Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access

Fourth Quarterly Progress Report

Council for Scientific and Industrial Research (CSIR), Paige-Green Consulting (Pty) Ltd and St Helens Consulting Ltd

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Abstract

The African continent may be facing a potential direct liability in excess of $150 billion to repair and maintain existing roads damaged from temperature and precipitation changes directly related to projected climate change through this Century. This liability does not include costs associated with impacts to critically-needed new roads, nor does it include indirect socio-economic effects generated from dislocated communities and from loss of rural access.

In order to help address this significant threat to Africa's development, the Africa Community Access Partnership (AfCAP), a research programme funded by UKAid, has commissioned a project that started in April 2016 and is expected to be completed by December 2018, to produce regional guidance on the development of climate-resilient rural access in Africa through research and knowledge sharing within and between participating countries. The output will assist the development of a climate-resilient road network that reaches fully into and between rural communities.

The study focusses on: (a) demonstrating appropriate engineering and non-engineering adaptation procedures; (b) sustainable enhancement in the capacity of three AfCAP partner countries to deal with the effects of climate on their low-volume access roads; (c) sustainable enhancement in the capacity of additional AfCAP partner countries; and (d) uptake and embedment across AfCAP partner countries.

This fourth Quarterly Progress Report outlines the progress that has been made since the third Quarterly Progress Report of February 2018, i.e. it covers the period from March 2018 to May 2018. It primarily focusses on the following seven activities/events: (a) progress on the establishment of demonstration sections; (b) feedback on the embedment workshop and meetings held in Mozambique; (c) improvements to the Engineering Adaptation Guidelines; (d) status of the country reports; and (e) knowledge dissemination.

Key words

Change Management, Climate Adaptation; Climate Change; Climate Impact; Climate Threat; Climate Vulnerability; Rural Access; Resilience; Vulnerability

Research for Community Access Partnership (ReCAP)

Safe and sustainable transport for rural communities

ReCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa and Asia. ReCAP comprises the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). These partnerships support 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 ReCAP programme is managed by Cardno Emerging Markets (UK) Ltd.

www.research4cap.org

Glossary (within the concept of this project)

Adaptation	Autonomous or policy-driven adjustments in practices, processes or structures to take account of changing conditions.
Adaptive Capacity	The degree to which adjustments in practices, processes and structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change [in climate].
Adaptation Needs	The circumstances requiring actions to ensure safety of populations and security of assets in response to climate impacts.
Adaptation Options	The array of strategies and measures that are available and appropriate for addressing adaptation needs. They include a wide range of actions that can be characterised as structural, institutional, or social.
Capacity Building	The ability of enhancing strengths and attributes of, and resources available to, an individual community, society, or organisation to response to change.
Change Management	A collective term for all approaches to preparing and supporting individuals, teams and organisations in making organisational or institutional changes in order to equip them to address and resolve new or recurring challenges impacting on them and their stakeholders (e.g. impacts of climate variability and change on their operations)
Climate Change	Change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.
Climate Variability	Variations in the mean state and other statistics of the climate on all spatial and temporal scales beyond those of individual weather elements. Variability may be due to natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external forcing (external variability).
Disaster	Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.
Early Warning Systems	The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organisations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss.
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
Extreme Weather Events	An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

Flood	The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods.
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.
Impacts (Consequences, Outcomes)	Effects on natural and human systems. In this report, the term *impacts* is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.
Impact Assessment	The practice of identifying and evaluating, in monetary and/or nonmonetary terms, the effects of [climate] change on natural and human systems.
Likelihood	The chance of a specific outcome occurring, where this might be estimated probabilistically.
Mitigation	The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability.
Resilience	The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.
Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term 'risk' is used primarily to refer to the risks of climate impacts.
Risk Assessment	The qualitative and/or quantitative scientific estimation of risks.
Risk Management	Plans, actions, or policies to reduce the likelihood and/or consequences of risks or to respond to consequences.
System Sensitivity	The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
Vulnerability Assessment	Process which attempts to identify the root causes for a system's vulnerability [to climate variability and change).

Acronyms, Units and Currencies

ADB	Asian Development Bank
AfCAP	Africa Community Access Partnership
AIS	Accident Information System
ANE	Administração Nacional de Estradas (National Roads Administration, Mozambique)
AsCAP	Asia Community Access Partnership
BMS	Bridge Management System
CCA	Climate Change Adaptation
DFR	Department of Feeder Roads, Ghana
ERA	Ethiopian Roads Authority
EU	European Union
FinnOC	Finnish Overseas Consultants
FWD	Falling Weight Deflectometer
GIS	Geographic Information System
HDM	Highway Development and Management Model
HiMS	Highway Management System
INGC	National Disasters Management Institute
IRF	International Road Federation
IRI	International Roughness Index
LAN	Local Area Network
NDF	Nordic Development Fund
PIARC	World Road Association
PMS	Pavement Management Sysyem
PMU	Programme Management Unit, ReCAP
QGIS	Open-source GIS
RAMS	Road Asset Management System
ReCAP	Research for Community Access Partnership
RIS	Road Information System
RMMS	Routine Maintenance Management System
ROMDAS	Road Measurement Data Acquisition System
SARF	South African Road federation
SDI	Spatial Development Initiative
SDP	Spatial Development Planning
TIS	Traffic Information System
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)

Executive summary

Africa is experiencing dramatic changes to the continent's climate, which is causing widespread damage to road infrastructure and its associated assets. Rural accessibility is being compromised in a number of countries and sub-regions for increasing proportions of the year, with both direct and indirect adverse effects on livelihoods and associated socio-economic development.

In order to help address this significant threat to Africa's development, the Africa Community Access Partnership (AfCAP), a research programme funded by UKAid, commissioned a project in April 2016 to produce regional guidance on the development of climate-resilient rural access in Africa through research and knowledge sharing within and between participating countries. Research is being conducted on appropriate and economic methodologies for risk and vulnerability assessments; prioritisation of adaptation interventions; and optimisation of asset resilience in the context of rural access. In addition, evidence of cost, economic and social benefit links to rural communities arising from more resilient rural access will be required to support wider policy adoption across Africa.

Previous outputs from this project included an overview of current and projected climate threats and their impact on low-volume road infrastructure in particularly AfCAP partner countries; risk and vulnerability assessment methodologies; adaptation methodologies; and engineering and non-engineering adaptation options. Preliminary work was also done to establish demonstration sections in three Lead Countries, namely Ethiopia, Ghana and Mozambique, followed by workshops held in these countries. The purpose of these workshops was to assess these outputs as well as to identify the countries' priorities for uptake and embedment.

The current focus of the project is on demonstrations of appropriate practices, capacity building, and the uptake and subsequent embedment of outcomes at a range of levels, from informing national policies, through regional and district planning, down to practical guidance on adaptation delivery at rural road level. The demonstrations will largely focus on demonstrating the vulnerability assessment and climate adaptation methodologies.

This fourth Quarterly Progress Report presents the progress made since February 2018. The following were achieved during this quarter:

a) Further support provided to ANE in Mozambique for the establishment of demonstration sections on the Mohambe to Maqueze road in the Gaza Province;

b) A successful half-day workshop followed by two days of training and meetings were held in Mozambique focussing on the uptake of the vulnerability assessment methodology, the integration of climate adaptation in asset management, and embedment of climate change in policies and strategies;

c) Updating of the Engineering Adaptation Guideline, which is one of three guidelines supporting the Climate Adaptation Handbook;

d) Production of the Second draft of the Mozambican Country Report, also including the outcomes of the workshop and meetings held during April 2018;

e) Successful poster presentation at the Gender Summit 14 – Africa (Climate Change through the Gender Lens – Focus on Africa), held in Kigali, Rwanda in March 2018.

1 Background

1.1 Brief introduction to the programme and beneficiaries

The Africa Community Access Partnership (AfCAP) is a programme of applied research and knowledge dissemination funded by the UK Government though the Department for International Development (DFID). AfCAP is promoting safe and sustainable rural access in Africa through research and knowledge-sharing between participating countries and the wider community.

The proposed main beneficiaries of this Regional Project are the AfCAP partner countries, which currently consist of the Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Liberia, Malawi, Mozambique, Sierra Leone, South Sudan, Tanzania, Uganda and Zambia. The main focus is on low-volume road network and transport services that serve rural communities.

The AfCAP partner countries are shown in Figure 1.

Figure 1 AfCAP partner countries

1.2 Delivery organisations

The delivery organisation of the project is a Consortium consisting of the Council for Scientific and Industrial Research (CSIR), Paige-Green Consulting (Pty) Ltd and St Helens Consulting Ltd. The Consortium is led by CSIR.

