Consolidation, Revision and Pilot Application of the Rural Access Index (RAI)

TG2 Final Report

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Abstract

The overall aims of this project are to develop a harmonised approach to measurement of the Rural Access Index (RAI) that is relevant, consistent and sustainable, and which facilitates the implementation of RAI across UN member countries. The project has consolidated existing and proposed approaches to data collection and measurement in collaboration with the World Bank and other stakeholders and presents a refined measurement process designed to minimise inconsistencies in data collection, meet international standards and provide a clear framework for data validation.

The results presented are based on extensive consultations with key stakeholders, and experience from work in four trial countries (Ghana, Malawi, Myanmar and Nepal). Supplemental Guidelines have been developed to provide detailed advice on how to measure RAI using geospatial resources. The results of the project have been widely disseminated at a number of global events, and three scientific papers have been prepared.

The next phase of the project will focus on uptake and embedment of RAI as a key Sustainable Development Goal indicator (SDG 9.1.1), and extend RAI measurement to more countries in a sustainable way. An RAI Measurement Tool has been developed in parallel to this project and is also discussed in this report.

Key Words

RAI, Rural, Roads, Access, Poverty, Index, SDG, Methodology, Geospatial

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Acronyms, Units and Currencies

ADB	Asian Development Bank
AfCAP	Africa Community Access Partnership
AfDB	African Development Bank
AsCAP	Asia Community Access Partnership
CSO	Central Statistical Office
DESA	Department of Economic and Social Affairs
DFID	Department for International Development
DoH	Department of Highways
DRD	Department of Rural Development
EIB	European Investment Bank
FAO	Food and Agriculture Organization of the United Nations
FAQ	Frequently Asked Questions
GAUL	Global Administrative Unit Layers
GBP	British Pounds
GCRF	Global Challenges Research Fund
GIS	Geographical Information System
GRID3	Geo-Referenced Infrastructure and Demographic Data for Development
GRIP	Global Roads Inventory Project
GRUMP	Global Rural Urban Mapping Project
GTF	Global Tracking Framework
HDI	Human Development Index
HDM-4	Highway Development and Management tool (version 4)
IADB	Inter-American Development Bank
IAEG-SDGs	Inter-agency and Expert Group on SDG Indicators
IMT	Intermediate Means of Transport
IRF	International Road Federation
IRI	International Roughness Index
ISDB	Islamic Development Bank
LIC	Low Income Country
LSMS	Living Standards Measurement Study
LSS	Living Standard Surveys
MDA	Ministries, Departments and Agencies
MDB	Multilateral Development Bank
MIC	Middle Income Country
MIMU	Myanmar Information Management Unit
ML	Machine Learning
MoBA	Ministry of Border Affairs
MoC	Ministry of Construction
MoPF	Ministry of Planning and Finance
MSDP	Myanmar Sustainable Development Plan
NASA	National Aeronautics and Space Administration
NSO	National Statistical Office
NSS	National Statistical System
ONS	Office for National Statistics
OSM	OpenStreetMap
PIARC	World Road Federation
PIDA	Programme for Infrastructure Development in Africa
PMU	Programme Management Unit
QGIS	Open Source GIS product (previously known as Quantum GIS)
RAI	Rural Access Index
ReCAP	Research for Community Access Partnership
SDG	Sustainable Development Goal
SRTM	Shuttle Radar Topography Mission
SSATP	Africa Transport Policy Programme
SuM4All	Sustainable Mobility for All
TG1	Task Group 1
TG2	Task Group 2

TG3	Task Group 3
TOR	Terms of Reference
TRL	Transport Research Laboratory
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)
UK ONS	UK Office of National Statistics
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFPA	United Nations Population Fund
UNGP	United Nations Global Platform
UNSC	United Nations Security Council
UNSD	United Nations Statistics Division
US	United States
UTM	Universal Transverse Mercator
WRA	World Road Association
WRC	World Road Congress

Executive Summary

The 'Consolidation, Revision and Pilot Application of the Rural Access Index (RAI)' project started in September 2018, with the aim to develop a harmonised approach to data collection and measurement of the RAI that is relevant, consistent and sustainable. The RAI was adopted as Sustainable Development Goal (SDG) 9.1.1 in 2016. This project has worked closely with the World Bank as custodian of SDG 9.1.1 plus other development banks and regional organisations.

The current methodology for calculation of RAI was published by the World Bank in 2016. The project has developed Supplemental Guidelines to that methodology. These guidelines follow the key tenets of the 2016 methodology, while emphasising the involvement of National Statistical Offices (NSOs) and government agencies in the process, and providing transparency and consistency in how the RAI is calculated. They also provide an alternative approach to the 'all-season' aspect of RAI by focusing on the intended purpose of the road network and the changing risks of accessibility to that network, rather than relying on physical measurements of road condition. Importantly, they encourage NSOs to engage with new online tools and platforms such as WorldPop, Open-Street-Map and others to improve the accuracy and accessibility of data and statistics for RAI. They also provide step-by-step procedures for calculating RAI, and for documenting the exact data-sets and methodology used.

The project has trialled the Supplemental Guidelines in four countries: Ghana, Malawi, Myanmar and Nepal. Several visits were made to these countries to collect, check and process data, facilitate coordination between key stakeholders, and consolidate the RAI process through training and capacity building.

There are three main sources of data necessary to measure RAI: rural population, road network and all-season status of roads. WorldPop has been identified as the most appropriate source for georeferenced population data. All countries provided road network mapping in GIS format, although the quality and completeness varied significantly, which is an issue for the measurement of RAI because low quality datasets can make a significant difference to the result. OpenStreetMap (OSM) was considered as an alternative, but as a crowdsourcing product the coverage can be variable, especially in rural areas.

Probably the biggest challenge was identifying the all-season status of roads. The 2016 methodology used road condition to interpret all-season status, but in the trial countries it was found that this information was unreliable or inconsistent, or simply not available. Therefore, an alternative methodology was developed to measure all-season status, called Accessibility Factors, which can be determined quickly and easily without onerous data collection.

The report concludes that it is technically straightforward to measure RAI in most countries, although coverage of mapping in many Low Income Countries (LIC) and Middle Income Countries (MIC) is still an issue. This report makes recommendations across many areas including adoption of RAI for policy so that it becomes more relevant to countries at national, sub-national and project levels. In addition, improving coordination among national statistical offices (NSO) and transport agencies; encouraging publication of official road network data to OSM; and encouraging publication of other administrative data to geospatial platforms is also recommended. Further promotion of RAI and the SDGs at international conferences and events by the data custodian and regional partners is also proposed, so that countries are better aware of their measurement and publication responsibilities in relation to the Sustainable Development Goals.

1 Background

The Rural Access Index (RAI) was developed by the World Bank in 2006 and is one of the most important global development indicators in the transport sector. The RAI is defined as the "proportion of the rural population who live within 2 km of an all-season road". There is a common understanding that the 2 km threshold is a reasonable extent for people's normal economic and social purposes and equates to approximately 20-25 minutes walking time.

The 2006 methodology was based on household surveys and had several issues with inconsistency across countries and a lack of sustainable regular updates (Roberts, 2006). In addition, the approach was felt not to be spatially representative and of limited operational usefulness, resulting in weak client ownership.

In 2016, the World Bank partnered with the Department for International Development (DFID) of the United Kingdom and the Research for Community Access Partnership (ReCAP) to develop a new methodology (World Bank, 2016). The 2016 methodology took advantage of geospatial techniques and data collected using innovative technologies.

The RAI was adopted as Sustainable Development Goal (SDG) Indicator 9.1.1 in 2016, using the geospatial methodology developed in 2016. The above methodology document is referenced in the SDG 9.1.1 metadata.

In 2018, ReCAP initiated this project to develop a harmonised approach to data collection and measurement of the RAI that is relevant, consistent and sustainable. The first phase under Task Group 1 (TG1) was completed in 2018 and included a comprehensive review of the status of the RAI to date (Vincent, 2018). It included a detailed history of the development of the RAI and gave several references to key documents. The project is designed to facilitate scaling up implementation of the RAI across UN member countries.

The second phase under Task Group 2 (TG2) which is summarised in this report is an opportunity to consolidate existing and proposed approaches to data collection and refine the RAI methodology in collaboration with the World Bank and other stakeholders. The refined methodology aims to eradicate inconsistencies in data collection, meet international standards and provide a clear framework for data validation. This process aims to raise the profile of the RAI by putting in place clear data-quality standards and robust analytical methods. This will enhance the RAI's reliability as an indicator (in terms of accuracy and repeatability) and should increase the number of countries routinely collecting RAI data.

2 Research Objective

The stated aim and objective of the RAI project were:

- **Aim:** To develop, propose and obtain agreement on a harmonised approach to data collection and measurement of the Rural Access Index that is relevant, consistent and sustainable.
- **Objective:** To scale up implementation of the RAI across UN member countries in order to advance the status of SDG Indicator 9.1.1 to Tier II and eventually Tier I in the tier classification of the SDGs.

Phase TG1 was completed in 2018 and included a comprehensive review of the status of the RAI to date (Vincent, 2018). TG2 was formulated on this basis.

TG2 provided an opportunity to consolidate existing and proposed approaches to data collection and revise the RAI approach in collaboration with the World Bank and other stakeholders. The goal was to recognise and understand any implications of inconsistencies in data collection, to meet international standards of data analysis and provide a clear framework for data validation.

TG2 has addressed the aim and objective of the project by developing Supplemental Guidelines to the 2016 RAI Methodology (World Bank, 2016). These Supplemental Guidelines are described in Section 4 and the full document can be found on the ReCAP website at:

http://research4cap.org/Library/Workmanetal-TRL-2019-RuralAccessIndexSupplementalGuidelines-ReCAP-GEN2033D-191219-compressed.pdf

Phase TG2 was also used to inform and plan the next phase, TG3, and to try to secure commitments for funding. TG3 will be the final phase of this project and is designed to scale up the RAI methodology trials to 30 countries, including all ReCAP countries, in a repeatable and sustainable way. The work programme for TG2 can be seen in Annex A.

3 Research Methodology and Activities

This Section describes the research methodology and introduces specific activities conducted under TG2. Further detail under each activity is given in subsequent Sections in this report.

3.1 Methodology

The methodology applied for this project was to essentially follow the tasks outlined in the Terms of Reference (TOR), and to incorporate them where appropriate into guidelines. When SDG 9.1.1 was promoted to Tier II on the UN scale in December 2018, this limited the extent to which the existing 2016 methodology could be changed, as any significant changes could have resulted in the indicator being demoted to Tier III. This was recognised as a risk in the project proposal. With this in mind, it was agreed with the custodian that the original methodology to measure RAI should remain substantially the same, but could be refined by developing Supplemental Guidelines to the existing 2016 methodology. These Supplemental Guidelines incorporate the findings and activities of items 1 to 9 below, while activities 10 to 12 are more focused towards TG3.

3.2 Activities

1. *Establish a co-ordinated measurement framework with consistent data collection approach and methodology, in co-operation with the World Bank or other donor partners as required.*

   TG2 developed Supplemental Guidelines to the existing 2016 RAI methodology (World Bank, 2016). These Supplemental Guidelines contain detailed, step-by-step procedures for calculation, documentation and publication of RAI (SDG 9.1.1) for a country. They follow the key tenets of the 2016 methodology, emphasising the involvement of National Statistical Offices (NSOs) and government agencies in the process, and providing transparency and consistency in how the RAI is calculated. They also provide an alternative approach to the 'all-season' aspect of RAI by using Accessibility Factors. Importantly, they encourage NSOs to engage with new online tools and platforms such as WorldPop, Open-Street-Map (OSM) and other open access geospatial software to improve the accuracy and accessibility of data and statistics for RAI. The Supplemental Guidelines were first distributed for comment in May 2019 and have been successively refined following comments from the World Bank, ReCAP and others, culminating in a final December 2019 version published on the ReCAP website here. These Supplemental Guidelines are discussed in Section 4. In addition, TG2 and ReCAP have presented at many workshops, conferences and events to spread awareness of the project and to promote RAI as a useful and important indicator (see Section 15).

