to take place over 3 days in November or December 2016, but dates will be confirmed when the ground truthing is completed. This will also depend on weather. Training will be facilitated by RCMRD. This training should be regarded as a training of trainers so that the people trained will be able to pass on their knowledge to others in the future, especially within RCMRD.

- When training is complete the staff trained can proceed to assess the imagery to define road condition on all identified roads.

Potential High-tech solutions

The following are potential technologies identified by MTRD and DRSRS during the initial visit of the team. This should be seen as a shortlist against which concept notes can be prepared and potential funders can be identified and approached. If any of these options are taken forwards MTRD will need to explore possibilities for funding where appropriate; AFCAP and TRL will assist as necessary.

- UAVs / Drones – There is some interest in drones from Kenya, but a firm purpose would need to be identified as this is an expensive undertaking. This will be further discussed and may be of interest to other donors. There are significant restrictions on UAV flights in Kenya, which would need to be fully assessed before any project is taken forward.

- Archive imagery – Many unpaved rural roads are not assessed for condition on a regular basis. The necessary frequency of condition assessments has not been tested, and there may be a case for exploring the most effective frequency. Archive imagery could be used to determine the necessary frequency of condition assessments, by comparing the changes in condition over a number of years. Very high resolution imagery has been available for less than 10 years, but Kenya does not have a catalogue of very high resolution imagery, so this would require procurement. The imagery can also be used for back analysis, for example comparing the life of an old road to the durability of a new one.

- Social Media – There is also some interest in developing the use of social media to involve the public more in road maintenance and road safety, which will be explored further.

- Mapping of materials: There is experience in this area within Africa, including work carried out by TRL and under AFCAP projects. Some of this work has involved the use of satellite imagery or aerial imagery, for the location of materials such as calcretes, cinder gravels and laterites, all of which are being researched for use as road building materials.

Programming

- A programme for the pilot phase in Kenya has been produced, as shown below in Figure 2.

Figure 1a: Proposed area of investigation – Marsabit district for tasked imagery

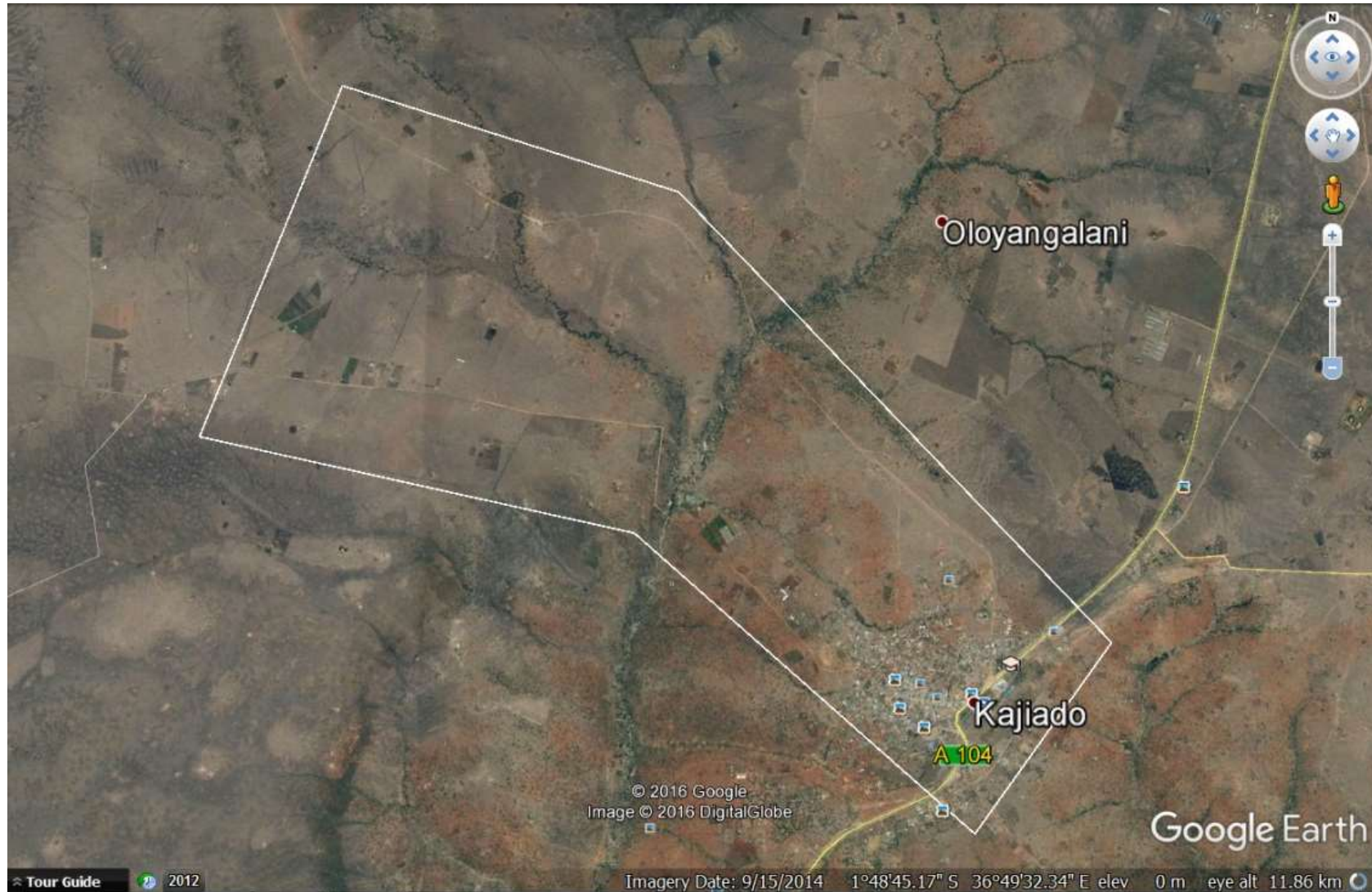Figure 1b: Proposed area of investigation – South of Nairobi for training reasons

Figure 2: Programme for Kenya Satellites Programme – Pilot phase