1.3 Key dates

The period of implementation of this project is 33 months, from April 2016 to December 2018. It is conducted in two phases:

- Phase 1: April 2016 to February 2017 (11 months)
- Phase 2: April 2017 to December 2018 (21 months)

2 Project Background

2.1 General

Africa is experiencing more extreme climate events such as droughts, floods, storms and cyclones. Dramatic changes to the continent's climate is causing widespread damage to road infrastructure and its associated assets. Rural accessibility is being compromised in a number of countries and sub-regions for increasing proportions of the year, with both direct and indirect adverse effects on livelihoods and associated socio-economic development.

In order to help address this significant threat to Africa's development, the Africa Community Access Partnership (AfCAP), a research programme funded by UKAid with the aim of promoting safe and sustainable transport for rural communities in Africa, commissioned a project in April 2016 to produce regional guidance on the development of climate-resilient rural access in Africa through research and knowledge sharing within and between participating countries. Research is being conducted on appropriate and economic methodologies for risk and vulnerability assessments; prioritisation of adaptation interventions; and optimisation of asset resilience in the context of rural access. In addition, evidence of cost, economic and social benefit links to rural communities arising from more resilient rural access will be required to support wider policy adoption across Africa.

The project consists of two Phases. The focus of Phase 1 (April 2016 to April 2017) was primarily on the establishment of an approach to climate adaptation through research and knowledge exchange. A further aim was to provide consensus for the implementation of demonstration sections in Ethiopia, Ghana and Mozambique, and to deliberate on the initial guideline documents produced at workshops held in these three countries.

Outputs from Phase 1 addressed current and projected climate threats and their impact on low-volume road infrastructure; risk and vulnerability assessment methodologies; adaptation methodologies; and engineering and non-engineering adaptation options. Preliminary work was also done to establish demonstration sections in three lead countries, namely Ethiopia, Ghana and Mozambique, followed by workshops held in these countries. The purpose of these workshops was to assess these outputs as well as to identify the countries' priorities for Phase 2 of this project.

Phase 2 (May 2017 to December 2018) will mainly focus on demonstrations of appropriate practices, capacity building, and the uptake and subsequent embedment of outcomes at a range of levels, from informing national policies, through regional and district planning, down to practical guidance on adaptation delivery at rural road level. The demonstrations will largely focus on the vulnerability assessment and climate adaptation methodologies.

During Phase 2, synergies are being sought with relevant Development Partners' programmes such as those in Ethiopia (World Bank), Kenya (World Bank), Mozambique (EU, NDF, World Bank) and Tanzania (DFID), focussing on programmes that are aligned with the general objectives of this project. This is considered important to prevent duplication of efforts and to harmonise approaches that could be deployed across the sub-Saharan region.

2.2 Research objectives

The overall project objectives remain as follows (quoted from the project's Terms of Reference):

- *The fundamental research objective of this project is to identify, characterise and demonstrate appropriate engineering and non-engineering adaptation procedures that may be implemented to strengthen the long-term resilience of rural access*
- *Capacity Building and Knowledge Exchange. The appointed consultants must engage meaningfully, from project inception onwards, with relevant partner-country Road and Transport Ministries, Departments and Agencies/Authorities in a knowledge dissemination and capacity building programme*

based on the outputs from the research. Capacity building should include a wide range of targets from central government agencies to village groups.

- *Uptake and Embedment are integral elements of this project. The appointed consultants must ensure that there is focus on uptake and subsequent embedment of outcomes. This must be aimed at a range of levels from informing national policies, through regional and district planning, down to practical guidance on adaptation delivery at rural road level.*

2.3 Scope of Phase 2

The following five distinct parts have been adopted for Phase 2, reflecting the programme's aim and objectives (cf. Inception Report for Phase 2 (Verhaeghe et al., 2017a) for more information on the methodology and programme):

1. **PART A:** *Demonstrate appropriate engineering and non-engineering adaptation procedures*

   Identify, characterise and demonstrate appropriate engineering and non-engineering adaptation procedures that may be implemented to strengthen the long-term resilience of rural access. Assess the socio-economic impacts of adopting more climate resilient adaptations.

2. **PART B:** *sustainable enhancement in the capacity of three AfCAP partner countries*

   Engage meaningfully, from project inception onwards, with relevant partner-country Road and Transport Ministries, Departments and Agencies/Authorities in a knowledge dissemination and capacity building programme based on the outputs from the research. Capacity building should include a wide range of targets from central government agencies to village groups.

3. **PART C:** *sustainable enhancement in the capacity of additional AfCAP partner countries*

   Carry out situational analysis and initiate capacity building programme in additional countries.

4. **PART D:** *uptake and embedment across AfCAP partner countries*

   Uptake and embedment will assume the format of informing national policies, through regional and district planning, down to practical guidance on adaptation delivery at rural road level.

5. **PART E:** *Phase 3 recommendations*

   Set out costed long-term monitoring and evaluation proposals, as well as any future actions that may be required to strengthen uptake and embedment.

More information on the activities to be provided in Parts A to E are contained in the Inception Report for Phase 2 (cf. Verhaeghe et al., 2017a). Chapters 4 to 7 of this report address the progress achieved on Parts A to D, respectively.

3 Overview of Previous Progress Reports

Table 1 presents an overview of the project activities reported in the Inception Report and subsequent Progress Reports for the period April 2017to February 2018.

Table 1 Project Activities reported in previous Progress Reports

Document/Period (Reference)	Activities Reported
Inception Report Apr to Jun 2017 (Verhaeghe et al., 2017a)	– Outcomes of two workshops: (a) Tanzania Stakeholder Workshop (April 2017), and AfCAP Workshop held at the 8th Africa Transportation Technology Transfer Conference held in Zambia in May 2017 – Methods and/or screening tools used by the World Bank, the EU, the European Conference of Directors of Roads (CEDR) and the Asian Development Bank (ADB) for mapping climate vulnerability regionally, nationally and locally, and benchmarking of the method proposed by the AfCAP Project Team against these four methods – Progress on drafting of a generic Handbook outlining the climate adaptation methodology, as well as on guidelines for non-engineering adaptation measures.
1st Progress Report Jun to Aug 2017 (Verhaeghe et al., 2017b)	– Progress on the establishment of demonstration sections – The development of a climate threat and vulnerability methodology for application at a local/project level – The development of the draft *Climate Adaptation Handbook* and the three associated guidelines, namely *Change Management Guidelines*, *Climate Threats and Vulnerability Assessment Guidelines*; and *Engineering Adaptation Guidelines*.
2nd Progress Report Aug to Nov 2017 (Verhaeghe et al., 2017c)	– Progress on the establishment of demonstration sections – Further progress made on a climate threat and vulnerability assessment methodology – Feedback on the workshop held in Mozambique in September 2018 – The adaptation of conventional asset management practices to incorporate climate effects – The status of the country progress reports primarily focussing on the aspects of change management.
3rd Progress Report Nov 2017 to Feb 2018 (Verhaeghe et al., 2018)	– Progress update on demonstration sections – Feedback on workshops held in Ethiopia and Ghana – Updating of the Climate Risk and Vulnerability Assessment Guideline, and modification of the Handbook and Change Management Guidelines by the incorporation of the 'do nothing' strategic option – Status of the Country Reports for the three Lead Countries – Report back on the 1st Inter-Regional Implementation Meeting held in Uganda

4 Activity Progress: Demonstrations (Part A)

4.1 Mozambique

In March 2018, the Task leader (Dr Phil Paige-Green) and Mr Julius Komba, a senior engineer who will act as the Resident Engineer for the supervision of the construction of the demonstration sections on the Mohambe to Maqueze road in Mozambique, visited the demonstration site. The purpose of the site visit was for the senior engineer to gain a full understanding of the problems being addressed in the demonstration sections and the proposed adaptation measures. The site visit was accompanied by Ms Raquel Langa (ANE, Maputo), Mr Dady Novelo (ANE, currently working on a site in Chibuto), Mr Carlos Chissano (Contractor) and Mr Jorge Mugare (Supervisor). During the site visit, activities that will be undertaken during the construction of the demonstration sections were discussed, including the step-by-step construction process for each of the demonstration sections, and the identification of material tests to be conducted by the contractor before the start of the construction.

Following the visit, the designs for the demonstration sections were finalised, and the estimated Bill of Quantities for the proposed adaptations were updated and submitted to ANE. Latest communication received from ANE indicates that the World Bank has already approved funding, and ANE is currently preparing an instruction to the contractor for the implementation of the proposed adaptation measures.

4.2 Ethiopia

As reported in the second Quarterly Progress Report, the road in Ethiopia that was identified for the demonstration sections (Tulubolo to Kela road) became a non-viable option on account of the high standard of upgrading that had been proposed.

Three potential new roads were identified by the Ethiopian Roads Authority (ERA) in late April 2018. They are:

- Butajira to Gubre road;
- Butajira to Ziway road; and
- The Ziway -Shaeshemene-Hawasa road.