   Vincent (2018) noted in the Scoping Report that the Highway Development and Management tool (HDM-4) can be used to produce a balance between investments at all levels of the road network, including rural roads. HDM-4 is not mentioned in the TOR, but TRL consulted their in-house HDM-4 expert. It was discussed that although it is possible to use HDM-4 at the strategic level to help identify the extent of rural network that would be financially viable for a country, and to balance capital and maintenance expenditure among trunk roads, feeder roads, city roads etc., it was not necessary to consider identification of 'all-season' roads in HDM-4, and that there was no role for HDM-4 to play in RAI measurement at this time.

2. *Consult with ReCAP member countries (both National Statistics Offices and relevant road agencies and transport departments), and engage with non-member countries and MDBs where appropriate, to explore the feasibility of scaling up the use of spatial data and techniques and high resolution remote sensing technologies for obtaining population data and road network information across multiple countries.*

   TG2 has explored various sources of spatial data and techniques for obtaining population data. WorldPop was endorsed by the World Bank in the 2016 Methodology, and the Supplemental

Guidelines reiterate WorldPop as the preferred source of population data. The Supplemental Guidelines recommend that the NSOs work with WorldPop to reconcile their data to latest national census and projections, and to disaggregate the WorldPop data to greater degrees of granularity where possible. TG2 had some success through encouraging the Malawi NSO to engage with WorldPop to reconcile WorldPop projections with district-level census data from 2018. Other sources of spatial population data are also becoming available, including data through Facebook's Data for Good programme, and although the coverage is still limited, it will be important to monitor that in future.

With regards to road network information, OpenStreetMap (OSM) is almost the *de facto* standard for crowd-sourced mapping of roads, buildings and other infrastructure, and the Supplemental Guidelines encourage countries (NSOs, roads agencies, NGOs etc.) to liaise with their local OSM community groups to help ensure that OSM accurately reflects official statistics. While there may be legitimate concerns on the coverage and accuracy of road network mapping, and the availability of attribute data (such as surface types) in OSM for some countries, Multilateral Development Banks (MDB) including World Bank, and bilateral donors such as DFID, often provide direct support for activities to update OSM. Another initiative in this area which could be extremely significant is Facebook's recent (Facebook, 2019) November release of the RapID tool to generate updates for OSM based on machine learning from satellite data. This could speed up the population of OSM to fill in any gaps in data, so that there would be much greater confidence in the coverage and accuracy of OSM for many countries.

The identification of all-season roads is essential to the RAI. The 2016 methodology advises use of road condition to determine whether a road is all-season or not. Research has been undertaken to determine road condition from satellite imagery (Workman, 2018), which has the potential to inform the basic condition and therefore accessibility of the road network. At present this is an expensive option for countries, although there are opportunities arising to use streamed satellite imagery at reduced cost. It is likely that this option will become more technically and financially feasible as the technology improves and as increased competition drives prices down. The advantages of a system that uses satellite imagery are that it can be applied to large areas quickly, and it foregoes the need for extensive and onerous visual road condition surveys. The potential to use machine learning in this area is also being researched and if successful could lead to the increased use of satellite imagery in road asset management.

In the meantime, in the absence of road condition data from either traditional vehicle-driven surveys or from remote sensing imagery, TG2 introduced the alternative approach of Accessibility Factors into the Supplemental Guidelines.

These aspects are discussed in Section 7 of this report and in the Supplemental Guidelines.

3. *Agree data standards and quality assurance measures (i.e. which takes precedence – data collected by individual countries, or data collected by the SDG custodian – World Bank).*

   The Supplemental Guidelines describe a quality assurance process for the RAI, requiring evaluation of input data sources, and production of metadata to accompany any RAI calculation, to improve the accuracy and transparency of any published values. This is discussed further in Section 4 of this report.

4. *Liaise with the World Bank, AfDB and ADB (among others) to develop, assemble and rollout a complete catalogue of all RAI data known to exist (which could be in the form of an inventory or database) as a baseline of existing data (2006 onwards), and examine the efficacy of such*

a catalogue for recording the method used to calculate each dataset and verification of their accuracy.

TG2 investigated data from previous RAI surveys (see Section 5). A list of all RAI data identified under TG2 is provided in Annex B. World Bank, as custodian of the RAI, maintains a Data Catalog where SDG indicator data results and metadata are published and disseminated. However, it is believed that RAI has been calculated for other countries and projects, but these have not always been sent to the World Bank RAI team or officially recorded as the value for SDG 9.1.1. Annex B includes other instances of RAI (e.g. for Myanmar Transport Sector Policy Note (ADB, 2016), and from Vietnam (2017)) that are not included in the World Bank Data Catalog. Greater awareness of the publication process is therefore required by all countries intending to measure RAI.

5. *Establish a mechanism through which any organisation or project intending to measure new values of RAI will routinely notify the World Bank as the current custodian of SDG 9.1.1, so that this information can be integrated into the World Bank planned schedule of future RAI measurements.*

   The Supplemental Guidelines describe a quality assurance process for the RAI, including evaluation of input data sources, and production of metadata to accompany any RAI calculation. It also includes a coordination mechanism that outlines a clear path to measurement and publication of the RAI. Any country can contact World Bank as custodian to discuss any aspect of the data collection and publication process. As above, greater awareness of the publication process is required by all stakeholders, including the custodian and partner agencies, as well as NSOs and roads agencies in country.

6. *Investigate the feasibility of using an accuracy range across countries, and method-correction factors in order to accommodate variations in data collection by country.*

   The Supplemental Guidelines require agreement among the NSOs, transport ministry and roads agencies on the most applicable data sources and methods to use for calculation of RAI. They also provide alternative approaches to calculating RAI so that, for example, if road condition data is not available in country, then accessibility factors can be defined and used with ground-truthing so that they reflect conditions in a country. TG2 has also liaised with the ReCAP-funded RAI support project on a web-based RAI Measurement Tool that calculates a 'default' RAI for all countries using open source data, which essentially provides a figure, which countries will in future be able to update by calculating their own in-country data (see Section 11). TG2 has also conducted limited sensitivity analysis of RAI which can help identify the best data sources to use in a particular country (see Section 14). At this stage there is insufficient detailed data (four countries) to establish objective and reliable accuracy ranges and correction factors. In order for this to be possible it would be necessary to monitor a number of countries who are able to improve their data to calculate a very accurate RAI. This process is being undertaken in Malawi and has been outlined for the other countries, but will take additional time and resources beyond this project.

7. *Explore the viability of implementing a secondary rural access indicator, and calculate a more realistic value that is deemed more appropriate locally and aligned with the SuM4All Global Tracking Framework.*

   TG2 has produced a paper 'Secondary RAI Measurement; Options and Methodology' that discusses how a new indicator might take account of local infrastructure that might not be included in the standard RAI measurement. Examples include motorcycle trails and navigable waterways. It describes how accessibility factors may be used to include roads as accessible

to motorcycles that are not accessible to larger vehicles, and explains how 'tracks' and 'paths' from OSM may be incorporated into that calculation. Regarding navigable waterways, it describes how water transport can be very important for rural access in some countries, and explains how locations of features such as jetties can be incorporated into such an indicator. This is in line with the SuM4All 'Global roadmap of action toward sustainable mobility' (SuM4All, 2019). The Secondary RAI Measurement paper is included as Annex G to this report. It is considered that this aspect of rural access is most likely to be included as a separate indicator, as its inclusion in RAI is likely to greatly change the existing measurement results, based on experience in the trial countries.

8. *Specify a clear custodian framework for collection of RAI datasets and set out roles and responsibilities for populating the RAI catalogue/inventory both centrally and at country level, as well as for quality assurance purposes.*

   Responsibilities of custodian agencies are given in the Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (UN Statistical Commission, 2016). Those responsibilities include collecting data from existing mandates, compiling internationally comparable data in the different statistical domains, supporting increased adoption and compliance with internationally agreed standards and strengthening the national statistical capacity. Other responsibilities include communicating and coordinating with national statistical systems in a transparent manner, including on the validation of estimates and data adjustments where necessary, compiling international data series, calculating global and regional aggregates, and providing them (along with metadata) to the UN Statistics Division. The World Bank Data Catalog and year-by-year summary of RAI help the World Bank RAI team fulfil these responsibilities. ADB has also partnered with the World Bank to provide support, and AfDB is in the process of becoming a joint partner. It is recommended that the World Bank continues to work with these partners to motivate RAI measurement through their existing contacts with countries (see Section 16).

9. *Trial the proposed measurement framework, including data collection and verification process, in at least four ReCAP countries.*

   A methodology for country selection of four ReCAP countries to take part in the initial trials was discussed at the TG2 kick-off meeting on 28th September 2018, and was subsequently submitted to the ReCAP PMU on 28th October 2018. The methodology was based on a combination of perceived data coverage, data management, availability of mapping, different topographical environments, and varied modes of rural transport. Nine countries were shortlisted (Ethiopia, Ghana, Malawi, South Sudan, Tanzania, Uganda, Bangladesh, Myanmar, and Nepal) from which Ghana, Malawi, Myanmar and Nepal were agreed for inclusion in the trial (see RAI Progress Report 1). TG2 conducted pilot visits to each country to identify relevant agencies, determine in-country data availability, and conduct a preliminary assessment of the country's readiness to calculate RAI sustainably. From experience of all trial countries, TG2 devised an assessment framework, and conducted further visits to gather more feedback and conduct further awareness workshops as necessary. Section 13 describes the assessment framework, and gives general experience, conclusions and recommendations from the four trial countries. Annexes C, D, E and F provide country assessments for Ghana, Malawi, Myanmar and Nepal respectively.

10. *Identify other funding sources and financial support outside ReCAP for broadening implementation of the Rural Access Index, with a view to demonstrating uptake and embedment in at least 30 countries during TG3. It is essential that commitment and buy-in*

from identified countries (including partner countries) and funding sources, is achieved before commencing TG3.

TG2 has identified many potential funding sources for broadening implementation of the RAI. These are discussed in Section 10. However, it has proved challenging to get commitment from any external funding sources, and it is unlikely that any joint funding of an RAI initiative would be possible in the short term and without going to international tender. In the likely absence of additional funding at this stage to support country measurement of RAI, TG2 has made a proposal to ReCAP for activities to be conducted within the £150,000 ReCAP TG3 budget, which would provide tools and resources to help expand implementation and embedment of RAI in future. TG3 recommendations are given in Section 16.3.

11. *Draft a framework for scaling up RAI data collection and measurement beyond ReCAP member countries, with a view to achieving greater geographic coverage in TG3, and a strategy for promoting SDG Indicator 9.1.1 from Tier III to Tier II, and from Tier II to Tier I in the UN classification.*

    As discussed above, TG2 has liaised with the ReCAP-funded 'RAI Support' project on a web-based tool that calculates a "default" RAI for all countries using open source data (see Section 11). This project has already produced an RAI figure for all countries, and has resulted in the production of regional and global estimates for RAI for 2019. Part of the proposal for TG3 is to develop this tool further and encourage countries to upload their own data to refine the default calculations and publish their RAI. In addition to the RAI calculation, the RAI tool also produces maps showing areas of rural population further away than 2 km from an all-season road. Such maps can be the starting point for developing a rural access plan for a country by identifying major pockets of population that do not have access to all-season roads. They can be used to identify priority areas for improvement, and can be linked in with agricultural development plans, regional development plans, political considerations etc. These maps almost become planning tools rather than static maps of statistical indicators, and so can be used to further promote RAI. Other parts of the TG3 proposal are to produce online videos and other training material to help in the marketing and general encouragement for more countries to regularly calculate and publish RAI. Recommendations for TG3 are given in Section 16.3.

