ReCAP
Research for Community Access Partnership

UKaid
from the British people

Cost/Benefit Analysis of SEACAP trials in Vietnam

Inception Report

Robert Petts, John Hine, Hien & Pham Gia Tuan

RECAP Project Reference Number: RAS2110A

January 2017

Intech Associates

The views in this document are those of the authors and they do not necessarily reflect the views of the Research for Community Access Partnership (ReCAP), DFID or Cardno Emerging Markets (UK) Ltd for whom the document was prepared.

Quality assurance and review table			
Version	Author(s)	Reviewer(s)	Date
1	Petts, Hine, Hien, Tuan	L. Sampson. J R Cook	Jan 2017

ReCAP Project Management Unit
Cardno Emerging Market (UK) Ltd
Oxford House, Oxford Road
Thame
OX9 2AH
United Kingdom

ReCAP Database Details: [Project Title]			
Reference No:	RAS2110A	**Location**	Vietnam
Source of Proposal	PMU/AsCAP Partners	**Procurement Method**	QB Selection
Theme	A	**Sub-Theme**	1,2,3,7,8
Lead Implementation Organisation	Petts, Hine, Hien, Tuan	**Partner Organisation**	
Total Approved Budget	£50,000	**Total Used Budget**	£49,000
Start Date	28 November 2016	**End Date**	25 April 2017
Report Due Date	24 January 2017	**Date Received**	Draft 16 Jan, Final 29 Jan 2017.

Abstract

The overall aim of this project is to undertake an independent economic analysis of the rural road surfacing and paving options investigated in the Rural Road Surfacing Trial (RRST) programme in Vietnam for comparison with a similar cost/benefit study undertaken at the end of the Africa Community Access Programme, Phase 1 (AfCAP1).

The vast majority of the Vietnam RRST research was undertaken between 2003 and 2012 where three phases of trial road selection, design and construction were undertaken under joint DFID-World Bank funding in cooperation with the Ministry of Transport. From 2009 to 2012 the trials monitoring and analysis was funded under the World Bank Rural Transport 3 Program (RT3).

A separate SEACAP initiative carried out a performance study of gravel roads (RRGAP) constructed under the GoV-WB rural transport RT1 and RT2 projects. This research produced recommendations on the limitations of Low (traffic) Volume Road (LVR) gravel surfacing in Vietnam, and is important reference documentation for the current Cost/Benefit investigations.

This Inception report describes the activities of the initial phase of the study, which principally reviews the background and desk study of relevant literature, and sets out proposals for the Cost Benefit assessment approach of the SEACAP surfacing and paving research.

Key words

SEACAP, LVRR, surfacing, paving, trials, research, economic, review, Vietnam

Acknowledgements

The authors would like to acknowledge the support and cooperation of TDSI, the Vietnamese Government organisations and World Bank that participated in the original SEACAP surfacing and paving trials and this follow up economic review. We would also like to acknowledge the contributions of Dr Jasper Cook who played a leading role in the original SEACAP trials and the establishment of the performance monitoring and database development. The personnel involved with the original SEACAP trials in Vietnam have also made valuable contributions to this study.

Acronyms, Units and Currencies

$	United States Dollar (US$ 1.00 ≈ provide conversion to local currencies)
ADB	Asian Development Bank
AfCAP	Africa Community Access Partnership
AsCAP	Asia Community Access Partnership
CBA	Cost Benefit Analysis
CDI	Individual Condition Deterioration Index
DBM	Dry Bound Macadam
DBST	Double Bituminous Surface Treatment
DCP	Dynamic Cone Penetrometer
DEI	Defect Extent Index
DFID	Department for International Development
DRVN	The Directorate for Roads of Vietnam
e	Emulsion
EngKaR	Engineering Knowledge & Research (DFID programme)
ENS	Engineered Natural Surface
EOD	Environmentally Optimised Design
esa	Equivalent standard axle (80kN)
FY	Financial Year
GoV	Government of Vietnam
HDM4	Highway Design and Management Model (version 4)
IRR	Internal Rate of Return
LIC	Low Income Country
LMIC	Low and Medium Income Country
LVRR	Low Volume Rural Road
m	metre
km	kilometre
MERLIN	Machine for Evaluating Roughness using Low-cost Instrumentation
MOT	Ministry of Transport (Vietnam)
MSME	Micro, Small or Medium Enterprise
NPV	Net Present Value
PDoT	Provincial Department of Transport
penmac	Penetration macadam
PMU	Programme Management Unit
RCDI	Road Condition Deterioration Index
ReCAP	Research for Community Access Partnership
RRGAP	Rural Road Gravel Assessment Programme
RRSR	Rural Road Surfacing Research
RRST	Rural Road Surfacing Trials
RT2 RT3	Rural Transport Program 2 & 3 (World Bank & Vietnam Government projects)
SBST	Single Bituminous Surface Treatment
SEACAP	South East Asia Community Access Programme
SR	Systematic Review
TDSI	Transport Development and Strategy Institute (Vietnam)
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)
voc	Vehicle operating costs
vpd	Vehicles per day (motor vehicle equivalent)
WB	World Bank
WBM	Water Bound Macadam

RESEACH 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.

See www.research4cap.org

Contents

1. Executive Summary

The overall aim of this project is to undertake an independent economic analysis of the rural road surfacing and paving options investigated in the Rural Road Surfacing Trial (RRST) programme in Vietnam for comparison with a similar cost/benefit study undertaken at the end of the Africa Community Access Programme, Phase 1 (AfCAP1).

The vast majority of the RRST research was undertaken between 2003 and 2012 in Vietnam where three phases of trial road selection, design and construction were undertaken under joint DFID-World Bank funding in cooperation with the Ministry of Transport. From 2009 to 2012 the trials monitoring and analysis was funded under the World Bank Rural Transport 3 Program (RT3).

A separate SEACAP initiative carried out a performance study of gravel roads (RRGAP) constructed under the GoV-WB rural transport RT1 and RT2 projects. This research produced recommendations on the limitations of Low (traffic) Volume Rural Road (LVRR) gravel surfacing in Vietnam, and is important reference documentation for the current Cost/Benefit investigations.

This Inception report describes the activities of the initial phase of the study, which principally reviewed the background and carried out a desk study of relevant literature. It also sets out proposals for the Cost Benefit assessment approach of the SEACAP surfacing and paving research.

2. Introduction

This Cost/Benefit Analysis of SEACAP trials in Vietnam Study is being carried out by a team appointed by the ReCAP PMU; comprising Robert Petts (Team Leader), John Hine (Transport Economist), Mrs Hien (Transport Economist) and Pham Gia Tuan (Transport Engineer).