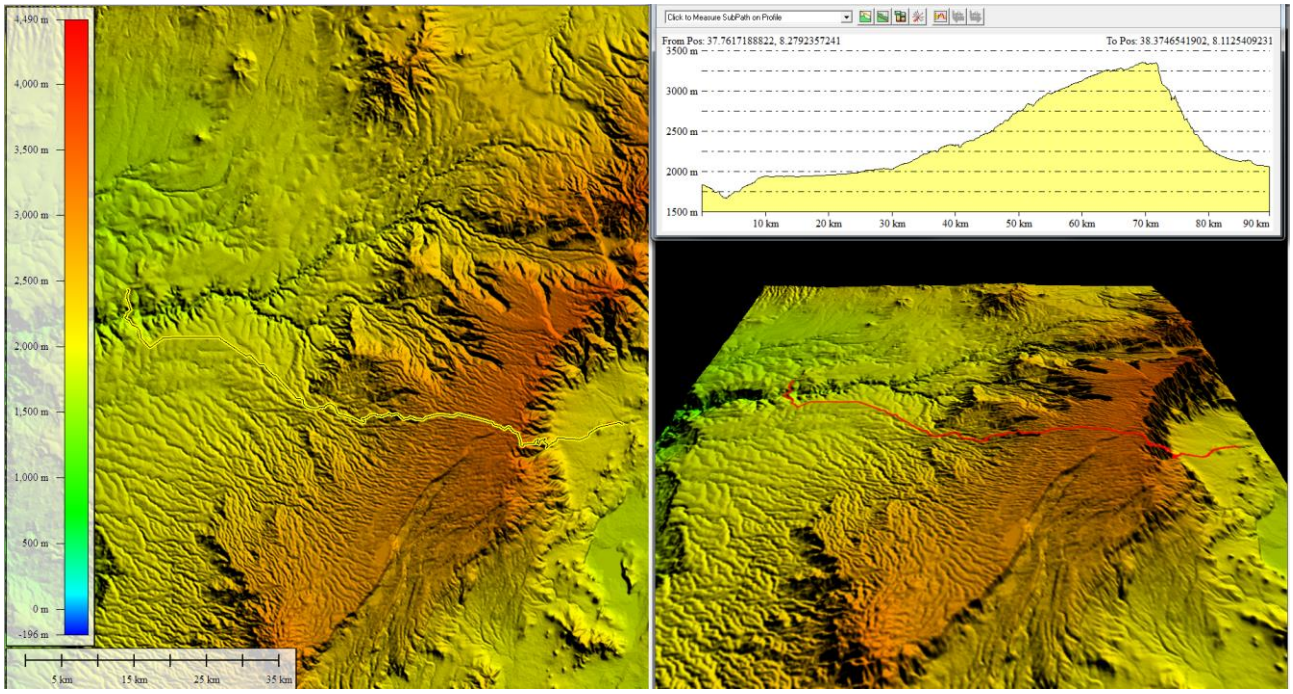
The Butajira to Gubre road (see Figure 2), which runs parallel to the Tulubolo to Kela road, experienced significant problems associated with flooding, whereas the other two roads are seemingly located within a flat and dry area. Based on a preliminary assessment, the Butajira to Gubre road was selected as the most likely candidate for new demonstration sites.

Instead of the Project Team conducting the vulnerability assessment, it was decided that a team of experienced Ethiopian road engineers, hydrologists and geotechnical engineers, led by a member of the Project Team, would perform the assessment, inclusive of the identification of vulnerable sections and/or structures, and the formulation of proposal and concepts designs for remedial action to render these sections/structures climate resilient. The assessment will be done in accordance with Stages 2 and 3, and part of Stage 4, of the methodology as contained in the Climate Adaptation Handbook (Head et al., 2017). It will form part of further training and capacity building.

4.3 Ghana

No response to date has been received on a request for an update on the status of the demonstration sections that were planned to be constructed on the Tampion to Tidjo road near Tamale. At this stage, there is as yet no confirmation that this this road is still going to be upgraded or, alternatively, whether a new road should be identified. If the latter, a similar process as the one that will be implemented for Ethiopia will be adopted, i.e. assessment of the road by a team from Ghana led by a member of the Project Team; identification of vulnerable sections/structures; and identification/design of adaptation measures.

Figure 2 Profile of the Butajira to Gubre road (Ethiopia)



4.4 Demonstration of appropriate non-engineering adaptation options

Two 'soft' demonstration procedures have been developed and partially implemented in one country to date (Mozambique) to guide practitioners through the processes of:

- Identifying vulnerable districts and road links within those, using the vulnerability assessment framework developed in Phase 1 and further improved in Phase 2, and developing local capacity to apply this methodology on a broader scale; and
- Initiating the embedment of 'climate adaptation' in road asset management systems so as to support prioritisation and decision-making based on a broader spectrum of attributes in addition to present road conditions.

Included in the above is the training of road condition assessors for identifying potential environment-related risks and threats within and outside the immediate road environment. This training has already been provided as part of the workshops and associated hands-on field training in the three countries (cf. 2nd and 3rd Progress Reports), with further training to be provided in Ethiopia in particular, but possibly also in Ghana (cf. Sections 4.2 and 4.3 above).

Half-day workshops and two to three days of meetings and further interactions in between have been planned for the three countries to not only address the implementation of the vulnerability assessment methodology and its integration in decision support systems, but also to provide support and technical advice to road authorities on the uptake and embedment of climate change/adaptation in policies, strategies and plans, among others (i.e. Part D of Phase 2).

The first country visit (Mozambique, April 2018) has been completed. The discussions held and the outcomes thereof are summarised in Chapter 7. The country visit to Ethiopia, initially planned for May 2018, had to be postponed to early June 2018. The Project Team is still awaiting a response from Ghana as to whether the interactions will take place either in late June or in early July 2018.

5 Activity Progress: Capacity Enhancement in Three Countries (Part B)

5.1 Modifications to the Engineering Adaptation Guideline

Following the workshops and ensuing discussions, site visits undertaken in Ethiopia, Ghana and Mozambique, and feedback received from the AfCAP PMU and Technical Panel, a number of improvements have been made to the Engineering Adaptation Guideline (Paige-Green et al., 2018). These include:

- Additional detail on hydrological issues and return periods;
- Additional information on structures;
- Additional information on water harvesting/ponds;
- Additional discussion on slope stability and stabilisation measures;
- Reduction in detail on subgrade problems;
- Flow diagrams to assist with decision making where appropriate.
- More detailed descriptions and simplification of the vulnerability assessment data collection forms and closer link to asset management data requirements; and
- Inclusion of more illustrative materials.

With respect to the last bullet, a *Visual Assessment Guide* is being developed, as *an additional project output*, in which each of the factors to be assessed as per the *Resilience Field Assessment Form* (cf. Appendix A of the Engineering Adaptation Guideline) is described with illustrations of the different degrees and severities. In this way, assessments made by different assessors should become more uniform. This is essential if the assessments are to be used to prioritise the adaptations requirements and/or are to be incorporated in asset management systems.

A second draft of the Engineering Adaptation Guideline has been submitted to the ReCAP PMU for their comments and suggestions for additional changes or additions.

5.2 Status of Handbook and other Guidelines

A Briefing Note on the *Integration of Climate Change in Asset Management* had been prepared previously. This Briefing Note formed the basis for the incorporation (methodological) of road asset management principles in the Handbook and the three associated Guideline documents. The integration of climate change information with asset management was one of the key items discussed in the most recent workshops held in Mozambique (cf. Chapter 7).

A number of items to be considered in linking climate adaptation to road asset management systems were listed in the 3rd Quarterly Progress Report (Verhaeghe et al., 2018). This report also highlighted some of the key challenges to be considered in order to link the road asset management system to any climate related information. It also proposed several steps to be followed for embedment.

During the workshop held in Mozambique a number of engagements took place to establish the practical issues dealing with embedment of climate change information. Similar engagements will be held in Ethiopia and Ghana over the coming weeks.

A major output of the project is a generic Climate Adaptation Handbook outlining the climate adaptation methodology, as well as guidelines for non-engineering adaptation measures, i.e. Change Management Guideline (Head and Verhaeghe, 2017). These documents have been produced in the preceding period, and in recent versions the embedment of climate risk and vulnerability into Road Asset Management Systems (RAMS) received attention. Vulnerability scores were proposed that could also be incorporated into a RAMS. These items would have to be investigated in more detail pertaining to the three AfCAP Lead Countries (and beyond those) in order to make the implementation practical. This is one of the key items that is addressed in the workshops that have been or will be held in the three countries.

Since the previous series of workshops a number of improvements were made to the Handbook and linked Guidelines, including:

- More focus on areas impacted by flooding from regional catchment basins;
- Strengthening relationship with Asset Management (e.g. data requirements);
- Harmonisation of vulnerability assessment methodologies;
- Relationship between Environmental Impact Assessment and Climate vulnerability assessments; and
- Greater focus on 'Do nothing / Do minimal' scenario (funding constraints).