12. *Provide detailed recommendations on the way forward in TG3, including the application of the upgraded RAI methodology in all ReCAP countries: this being dependent on funding being identified and available.*

    As mentioned earlier, TG2 has made a proposal to ReCAP for activities to be conducted within the £150,000 ReCAP TG3 budget, which would provide tools and resources to help expand implementation and embedment of RAI in future.

    In addition, the resources necessary to support the rollout to 30 countries were considered, in terms of country support to collect, process and analyse the necessary data. Enhancement of the RAI calculation tool (see Section 11) would be a key part of this, but physical support to 30 countries would require significant funding above and beyond that provided as core funding for TG3. The recommendations included in Section 16.3 focus on the requirements for the way forwards in TG3.

3.3 Contract amendments

It should be noted that there have been three amendments to the contract to date:

- January 2019: Participation at the IRIM conference in Nepal.
- September 2019: Participation at PIARC WRC 2019 conference in Abu Dhabi.
- November 2019: Participation at Africa GIS conference in Rwanda, SSATP AGM in Zimbabwe, ieConnect workshop in Morocco, and revision of milestones.

It was also agreed by exchange of letters that the Database Specialist would take on the majority of the Senior Researcher's role, given a shift in emphasis of the project and work commitments of the Senior Researcher.

4 Supplemental Guidelines for RAI

The current methodology for measuring RAI, 'Measuring Rural Access Using New Technologies' (World Bank, 2016) was developed by the World Bank with assistance from UK Aid.

It described how spatial techniques can be used to calculate RAI and identified various data sources that could be used. It established a set of main principles: that the RAI should be simple, sustainable, consistent, and operationally relevant.

Simplicity was important so that the method could be applied in all countries. Sustainability was addressed through use of existing data where possible, and by not creating an additional burden on countries to collect data that they would not normally collect. It took advantage of publicly available data where possible and encouraged working towards harmonisation of country-based data with open source data. Consistency of approach was to be achieved through using harmonised measurements of rural access across all countries. Operational relevance was to be achieved through enabling or encouraging use of RAI for policy-making at the national and sub-national level.

The 2016 methodology went a long way to achieving these aims, and in fact was instrumental in helping SDG 9.1.1. move from Tier III to Tier II in the SDG tier levels.

TG2 under the ReCAP programme has developed Supplemental Guidelines in coordination with the World Bank. These guidelines have been developed to provide further information and assistance to any agency involved in the calculation, quality assurance or publication of the RAI (SDG 9.1.1) and can be seen on the ReCAP website at:

http://research4cap.org/Library/Workmanetal-TRL-2019-RuralAccessIndexSupplementalGuidelines-ReCAP-GEN2033D-191219-compressed.pdf

These Supplemental Guidelines contain detailed, step-by-step procedures for calculation, documentation and publication of RAI for a country. They follow the key tenets of the 2016 methodology and emphasise the involvement of National Statistical Offices (NSOs), planning agencies and roads agencies in the process. They help to provide transparency and consistency in how the RAI is calculated. They provide a mechanism to document the decision-making processes along the way through the production and quality assurance of metadata. They also explain in detail the role of the custodian in the overall SDG process.

These guidelines also provide an alternative approach to the 'all-season' aspect of RAI by focusing on the intended purpose of the road network and the changing risks of accessibility to that network, rather than relying on physical measurements of road condition.

These guidelines encourage NSOs to engage with new online tools and platforms such as WorldPop, OpenStreetMap and others to improve the accuracy and accessibility of data and statistics for RAI and other SDG indicators, which over time can reduce the burden of reporting on NSOs. This can also have spin-off benefits for other government agencies in terms of making such fundamental data-sets more accurate and available.

The Supplemental Guidelines were first distributed for comment in May 2019 and have been successively refined following comments from the World Bank, ReCAP and others, culminating in the final published version on the ReCAP website.

Subsequent sections of this report elaborate on key portions of the Guidelines.

5 Catalogue of RAI Data

TG2 conducted extensive investigations and consultations with key stakeholders on both the 2006 and 2015/6 RAI measurements. All report authors were interviewed, and reports were reviewed with the aim of developing a data catalogue for the past 15 years of RAI measurement.

Unfortunately, data was not forthcoming in a format that could be established in a database, and no metadata was available. For the 2006 measurements much of the raw data is held in Living Standards Measurement Studies (LSMS), which are still available online, but the precise methods used to extract the RAI from these household surveys are not clear and it is possible that different methods were used in different countries. Consequently, the only data that are available are the headline RAI measurement values, as shown in the 2006 TG1 report (Roberts, 2006).

The World Bank has established a Data Catalog where SDG indicator data, results and metadata can be published and disseminated. World Bank, as custodian of the RAI, will publish data from a country to this catalogue once it has been quality assured. As custodian, World Bank is also responsible for producing inputs into the SDG Global Progress Report, and producing national SDG reports including lessons learned, to feed into review and improvement of the methodology in future, along with potentially new data sources and methodologies (such as mobile phone network data, machine learning etc.). At present there is some basic data from 2006 and 2015/16 stored on this platform. The Data Catalog also contains a year-by-year summary of RAI results. This is an appropriate place for the RAI catalogue to be established.

During the course of TG2, several cases of countries calculating RAI (or something very similar) have been identified, however these have not always been forwarded by those countries to the World Bank as custodian, and have therefore not been quality assured or published as an official SDG 9.1.1 Indicator. The Supplemental Guidelines developed under TG2 make this publication process clearer, however more effort is required to raise awareness in those countries. In addition, TG2 has identified other countries that are actively looking to calculate RAI in the near future, including Colombia and the Philippines.

Annex B contains a list showing all countries identified to date, along with online links to reports where available. At least 30 countries have been identified that are either calculating RAI since 2016 (including the RAI in 16 countries calculated by the World Bank) or are actively looking to calculate RAI in the near future. It is suspected that the true number of countries is significantly higher.

Additionally, some agencies are using the RAI as a monitoring tool at project level, for example AfDB and World Bank. The approach adopted in the Supplemental Guidelines is a broad-based approach to measure RAI at country level and is not appropriate for monitoring project progress because it relies on a sustainable approach to not collect detailed data on individual roads, due to the burden of resources for data collection. Detailed data collection is necessary at project level, so a different approach should be adopted for project monitoring. Nevertheless, the information gained from project monitoring could be used to inform country-level RAI measurement.

It is surprisingly difficult to determine which countries currently record and report RAI. A list of countries and links to online reporting platforms is maintained by the UN ECE Task Force on National Reporting Platforms, but that only covers UN ECE countries, and requires searching through these websites individually to determine which countries are currently recording and reporting RAI. SDG 9.1.1 is not currently covered in the global SDG Indicator Report because at the time of last publication in 2018 that only covered Tier I and Tier II indicators (RAI was only promoted to Tier II in December 2018).

Section 16 makes a recommendation for the custodian and partner agencies to conduct a survey of NSOs / planning agencies to determine which of them are collecting, or planning to collect, SDG 9.1.1.

6 Engagement of Key Stakeholders, National and International

6.1 Roles of custodian, joint partners and international bodies

The UN Department of Economic and Social Affairs (DESA) is home to the UN Statistics Division (UNSD). A key responsibility of the UNSD is to assist countries in the development of their National Statistical Systems (NSS), in accordance with the Fundamental Principles of Official Statistics (UN Economic and Social Council, 2013). These fundamental principles include the need for statistical agencies to decide on the definitions, methods and procedures for data collection, processing, storage and presentation of statistical data; and to coordinate among statistical agencies within countries to achieve consistency and efficiency in the statistical system.

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, includes 17 Sustainable Development Goals (SDGs).

World Bank is the custodian of SDG 9.1.1 and joint partners currently include:

- United Nations Economic Commission for Europe (UNECE)
- United Nations Environment Programme (UNEP)
- Asian Development Bank (ADB) (joined in June 2019)

The African Development Bank (AfDB) is also in the process of becoming a joint partner, following an initial meeting held in September 2019.

The main responsibilities of custodian agencies are to collect data from countries under existing mandates and reporting mechanisms, to compile internationally comparable data in the different statistical domains, to support increased adoption and compliance with internationally agreed standards, and to strengthen national statistical capacity. Other responsibilities of a custodian agency include:

- Communicating and coordinating with national statistical systems in a transparent manner, including on the validation of estimates and data adjustments when these are necessary;
- Compiling the international data series, calculating global and regional aggregates and providing them, along with the metadata, to the UN Statistics Division;
- Preparing the storyline for the annual global progress report; and
- Coordinating on indicator development with the NSS, other international agencies and stakeholders. The Expert Group on SDGs encourages all agencies involved to collaborate on the development of the indicators.

The custodian agency is responsible for aggregation and publication on the custodian agency websites and on UN websites as appropriate.

The regional MDBs also have an important role in raising awareness of the RAI and motivating countries to measure it. ADB's vision of a prosperous, inclusive, resilient, and sustainable Asia and the Pacific (Strategy 2030), for example, is aligned with the SDGs and the 2030 Agenda for Development, which helps to promote RAI among member countries (ADB, 2018; UN, 2015).

Now that SDG 9.1.1 has been promoted to Tier II there should be more onus on countries to measure and report RAI. This motivation can be exploited by the regional MDBs, perhaps by including a clause in their road projects to support RAI measurement nationally. AfDB already uses RAI to measure project progress, but it is not at present promoted as a national indicator.

6.2 Role of national institutions

At the national level the National Statistics Office (NSO) or its equivalent is mandated within their country to collect, compile, analyse, abstract and publish statistical information on a wide range of topics. Many other government departments can collect and compile statistics related to their area of expertise, but the NSO typically takes a coordinating role to ensure adherence to fundamental statistical principles across all agencies, and to minimise redundancy and inconsistencies. The project therefore focused on the NSO as the key stakeholder for organising and reporting the measurement of RAI in each country.

Essentially, the RAI should fit into any other reporting process that the country already follows. Typically, the Finance or Planning Ministries are responsible for overall definition, reporting and publication of national indicators, and the inclusion of RAI should fit into those reporting processes. In some countries, the NSO may be part of the Finance or Planning Ministry, while in others it may be a separate organisation.

The NSO in a country should liaise with other agencies (roads agencies, development agencies, mapping agencies etc.) as necessary and incorporate the RAI into its NSS along with the other SDGs. The NSO should send the data to the custodian agency for validation and, once accepted, it should publish the indicator internally on relevant country websites.

7 Measurement of RAI

RAI has been measured in various different ways since its inception in 2006. There is one core methodology, established by the custodian in 2016, but some countries still attempt to measure RAI using different methodologies, many of which do not seem to be reported to the custodian. This project has consolidated the methodology established in 2016 and included refinements where necessary to produce a more sustainable and consistent approach.

Open source data is a key resource for measuring RAI. Approaches using solely open source data have been trialled (Rozenburg et al, 2019). However, these approaches are very much reliant on the quality and coverage of open source data, which is good for population but variable for road network mapping. The key aspect that tends to be missing is the all-season status of the road network, which limits the accuracy of the results.

The following Sections assess the layers of information required to measure RAI, and how they have been addressed during this project to enhance the accuracy and sustainability of the process.

7.1 Population

Many censuses and household surveys are now georeferenced at the level of the household.
Such household-level data would be ideal for RAI measurement, but because of data protection regulations it is unlikely that NSOs will make that data available to any outside agency. Most NSOs publish census data aggregated at the level of the administrative area such as the district or even at the level of the enumeration area, however the resolution of such data, and its irregular boundaries, mean that it is not suitable for RAI calculation.

The 2016 methodology recommends WorldPop as the best available geospatial population data source, reconciled with national census figures at 100m x 100m resolution. WorldPop continues to be recommended in this project as appropriate for the purpose of calculating RAI. Some minor discrepancies in WorldPop's metadata have been identified throughout the trial process on the four countries, and these have been rectified by WorldPop promptly.