This Inception Report describes the background and initial investigations of the study, and sets out the proposed approach to meet the assignment objectives.

3. Background

3.1 Overview

The Research for Community Access Partnership (ReCAP) funded by the UK government through the Department for International Development (DFID) is a programme of research and knowledge dissemination covering Africa and Asia. It is a combination of the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). The first phase of AfCAP commenced in June 2008 and ended in July 2014. The second phase, which will also run for 6 years, commenced on the 1st August 2014 under the ReCAP umbrella. AsCAP is a new programme, but will build on the South East Asia Community Access Programme (SEACAP) that was completed in 2009. The management of ReCAP is contracted by DFID to Cardno UK. The aim of ReCAP is to build on the previous programmes of high quality research and take this forward to a sustainable future in which the results of the research are adopted in practice and influence future policy.

3.2 Project Context

The current AsCAP Regional Steering Committee has recognised the potential usefulness of the SEACAP research and basic data in terms of contributing to the current AsCAP programme. In this context, the significant amounts of data on Low Volume Rural Road (LVRR) performance collected and analysed under SEACAP are seen as being particularly relevant. The vast majority of the research was undertaken between 2003 and 2012 in Vietnam where three phases of trial road selection,

design and construction were undertaken under the Vietnam Rural Road Surfacing Trial (RRST) programme, under joint DFID-World Bank funding in cooperation with the Ministry of Transport.

Prior to the SEACAP surfacing research in Vietnam, the normal practice applied for Low Volume Rural Road (LVRR) surfacing throughout the country was either natural gravel (predominantly) or penetration macadam (penmac). Local concerns regarding the cost effectiveness and appropriateness of these techniques led to the various LVRR surfacing and paving research undertaken under SEACAP. The issues relating to the choice of surfacing for LVRR are summarised in Annex C.

The MOT Science and Technology Department Director invited around 60 delegates including MOT staff from PID, RTU, TDSI, PMU18 and selected PDOTS, plus professors and researchers from RITST and relevant universities to participate in a 1 day workshop on rural road surfacing organised by the RTU on 18 September 2001. A briefing document was provided, offering a justification for the use of alternative surfacings to the traditional gravel and penetration macadam then currently specified for rural roads. This was the point of initiation of the SEACAP surfacing trials implemented principally under SEACAP.

Under RRST, 156 km of trial roads were constructed within a range of road environments in 16 provinces, from which representative sections were selected for ongoing performance monitoring.

A separate SEACAP initiative carried out a performance study of gravel roads (RRGAP) constructed under rural transport RT1 and RT2 projects (SEACAP4). This research produced recommendations on the limitations of Low (traffic) Volume Rural Road (LVRR) gravel surfacing in Vietnam, and is important reference documentation for the current Cost/Benefit investigations.

From 2009 to 2012 the RRST monitoring and analysis was funded under the World Bank Rural Transport 3 Programme (RT3). The RRST data is comprehensive and contains 5 to 7 years of performance monitoring. It could provide a suitable information source for an economic analysis of the surfacing and pavement designs investigated under the RRST programme compared with the traditional gravel wearing course in life-cycle terms.

Separate proposals have been prepared regarding a comprehensive update and review of the trials data (Intech 2016).

However, a separate Cost Benefit Analysis of the Vietnam trials research is being carried out under this assignment. The economic indicators obtained from this independent study should be compared with a similar study undertaken at the end of AfCAP 1 to confirm (or otherwise) the assumptions and published outcomes from that study, which have been questioned in some quarters.

4. Assignment Methodology

The overall aim of this project is to undertake an independent economic analysis of the options investigated in the RRST programme in Vietnam for comparison with a similar cost/benefit study undertaken at the end of AfCAP1. To undertake Cost Benefit Analysis (CBA) and calculate EIRRs and NPVs, specific investment designs/maintenance strategies need to be identified with realistic alternatives in association with relevant traffic volumes and traffic composition. Changes in road deterioration (both for project/strategy and the alternatives) can be accommodated within models such as HDM4, or RED or alternative approaches, through forecasting the effect on road roughness and Vehicle Operating Costs. However, these approaches have limitations for LVRR.

A variety of approaches and CBA models can be used to evaluate the findings of the RRST hence under the current study it will be necessary to review methodologies and develop an appropriate assessment approach for the specific circumstances of the Trials and their application.

It is likely that benefits of the RRST research could have materialised from three principal sources:

- Preservation of the infrastructure investments in life cycle terms,
- Savings in user costs (principally VOC and time savings), and
- Other social and development benefits.

These will be investigated under this study and compared to the AFCAP review.

4.1 General Approach

The proposed general approach to the assignment follows the ToR and divides the responsibilities between the four separately contracted experts:

- Team Leader/SEACAP Data Expert (TL) – Robert Petts
- Transport Economist/CBA Expert (TE) – John Hine
- Local Transport Economist (LTE) – Mrs Hien
- Local Rural Roads Expert (LRRE) – Pham Gia Tuan

During the Inception period the ToRs and contracts with the individual experts have been finalized.

Key Contact persons have been informed of the programme and arrangements by the PMU:
- OtB Engineering Ltd and OTB Vietnam Ltd as the custodians of the SEACAP database.
- Mdm Phuong Thi Minh Tran, World Bank Hanoi (ptran1@worldbank.org)
- Dr Dang Tran Thi Kim University of Transport, Hanoi (tranthikimdang@gmail.com)

5. Study Workplan

The work plan was essentially unchanged from the submitted proposal and is included in Annex A.

The proposed programme recognizes the constraints imposed by existing commitments of the experts, administrative arrangements and the Christmas – New Year, and Tet holiday periods in Vietnam. It also recognizes the key deliverables requirements:

- An inception report based on a desk study/literature review (Milestone 1).
- A draft report for presentation and discussion at a PMU/DFID meeting at the DFID offices in London. The report should outline the outcomes of the study and provide updated cost/benefit data based on this study for comparison with the previous AFCAP1 study (Milestone 2).
- Brief report on the outcomes of the meeting with DFID (Milestone 3).
- A final report based on the comments from the workshop (Milestone 4).

5.1 Outline Programme

The assignment will be carried out over a period of 19 weeks.

The Outline programme is summarized in the Table 5.1 following.

The detailed programme and resource deployment is shown in Annex A.

Resource inputs will be expected to be provided by the Key Contacts and separate arrangements made for this if necessary by the PMU.