6 Activity Progress: Capacity Enhancement in Other Countries (Part C)

6.1 Gender Summit 14 – Africa

A poster titled "*Advances in multidisciplinary research: What climate change means for women's rural accessibility and transport engineering in sub-Saharan Africa*" (authors: A le Roux, K Arnold, S Khuluse-Makhanya, B Verhaeghe and F Engelbrecht) was presented at the Gender Summit 14 – Africa ("Climate Change through the Gender Lens: Focus on Africa"). The Gender Summit was held in Kigali, Rwanda on 19 to 20 March 2018. The poster was presented by Ms K Arnold.

The poster was very well received. The poster presentation won a spot in the Top Five of the poster presentation competition. Conference participants were particularly interested in the multidisciplinary dynamics of the research, this often being a challenge faced in these types of projects with engineers, climate scientists and social scientists (to name a few disciplines) 'speaking different professional languages'. There was also interest in the relevance and roll-out of the work not only in the project's three Lead Countries, but also the potential for expansion to other African countries.

Based on her observations at the Summit, Ms Arnold noted that the research space of climate change and gender, specifically with reference to transport and mobility in Africa, is largely unexplored and provides great scope for future research. This aligns well with the ReCAP agenda of improving the accessibility of the rural poor, given that women are among the most socially and economically vulnerable groups. A strong message of the Summit was that women play a key role in ensuring food security in Africa. Transport plays a critical role in food security in ensuring that food produce reaches the market. The AfCAP research in Ethiopia, in particular, has identified that there is sufficient food for the population, but the greatest challenge is in getting the food to where it is needed in the context of crop failure in some areas due to a changing climate.

A one page summary of the poster will be included in the proceedings of the Congress. The summary that has been submitted by the Project team is included in Annex 1.

6.2 Journal articles and conference papers

As was noted in the 3rd Quarterly Progress Report, three abstracts were submitted for the forthcoming SARF/IRF/PIARC Regional Conference for Africa to be held in Durban in September 2018 . The abstracts were entitled:

- AfCAP Climate Adaptation Handbook to Preserve Road Assets (authors: B Verhaeghe and M Head);
- Making Africa's roads more resilient to climate change (authors: P Paige-Green and B Verhaeghe); and
- A methodology for assessing the vulnerability of rural roads to a changing climate to guide the prioritisation of climate resilient engineering interventions (authors: A le Roux, S Khuluse-Makhanya and K Arnold).

In their feedback, the conference organisers recommended that all three abstracts be consolidated into one paper, which in the Project Team's opinion was not realistic given the diverse nature of the subject areas presented in the three proposed papers. A counter proposal was made to only produce two papers. Correspondence with the conference organisers as to whether our proposition would be acceptable is still pending.

In the meantime, the Project Team prepared a paper aligned with the third bullet above, which has been submitted to Africa Geo 2018 (https://africageo.org.za/). The paper is titled: "*Implementing a GIS based methodology for determining highly vulnerable rural access roads to a changing climate in Ethiopia*". Africa Geo 2018 is a peer-reviewed conference that will be held in September 2018 in South Africa. Approved publications will be published in the Journal of Geomatics, a journal recognised by the South African Department of Higher Education.

The abstract of the paper is reproduced in Annex 1. The paper has also been submitted to ReCAP for approval.

6.3 Publication of the Handbook and Guidelines on the ReCAP Website

While the current series of workshops and meetings are still ongoing, and given that the feedback from these meetings/workshops could still impact on the structure and contents of the Handbook and the three associated Guidelines, the Project Team is nevertheless of the opinion that these documents should be published as soon as possible on the ReCAP Website, enabling practitioners in other sub-Saharan countries as well as allowing interested parties from other regions/continents to access the documents and start implementing the relevant parts. The Project Team has already received several requests for the sharing of these documents for academic or other purposes.

The documents could be marked as "preliminary drafts" and should include a contact point for any enquiries or comments the readers/users might have. Their feedback would assist the Project Team to effect further improvements to the documents before they are formally launched.

7 Activity Progress: Embedment (Part D)

7.1 Workshops held in Mozambique

7.1.1 General

Part D of the project focusses on demonstrations of appropriate practices, capacity building, and the uptake and subsequent embedment of outcomes at the range of levels, from informing national policies, through regional and district planning, down to practical guidance on adaptation delivery at rural road level.

A three-day workshop was held in Mozambique from 10 to 12 April 2018. The purpose of this workshop was to:

1. Identify and agree on areas and actions for the Project Team to assist Mozambique with the embedment of climate resilience in policies, strategies and plans;
2. Explore the integration of climate adaptation considerations in asset management; and
3. Explore the embedment of the vulnerability assessment methodology in ANE's decision support systems, including their Geographic Information System (GIS), and to demonstrate how it can be applied to support high-level decision making.

The Project Team's members involved in this workshop were Mr Johan Maritz (policy), Mr Michael Roux (asset management) and Ms Kathryn Arnold (vulnerability assessments).

The workshop programme is presented in Table 2. It comprised a half-day opening workshop (morning of Day 1) and a technical training session (morning of Day 2), with meetings with stakeholders held during the afternoons of both days and a closing meeting with senior management of ANE in the morning of Day 3).

The lists of attendees for the opening workshop and the technical training session are provided in Annex 2.

Table 2 Three-day Workshop Programme

Day 1: Tuesday, 10 April 2018		
	08:30 - 09:00	Introductory meeting with Senior Management of ANE
WORKSHOP/MEETINGS INVOLVING POLICY MAKERS AND DEVELOPMENT PARTNERS		
Topic 1	09:00 - 10:00	Introduction of AfCAP Climate Adaptation project
Topic 2	10:00 - 11:00	Discussion on climate change assessment methodologies and linkages to road asset management
Topic 3	11:30 - 12:30	Discussion on change management issues related to climate change
	12:30 - 13:00	Plenary Discussions/Summary
Topic 4	14:00 - 17:00	**Individual separate meetings** with policy makers/ stakeholders
Day 2: Wednesday, 11 April 2018		
Topic 5	09:00 - 13:00	**Technical training session:** Exploring the embedment of climate change in vulnerability assessments and decision support systems, including training and policy implications
Topic 6	14:00 - 18:00	**Individual meetings** with Development Partners: EU delegation to Mozambique

Day 3: Thursday, 12 April 2018		
Topic 7	08:30 - 12:00 (flexible timing based on availability)	**Meeting with Senior Management of ANE:** Presentation of the outcomes of the previous days' deliberations; discussion and agreement on policy and embedment actions; and identification of any assistance that AfCAP and the Project Team could provide moving forward
Topic 8	12:00 - 13:00	**Follow up discussion with FinnOC**

7.1.2 Topic 1 – Introduction of AfCAP Climate Adaptation Project

Mr Maritz presented a broad overview of the project and outlined the programme for the mini workshop and planned engagements. Considering that some of the participants were new to the project this overview proved useful. It reiterated the project objectives, profiled the various project phases and emphasised the current phase of policy and embedment issues. The key written documentation (Climate Adaptation Handbook and three associated Guidelines) were briefly profiled.

Also present were Finnish Overseas Consultants (FinnOC) providing technical assistance to ANE for the "Development of Capacity for a Climate Resilient Road Sector", a project funded by the Nordic Development Fund (NDF). FinnOC was not aware of the AfCAP project. They were particularly interested in the workshop topics considering that their project deals with similar issues. Their participation identified an overlap between the AfCAP project and the NDF project. It was agreed that separate discussions would be held to share information and to explore collaboration.

7.1.3 Topic 2 – Introduction on climate change assessment methodology and linkages to asset management

Ms Arnold presented the current climate change management assessment methodology for a national to district scale analysis. She also reiterated that a similar methodology exists which can be applied for local level assessments. The latter is based on well-established methods for local data collection. The linkage between the climate assessment steps and road asset management systems (RAMS) was also described. Several possibilities exist to link information to the road asset management system, but this is also dependent on the nature/extent of the road asset management system currently being used by ANE. Ms Arnold also raised the issue of embedding the climate change information within ANE and proposed that it be placed within ANE's GIS unit. A meeting was proposed between Ms Arnold and Mr Manuel Tangune (ANE's GIS person) scheduled for later during the afternoon in order to investigate ANE's GIS, software and capabilities. (See Topic 4)

Mr Roux then presented an overview of the integration of climate change into road asset management. Integration actions are required during the various steps in the asset management process and these actions were described in his presentation. He also provided suggestions on how the climate change information could be linked to the current ANE road asset management system. He indicated that an operational RAMS should be used where possible and extended to include climate change information. It would however be important to investigate the nature and detail of the ANE RAMS before a specific proposal for embedment could be made. Officials from ANE's Planning Department (DIPLA) working with road asset management indicated that the department is using the HiMS systems. This is a commercial system currently being administered by SATRA Infrastructure Management Services on behalf of ANE. A meeting was scheduled between Mr Roux and Mr Satyanarayana Bulusu after the morning session for Mr Roux to gain an understanding of the HiMS. (See Topic 4)

7.1.4 Topic 3 – Presentation on change management issues related to climate change

Johan Maritz presented on policy and related embedment issues. He also reiterated that it was important to identify clear actions that can be taken forward in order to embed the key climate change data items into systems. He profiled the main policies that deal with national climate change adaptation and provided an overview of key Climate Change Adaptation (CCA) structures currently operational within the

Mozambican government systems/structures. Notably ANE needs stronger representation within current government systems. This can be developed in time.