In most countries, population censuses are only carried out every 10 years, so for the intervening years population projections have to be made. In some cases WorldPop is reconciled to UN projections, rather than in-country projections, which can cause differences in the population values. In many cases, NSOs will only be able to endorse WorldPop as a source of data if the WorldPop data match exactly the official country figures. Where possible, official country values should be used in WorldPop published data-sets, and NSOs should engage with WorldPop to enable WorldPop to produce data at the best level of disaggregation possible (typically, the enumeration area).

Other sources of spatial population data are also becoming available, including data through Facebook's Data for Good programme, and although the coverage is still limited, it will be important to monitor that in future.

Details on how to use population datasets to measure RAI can be found in the Supplemental Guidelines.

7.2 Urban/rural boundaries

As noted in the Supplemental Guidelines, there is no definitive guide on how to define urban and rural boundaries that is consistent among countries. UN advice is to allow each country to define them in accordance with their own regulations. Wherever possible, country-defined boundaries should be used, but as a default the GRUMP database should be used, as was recommended by the World Bank in the 2016 methodology. If the UN is able to produce a worldwide definition of rural and urban boundaries in future, then this can be considered for inclusion in the measurement methodology, but at present the default should be country recognised boundaries.

It should also be recognised that many international boundaries are in dispute or are imprecisely located in available electronic mapping. The Supplemental Guidelines recommend use of the national boundaries of the Food and Agriculture Organization (FAO) Global Administrative Unit Layers (GAUL) dataset (FAO, 2015), which correspond to UN Member State recognised boundaries.

7.3 Road network information

The 2016 RAI Methodology recommends that mapping data from the responsible government agencies should be used in order to define the road network. Experience with the trial countries shows that this GIS based information can be inaccurate and incomplete. It is also considered as sensitive information in some countries so it is may not be freely available. Various issues were encountered in the data of trial countries, for example:

- Normally, more than one agency is involved in the planning and management of road networks, which means that separate datasets exist under the responsibility of different organisations. In some cases there are overlaps and disconnections among different networks, causing duplication or even triplication in some cases.
- Some roads are unconnected to the main network.
- Attribute data (such as classification, surface type or condition) can be inaccurate or missing.
- Some countries recognise that their road network mapping is not up to date, and do not have policies in place to keep it up-to-date. This can be a difficult task, requiring GIS expertise that roads agencies (particularly rural roads agencies) tend to lack.

The best open source dataset for roads is generally considered to be OpenStreetMap (OSM), which is a crowdsourcing product. Some issues with OSM data coverage and reliability are:

- It is more complete in urban areas than in rural areas.
- It varies between countries, depending on how active the OSM community is.
- The classification does not always match those designated by the roads authority – there are default classifications in OSM that can be changed to match the country classifications, but they seldom are.
- The road density can be inconsistent, for example if there is an active community in one district they can digitise the entire network, but the neighbouring district may have sparse data if the community there is not so active.

These findings make it important that the responsible agencies check the road network data before it is used to calculate RAI; and that the custodian assesses the data and metadata produced by the country against other data sources to help ensure that sufficient analysis has been conducted to render the RAI calculation credible. Details on how to use road network datasets to measure RAI can be found in the Supplemental Guidelines.

The Supplemental Guidelines also recommend that countries work towards ensuring that road network data collected by the respective roads agencies is published on OSM and official geonodes1 where possible, although it is recognised that some countries regard this as sensitive data not for publication. Local OSM community groups should liaise with roads agencies to promote coordination of activities and sharing of data, and to share experiences on data quality assurance, OSM editing tools, etc.

[1] A GeoNode is a web-based application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI). It is designed to be extended and modified and can be integrated into existing platforms. http://geonode.org/

7.4 Identification of all-season roads

The 2016 methodology uses an interpretation of road condition and/or roughness to determine the all-season status of a road (World Bank, 2016). The main issue with this approach is that not all countries regularly measure the condition of their rural road network, especially for unpaved roads. Condition assessment is an onerous and resource-heavy activity, and it would not be sustainable to expect countries to measure road condition solely to report the RAI. Also the assignment of all-season status to roads based on roughness or Good/Fair/Poor condition did not necessarily indicate which roads were all-season in the trial countries.

Therefore, a more sustainable process of defining a broad assessment of all-season status on a country basis was devised for use where reliable condition data is not available. This process is based on Accessibility Factors. This alternative approach identifies high and low risk areas, based on surface type, climate and terrain, and incorporates ground-truthing with local engineers and/or road users. Accessibility factors determine the likelihood of a group of roads being all-season, or the risk of them being inaccessible. This is closely aligned with the intent of the original 2006 study (Roberts, 2006), i.e. 'accessible all year with the prevailing mode of transport', and '… may be temporarily unavailable during inclement weather'.

The concept of Accessibility Factors and how they can be applied to produce a final RAI calculation is described in the Supplemental Guidelines. A brief summary is shown in Figure 7-1.

Accessibility Factors:
A country is divided into high and low risk zones, based on the risk that climate and terrain will affect the all-season status of a road. The accessibility factor is then determined by establishing the actual situation using ground truthing in specific areas that represent each zone.

Figure 7-1: Accessibility Factors

Applied to result when no road condition available

Climate \ Terrain	Low Risk (e.g Flat Rolling)	High Risk (e.g Mountainous)
Low Risk (e.g Dry season)	1	0.9
High Risk (e.g Wet season)	0.9	0.8

8 Data Standards and Quality Assurance

The Supplemental Guidelines show how metadata should be collected and presented during the measurement process for RAI. This is very important to demonstrate the transparency and robustness of the RAI calculation, to ensure that the calculation can be replicated, and to ensure that the same data sources and methods are used in future years for any one country.

Metadata is used to help ensure consistency of calculation, and to provide a basis for quality assurance. It lists essential information such as the data sources used, any assumptions made, and the mapping projection used in order to calculate distances. If RAI is calculated at sub-national levels, then the metadata should also be produced at the same level.

The metadata should also be published along with the RAI calculation for a country, so that the source and methods used for the calculation are documented.

Table 8-1 shows sample metadata as described in the Supplemental Guidelines.

Table 8-1: Sample Metadata

Metadata Tag	Value
Rural Access Index	
RAI Value:	*45.2*
Rural population not within 2 km of an all-season road:	*5,500,140*
Level:	*National*
Date:	*July 2019*
Administrative Boundary	
Source:	*FAO Global Administrative Unit Layers (GAUL) dataset*
Date:	*2015*
Total Area (km^2):	*119,000*
Population	
Source:	*WorldPop*
Date:	*2019*
Total population:	*17,300,000*
Notes:	*WorldPop 2019 projection derived from 2015 national census disaggregated to level of enumeration area*
Urban / Rural Boundary	
Source:	*Department of Surveys*
Date:	*March 2015*
No of Urban Areas:	*30*
Total Urban Area (km^2):	*985*
Total Rural Area (km^2):	*118,015*
Notes:	*No changes made to urban/rural boundaries since 2015*
Road Network	
Source(s):	*OpenStreetMap (OSM)*
Date:	*Downloaded February 20th 2019*
Total Length (km):	*Total: 49,000*
Classification:	*Primary: 7,000* *Secondary: 12,000* *Tertiary: 30,000*
Surface Type:	*Paved: 5,000* *Unpaved: 44,000*
Notes:	• *Based on Roads Authority data for classified network only*
Accessibility Factors	
Notes:	• *Paved roads:* o *All paved roads assumed to be accessible all-year round* • *Unpaved roads:* o *Flat/rolling areas factor 0.95 (length affected 42,528 km)* o *Mountainous areas factor 0.8 (length affected 472 km)*
Changes with justification:	*The factor for unpaved roads in flat/rolling areas was changed from 1.0 to 0.95 in 2018 to reflect seasonal flooding experience.*
Mapping Projection Projection:	*Universal Transverse Mercator (UTM) zone*

9 Measurement of RAI in the Future

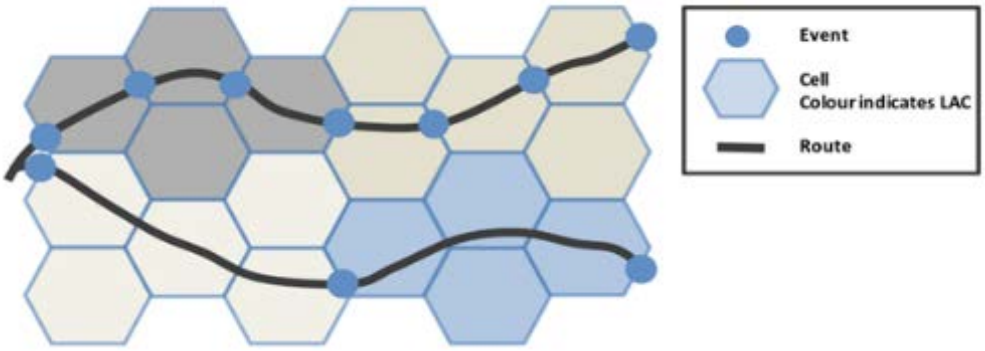
A number of technologies were considered for measurement of RAI in future.

Of these, the most promising is the use of mobile phone network data. Mobile phones create 'events' as they traverse cell boundaries. These events are created irrespective of whether a call is being made at the time of crossing the boundary (see Figure 9-1). Mobile phones are continually making connections to cell hubs, and this data is recorded by the phone companies. The data is of use to mobile suppliers for billing purposes and investigations as necessary, but they are willing to sell it on to processing companies for other uses, so long as it can be effectively anonymised and does not breach local regulations on data protection.

Such mobile phone network data can be used to determine traffic levels and speeds on roads. And, by inference, changing patterns of traffic levels and speeds throughout the year can be analysed to identify roads on which there is a major drop-off in traffic, or where there are reduced speed levels. Such events could be correlated with weather data (also potentially available online) to identify roads which are all-season or not.

All studies which use mobile phone network data, however, take time to set up (to assess in-country mobile phone network coverage, to assess usage patterns, to negotiate use of data with mobile phone network providers, to define the study coverage areas, to identify the cell sites, to filter out the types of pattern to analyse, obtain the data, conduct the analysis, perform ground-truthing, and refine the analysis as necessary). A pilot study in a single rural area would likely cost in the order of £60,000 - £75,000 and would take several months to complete, and so this approach has not been investigated further at this time. However, it is recommended that such a research project be conducted to work out the issues and assess the scalability of such a solution.

Figure 9-1: Cell events triggered as mobile phones move between coverage areas



The use of satellite imagery was also considered to produce similar outputs. Research has been carried out previously in ReCAP to determine the feasibility of using satellite imagery to identify unpaved road condition (Workman, 2018). This proved to be feasible to a limited extent, and research is ongoing to explore this further to see if machine learning can be applied to increase the accuracy and speed at which the imagery can be assessed.

Although none of the technologies explored are at the stage whereby they could be used to measure RAI, both show significant promise for the future. A paper was produced on this subject and presented during the RAI workshop at the PIARC World Road Congress in October 2019.

10 Funding Sources for TG3

Task Group 3 (TG3) is due to start in 2020 with the main activity being a roll-out of RAI measurement to a total of 30 countries. At present the core funding for TG3 is limited to £150,000, which has been earmarked for the consultant to support uptake and embedment of RAI in the remaining 26 countries to measure RAI in line with the enhanced process. Additional funding to support country data collection, processing and implementation is being sought for TG3, which would be used to follow a similar process to that followed in TG2, i.e. visit countries, support them to identify and check data and provide training in the processes to measure RAI using GIS and other tools.

To date the team has engaged with the following organisations to source TG3 funding:

- Asian Development Bank (ADB)
- African Development Bank (AfDB)
- European Investment Bank (EIB)
- Inter-American Development Bank (IADB)
- Islamic Development Bank (ISDB)
- World Bank country offices in trial countries
- World Bank
- Azavea corporation
- Trial country road authorities/road funds, mainly for individual ReCAP countries
- Satellite Applications Catapult

In addition, the team has liaised with the ReCAP PMU to approach PIARC and IRF as “honest brokers” to facilitate the process of seeking funds for TG3. The following possibilities were explored:

- IRF put the team in touch with several potential funders, including LaFarge, Michelin Foundation, and others. These leads have been followed up by ReCAP and the team, but to date no definite funding has been secured.
- PIARC were able to offer links to members and suggested that this is best carried out through their committees, which would be reformulated in January 2020. This will be further explored when the committees are formed.
- The team has also been in touch with the UN with respect to potential funding, but there have been no positive commitments to date.