Table 5.1 – Outline Programme

Activity	Team Member	Completion (week after start of project)
Start-up meetings to agree the methodology, scope of the project and actions.	TL/TE/PMU	1
Inception Report to cover a desk study/literature review.	Team	6
Draft report outlining the economic indicators from the SEACAP trials in Vietnam and a comparison with the AFCAP1 cost/benefit indicators	Team	15
PMU/DFID meeting and report	TL/TE	17
Final report	TL	19

6. Inception Phase

Data and information relevant to this assignment have been identified and assembled by the local experts.

A desk study has been carried out of the previous relevant studies listed in the ToR, plus the SEACAP4 Gravel Performance Study. The available RRST data will be assembled and a summary report compiled (LTE & LRRE) and reviewed (TL & TE). The World Bank Hanoi office has been consulted regarding cost benefit analysis approaches used under the RT2 and RT3 programmes and current LVRR initiatives, and a report will be prepared (LTE). Particular attention has been paid to any existing post-implementation assessment studies. From these investigations, the proposed cost/benefit analysis approach for the RRST is being developed.

7. Desk Study Investigations

7.1 Literature Review - Key Literature Sources and Evaluation Models.

A range of reports and models have been consulted and reviewed for the study. Key sources of material are listed below.

Rural Road Impacts:

- Cuong ,N.V. (2011) Estimation of the impact of rural roads on household welfare in Vietnam. Asia-Pacific Development Journal 18 (2): 105-135.
- Hine J, Abedin M, Stevens RJ, Airey T, Anderson T (2016) Does the extension of the rural road network have a positive impact on poverty reduction and resilience for the rural areas served? If so how, and if not why not? A systematic review. London: EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London.
- Mu, R., van de Walle, D. (2007) Rural roads and local market development in Vietnam. Policy Research Working Paper 4340, Impact Evaluation Series No. 18. Washington, DC: World Bank.

Cuong, and Mu and Van de Walle have conducted specific studies of rural impacts in Vietnam. Unfortunately, the results of these two studies are not very conclusive, although there is some evidence of impact, particularly from Cuong where the presence of an all-weather road was consistent with an increase of rural incomes by 8%, although it was not found to be statistically significant. Further, significant reductions in poverty associated with the RT3 rural roads programme are reported in the World Bank 2014, Implementation Completion and Results report referred to below.

The Systematic Review (SR) by Hine, et al. provided a detailed analysis on 56 quality worldwide studies of rural road impact. The SR found overall, a strong positive impact of rural road investment on income growth and poverty reduction also with net beneficial effects on transport costs, traffic volumes, agricultural output and marketing, employment growth and health and education impacts. Major methodological and data issues remain with studies of final impacts of rural roads on local communities. Despite many years of research, road impact studies have not been successful in specifically helping the planning process of rural roads. In particular, the results tend to be diffuse and not easily connected to specific road engineering standards, hence planning has been largely reliant on Cost Benefit Analysis and ranking based procedures.

Road Investment Models

- World Bank (2000) Highway Development and Management Model (HDM4). Washington, DC and Paris: World Bank and the World Roads Association (PIARC).
- World Bank. (2006) Roads Economic Decision Model (RED), Sub-Saharan African Transport Policy Program, World Bank, Washington DC.

The two most important models currently used in Cost Benefit Analysis of rural roads are HDM4 and RED. Both models calculate economic costs and benefits including decision criteria such as IRRs and NPVs for road investment based on changes in vehicle operating costs and road maintenance costs. HDM4 is a relatively complex Windows-based model that models road deterioration, road maintenance effects (including the progression of road roughness) and vehicle operating costs. In contrast RED is a simpler spreadsheet based method that models changes in vehicle operating costs; based on user inputs of road roughness.

Studies Related to Finding the Cost Benefit Impact of Research In General, and Rural Road Research In particular

- AFCAP Workshop on Cost Benefit Analysis (2013) Summary Report of Workshop Outcomes 11th September 2013, London
- Carruthers, R. and A. Nogales (2013) Economic Cost, Benefit and Value for Money Analysis of AFCAP Research Outputs final Report.
- Rust, F., Strydom, J. , and J Hine (2016) ReCAP Benefit Assessment System (ReCAP-BAS) Literature review, CSIR South Africa, RAF 2092 A

The CSIR report investigates a range of ways of assessing the benefits of research and identifying research priorities. Part of the report addresses the use of Cost Benefit Analysis to assess research benefits and a number of examples are provided. Major issues are identified, in particular there are a number of steps between providing research outputs and the findings being implemented on a regular basis.

The other two reports provide estimates of possible cost benefit returns of the AFCAP research, particularly into the adoption of low cost seals on the rural road network. In this case two alternative approaches are explored.

Reports relating to the Vietnam RT3 Rural Road Programme.

- Cartier Consult (2013) Sustainability Review of the Third Rural Transport Project (RTP3) in Vietnam : Final Report
- World Bank (2014) Implementation Completion And Results Report (IDA-41500 IDA-50320 TF-56320 TF-92068) Vietnam Third Rural Transport Project. Washington DC.
- World Bank (2005) Project Appraisal Document. Vietnam, Rural Transport III , Washington DC.

- Ministry of Transport Vietnam (2005) Third Rural Transport Project (RT3) Consultancy Services for Technical Assistance for Project Preparation Draft Final Report, prepared by Roughton International.

The above reports describe the important RT3 programme supported by the World Bank, including the initial consultant's report, the Project Appraisal Document and completion and sustainability reviews. RT3 was designed before the final findings of the SEACAP research and these reports provide a rich source of material on which to base rural road policy in Vietnam before the research final outcomes. However, the final principal strategic shift from predominantly gravel roads (RT2) to predominantly DBST sealed roads (RT3) was informed by interim conclusions from SEACAP.

7.2 Relevant SEACAP Reports

- J. R Cook and R.C Petts, 2005, Rural Road Gravel Assessment Programme, Final Report. SEACAP 4 for DfID and Ministry of Transport, Vietnam.
- R C Petts and J R Cook, 2006, SEACAP 1: Intech-TRL Final Report– 3 Volumes. MoT and DFID, Vietnam.
- Intech Associates & TDSI, 2016, Assessment of the SEACAP-WB LVRR Pavement Trials as Knowledge Resources for ASCAP/ReCAP Uptake

The Rural Road Gravel Assessment Programme (RRGAP) investigations, carried out at 766 of the RT1 and RT2 road sites, found serious constraints to the use of surfacing gravel in most of the studied 16 Vietnam programme provinces. Constraints and high material losses were due to factors relating to material availability, material quality, climate, terrain, drainage provision and maintenance regime.