Mr Maritz reported that the main policy and embedment issues will be reflected in a country report. The purpose of the country report (cf. Section 7.2) would be to:

- Reflect on relevant policy items;
- Strengthen ANE adaptation policies;
- Agree on actions to reduce vulnerability to climate change;
- Help forge links to strengthen Government policy; and
- Facilitate development of more effective adaptation strategies.

7.1.5 Topic 4 – Separate meetings with ANE, SATRA and FinnOC

During the afternoon of day 1 a number of separate meetings were held at ANE's Head Office, emanating from the morning's workshop:

Meeting 1: ANE (Planning Department) – Mr Maritz

To clarify the ANE institutional structure, a meeting was held with Ms Amilia Boene. Discussions were also held regarding the World Bank screening tool which has been used on some ANE projects. It was however noted that this tool is an online tool, which presents several problems. It is difficult to access from within the ANE's LAN and has only been used on two projects. It has a more coarse resolution for information items. All items are selected from a set of available information and no spatial output is produced. ANE (Ms Boene) mentioned that the World Bank is working on a new tool, but that it is not available as yet. Currently no other mechanisms exist within ANE to consider climate adaptation information. There is also no clear link between the planning function and the use of GIS within its environment.

Meeting 2: SATRA Infrastructure Management Services – Mr Roux

ANE uses the HiMS Asset Management System as its road asset management system. The system is a New Zealand system and is being operated and maintained for ANE by an Indian company, SATRA Infrastructure Management Services. SATRA is represented in ANE by Mr Satyanarayana Bulusu. The system includes the following sub-systems: Road Information System (RIS), Pavement Management System (PMS), Routine Maintenance Management System (RMMS), Bridge Management System (BMS), Accident Information System (AIS), and Traffic Information System (TIS). Of these sub-systems, it is only the RIS, PMS, BMS and TIS that are currently actively used. HiMS is also used to prepare files for analysis with HDM-4.

All the classified roads are included in the HiMS. There is also a network of unclassified roads at the community level, which are the responsibility of the district administrations, and urban roads which are the responsibility of municipalities. From anecdotal evidence, it appears as these last two categories of roads are currently not being managed by way of a formal RAMS. The same network is used in the HiMS and the GIS, but the link between the two systems is manual.

Visual assessment data for paved and unpaved roads are captured, stored and analysed in the HiMS. In addition, ANE uses ROMDAS to collect roughness (IRI and BI) and rutting information. FWD data is also collected.

The HiMS brochure states that HiMS was developed on the "zero-coding by the end user" principle and that HiMS offers most of its functionality to be configured by the end user. This was confirmed by Mr Bulusu who indicated that it would be possible to adapt the system to include climate change data and to carry out analysis using such data. What would be required to initiate this is an instruction from ANE management. It is also important to ensure ANE has a CCA policy to embed climate change information within its systems. Currently there does not appear to be such a policy.

Meeting 3: ANE GIS key person Mr Manuel Tangune – Ms Arnold

Ms Arnold met with the ANE GIS key person, Mr Tangune, in order to establish the extent of the ANE GIS (type, content and capability). Mr Tangune explained that ANE had two GIS personnel, one office based and one fieldwork based. He further indicated that GIS within ANE is mainly used for mapping purposes and

that not much spatial analysis takes place with their GIS. It is seen as a key method to convey road related information within ANE. ANE uses ArcGIS software which is widely used. It also uses QGIS which is an open source GIS (used as an additional licence due to the costs associated with ArcGIS). ANE uses a distributed desktop GIS architecture with no centralised network capabilities either within the ANE headquarters or between provincial/district offices. Data updates are shared manually between the GIS and RAMS technicians (and vice-versa), and data backups are done on hard drive. ANE has several sets of spatial information; notably items that form part of **a base layer set** such as rivers, soils, administrative areas, towns, and roads. Additionally, a high resolution Lidar point dataset for 5km of either side of all the roads in Gaza has been created for ANE's use by external consultants. Information received from visual assessments are linked to the road network dataset which is broken up into a series of links. **No climate related spatial data items** form part of the file sets kept within the GIS unit. There is however an established linkage with a spatial data sharing group known as the SDP (Spatial Development Planning) platform. Although not a formal SDI it does serve as a network of individuals within different departments and across different ministries to share or access spatial information. Ms Arnold indicated that it is possible to 'place' the climate change risk and vulnerability information within this ANE office. However some capacity building would be necessary if full benefit is to be derived from having these added sets of information.

Meeting 4: Finnish Overseas Consultants (FinnOC)

The Nordic Development Fund identified a project in 2014 to develop **capacity for a climate resilient road sector in Mozambique**. The project objective is to provide ANE and other stakeholders with capacity and tools to manage climate threats to road development, including planning, design, construction and maintenance. It is mostly focussed on the Nacala Road project and consists of the following activities:

- Capacity development and mainstreaming of climate change adaptation within ANE
- Climate change-proofing of the Nacala Corridor road (Muita-Mandimba-Lichinga road)
- Road network vulnerability mapping
- Economics of climate change
- Road asset management and technical issues

The project is being executed by FinnOC who is represented in ANE by Ms Jukka Torniainen (team leader) and Ms Casandra Bischoff (capacity building expert). Both expressed a keen interest in the AfCAP project and indicated that **possible collaboration would assist in avoiding duplication of effort**. There is a clear overlap between these two initiatives. A meeting was therefore arranged for after the third day's programme for the AfCAP and FinnOC teams to discuss further possible collaboration and information sharing.

7.1.6 Topic 5 – Technical training session

The technical training session/workshop was aimed at exploring the embedment of climate change in vulnerability assessments and decision support systems, including training and identification of policy implications.

Prior to the start of the second day's workshop, two contributions were made to the workshop participants resulting from discussions held the previous day. These included:

- Mr Tangune (ANE) – Reflection on the ANE GIS system and application; and
- Mr Bulusu (SATRA) – Presented on the HiMS system currently used by ANE.

These contributions reflected on systems currently in place at ANE that could be enhanced through the adding of climate change information. The GIS in particular is capable of using the prepared spatial data inputs prepared for the AfCAP climate change adaptation project.

These two contributions were followed by the second day's presentations. The first presentation, presented by Ms Arnold, dealt with Regional Climate Risk Screening for Climate Adaptation of Rural Road Networks, Phase 1 to 3 described in the Climate Threats and Vulnerability Assessment Guideline (le Roux et al., 2017). These phases were presented in detail, namely identifying the main regional climate threats that influence the risk and vulnerability of roads, collecting and preparing relevant data, and finally analysing the data spatially in terms of road exposure and asset criticality to determine the more vulnerable districts. The

presentation profiled the series of spatial data sets that present a range of climate information including rainfall, temperature, extreme storm events, etc., as well as national and open source data repositories of the road network, flooding and socio-economic data. Data presented also contained the results of two climate models which have been downscaled to increase the resolution and allow for more specific road sections to be differentiated by such climate information.

The second presentation by Michael Roux dealt with Phase 4 of the Climate Risk Screening Method described in the Climate Threats and Vulnerability Assessment Guideline, namely the embedment of the outputs from the climate threats and vulnerability assessment in the RAMS.

The embedment phase requires three steps. In Step 1 the climate threat indicators to include in the RAMS are identified, in Step 2 the data for these indicators are exported to the RAMS and in Step 3, the indicator data is analysed in the RAMS. The outputs from the district level climate threats and vulnerability assessment, such as the Flood Exposure Index and the Road Critically Index could be exported to the RAMS. As these indicators are calculated at district level, the same indicator value would be allocated to all road links or structures (bridges and culverts) in a district. An alternative would be to only include these indicators in the GIS to be able to identify and display the most vulnerable districts. The road links and structures in these vulnerable districts could then be prioritised for the local/road level climate risk and vulnerability assessment.