Other potential fund sources include the Global Challenges Research Fund (GCRF), which includes programmes specifically for SDGs, however the timing for calls on relevant programmes did not align with the timing of this project.

In the absence of additional funding to support country measurement of RAI, TG2 has made a proposal to ReCAP for activities to be conducted within the £150,000 budget, which would provide tools and resources to help expand implementation and embedment of RAI in future. This includes motivating additional countries to measure RAI using the 2016 methodology and the Supplemental Guidelines. Even though there are no funds for in-country support, countries can be supported to measure RAI remotely, based on the Supplemental Guidelines. At present it is estimated that 26 countries have measured RAI with direct support by the World Bank or ReCAP (8 in 2016, 15 in 2018 and 3 in TG2). Annex B indicates a total of 34 countries, although some differ in their methodology. It is likely that there are others who have measured but not reported RAI, so a survey of all countries has been proposed for TG3 (see Section 16.3).

11 RAI Measurement Tool

In July 2019, ReCAP engaged Azavea on the Rural Access Index (RAI), SDG 9.1.1 Support project. That project completed at the end of November 2019.

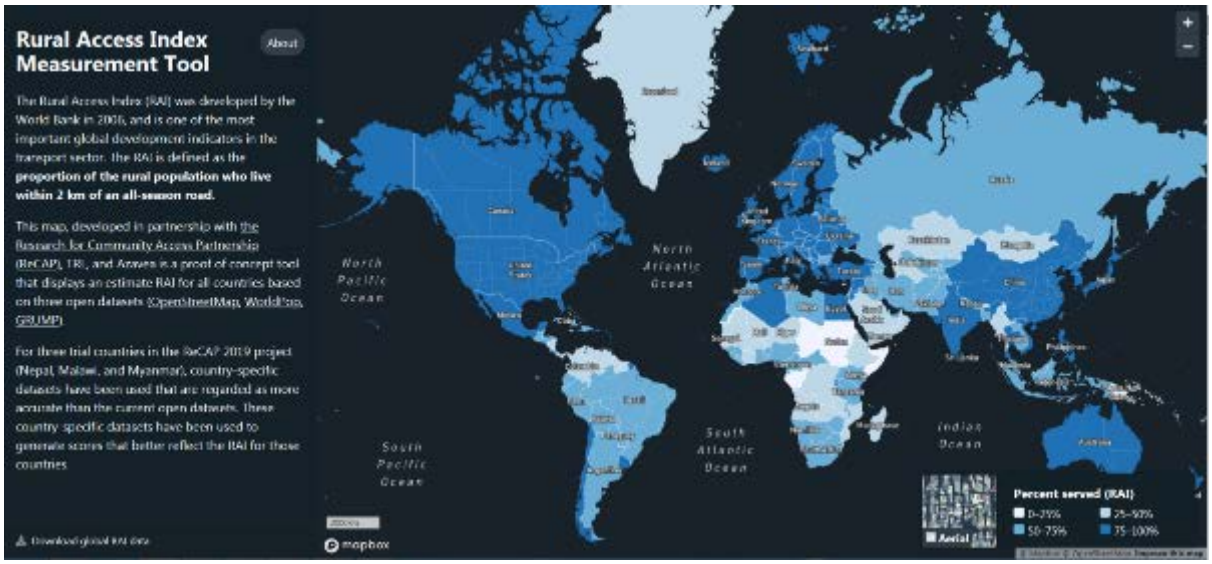
Azavea is also currently supporting the UN Global Platform's geospatial data processing technology through the provision of a custom implementation of Raster Foundry, a web-based imagery processing platform for finding, combining and analysing earth imagery at a global scale. The goal of these tools is to provide access to advanced, user friendly, web-based data processing that can support the generation of official statistics for SDG indicators.

The RAI Support project leverages Azavea's work in generating data for the SDGs, and is aligned with the goals of the "Report of the Global Working Group on Big Data for Official Statistics" (E/CN.3/2019/27) presented at the Statistical Commission, Fiftieth session in March 2019 at the United Nations Security Council (UNSC) in New York City (UNSC, 2018):

> "*...to develop a global platform as a collaborative research and development environment for trusted data, trusted methods and trusted learning, reiterated the need to present the business case for the platform, encouraged the Global Working Group to build on the success achieved thus far by delivering practical products and services for the global statistical system to support the production of statistics and indicators, including the Sustainable Development Goal indicators, and emphasized the need to carefully address societal challenges of trust, ethics, privacy, confidentiality and security of data*."

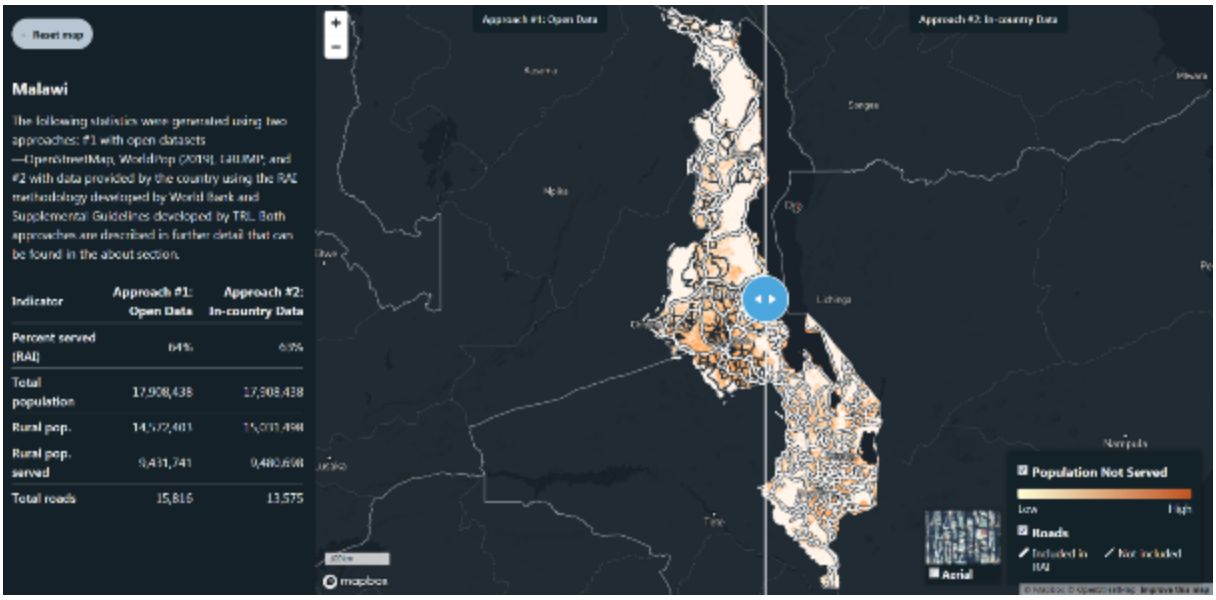
The RAI Support project produced a web-based RAI Measurement tool that calculates a 'default' RAI for all countries globally, using open source data (see Figure 11-1). TRL under TG2 worked with this project to advise on the default calculations and worked with the trial countries to provide additional, country-tailored datasets to improve the RAI calculation. This software was used by Azavea to measure RAI for the trial countries as presented in Section 12 of this report. It is hoped that in future, countries can produce their own datasets according to the Supplemental Guidelines for submission to the tool so that the tool could measure official RAI for those countries.

Figure 11-1 - RAI measurement tool



In addition to the RAI calculation, the RAI tool also produces maps showing areas of rural population further away than 2 km from an all-season road (see Figure 11-2). Such maps can be the starting point for developing a rural access plan for a country by identifying major pockets of population that do not have access to all-season roads. They can be used to identify priority areas for improvement, and can be linked in with agricultural development plans, regional development plans, political considerations etc. These maps in themselves become visual planning tools rather than static maps of statistical indicators, and can be used to further promote RAI as a simple and powerful indicator.

Figure 11-2 - RAI accessibility maps



The RAI tool also produces global and regional RAI and absolute number estimates for 2019 (see Table 11-1). These absolute numbers have an immediately challenging impact through quantifying the scale of the rural access problem.

Table 11-1 - RAI World and Regional Estimates

	Population (millions, 2019)			
Region	***Total***	***Rural***	***Living >2 km away from an all-season road***	***RAI***
Africa	*1,317.7*	*908.4*	*421.1*	*53.6*
Americas	*1,057.3*	*222.7*	*71.0*	*68.1*
Asia	*4,632.8*	*2,590.6*	*658.9*	*74.6*
Europe	*757.1*	*190.6*	*19.8*	*89.6*
Oceania	*37.4*	*12.8*	*7.4*	*42.2*
World	***7,802.3***	***3,925.0***	***1,178.2***	***70.0***

The outputs of this tool should be used to encourage other countries to calculate their own RAI using in-country data-sets, and/or to update online data sources such as OpenStreetMap with in-country data. It is hoped that, through further development, the Azavea tool may be linked into the UN Global Platform, and help promote RAI to a Tier I SDG indicator.

12 RAI Results for Trial Countries

Table 12-1 shows RAI measurements for the Trial Countries produced during TG2, and compares them with RAI measurements conducted in 2016, and with the 'default' measurements calculated using the RAI tool as described in Section 11.

Table 12-1: RAI Measurements for Trial Countries

Trial Country	RAI Methodology 2016	Supplemental Methodology 2019	RAI Calculation Tool default calculation (under Azavea project) 2019	Others
Ghana	-	n.a.[1]	63	66 [2]
Malawi	23.1	63	64	
Myanmar	-	62	46	35 [3]
Nepal	54.2	66	69	

Notes:
[1] Calculation for Ghana not available at this time due to delays in obtaining road network mapping
[2] Based on household surveys in 2012
[3] Based on Village Access Model in 2016

The results for Malawi and Nepal show some consistency between the RAI open source calculation tool and the RAI as measured using the Supplemental Guidelines. Myanmar is the exception, but this is likely to be mainly due to the less developed OSM network in the country, leading to a smaller network and consequently a lower RAI.

There are however significant differences between the 2016 measurement and the RAI as measured using the Supplemental Guidelines in Malawi and Nepal. Malawi shows the largest difference, because the methodology developed under TG2 with the input of the Malawi Roads Authority, identified much of the unpaved, gazetted network as 'all-season', while most of the unpaved network in Malawi in the 2016 measurement was regarded as not all-season due to its perceived poor condition. Detailed metadata for the 2016 measurement in Nepal is not available, so it is not possible to conjecture as to why there is a difference of more than 10%.