Overall gravel loss figures indicated that around 58% of the surveyed sites were suffering unsustainable deterioration of more than 20mm/year, while 28% were losing material at more than twice this rate of loss. Figure 7.1 summarises the research study results.

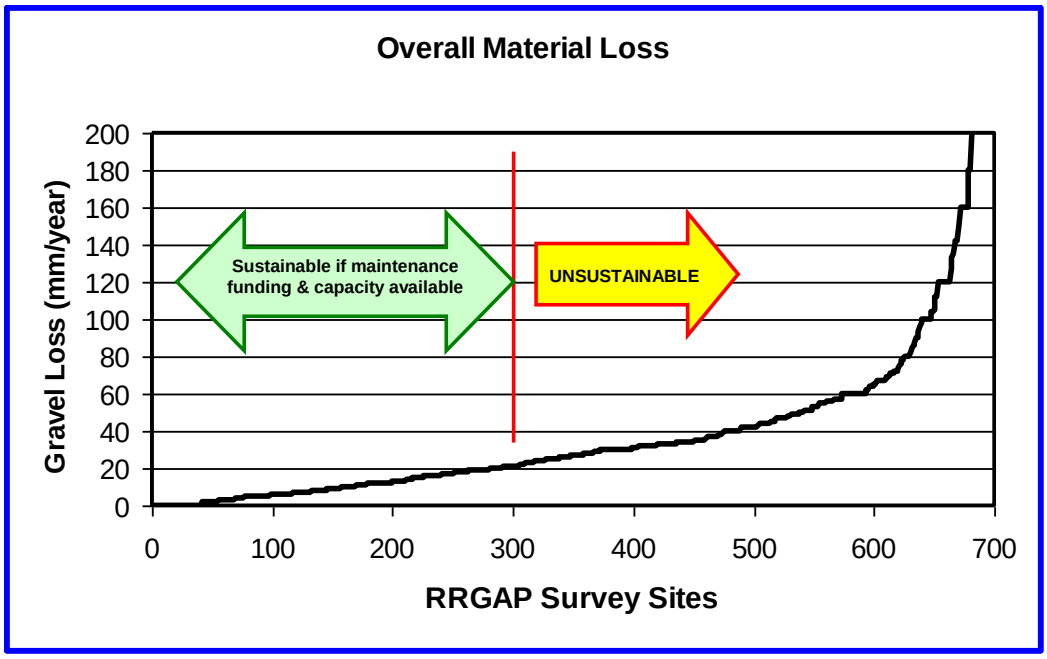


Figure 7.1 - RRGAP Adjusted Material Loss Summary

Initiated and implemented principally under SEACAP 1, rural road surfacing trials were carried out using a range of surfacing and paving types in Vietnam. The reports summarise the main findings of

the gravel road performance study and the construction and follow up on the paving and surfacing trials.

Under RRST, 156 km of trial roads were constructed within a range of road environments in 16 provinces, from which representative sections were selected for ongoing performance monitoring.

Table 7.1 summarises the RRST surfacing and paving types trialled in Vietnam.

Table 7.1 Range of RRST Trialled Options

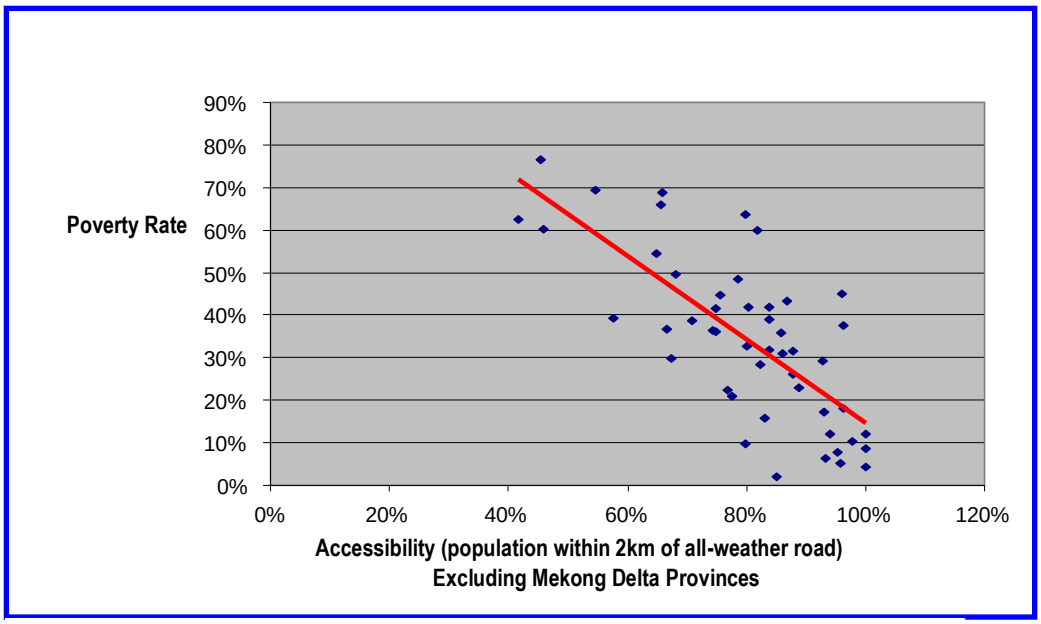
	Vietnam		
Trial Options	RRST-I	RRST-II	RRST-III
SEALS			
Double emulsion chip seal - DBSTe		**2006**	**2011**
Double bitumen chip seal - DBST		**2006**	**2011**
Emulsion sand seal over single chip seal - S/SBSTe	**2005**		
Single emulsion sand seal - SSe	**2005**	**2006**	
UNSEALED SURFACES			
Gravel Wearing Course	**2005**	**2006**	
Water-Bound Macadam (WBM)	**2005**	**2006**	
SEALED BASES & SUB-BASES			
Water-Bound Macadam (WBM)	**2005**	**2006**	**2011**
Dry-Bound Macadam (DBM)	**2005**	**2006**	**2011**
Emulsion Stabilised Sand	**2006**		
Cement Stabilised Sand	**2005**		**2011**
Lime Stabilised Clay Soil	**2005**		**2011**
Graded Crushed Stone			**2011**
Natural Sand	**2005**		
Natural Gravel	**2005**	**2006**	**2011**
BLOCK SURFACES			
Stone Setts/Cobble Stone	**2005**	**2006**	
Fired Clay Brick	**2005**	**2006**	**2011**
Concrete Brick	**2005**	**2006**	**2011**
CONCRETE			
Steel Reinforced	**2005**	**2006**	
Bamboo Reinforced	**2005**	**2006**	
Non-Reinforced		**2006**	**2011**
Notes: 2005 etc. Year of original construction			

A further and vital consideration identified by the SEACAP1 investigations is the relationship between poverty incidence and access to an all-weather road. Un-maintained earth and gravel roads cannot be categorised as 'all weather'[1] hence denying their associated communities suitable road access for their economic and social needs. There is an established link between poor access and poverty incidence (e.g. Figure 7.2 from the SEACAP 1 Final Report).