Mr Roux then illustrated how the measuring and recording of specific climatic effects on the road network, as described in the Engineering Adaptations Guideline, could be incorporated in a RAMS. This would require a visual assessment process to identify and rate problems specifically related to climatic effects. These problems should then be rated in terms of likelihood of occurrence and the impact should they occur. By capturing these problems and ratings in the RAMS, an index can be calculated that can then be used to rank and prioritise specific road links for climate resilience adaptation. The Climatic Effect Risk Index could also be combined with other indices usually calculated in a RAMS, such as a Visual Condition Index (VCI), to arrive at a combined index for the further ranking and prioritising of road links for maintenance and resilience adaptation.

The presentation also included recommendations on how condition data relating to specific structural elements of river bridges and major culverts that could make a structure vulnerable during flooding events, could be used to rank such structures in terms of priority for climate resilience adaptation.

During discussions the previous day with Mr Bulusu from SATRA, it was indicated that the **HiMS used by ANE is flexible and could accommodate the additional climate effect data and calculations required to analyse this data**.

7.1.7 Topic 6 – Engagement with development partners

A meeting was arranged by ANE with representatives from the EU delegation to Mozambique. The representatives were Mr Jose Carlos Edo Monfort (Second Secretary: Head of Section: Rural Development and Infrastructures) and Ms Maria Sonia Lopez Lopez (Attaché: Rural Development and Infrastructures). During the meeting, Mr Maritz and Mr Leta provided an overview of the AfCAP project to the EU representatives. They had not been informed previously of the AfCAP project. Given their focus on rural infrastructure, there seems to be a good link with the key AfCAP focus on rural accessibility. They also mentioned that they are starting the process to plan for the next EU funding cycle – **it was therefore an opportune time to discuss possible linkages/opportunities with new or future projects**. The EU projects in Mozambique also have a strong focus on climate resilience, but this aspect has not progressed to an advanced state. They also plan more support of road management systems in future projects. Mr Leta indicated that **AfCAP would be keen to coordinate activities to ensure that maximum benefit could be achieved for projects in Mozambique**. The Project Team provided the EU delegation with the Handbook and Guideline documents and requested the EU representatives to give feedback and comments on these documents.

7.1.8 Topic 7 - Meeting with Senior Management of ANE

On the last day of the visit (12 April), a meeting was held with ANE's Senior Management in order to provide feedback on the previous two days' activities. Members from the ANE management team present were:

- Mr Marco vaz dos Anjos – Director General
- Ms Irene Simões – Director of Maintenance
- Mr Luis Fernandes – Director of Emergency Services

Mr Maritz provided a brief contextual overview of the AfCAP project objectives and emphasised the current focus in Phase 2 of the project on dealing with policy and embedment. A summary was provided on the various programme items indicating which engagements/discussions took place (cf. Annex 3). The need to identify action items was emphasised.

The main outputs of the climate resilience and adaptation research were discussed. Mr Maritz indicated that these documents are currently in a trial phase, and in order to finalise them comments were sought from users of the documents, such as ANE.

It was agreed that the AfCAP Project Team arranges a follow up visit to present the various documents in more detail to ANE Senior Management. The timeline for such a visit would have to be agreed with AfCAP and would need to fit into the planning for the current phase (Phase 2).

From the discussions with the members from the ANE management team, the following action items were identified:

Action item 1: ANE Road Asset Management System and Climate Assessments

The HiMS RAMS implemented in ANE currently does not include climate related information. It only contains the standard inventory and condition data for the road network and structures such as bridges and culverts. It has however been indicated that it would be possible to add climate information as additional tables in the HiMS database.

The Project Team emphasized that is it a key activity to link climate information to the HiMS. The spatial information currently available (at district level) could form the first round of information embedment. There is however also a more important need to include climate risk information at the local/road link level. This might not be possible to include and implement during the current phase and was therefore proposed as a possible future (Phase 3) item.

Currently ANE does not have a CCA policy. In order to fully operationalise CCA in ANE, such a policy would firstly have to be adopted.

Action item 2 and 4; Risk and climate threat vulnerability assessment: (spatial information)

As a result of the AfCAP work in Phase 1 (and expanded in Phase 2), climate change spatial data items are available for use by ANE (and other departments). What has to be decided are the best place to house the information in ANE and the mechanism that could be used by ANE to make this climate change information available to other ministries and state agencies.

Regarding the hosting of the geospatial information at ANE, it was recommended that this should be done by the ANE GIS unit (represented by Mr Tangune.) This would not merely entail the handing over of data, but would require capacitation of the ANE GIS staff, as some items were the result of spatial data analyses and processing. A training and data transfer session accompanied with the relevant documentation would be required.

Action item 3: Research material / outputs provided

The Handbook and its associated Guidelines were provided to ANE, with a request for users of these documents to give input and comments that will be used to finalise the documents before they are shared formally with other AfCAP partner countries. As requested by Mr Marco Vaz dos Anjos, a due date for the

submission of such inputs and comments need to be provided. Mr Maritz undertook to establish the timeline and then to communicate the due date to ANE Senior Management.

Action Item 4: Contributing information into wider Climate Adaptation environment

Mr Fernandes (Director of ANE Emergency Services Department) indicated that ANE is already a member of the National Emergency Operations Centre (SENOE), which operates under the National Institute of Disaster Management (INGC) in Mozambique. Through this centre ANE is able to access a number of government ministries. Some of the development partners are also represented at SENOE. It is therefore regarded by ANE as a good forum where new data items could be introduced/shared. To initiate this action it was proposed that a request be made to SENOE for an opportunity to make a presentation on the geospatial climate related data that is available Mr Maritz proposed that this process should be driven by ANE to create awareness that the origin of the data is ANE. During the same event, the intention to develop an ANE CCA policy could be communicated.

Action Item 5: Coordination and collaboration between the FinnOC Change Management project and the AfCAP project

The Nordic Development Fund project being undertaken by the FinnOC, includes developing capacity for a climate resilient road sector (including change management and climate adaptation), which overlaps with the ReCAP project. The project has commenced recently and it is therefore an opportune time to engage and coordinate activities, especially where similarities exist. It also holds the potential to provide additional sites for the demonstration of climate resilience adaptations, considering that the NDF project focusses on the Nacala corridor (Phase 3).

During discussions between the AfCAP and FinnOC teams on the last day, it was proposed that AfCAP and FinnOC collaborate more closely to ensure duplication of effort and activities are avoided.

Action Item 6: Inclusion of Climate Change Resilience in Policy / Plans

Policy issues need to be addressed to enable embedment of climate change information in ANE activities and systems. It was therefore proposed that a strategy be developed dealing with climate change resilience in ANE. A further recommendation was that a key person in ANE should be tasked or appointed as champion to deal with CCA across all Departments in ANE. Such an individual could also represent ANE at other institutions and forums dealing with CCA.

7.2 Country reports

In the 3rd Progress Report (Verhaeghe et al., 2018) it was stated that the draft Country Reports reported in the 2nd Progress Report (Verhaeghe et al., 2017c) were redesigned in terms of both outline and content, and that they were modelled according to World Bank Country Reports.

Each report will contain the key climate challenges and vulnerabilities and would be structured as follows:

- Approach
- Climate and projected changes*
- Overview of Policy Environment
- Physiography, Livelihoods and Rural Connectivity*
- Vulnerability to Climate Change*
- Change Management options for Adaptation
- Actions for Implementation

(* from Threats and Vulnerability assessments conducted)

Based on the outputs obtained from the most recent workshops held in Mozambique, a second draft of the Mozambican Country Report has been produced, which has been submitted for review to the ReCAP PMU.

The Country Reports for Ethiopia and Ghana are still in a first draft format, awaiting feedback from the workshops that still need to be held in these countries. These also were submitted together with this progress report but only for information, not for review.

8 Progress against Target Dates

8.1 Summary of Progress

The planned start and completion dates for Work Packages are shown in Table 3 below (note that these are as per the dates shown in the Inception Report). Delivery dates that have not been met, or are unlikely to be met, are shown in **red**. New estimates for the delivery dates for these activities are shown in **blue**. The new estimates are dependent on the level of cooperation that the Project Team will receive from the AfCAP Lead Countries. Some of the current concerns with the Demonstration sections in particular were raised in Chapter 4 of this report, and addressed further in Section 8.2.

The overall project planning allowed for some float in the programme to accommodate unexpected events such as those currently experienced. However, these and other potential future risks will have to be managed very carefully from now on to ensure that the Project will meet all deliverables by the set deadline of December 2018.