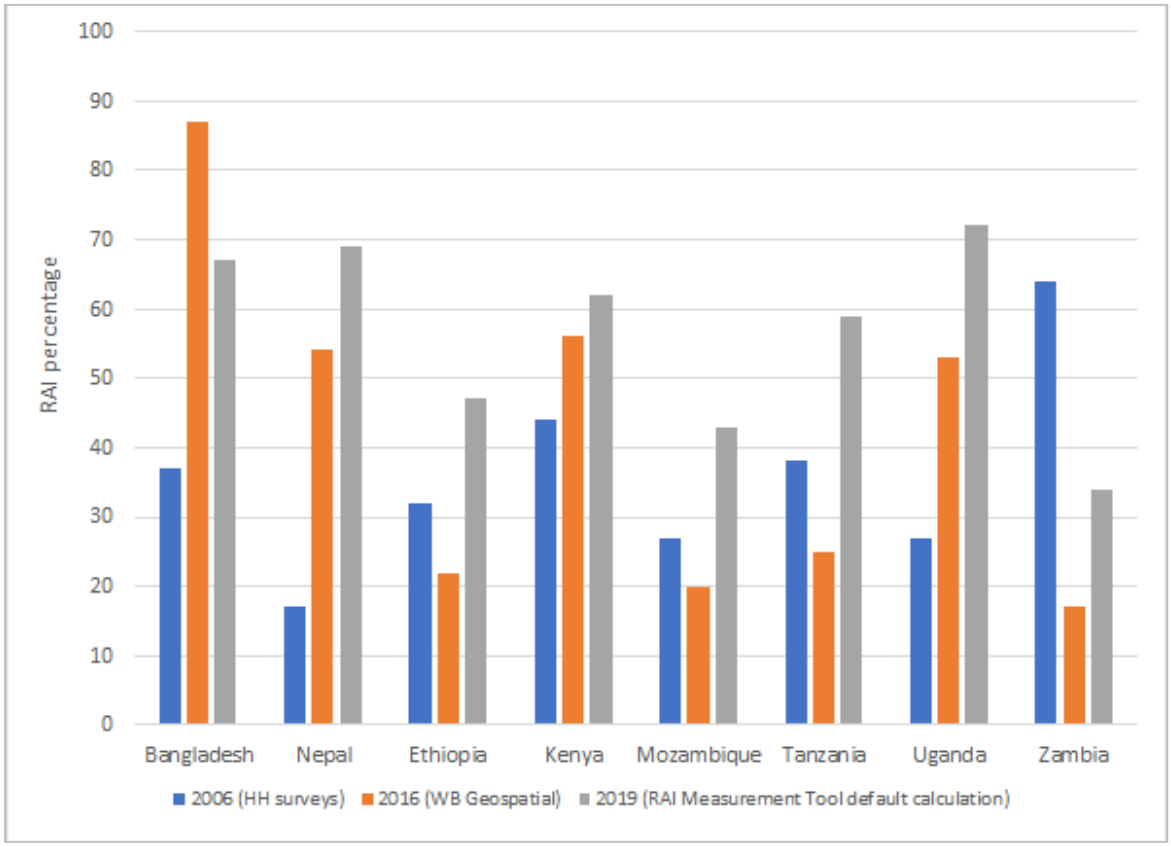
12.1 Publication status

- Results or analysis not yet sent to Ghana, there have been various delays in obtaining data from Ghana Feeder Roads Department in order to calculate RAI under TG2. See Annex C for results for Ghana.
- Results and analysis were sent to Malawi on 31st October. Malawi has endorsed the results using the 2019 Supplemental Methodology Calculation. TRL to send detailed results to World Bank. See Annex D for details of Malawi.
- Results and analysis were sent to Myanmar on 24th November 2019, no reply has been received to date. See Annex E for results for Myanmar.
- Results and analysis were sent to Nepal on 22nd November, some comments have been received from the ReCAP coordinator for Nepal, however there has been no official comment to date. See Annex F for results for Nepal.

12.2 RAI comparison

The results from 2006 using Household surveys, and from 2016 using the geospatial methodology have been compared frequently, and indeed those inconsistencies led to the development of this project. It is therefore interesting to compare the new values created using the RAI Measurement Tool with the values in the World Bank report from 2016, as shown in Figure 12-1. This comparison comes with some caveats, namely that the data used from WorldPop and OSM have not been assessed for each country, and the metadata from 2016 is not available, so it is expected that there will be some variation between these results and those that would be achieved using primary data from the countries themselves. It can be seen that the 'default' RAI values produced by the new tool are in general higher than the values produced using the 2016 methodology, except for Bangladesh which had a very high RAI estimate in 2016. It is likely that these higher values are the result of incorporating unpaved roads, while the 2016 methodology typically excluded unpaved roads.

Figure 12-1: RAI comparison



13 RAI Embedment Assessment

13.1 Trial countries

There was a requirement in Task 9 of the ToR to trial the refined measurement process for RAI in at least four ReCAP countries. Following a consultative selection process described in Section 3, Ghana, Malawi, Myanmar and Nepal were selected for trials.

13.2 Assessment framework

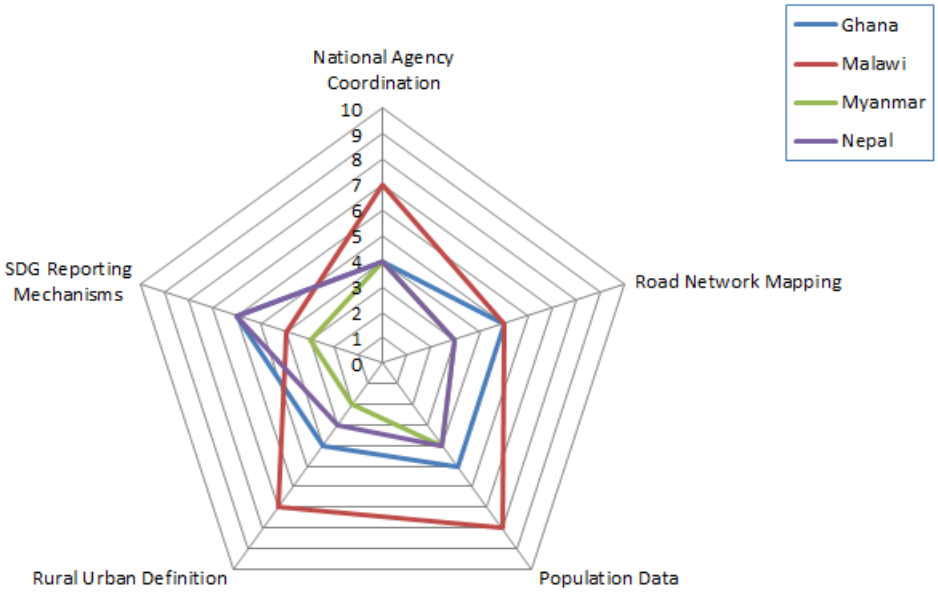
Based on initial visits to the trial countries, TG2 developed a framework to assess the current embedment of RAI within a country. This framework was useful to help assess countries' readiness to calculate RAI, and to make recommendations to improve RAI embedment in future. Table 13-1 gives the assessment criteria under each of the major headings. Results of the assessment for each of the trial countries are provided separately in Annexes C to F of this report, while general observations are given in the next Section.

Table 13-1: RAI Assessment Framework

RAI Embedment Assessment Criteria	
National Agency Coordination	
	Interagency working among NSO, Roads Agencies, Survey Dept etc.
	Data Publication and Sharing Policy
	Data Publication and Sharing Practice
Road Network Mapping	
	Road network mapping consistent with official published statistics
	Coordinated mapping across agencies
	Correlation with other data sources e.g. OpenStreetMap
	Correlation with available imagery
	Clear definition and procedures for identification of "all-season"
Population Data	
	Is latest population census data geo-referenced?
	Is population data available spatially on a website?
	Is enumeration area population data available spatially?
	Engagement with WorldPop
Rural Urban Definition	
	Is official definition clearly visible on website?
	Is it available and published spatially in-country?
	Is it clearly understood and used by roads agencies for "rural" statistics?
	Is it clearly understood and used for other statistical purposes?
SDG Reporting Mechanisms	
	Is there existing SDG Reporting mechanism?
	Is there existing SDG Reporting platform?
	Is RAI published as part of the SDG reporting platform?

The above criteria were assessed for each trial country, and an assessment produced with a corresponding spider diagram (see Figure 13-1). In each country, a score of 0 to 10 was allocated for each category, with 10 implying that all conditions are already met for RAI to be calculated and published successfully. The scoring is subjective, but the framework does allow for consideration of the major issues identified in this report, and identification of recommendations for improvement.

Figure 13-1: RAI Embedment Assessment



13.3 General observations on embedment in the trial countries

13.3.1 National agency coordination

NSOs are mandated within their country to collect, compile, analyse, abstract and publish statistical information on a wide range of topics. Many other government departments can collect and compile statistics related to their area of expertise, however the NSO typically takes a coordinating role to ensure adherence to fundamental statistical principles across all agencies, and to minimise redundancy and inconsistencies.

In the trial countries, the level of coordination between the NSO and the transport agencies is somewhat lacking. In general, where NSOs have in the past published statistics on the 'road network', they have taken data as read from the national roads agency only (i.e. have not concerned themselves with district or feeder roads). The NSOs include figures in statistical publications without working with all relevant agencies to determine the processes and procedures used to compile these statistics, to assess the comprehensiveness or accuracy of the data, or to compare it with other sources. The relationship between the NSO and the ministries of transport and roads agencies (or equivalent) in terms of producing statistics and calculating RAI should be formalised in the national statistical systems and in the SDG reporting processes, and the NSOs have a responsibility to play a greater part in ensuring proper reporting of statistics in relation to the road network.

13.3.2 Road network mapping

Road network mapping is clearly one of the biggest determinants of RAI under the 2016 geospatial methodology. All of the trial countries have (slightly different) issues with the coverage and quality of their road network mapping. The problems, however, are not technical and are not hugely difficult to address, especially given the availability of free or low-cost online imagery and resources such as OSM and a generally willing OSM community. What *is* required is cooperation and coordination among the various roads agencies in a country, under the oversight of a ministry of transport or equivalent; and greater coordination with the national statistics offices in understanding and reporting basic statistics on road inventory.

While there are caveats and assumptions made in the calculation of RAI for each of the trial countries in this report, with political will and cooperation it would easily be possible to improve the quality and coverage of road network mapping in the space of 3-6 months in each country, at least to the point where there is 95% confidence in the coverage.

It is important to note that such an exercise should be conducted anyway, from a pure asset management perspective. The very first question in asset management should be: where are my assets? In most countries, roads are the single most valuable national asset, and if any country is committed to asset management, then an accurate geospatial representation of the road network is essential. However, there needs to be coordination among the various agencies to ensure that there are no overlaps or omissions, and that common standards are followed. A definitive online map of the road network in any country provides a wealth of benefits to national and international, government and non-government agencies, to local businesses, and to the general public.

For many reasons, not only for RAI, it would be useful for such mapping to be published in OSM. But first and foremost, there should be coordination among the various roads agencies in a country to collate and improve their data sets.

13.3.3 Population data

All trial countries conduct a regular (every 10 years) population census under the management of the NSO. In all trial countries, population censuses are geo-referenced, i.e. the coordinates of individual households are recorded as part of the census. It is this geographic element, combined with absolute number of persons registered as living at that location, which is important for RAI.

While the NSO has the ability to identify the numbers of people living at a precise location, that data is typically not made available to other agencies (or to least, not to roads agencies) for reasons of privacy and security. The NSOs typically publish aggregated data at various sub-national levels, but those boundaries are irregular and so these aggregated published data are not amenable to analysis for RAI.

For purposes of RAI calculation, WorldPop is the preferred source for population distribution data. However, it is important that country NSOs engage with WorldPop to ensure that the population data published on the WorldPop platform is correctly reconciled to the latest national census and is reconciled with the lowest level of aggregation available. Endorsement of any data source by the NSO is important for any indicator to be published as an official data source.

None of the four trial countries had acknowledged WorldPop as a source of population data at the start of TG2. Furthermore, during the course of TG2, only Malawi NSO made contact with WorldPop to provide sub-national population data to enable WorldPop to publish data reconciled at that level.

For WorldPop to be fully embedded as the preferred source of population data for RAI (and other SDG indicators), further outreach, awareness and training to NSOs is recommended.

There is one further important point here. As indicated above, there is room for improvement in the coordination between NSOs and roads agencies. Therefore, where we recommend further engagement and awareness to NSOs in endorsement, use and reconciliation of sub-national data with WorldPop, we also recommend further targeted engagement with roads agencies to demonstrate the availability of such data for planning and prioritisation purposes. The by-products of this geospatial methodology for RAI (see Figure 11-2 on page 21) are potentially important for future rural development planning and road network planning, but roads agencies are typically not aware of the availability and use cases for such data. NSOs cannot be solely relied upon to provide that outreach.