The essential link between poverty incidence and all weather access is clearly demonstrated.

1 In the areas of Vietnam characterised by high rainfall and weak subgrades the terms 'all weather' and 'all season' are synonymous.

This study will investigate whether more up to date data is available relating to poverty incidence and accessibility to an all-weather road.



Source: Vietnam 2002 Living Standards Survey

Figure 7.2 - Poverty and Accessibility, Vietnam 2002

7.3 Data Collection

It is proposed to collect and compile the following data for the analysis. Much of this data will be readily available in the identified reports. However other data may have to be collected from other sources.

a) Overall rural road programme

- Construction and maintenance costs for different interventions.
- Data on current rural road network length and the lengths of road (by type, and if possible by terrain/region) improved /rehabilitated over the last ten years and any estimates of how this data will change in the future.
- The current construction costs involved for different types of road constructed.
- Current construction budgets, per year, from all sources including donors.
- Current Budgets/expenditure for maintenance per km of road, divided between main categories such as routine, periodic, emergency.
- The costs of key maintenance activities, per km or per square metre (i.e. emergency maintenance, routine maintenance through grading, regravelling, spot improvements for gravel; and for paved roads, pot-hole filling, crack maintenance, resurfacing etc.).
- Information relating to 'actual' maintenance policy indicating the priorities that are actually undertaken. This is in contrast to ideal maintenance policies that may be rarely carried out, because of shortage of funds.

b) Traffic

- A range of typical examples of daily traffic flows on rural roads, (if possible by terrain/region). This data should be broken down and clearly identify vehicle types, i.e. Cars, trucks, buses, motorcycles, cycles, animal carts, pedestrians, etc..
- Past and current traffic growth rates by vehicle type.
- Any data on LVRR axle overloading.

c) Road condition

- The spectrum of roughness values, together with age since construction, found on different classes of roads (including earth, gravel, paved, concrete etc.) and the mean values.
- Examples of roughness progression from construction.
- New estimates (if any) of gravel loss in different terrains/rainfall/traffic categories.
- Data on seasonal impassability by road type and time period for standard vehicle types and time period.

d) Vehicle Operating Costs (excluding taxation)

- Current estimates of new vehicle prices for different vehicle types.
- Tyre costs for different vehicle types.
- Garage mechanic charges per hour for different vehicle types.
- Fuel and lubricant prices.
- Crew costs for different vehicle types.
- Passenger time values.

e} Economic Planning data

- Current economic discount rates used in Vietnam.
- Standard Conversion Factors for adjusting construction costs to economic values, without tax.
- Economic Planning Models & Road Appraisal and Evaluation Reports.

The Vietnamese experts are currently identifying and collecting the data and information. The recently initiated World Bank support to the MoT-facilitated Local Road Asset Management Project (LRAMP) is seen as a potential source of valuable data.

8. The Cost Benefit Analysis Approach

Figure 8.1 Typical earth road in rain season (Image: Cook).

In order to estimate the benefits of the SEACAP research in transport cost benefit terms it is necessary to identify the net difference in discounted economic benefits associated with two scenarios of road investment. These are:

a) a programme of road investments that would have happened in the absence of SEACAP.
b) the programme of road investments that took place with the benefits of SEACAP and is currently ongoing.

The net difference in benefits then needs to be compared with the costs of the SEACAP research.

Prior to the SEACAP research, earth roads in Vietnam were normally unusable for many vehicles in the rains, due to generally weak subgrades or adverse terrain, and lack of engineering and maintenance. The default intervention for rural routes was usually gravel, albeit of variable quality. However, in some cases bituminous penetration macadam or un-reinforced concrete would be

used.

It is very difficult to model the earth road situation due to lack of local research on this anyway very variable scenario. It is therefore proposed that the 'without' case programme be derived from the base scenario of the use of gravel as the previously normal surfacing intervention.

Traffic thresholds for upgrading roads from earth to gravel and from gravel to seal/paved were developed for different road classes and different terrain for the Third Rural Transport Project (RT3) – Final Report (2014); see Table 8.1 following. However, there is doubt about the rationale for these criteria in view of the much wider range of factors that will influence a rational comparison of surface types. This is discussed further in the text following.

Table 8.1 – Guideline Threshold Motorized Traffic Volumes for Road Improvements

Road Class	Flat		Rolling		Mountainous	
	vpd (MT)	PCU	vpd (MT)	PCU	vpd (MT)	PCU
		Gravel Roads Compared to Earth Tracks				
V	50	35	55	40	60	45
VI	35	25	40	30	60	45
A	35	25	40	30	40	30
B	30	20	35	25	35	25
		Sealed Roads Compared to Gravel Roads				
V	400	300	350 - 400	250 - 300	250 - 300	175 - 225
VI	350 - 400	250 - 300	350	250	250 - 300	175 - 225
A	300 - 350	225 - 250	250 - 300	175 - 225	250 - 300	175 - 225
B	250 - 300	175 -225	250	175	200 - 250	150 - 175

MT ~ motorized transport; PCU ~ passenger car units; vpd ~ vehicles per day
Source RT3 Final Report World Bank 2014.

A date needs to be specified to be the starting point for the investment programme and assumptions made as to how the programme would develop, over say a fifteen or twenty years planning time horizon.

To undertake this analysis a representative spectrum of road categories needs to be identified. Each category would be associated with a specified surface type, road class, terrain, and range in traffic volume. Each road category could then be associated with a given/assumed length of the national road network and the proportion that would be upgraded for each year of the analysis. It is assumed that the highest traffic volume roads, in any year will be identified for upgrading. Inevitably a range of simplifying assumptions would have to be made for the analysis.

It is proposed that the economic analysis would be carried out using a spreadsheet based model with the vehicle operating cost values calculated from the RED rural roads model. Calculated road roughness values will be estimated from road condition surveys, and maintenance policy (i.e. observed gravel lost and grading and re-gravelling frequencies). If necessary specific items of road deterioration might be calculated from the HDM4 road planning model, particularly where direct observation is lacking.

8.1 Proposed RRST Evaluation Methodology

As gravel surfacing was the predominantly specified LVRR surfacing at the time of the Vietnam RT1 and RT2 projects, it is proposed to use gravel as the base scenario for the CBA.