Table 3 Anticipated start and end dates of Work Packages

WORK PACKAGE	START DATE	END DATE
Inception Phase	15 May 2017	15 June 2017
Management & Recommendations for Phase 3	15 May 2017	31 December 2018
PART A: DEMONSTRATIONS		
A.1: Mozambique demonstration programme • *Detailed design* • *Construction* • *Monitoring & evaluation (demonstrations)* • *Demo vulnerability assessment & RAMS*	15 June 2017 *1 July 2017* *To be determined* ***1 May 2018*** *End construction* *1 July 2017*	30 November 2018 *31 July 2017* *To be determined* ***31 August 2018*** *30 November 2018* *27 July 2018*
A.2: Ghana demonstration programme • *Detailed design* • *Construction* • *Monitoring & evaluation (demonstrations)* • *Demo vulnerability assessment & RAMS*	15 June 2017 ***10 July 2017*** ***(to be determined)*** ***30 October 2017*** ***(to be determined)*** *End construction* *1 July 2017*	30 November 2018 ***18 September 2017*** ***(to be determined)*** ***19 March 2018*** ***(to be determined)*** *30 November 2018* *27 July 2018*
A.3: Ethiopia demonstration programme • *Detailed design* ***Based on new road identified*** • *Construction* • *Monitoring & evaluation (demonstrations)* • *Demo vulnerability assessment & RAMS*	15 June 2017 ***7 August 2017*** ***1 June 2018*** ***13 November 2017*** ***(to be determined)*** *End construction* *1 July 2017*	30 November 2018 ***13 November 2017*** ***15 July 2018*** ***19 March 2018*** ***(to be determined)*** *30 November 2018* *27 July 2018*
PART B: CAPACITY ENHANCEMENT (three countries)		
B.1: Engagement with key stakeholders in 3 countries	1 April 2017	**16 October 2017** **31 July 2018**

WORK PACKAGE	START DATE	END DATE
B.2: Generic handbook on climate adaptation • 1st draft • 2nd draft • Final version	1 April 2017 24 July 2017 11 December 2017	24 July 2017 **11 December 2017** **30 June 2018** 30 April 2018 **31 July 2018**
B.3: Training modules and training workshops • 1st set of workshops • 2nd set of workshops	15 June 2017 **2 April 2018** **1 June 2018**	**16 October 2017** **7 February 2018** **27 July 2018** **30 September 2018**
B.4: Translation of documents in Portuguese	24 July 2017 **1 May 2018**	30 April 2018 **31 August 2018**
B.5: On-site training	Linked to the Design & Construction components of Part A	
B.6: Journal articles & conference papers	1 April 2017	15 December 2018
PART C: ENHANCEMENT OF CAPACITY (OTHER COUNTRIES)		
C.1: Identification of priorities	1 April 2017	20 August 2018
C.2: Capacity development events	1 April 2017	15 December 2018
C.3: ReCAP website	1 April 2017	15 December 2018
PART D: EMBEDMENT		
D.1: Review of policies, strategies and plans	15 May 2017	20 August 2018
D.2: Provision of advice and technical assistance	21 August 2017	15 December 2018

8.2 Proposed Actions

The following actions, almost identical to those stated in the 3rd Progress Report, are being undertaken on Part A and Part B in particular to ensure that project deliverables will be met by December 2018:

- **PART A:** With the exception of Mozambique, the physical executions of the demonstration sections are falling significantly behind schedule. Regular contacts are being made with DFR in Ghana to enquire as to when a contractor will be appointed for the road upgrading and therefore also the construction of demonstration sections, but with little responses received to date. On the other hand, Ethiopia has responded and offered three alternative road sections that could be considered for demonstrations. The Project Team's concern is that, even if the construction processes in these two countries were to be accelerated, there will be little to no time left to monitor the construction and performance monitoring of the implemented adaptation measures in Phase 2, unless these were to be postponed to Phase 3 of the project.

  Since the focus of Phase 2 is on the demonstration and embedment of the climate adaptation methodologies proposed, it was recommended to the PMU that sharing common understanding on vulnerability assessments and appropriate engineering designs, and the embedment thereof, are probably of greater importance right now than to construct (i.e. focus on quality control of the implementation of proposed designs) and monitor the performance of demonstration sections,

especially in view of the (apparent) challenges experienced by ERA and DFR to mobilise funding to new or to previously designated roads, respectively.

Although this would require further discussion with the ReCAP PMU, preliminary communication with the two countries have been initiated to redirected efforts towards the identification of new sites that are being challenged by climate effects where the Project Team together with nominated senior country engineers would further validate and implement the adaptation methodology with the expectation that, if found beneficial and indispensable, will be diffused nationally.

It should be noted that the demonstrations of the vulnerability assessments and the exploration into integration of climate change in decision support systems (such as asset management systems), which both are included in Part A, are likely to be completed ahead of schedule. These activities are conducted in parallel with the investigation into policy and other issues (Part D) through mini-workshops, training and discussion sessions to be held in the three countries between April and July 2018.

- **PART B:** Delays were experienced with the initiation of first set of workshops following the production of the Handbook and Guidelines, mainly caused by the fact that the PMU decided that these workshops had to be held at the previously identified demonstration sites to demonstrate and validate the vulnerability assessment and engineering adaptation methodologies proposed. In retrospect, it has to be acknowledged that this was indeed the correct decision; the benefits that were accrued following this decision outweighed the lost time (cf. Annex A).

  Sufficient float has been provided in Phase 2 of the project to accommodate such delays, and the Project Team is of the belief that Part B will be completed by contractual end date of December 2018.

  The Project team is of the opinion that the updated Handbook and Guidelines should be released and made available from the ReCAP Website as soon as possible so that interested parties and practitioners across and beyond the sub-Saharan African region could start using and interrogating them. They should be marked as “Preliminary drafts” and should have the details of a contact person provided to receive and respond to enquiries and comments, and to record these, as inputs into the revision and finalisation of the documents.

9 References

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Annex 1 Publications

Gender Summit 14 – Africa: Book of Abstracts

Advances in multidisciplinary research: What climate change means for women's rural accessibility and transport engineering in sub-Saharan Africa

Alize Le Roux, Kathryn Arnold, Sibusisiwe Khuluse-Makhanya, Benoit Verhaeghe & Francois Engelbrecht

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Background

The last century has seen the steady increase in the frequency and magnitude of extreme weather related disasters globally, with Africa being one of the most vulnerable regions in the world to the impacts of climate change. Rural communities in sub-Saharan Africa are some of the worst affected by these climate disasters in part due to high socio-economic vulnerability, natural resource dependency and low adaptive capacity.

The impacts of changing climate are already being felt widely across many development sectors. For transport, climate resilient road infrastructure in rural areas is vitally important for improving the quality of lives, particularly of women, by enabling the sustainable enhancement of economic productivity in rural areas through access, assuring the accessibility of rural communities to markets and essential service points such as health care and educational facilities.

The majority of the rural transport burden falls on woman who are responsible for the bulk of domestic travel, have less access to private vehicles and who typically spend more time travelling (e.g. to collect firewood and drinking water, or to transport crops for food processing or trade). Accessible rural transport services are therefore key to improving women's mobility in Africa.

Results

Research for Community Access Partnership (ReCAP), a programme funded by UKAid, commissioned an ongoing interdisciplinary research project with the aim of supporting regional guidance on the development of climate-resilient rural access in Africa through research and knowledge sharing within and between participating countries.

The study addresses the issues of appropriate and economic methodologies for vulnerability and risk assessments; prioritisation of adaptation interventions; and optimisation of road asset resilience in the context of rural access. In addition, evidence of cost, economic and social benefit links to rural communities arising from more resilient rural access will be provided to support wider policy adoption across Africa.

The outputs of this work are a framework and guidelines for assisting the development of climate resilient road networks in Africa that reach fully into and between rural communities, and which aim to holistically support local road engineers in prioritising and constructing road interventions that are sensitive to the changing climate. The handbook provides relevant information on climate adaptation procedures for rural road access, along with instructions on an appropriate methodology to address climate threats and asset vulnerability, to increase resilience for the foreseeable future. Detail regarding actual adaptation approaches and measures are included in the accompanying Guidelines covering Climate Threats and Vulnerability, Change Management and Engineering Adaptation.

Impact

The uptake and embedment of climate vulnerability and adaptation in government policies and strategies, as well as in standards, manuals, guidelines and decision support systems, will support improved prioritisation and optimisation of scarce financial and other resources for road construction and maintenance, ultimately benefitting rural communities, and especially women, through the provision of all-weather access to essential service facilities and markets.

What's Next

The project is currently in its second phase and will focus on the sustainable enhancement of capacity, as well as the uptake and embedment of the framework, handbook and guidelines into the decision support systems of the three Lead Countries, namely Mozambique, Ethiopia and Ghana. A third phase is planned for monitoring and evaluation, as well as to strengthen uptake and embedment.