Note that it would be possible for NSOs, if they have geo-referenced census population, to produce maps similar to (and even more detailed than) those produced by WorldPop. This would be a significant undertaking for most NSOs, and is not being recommended for the purposes of measuring RAI.

13.3.4 Rural urban definition

At present there is no globally agreed definition of what is a rural area and what is an urban area. The UN Statistics Division (UNSD) advises that because of national characteristics, which distinguish urban from rural, each country should decide which areas are to be classified as urban and which as rural, in accordance with their own circumstances (UN, 2015).

It is important that, where an official definition is clearly available spatially in a country, that that definition is used for RAI calculation, otherwise RAI cannot be correlated with other indicators and statistics in the country. There have been several studies to correlate RAI in the past (for example, with poverty, market access, access to social facilities). If different definitions of 'rural' have been used for those other indicators, then any attempted correlation with RAI is flawed.

Of the four trial countries, only Malawi was able to provide urban/rural boundaries geospatially and provide evidence of them being published on a statistical website. Ghana uses a definition of 'urban' as being settlements of more than 5,000 people, however does not provide any mapping for such settlements. Myanmar and Nepal did not provide a clear definition for 'urban' or 'rural'. Therefore, for Ghana, Myanmar and Nepal, the Global Rural Urban Mapping Project (GRUMP) v1 Urban Extent Polygons from 1995 were used.

The lack of a clear and accepted definition of 'rural' for international statistical purposes is an issue that the UN Expert Group on Statistical Methodology for Delineating Cities and Rural Areas is currently considering. Any recommendations from that group in future should be carefully considered in relation to RAI and other SDGs.

13.3.5 SDG reporting mechanisms

Most of the trial countries have produced recent SDG Indicator Baseline Reports, including:

- Measuring Myanmar's starting point for the Sustainable Development Goals – SDG Indicator Baseline Report (Myanmar Central Statistical Office & UNDP, 2017)
- Nepal's Sustainable Development Goals Baseline Report (National Planning Commission, Government of Nepal, 2017)

- Sustainable Development Goals (SDGs) Indicator Baseline Report (Ghana Statistical Service, National Development Planning Commission, 2018)

In general, these show that the trial countries are in the very early days of establishing their SDG reporting mechanisms. In none of the trial countries are the roads agencies officially listed as part of the SDG reporting process, so there are significant issues of collaboration and coordination between the NSOs and roads agencies. None of the trial countries had considered reporting SDG 9.1.1. nor had they reported a baseline value (despite baseline values for some countries being available in the World Bank 2016 methodology). None of the trial country roads agencies had more than limited knowledge of the RAI or the reporting mechanisms for the SDGs at the start of TG2.

With regard to reporting platforms themselves, most trial countries have some sort of website to report on their SDGs, and those websites are either linked to, or embedded within, the NSO and/or national planning agency websites. However, even if a country has an established SDG reporting website, the information there may not always be up-to-date. For example, the Ghana SDG reporting platform as of November 2019 still reports RAI / SDG 9.1.1 as a Tier III indicator "…*therefore no internationally established methodology or standards are yet available*", and Ghana "… *has not explored suitable data sources for this indicator*" (RAI became a Tier II indicator with an accepted methodology in December 2018).

Review of other non-trial countries has shown similar issues. Rwanda's SDG reporting platform, for example, publishes a value of 97.7% for SDG 9.1.1 in 2016-17. However, closer examination shows that this it is a proxy indicator ("*Proportion (%) of Households living within 2 km of an all-season road*"). It is unlikely that either this proxy value, or the true RAI, is so high. It is also unclear whether proxy value should be officially published as '9.1.1'.

In summary, although there has been significant progress in implementing national SDG reporting platforms, there is still work to be done in ensuring that these platforms are up-to-date with the status of the SDGs and that they properly reflect ongoing activities in the countries.

13.4 RAI as policy

At present, improvement of RAI is not embedded as a policy in any of the trial countries, although all trial countries have high-level objectives to improve rural accessibility. Nepal has the most formal indicators and targets to improve accessibility, and various programmes in Nepal have used *variants* of RAI and have produced detailed accessibility maps and analyses, albeit at different stratifications of the road network as opposed to an area-based approach. There are instances of MDBs and countries using RAI to affect policy, but not on a consistent basis. There is therefore some work to do if RAI is to be established in policy, both in terms of awareness and motivation.

As mentioned earlier, the African Union (AU) is interested in including RAI in their rural roads policy, which would go a long way to establishing RAI in Africa. Probably the most likely route to RAI as a consistently measured indicator is via the MDBs or institutions such as the AU. Some awareness of the potential additional uses of RAI data and how it can be presented to highlight accessibility issues would also support RAI as a policy instrument.

14 Sensitivity Analysis

Some limited sensitivity analysis has been conducted on the RAI, as described in this Section.

Thera are several different ways to calculate sensitivity analysis. One of the simplest is the one-factor-at-a-time (OFAT, or OAT) approach which varies one of the input factors while keeping the others constant, to see what effect each of the input variables has on the output.

There are essentially three input factors to the calculation of RAI: the road network, the population data, and the urban/rural boundary.

The RAI is clearly very sensitive to the coverage and quality of road network mapping data, and to the choice of which roads to include in the calculation. As described elsewhere in this report for Malawi, for example, by including unpaved roads in the calculation, the RAI increases from around 23% to 63%. The effect of adding a new road to the mapping will depend very much on the precise location of that road in relation to population in the area. There is little to be gained by conducting a formal sensitivity analysis by artificially varying the extent of road network data or choosing different roads for inclusion.

However, it is useful to understand the impacts of different models of population projections, and to consider the effects of using 'official' in-country Urban Rural boundaries versus 1995 Global Rural Urban Mapping (GRUMP) urban extent boundaries.

Table 14-1 shows three sources of population data for Malawi in 2018:

(1) Official data from the WorldPop website based on 2008 census projected to 2018 (individual countries dataset 2018);

(2) Unofficial data supplied to this project by WorldPop (October 2019) reconciled to District boundaries as supplied by Malawi NSO 2018 (standard random forests disaggregation); and

(3) Unofficial data reconciled supplied by WorldPop (October 2019) to District boundaries as supplied by Malawi NSO 2018 (predicted only into areas modelled as settled by the WorldPop built settlement growth model).

These are compared with official data from the 2018 Malawi census, and with UN DESA population estimates. Table 14-1 also shows the effects of applying different urban/rural boundaries to the estimates of urban/rural population.

Table 14-1: Sensitivity Analysis on Population Data and Urban Rural Split for Malawi

			Malawi Urban Boundaries				GRUMP			
Source	Year	Total	Urban	Rural	Urban %	Rural %	Urban	Rural	Urban %	Rural %
World Pop 1	2018	17,370,643	2,776,663	14,593,980	16.0%	84.0%	3,196,724	14,173,919	18.4%	81.6%
World Pop 2	2018	17,563,749	2,276,298	15,287,451	13.0%	87.0%	2,603,202	14,960,547	14.8%	85.2%
World Pop 3	2018	17,563,749	2,312,403	15,251,346	13.2%	86.8%	2,648,086	14,915,663	15.1%	84.9%
Malawi Population Census 2018	2018	17,563,749	2,810,200	14,753,549	16.0%	84.0%	-	-	-	-
UN DESA	2018	18,143,217	3,245,933	14,897,284	17.9%	82.1%	-	-	-	-

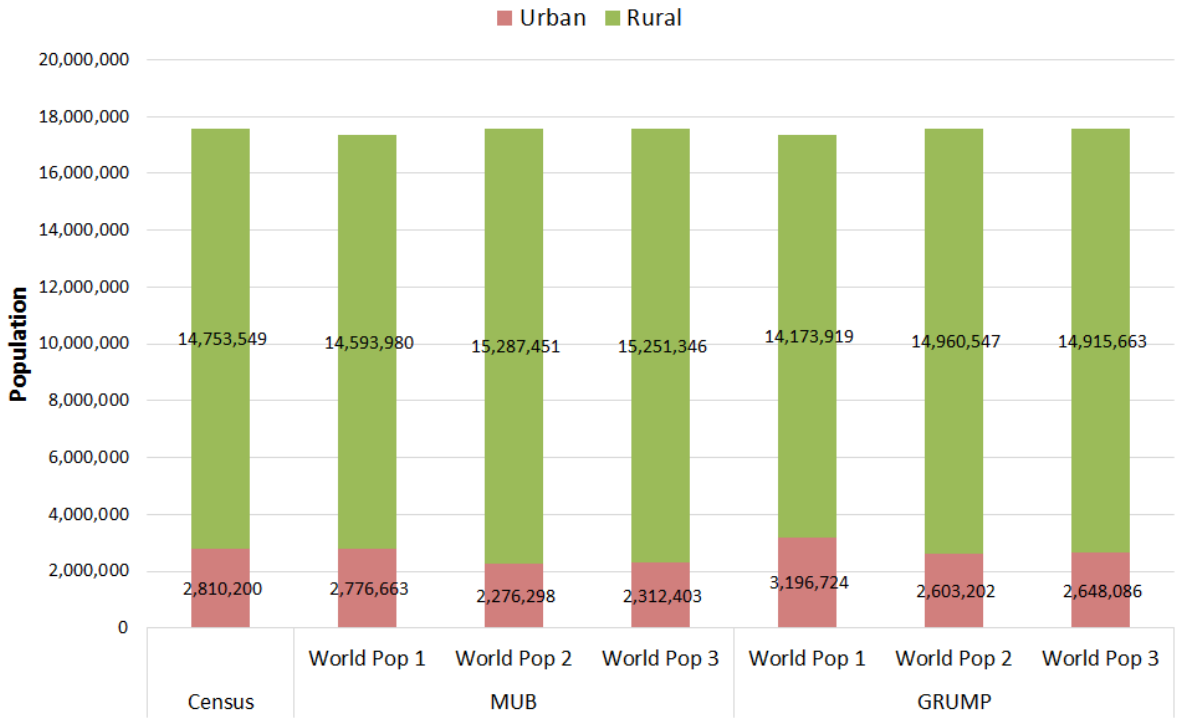
Sources:

(1) Official from WorldPop website based on 2008 census projected to 2018 (individual countries dataset 2018)
(2) Unofficial supplied by World Pop October 2019 reconciled to District boundaries as supplied by Malawi NSO 2018 (standard random forests disaggregation)
(3) Unofficial reconciled supplied by World Pop October 2019 to Districts boundaries as supplied by Malawi NSO 2018 (predicted only into areas modelled as settled by built settlement growth model)
(4) Malawi Population Census 2018
(5) UN Department of Economic and Social Affairs (DESA), Population Division

There are several observations that can be made from Table 14-1, and as shown in Figure 14-1, that show the choice of data source and urban boundary can be significant in estimating the total population being analysed:

- The urban/rural split according to the most recent Malawi population census is 16% vs. 84% urban/rural. WorldPop source (1) reflects that split exactly applying the Malawi Urban Boundaries (MUB); while applying GRUMP means that the rural proportion of the population is reduced to 81.6%. In terms of absolute numbers, applying GRUMP boundaries instead of MUB to WorldPop source (1) gives a reduction in rural population of more than 420,000 (or 2.8%).
- Using WorldPop source (2) and applying MUB gives a rural population of 15,287,451 versus the Malawi Population Census figure of 14,753,549, an increase of 533,902 (or 3.6%).
- Therefore the choice of GRUMP rural boundary applied to WorldPop source (1), versus MUB applied to WorldPop source (2), gives a difference in rural population of 1,113,532 (or 7.8%).

Figure 14-1: Urban Rural Split under different Data Sources and Boundaries



Looking at the effects of the above models on RAI calculations, Table 14-2 shows the total populations that live further than 2 km from an all-season road, and the RAI itself, under different combinations of WorldPop data sources and urban/rural boundary models. Figure 14-2 shows the RAI figures for the different models in graphical form. The main observations are:

- The absolute number of rural population that lives further away than 2 km from an all-season road varies from 4,522,177 to 6,035,909, a difference of 1,483,732 depending on which combination of population source and urban/rural boundaries are applied.
- In terms of the RAI itself, it ranges from 59.8 to 68.5, a difference of 8.7 percentage points depending on which combination of population source and urban/rural boundaries is applied.