However, Vietnam road environments experience a very wide range of variables that need to be considered for economic evaluation of LVRR surfacing options. With the limited resources available for this assignment, it is proposed to develop a matrix of key variables that will be applicable to this evaluation and for future CBA assessment of LVRR surfacing in Vietnam. It is proposed to investigate the extremes of this matrix to gauge the range of likely economic scenarios and benefits of the SEACAP trials and surfacing research.

The proposed variables are:

- **Traffic**. The traditional 'rule of thumb' (severely questioned by SEACAP4 investigations) suggested that earth roads should be upgraded to gravel at 50vpd, and that gravel should be upgraded to paved at 200vpd. Therefore, the matrix options are suggested as 50vpd and 200vpd.
- **Subgrade strength**. The majority of the Vietnamese population lives in flat lowland areas with generally weak clay soils where rice (the staple food crop) is grown in paddy fields. Research has shown that the traffic bearing capacity of in-situ soils increases significantly above a CBR of about 12(Rolt et al, 2009). Therefore, the matrix options on subgrade strength are suggested as CBR 6 and CBR 12.
- **Weather**. Rainfall varies significantly across Vietnam; up to a maximum of over 4 metres/year. Therefore, the matrix options on Annual Rainfall are suggested as 1,000mm and 2,000mm.
- **Gradient**. Gradient has a significant effect on unpaved road material losses and maintenance needs. It is generally recommended that gravel should not normally be laid on longitudinal gradients of more than 6%. Therefore, the matrix options for longitudinal gradient are suggested as 0% and 4%.
- **Maintenance**. The funding and resourcing of maintenance for LVRR in Vietnam (and most economically emerging nations) is highly problematic. Therefore, the matrix options for maintenance regime are suggested as 'full maintenance' and 'no maintenance'.
- **Gravel haul**. The matrix options for gravel haul distance for construction and maintenance are suggested as 1km and 10km.
- **Surface Upgrade Options**. The SEACAP Scoping Study (Intech & TDSI 2016) visited a number of provinces that confirmed that their current default surface upgrading techniques were DBST and un-reinforced concrete. These are proposed as the upgrade options to be compared to gravel.

The study will assess the benefits of the RRST research that could have materialised from three principal sources:

- Preservation of the infrastructure investments in life cycle terms,
- Savings in user costs (principally VOC and time savings), and
- Other social and development benefits.

9. Other Considerations

The local road and bridge network in Vietnam comprises about 253,000 km, or about 85%, of Vietnam's total network of 295,000 km. Research carried out in Vietnam and neighbouring countries since 2000 under SEACAP and other initiatives has shown that investments in local roads and bridges has had a significant impact on poverty alleviation, social participation, school attendance and health services. Based on the results of this research, it has been estimated that an investment of 1% of GDP per year in rural transport has helped reduce the poverty rate by 1.5% per year, on average.

Vietnam has made impressive steps in substantially increasing the extent of the paved road network in a very short period of time since the original SEACAP investigations (Table 9.1).

Table 9.1: Vietnam Road Length in km by category and pavement type (2014)

Category	Paved	Gravel	Earth	Total	% paved	
					2004	2012
National road	17,910	656	178	18,744	83.5	95.6
Provincial road	21,888	2,409	1,515	25,812	53.6	84.8
District road	25,326	9,326	8,664	43,316	20.2	58.5
Urban road	17,794	2,516	2,329	22,639	60.2	78.6
Commune road	67,273	36,203	81,624	185,100	2.2	36.3
Total	150,191	51,110	94,310	295,611	**19.0**	**50.8**

Source: DRVN

Annex A: Assignment Workplan

FIGURE 1 - WORK PROGRAMME																			PRIME RESPONSIBILITY	RESOURCE INPUTS			
		Xmas-NY					TeT-VN																
WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		TL	TE	LTE	LRRE
Start up meeting																				TL-TE-PMU	2	2		
I. Desk study																								
A desk study of relevant studies																				TL + TE	2	2		
The available RRST data summary report compiled (LRRE) and reviewed (TL & TE)																				LRRE	3	1		9
World Bank Hanoi office cost benefit analysis report will be prepared (LTE)																				LTE	1	1	10	
Proposed cost/benefit analysis approach development																				TE	1	3	2	
II. Cost Model Assessment																								
Report on RRST cost model (LRRE) and reviewed (TL).																				LRRE	3			8
III. Maintenance Relationships																								
The available monitoring RRST data and RRGAP review (LRRE) and reviewed (TL)																				LRRE	3	1		8
IV. VOC Cost Models																								
Compile Report on available data on VOC & Vietnam application (LTE) and Reviewed (TE).																				LTE	2	2	10	
V. Development CBA Model																								
Construction Evaluation Model and develop appropriate Economic Indicators for the RRST programme																				TE	2	9	1	
Consideration other possible measurements of benefit (TE)																				TE	1	1	2	
Compare and contrast with the economic indicators from the AfCAP 1 study (TE).																				TE	2	2		
Final Report																					3	1		
MILESTONES						1									2		3		4					
																				TOTAL PERSON DAYS INPUT	25	25	25	25

Annex B: References

i. Toney Airey & Geoff Edmonds, 2015, ASCAP Scoping Study.

ii. Asian Development Bank, 2011, Cambodia Transport Sector Assessment, Strategy, and Road Map.

iii. Asian Development Bank, 2015, Republic of the Union of Myanmar, Transport Sector Policy Note, Sector Note: Rural Access and Road Management (draft).

iv. M. Burrow, R, Petts, M. Snaith, G. Ghataora, H. Evdorides, 2015, What is the evidence supporting the technology selection for low-volume, rural roads in low-income countries and what evidence is there to support the sustainability of different rural road technologies? A systematic review, for DfID.

v. J. R Cook and R.C Petts, 2005, Rural road gravel assessment programme, Final Report. SEACAP 4 for DfID and Ministry of Transport, Vietnam.

vi. J R Cook & B Meksavanh, 2009, Performance Monitoring of Low Volume Rural Roads in North West Lao PDR.

vii. J R Cook and P G Tuan World Bank Transport Note on Rural Road Pavement and Surfacing Options: Improving Vietnam's Sustainability.

viii. J. R Cook, 2012, Climate Resilient Rural Roads Technical Paper No. 1. The Vietnam Rural Road Surfacing Research Programme2003-2012. Internal Technical Summary. World Bank.

ix. J R Cook, R C Petts, PG Tuan, 2015, SEACAP 10 Years on: Mainstreaming Sealed Road Research on Rural Roads. CAPSA.