Abstract for Geo Africa 2018

Implementing a GIS Based Methodology for Determining Highly Vulnerable Rural Access Roads to a Changing Climate in Ethiopia

Kathryn Arnold[1]*, Alize le Roux[1], Sibusisiwe Khuluse-Makhanya[1] & Francois Engelbrecht[2]

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Abstract

Climate-related natural disasters have been steadily increasing in both incidence and intensity across the globe over the last century. This is especially true for Ethiopia given the country's high and recurrent exposure to extreme droughts and floods, the two most notorious disasters that have impacted on the country's development trajectory and the livelihoods of its citizens. Climate-related risks are the major driver of hunger and food insecurity in Ethiopia, with the majority of poor communities being most vulnerable to their impacts. Due to the high degree of food and water insecurity caused partially by climate variability, it is argued that improved rural accessibility is vital to reducing the number of highly vulnerable communities, and increasing rural resilience. In this paper, a geospatial indicator-based risk and vulnerability assessment method is applied as a tool for determining highly vulnerable rural access roads to changing climate in Ethiopia. The assessment is intended to help guide, through prioritisation, the identification of highly vulnerable areas where appropriate climate adaptation measures would be most effective in reducing the impacts of climate variability and change. The research methodology relies on using GIS processes and techniques to identify the major climate threats affecting roads in Ethiopia; to collect and pre-process data; and to analyse data in an assessment of the physical exposure of the road network as well as road criticality as a function of community access. The methodology has proved to be an efficient and effective way of identifying high risk regions in terms of community dependence on roads for accessibility and the physical impact of climate on road infrastructure.

Annex 2 Workshop Participants (Mozambique)

Attendees of the mini-workshop held on 10 April 2018 (morning session)

Workshop Programme:

Topic 1	09:00 - 10:00	Introduction/discussion of the AfCAP Climate Adaptation project and its objectives; overview of Climate Adaptation Handbook/Guidelines
Topic 2	10:00 - 11:00	Introduction/discussion of climate change assessment methodologies and linkages to road asset management
	11:00 - 11:30	*Tea*
Topic 3	11:30 - 12:30	Presentation/Discussion on change management issues related to climate change
	12:30 - 13:00	Plenary Discussions/Summary

List of attendees:

Name	Organisation
1. Derwo Roia	ANE
2. Artur Chilanti	ANE
3. Angelina Balate	ANE
4. Manuel Tangune	ANE
5. Arafat Zainadine	INGC/CENOE
6. Antonia Eristo	DNAAS
7. Manuel Cossa	ANE
8. Moises Dzimba	ANE-GAZA/GE
9. Celse Elesio Mabjaia	ANE-DIMAN-DGN
10. Ewelie Tembe	ANE/DEM
11. Maria Fransicsco	ANE
12. Sana A. Xeninde	ANE-Maputo
13. Raquel Fauega	ANE
14. Antonia Cristo Santos	DNAAS
15. Paul Cossa	ANE
16. Artun Ottilaule	ANE
17. Getulio Pateguana	ANE

Name	Organisation
18. Avelino Machava	ANE
19. Jukka Tornianen	FinnOC
20. Casandra Bischoff	FinnOC
21. Nkululeko Leta	RECAP
22. Johan Maritz	CSIR
23. Michael Roux	CSIR
24. Kathryn Arnold	CSIR

Attendees of the mini-workshop held on 11 April 2018 (morning session)

Workshop programme:

Topic 5	09:00 - 13:00	**Technical training session:** Exploring the embedment of climate change in vulnerability assessments and decision support systems, including training and policy implications

List of attendees:

Name	Organisation
1. Michael Roux	CSIR
2. Manuel Tangune	ANE
3. Ewelie Tembe	ANE/DEM
4. Nkululeko Leta	RECAP/AFCAP
5. Arafat Fainaeline	INGC/CENOE
6. Derwo Roia	ANE
7. Antonia Cristo Santos	DNAAS
8. Raquel Fauega	ANE
9. Manuel Cossa	ANE
10. Celse Clesie Luisela Mabjaia	ANE-DIMAN-DGN
11. Maria Fransicsco	ANE
12. Johan Maritz	CSIR
13. Kathryn Arnold	CSIR
14. Dana A. Xeninde	ANE-Maputo
15. Satyanarayana Bulusu	SATRA

Annex 3 Extracts of Presentation to Senior Management of ANE (Mozambique)

AfCAP Africa Community Access Partnership

UKaid from the British people

Climate Resilience and Adaptation Mini Workshop and Embedment engagements – Feedback to ANE management team

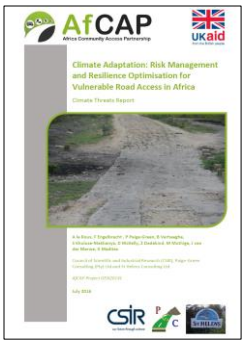
ANE, Mozambique

12 April 2018

AfCAP Africa Community Access Partnership

The Project

To provide regional guidance on the development of climate-resilient rural access in Africa through research and knowledge sharing within and between participating countries



AfCAP Africa Community Access Partnership

Phase 2: May '17 to December '18

AfCAP Climate Adaptation Programme: Overview

- **Overall objectives:**
  - To **deliver processes** to identify, characterise and demonstrate appropriate engineering and non-engineering adaptation procedures defining:
    - Climate threats and impacts
    - Vulnerability to impact (risk)
    - Non-engineering and engineering adaptations
    - Priorities
  - to engage with all relevant stakeholders in a **knowledge dissemination** and **capacity building** programme
  - to focus on uptake and embedment of outcomes informing national policies, through regional and district planning, to delivery at rural road level.

Phase 2

AfCAP Africa Community Access Partnership

Main objectives of the Mini-Workshop and engagements for period 10-12 April 2018:

- To provide a project overview
- Context and current reality understanding
- To share new improvements to Risk/Threat Assessment Guidelines (Kathryn)
- To explore the opportunities to related/embed Climate change data into ANE systems - the Asset Management System (Michael)
- Utilising existing networks to share / embed spatial information
- Reflect on policy issues
- To identify key action items with ANE management

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Workshop and engagement programme:

- Tuesday: 10 April 2018
  - Welcome and Overview
  - Overview of Handbook and Guidelines with discussion
  - Introduction of climate change assessment methodologies and links to asset management
  - Policy development and change management with discussion
  - Meet with other stakeholders (FinnOC, ANE staff)
- Wednesday: 11 April 2018
  - Technical session: Embedment of Climate change vulnerability assessment into ANE Asset Management System
  - Afternoon: Meet with EU delegation on information exchange, possible linkages, EU future road projects
- Thursday: 12 April 2018
  - Morning: ANE Senior Management – feedback of workshop and engagements

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Item 1: ANE Road Asset Management System and Climate assessments:

- Overview of ANE HIMS asset management system
- Currently does not include climate related information
- Discussed possibilities with technical staff to include climate assessment information
- Consensus that it possible to add information
- Looked at relationship between HIMS and GIS

Proposal:

- To explore ways to assist ANE to embed Climate assessment information into HIMS
- Possible further assistance in Phase 3 of AfCAP project.
- Requires an ANE policy decision – linked to a ANE policy

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Item 2: Risk and climate threat vulnerability assessment: (spatial information)

- Several sets of spatial information produced as part of climate assessment process
- Question: Who is best placed to host the spatial information?

Proposal:

- In ANE there is an established GIS function that could be the possible point of contribution. (Expand the geospatial base)

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Item 3: Research material / outputs provided

- Handbook and 3 Guidelines provided to ANE staff
- Status of documents – in draft stage. Process of trialling.
- Need feedback to ensure completeness and usefulness

Proposal:

- Request that ANE provide feedback on these items

Item 4: Contributing information into wider Climate Adaptation environment

- Value contribution to wider climate change knowledge base possible
- National Emergency Centre a key mechanism with a range of represented stakeholders (including Development partners)
- ANE (GE) a lead into this platform

Proposal:

- Through ANE GE a **submission** can be made to present work and information that can contribute to wider Climate change spatial knowledge base (National Disaster Management Institute)

Item 5: Coordination and collaboration between FinnOC change management and AfCAP project

- Clear similarity between projects considering change management and climate adaptation (FinnOC: *Road network vulnerability assessment and mapping. Focus on Zambezi Valley, Cuamba-Muita-Massangulo-Lichinga road). Looking at GIS and road asset management system. Training programme.*
- Sharing of information necessary

Proposal:

- Propose that AfCAP and FinnOC collaborate more closely to ensure duplication of effort/ activities are avoided.

Item 6: Inclusion of Climate Change Resilience in Policy / Plans:

- To ensure that climate change issues be addressed within road activities and find its implementation within projects, research etc. a policy statement might be required
- Can also mean that it be reflected in Transport Strategy

Proposal:

- Consider (if not yet existing) to put in place a **strategy or strategy statement dealing with climate change resilience within ANE**. This could also relate to transport strategy
- Charge /Appoint a person to be the **Climate change champion** in ANE (could deal with cross cutting issues and external representation) perhaps through a cross cutting unit CIU). Also links with FinnOC – looking into functions re climate change.

Acknowledgements

- CSIR wants to thank ANE management for hosting us during this week as well as for helping to make arrangements with stakeholders.
- Thank all staff for participating and contributing.
- We hope to add value and contribute to ANE's activities to support their work.

The CSIR / AfCAP team.

12 April 2018