x. https://hubs.worldbank.org/docs/imagebank/pages/docprofile.aspx?nodeid=20336900

xi. F. Gleeson, 2003, Report on Puok Market trials construction. Siem Reap, Cambodia, LCS Working Paper No 13, for DfID.

xii. Intech Associates, 1993, Roads 2000 – A programme for labour and tractor based maintenance of the Classified Road Network, Pilot Project Final Report.

xiii. Intech Associates, 2016, Assessment of the SEACAP-WB LVRR Pavement Trials as Knowledge Resources for ASCAP/ReCAP Uptake, Scoping Study Report.

xiv. Intech-TRL, 2006, SEACAP 2: Cambodia Transport Mainstreaming Partnership, Final Report.

xv. Intech-TRL, 2006, SEACAP 8: Cambodia Low Cost Surfacing Phase 2. Final Report.

xvi. R C Petts and J R Cook, 2006, SEACAP 1: Intech-TRL Final Report– 3 Volumes. MoT and DFID, Vietnam.

xvii. R C Petts, 2007, Rationale for the compilation of international guidelines for sustainable road surfacing, LCS Working Paper No 1 (edition 3), for DfID.

xviii. R C Petts, 2012, Handbook of Intermediate Equipment for Road Works in Emerging Economies.

xix. M I Pinard, 2000, Managing SADC Roads Agencies in The New Millennium: The Role of Road Asset Management Systems.

xx. J Rolt, J R Cook H. Kackada, 2009. Behaviour of Engineered Natural Surfaced Roads: Experimental Evidence in Cambodia. SEACAP 19, Tech Paper 2.2 for Royal Gov, of Cambodia.

xxi. Roughton International, 2008, SEACAP 17 Rural access roads on route No.3, Module 2. Completion of construction report. Report to the Ministry of Public Works and Transportation, Lao PDR and DfID.

xxii. Roughton International, 2013, Monitoring Programme in Lao PDR (SEACAP 17), Monitoring Report.

xxiii. World Bank, 1981, The Road Maintenance Problem and International Assistance.

xxiv. World Bank, 2008, Safe, Clean, and Affordable Transport for Development - The World Bank Group's Transport Business Strategy for 2008-2012.

xxv. World Bank, 2013, Nepal Road Sector Assessment Study.

xxvi. World Bank, 2014, RT3 Implementation Completion and Results Report.

ANNEX C: Issues relating to the surfacing choice for LVRR Rationale for LVRR.

C.1 The Effectiveness of Unpaved Roads

Engineered Natural Surface (ENS) roads are the most basic, and low cost, form of road transport infrastructure. They utilise existing or immediately adjacent materials along an alignment to form a shaped and drained low cost basic rural access road. The nature of these natural materials can vary from clayey/sandy soil to weathered rock. Materials with a CBR of about 12 or more are usually suitable for motorised traffic of up to 50vpd or greater. The surface may be effectively un-serviceable in periods of heavy rain. However, essential annual routine maintenance of camber reshaping and drainage is required to keep the surface serviceable at other times. Even this low-cost level of regular intervention is beyond the resources and capacity of many road authorities in emerging nations for minor routes. Many of the earth roads in Vietnam are on soils that are very weak in the rains.

Figure C.1 - Rural gravel road in Vietnam lacking maintenance.

The next level of investment, and widely used by many road authorities, is a natural gravel or laterite surface. However, most authorities have found difficulties in sustaining gravel surfaces and few manage to resource and carry out the high levels of routine maintenance and periodic re-gravelling required. There is little evidence of periodic maintenance re-gravelling on the extensive unpaved road networks of Vietnam in the SEACAP region. The problem is also common and has been longstanding in many Asian and African countries (Intech, 2016).

In many regions, there are now serious problems with sourcing natural gravel deposits within reasonable haul distances, and that comply with acceptable grading and plasticity criteria.

Realisation of the problems associated with gravel surfaces in Vietnam led to the Rural Road Gravel Assessment Programme (RRGAP) performance study by Intech-TRL (Cook & Petts, 2005), funded by DFID under SEACAP4. From the RRGAP investigations, and consideration of other complementary research and knowledge of the performance of gravel roads elsewhere, guidelines were proposed for the restriction and use of gravel as a rural road surfacing.

These guidelines highlighted the limitations of gravel surfacing applications and the need for robust, researched criteria for the range of local resource based surfacing and paving options that generally provide lower maintenance, and certainly better whole life cost attributes, than unpaved surfaces in a weak maintenance environment typical of emerging economies.

C.2 Technical, Social and Economic Issues

There is a range of alternative low-cost surfacings which are already proven and used in various locations around the world. Unfortunately, many national Specifications do not recognise or exclude

these surface options and therefore they cannot be specified or used under normal contract arrangements.

Many of these options optimise the use of local materials and other available resources and could have superior durability and whole life cost attributes, compared to unpaved, and certainly un-maintained unpaved, surfaces.

Many of the options can use labour-based or local resource based approaches, and can generate up to 1,500 worker-days per km during construction. The local communities (particularly the poor and otherwise un- or under-employed) would benefit considerably from their adoption in terms of productive work creation, empowerment of groups that currently are severely disadvantaged, and local enterprise creation. These advantages are in addition to the economic benefits to the poor communities through provision of improved infrastructure that would otherwise not be provided, and tackling poverty through creation of increased social and economic opportunities in the communities. Appropriate use of the various surfacing options would depend on local circumstances.

The labour-based techniques can create equal opportunities for female employment where properly managed and social traditions are approached sensitively with suitable consultation. The alternative surfacings are often low maintenance so that they would considerably ease the financial and (often intractable) institutional burdens on road authorities and communities. Organisations, enterprises and community groupings with limited resources and skills could use them. The alternative surfacings would also provide considerable environmental benefits. They should be more sustainable and climate resilient.

There is also considerable potential to use the alternative surfacings on short, problematic sections such as through villages, on weak subgrades and hill sections; effectively a 'spot improvement', 'Environmentally Optimised Design – EOD', or basic access approach, for situations when resources are particularly constrained. Considering the wide range of circumstances and factors, which usually vary along a road route, it is often appropriate to specify different surfaces and paving thicknesses for sections of different characteristics.

A particular constraint is that the alternative surfacing techniques are often not properly documented and accessible; decision makers are usually not aware of the options, potential, requirements, appropriate specifications, cost and benefits.

The DFID funded Systematic Review of technology selection for low-volume, rural roads in low-income countries (Burrow et al, 2015) made an important Policy and Practice recommendation:

> *'To appreciate the very different resource environment in LICs/LMICs, which is characterised by the scarcity and high cost of finance/capital for the private sector, low labour costs, the availability of usable non-standard materials, typical overdependence on imported materials, skills and equipment, and a weaker institutional support framework. This necessitates the development of more sustainable and local resource-based technologies, such as those identified in this review, and operationally effective asset management systems.'*

There is therefore an urgent need to document the extensive local-resource-based SEACAP surfacing trials experiences and develop usable guidelines to enable road authorities to be informed of, review, adapt, adopt and mainstream the range of alternative, affordable, robust and sustainable surfacings suitable for their physical and operational environment.

C.3 Capital Requirements

Although not an issue in Vietnam, the road sector in many emerging economies is usually dominated by a relatively small number of large, locally owned or foreign enterprises using capital intensive methods. Predatory pricing by foreign or subsidised enterprises can even undermine established local capacity. There are large capital investment requirements in terms of specialist equipment, such as asphalt hot mix plant, dedicated single function heavy plant and large haulage fleets. Typical conventional roadworks fleet capital requirements are usually well in excess of US$1 million equivalent. In an economic environment where credit is severely restricted or very expensive (typical market interest rates of 15-35% p.a. – recent research by Intech), this can lead to an imperfect market with distorted prices and great difficulty for Micro, Small and Medium Enterprises (MSMEs) to enter or compete.

The SEACAP trialled surface options are generally very low in equipment capital requirements and intermediate equipment options are available (Petts, 2012) and are ideal for MSME implementation. Furthermore, many of the equipment items required have commonality with other sectors (e.g. concrete mixing and small compactors for the building sector, or tractor hauling, mixing etc. with the agricultural sector) and are often available to hire on the local market. Dry hire rates of the order of US$ 10 -50 per day are often achievable for the limited number of individual intermediate equipment items required for the alternative surface techniques. This substantially reduces the MSME capital requirements, as they can often hire in such equipment only when they have contract work requiring their application if contract arrangements allow.

The opening up, and promotion, of the LVRR sector to local MSMEs and the adoption of alternative surfacing and low capital equipment methods would make road provision and maintenance more competitive, affordable, achievable and sustainable in many emerging economies.

The considerable benefits of the permissible use of low capital and intermediate equipment use needs to be recognised and allowed in Surfacing and Paving Specifications and contract arrangements/documentation.

C.4 Climate Resilience

The climatic environment in South East Asia, with its variability and frequency of extreme weather events, makes AsCAP and former SEACAP partner countries highly susceptible to climate impacts. At the same time, it is increasingly acknowledged that rural transport infrastructure is particularly vulnerable to climate threats and associated impacts. The risks arising from these impacts are considerably increased when the likelihood of increasing climate threats from future climate change is taken into account. There is therefore an increasing focus on identifying and applying cost-effective approaches to increasing the climate resilience of rural roads that takes in account the local road environments and the constrained budgets within which most road authorities have to work.

There is wide range of possible interventions required to make roads more climate resilient (Table C.1) and one of these is replacing existing earth or gravel surfaces with more erosion resistant options such as bituminous seals, concrete, stone, bricks or concrete blocks. It is important to note that improved surfacing is only one of a number of potential interventions, there has nevertheless, recently been an appreciation that the SEACAP surfacing trials, and the Vietnam RRSR trials in particular, are a valuable source of information on the climate resilience of surfacing options.

Table C.1 - Engineering Climate Resilience Options

Ref.	Adaptation Option	Comment
1	Pavement sealing	Pavement sealing recommended for steep gradients (>8-10%).
2	Additional or enlarged culverts	Additional or enlarged or improved existing cross culverts considered essential to improve overall road drainage.
3	Side drainage.	Additional side drains and associated turn-outs. Scour checks where necessary, Lined drains required with gradients >6%.
4	Raised embankments	Raising of earth embankments where the alignments are low and is being impacted by flooding and/or the weakening of the pavement by saturation.
5	Culvert or bridge abutment protection.	Gabion, concrete, masonry or bioengineering protection where erosion of abutments is identified as a significant risk.
6	River/stream erosion protection	Gabion, concrete, masonry or bioengineering protection where erosion of the alignment by rivers or streams is identified as a significant risk.
7	Cut and fill slope protection	Gabion, concrete, masonry or bioengineering protection where erosion or deterioration of existing earthwork slopes is identified as a significant risk.
8	Re-alignment	Re-alignments where an identified climate impact hazard and consequent engineering risk may be most cost-effectively overcome by avoidance.
9	River/stream crossing	Existing fords or low level bridges might be replaced by climate resilient structures such as vented fords, or submergible multiple culverts.

The specific threats and impacts will vary from country to country but the overall scenario holds true not only for Asia, but also for Sub-Saharan Africa.

There are currently a series of ReCAP projects, potential projects and associated projects where climate resilience is of central importance and where further assessment and analysis of the SEACAP trials could provide a cost-effective source of additional climate resilience data:

- AfCAP regional project: GEN2014A: Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access.
- AsCAP regional project: P170, Increasing Rural Access sustainability through climate-focused LVRR maintenance
- Myanmar: AsCAP National Project (Planned) on developing appropriate rural standards and specifications.
- Myanmar: KfW funded Rural Road Development programme, Taunggyi, Shan State, 2014-16
- Myanmar: ADB funded rural roads programme, initially in three trials areas and including road trial, 2017-2020 (Linked to AsCAP).

The funding, resourcing and delivery of road maintenance is now one of the greatest challenges for governments and road authorities for low volume roads in emerging nations. For decades the leading agencies in the sector have been promoting the economic justification for effective maintenance. However, in 1981 a World Bank study reported that *"The evidence is abundant that satisfactory basic systems (of road maintenance) can seldom be established in less than fifteen or twenty years and that help may still be needed thereafter to deal with expansions of maintenance workload and avoid retrogression".*

The road maintenance problems have been extensively investigated since. However, they are still almost universally prevalent in emerging nations. The complexity and range of interconnecting political, financial, economic, technical, human resources and technical issues make the maintenance challenges seemingly intractable. However, one of the approaches that could substantially reduce the LVRR network maintenance burden and increase climate resilience, would

be the wider use of more durable and sustainable, and intrinsically lower maintenance surface options. Often, these alternative surfaces have significant net benefits in whole-life-costing terms. However, political and management decision makers often do not have access to the compiled knowledge that would facilitate the uptake and application of these options.

The study will consider whether there is sufficient evidence relating to the foregoing issues to enhance the support for the CBA assessment of the RRST.