Table 14-2: Sensitivity Analysis on RAI for Malawi

			Pop outside 2 km buffer		Rural Access Index	
Source	**Year**	**Total**	**MUB**	**GRUMP**	**RAI (MUB)**	**RAI (GRUMP)**
World Pop 1	2018	17,370,643	4,600,331	4,552,177	68.5	67.9
World Pop 2	2018	17,563,749	5,771,662	5,735,791	62.2	61.7
World Pop 3	2018	17,563,749	6,035,909	5,994,757	60.4	59.8

Figure 14-2: RAI calculation under different Data Sources and Boundaries for Malawi

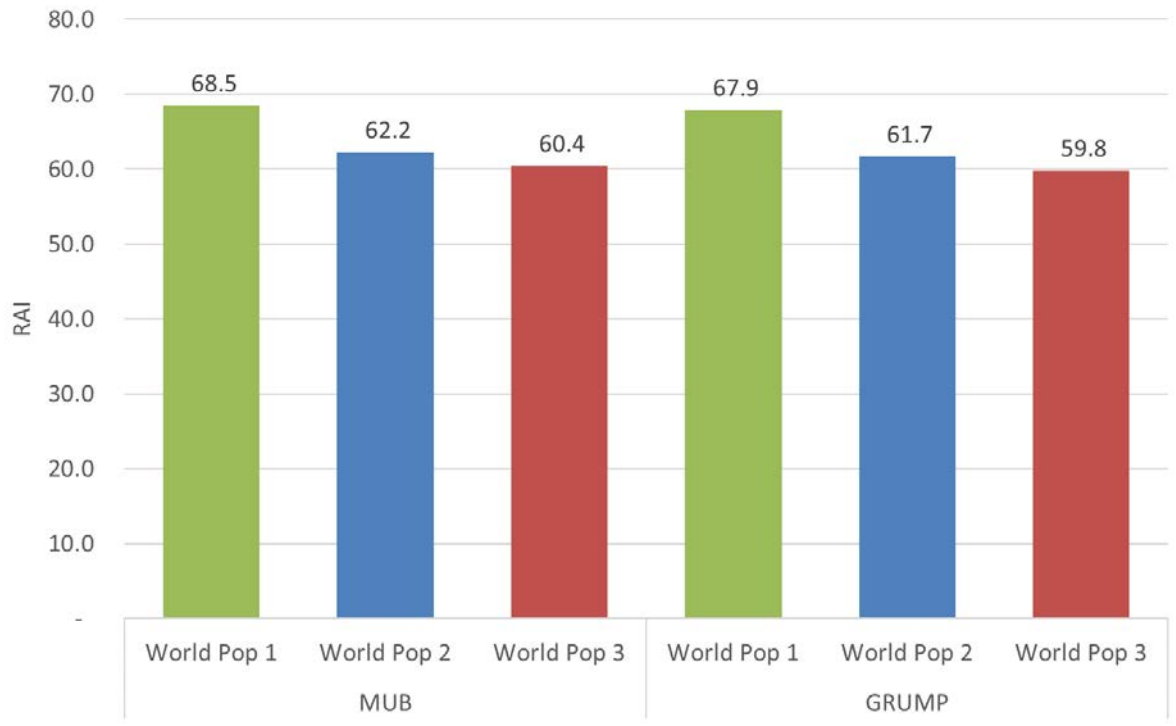
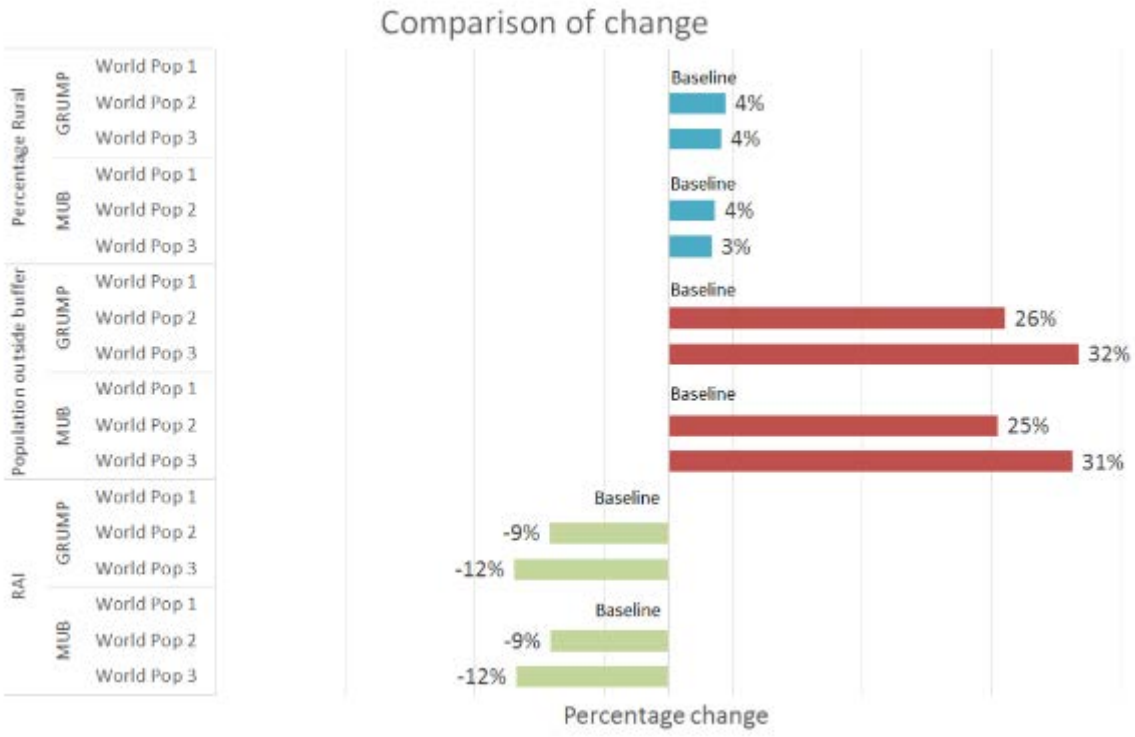


Figure 14-3 shows the overall impact of using the different population data sources and urban/rural boundary models for Malawi. The main conclusions which can be drawn are:

- A relatively small change (4%) in input population data can have a relatively large impact on the outputs (up to 32% in terms of absolute numbers of population outside the 2 km buffer, and up to 12% on RAI itself).
- The choice of MUB or GRUMP has relatively little impact on RAI (only +/- 1% on absolute numbers of population outside the 2 km buffer, and ~ 0.6 on RAI itself).

Figure 14-3: Sensitivity Analysis on RAI of Population Data and Urban/Rural Boundaries in Malawi



The above conclusions relate only to Malawi. Sensitivity analysis would need to be conducted in other countries to help understand the impacts on the final RAI calculations and to help determine the best sources of data for those countries in calculating RAI.

However, in general, latest population census data should be used as it should be more accurate and up-to-date. If different population distribution models and different urban/rural boundaries are available, then careful analysis should be made in conjunction with the national statistical offices and in comparison with other reports including the national census and other population estimates to determine the best sources and models to use.

The other general recommendation is that, in order to facilitate comparison over time, the same combination of sources of population models and urban/rural boundary should be used for any given country. This reinforces the importance of documentation of the exact methodology used in any one country, to ensure that the same data sources are used for that country in future.

15 Dissemination

15.1 RAI working group meetings

During the course of the project a total of seven RAI working group meetings have been held:

- January 2018
- July 2018
- September 2018
- January 2019
- May 2019
- September 2019
- January 2020

These working group meetings have been hosted by the ReCAP PMU, and attended by members from DFID, World Bank, Asian Development Bank, African Development Bank, Islamic Development Bank, and latterly from the UN Statistics Division, TRL, Azavea, the UK's Office of National Statistics and WorldPop. The goal of the working group was to maintain the RAI indicator (9.1.1) in the Sustainable Development Goals (SDG), and to progress from a Tier II to Tier I indicator by 2025. The purpose of the working group is to exchange information between DFID, World Bank, other MDBs and the ReCAP PMU on progress with the each RAI Task Group, and to share data collected by ReCAP and the World Bank. The TRL team have contributed significantly to these working groups throughout TG2, and will continue to do so during TG3, in order to share knowledge, data and outputs of the research with the custodian, partner agencies and key stakeholders of SDG 9.1.1.

15.2 Transforming Transportation 2019 (TT19)

A workshop was held at the World Bank hosted TT19 conference in Washington D.C. in January 2019, which included a short presentation and some discussion on the RAI. This was chaired by DFID and was attended by representatives of World Bank, ADB, AfDB and other key stakeholders in the rural roads sector. It was well received and raised awareness of the RAI at a high level.

15.3 Inter-regional implementation meeting Nepal

The Inter Regional Implementation Meeting (IRIM) for ReCAP was held in Kathmandu, Nepal in February 2019. A workshop on RAI was held at this event at which various issues were discussed, including how to define more accurately the all-season status of a road. The result of the plenary discussion was that the majority of participants considered a road to be all-season if it is inaccessible for 7 days or less per year. A summary of the IRIM event can be found on the ReCAP website at http://www.research4cap.org/Library/Thapa-Scriptoria-ReCAPThinkPieceIRIM2019-ReCAP-KMN2160A-190411.pdf.

15.4 UN Big Data conference on SDGs

The RAI team was represented at the United Nations Global Working Group's 5th International Conference on Big Data for Official Statistics, held in Kigali, Rwanda in May 2019. This was an informative and relevant forum for discussing RAI and a meeting was held with UN Statistics Division and UK ONS representatives, ReCAP and Azavea at the conference to discuss the potential for including RAI measurement on the UN Global Platform. This meeting was a precursor to the development of the RAI calculation tool.

15.5 Malawi workshop

A workshop was held in Lilongwe, Malawi in August 2019, which included representatives from Ghana. The aim of this workshop was to discuss and agree on key aspects of the RAI supplemental guidelines

and RAI data and measurement. All the key stakeholders from Malawi attended and the workshop was a great success. The workshop proceedings are available on the ReCAP website. This workshop had a significant impact on the project as it allowed the team to get feedback on the proposed guideline form a practical situation, and make adjustments accordingly.

15.6 PIARC RAI paper and workshop

A paper on RAI measurement was written for the PIARC conference in Abu Dhabi in October 2019. This paper was a requirement of the terms of reference and was titled: 'Raising the profile of the rural access index as a vital SDG indicator for measuring rural development and connectivity'. The paper won a prize from the World Roads Association (WRA) UK national committee for the best paper in the category of 'Sustainable Development'. The paper can be seen on the ReCAP website at http://www.research4cap.org/Library/Workmanetal-TRL-2019-RaisingProfileRAIasSDGIndicator-PIARC-190709.pdf

The terms of reference required that a stakeholder workshop be held to disseminate the work carried out under TG2, and to present outline recommendations for TG3. An opportunity arose to hold this workshop at the PIARC WRC 2019 conference in Abu Dhabi in October 2019. This was agreed because alignment would minimise costs and a broad audience of road practitioners, policy makers and others would be present, including many ReCAP country representatives.

At the workshop the panellists included:

- Guangzhe Chen, Global Director of the Transport Practice, World Bank
- Jamie Leather, Chief of Transport, ADB
- Nazir Alli, AfCAP Steering Committee Chair
- Joseph Haule, Team Leader, ReCAP PMU
- Ashok Kumar, Senior Engineer, World Bank

Presentations were made by Annabel Bradbury (who moderated the sessions), Robin Workman, Kevin McPherson, Chisomo Kauma (from Malawi) and Mahesh Chandra Neupane (from Nepal), followed by fruitful discussion between the audience, presenters and panellists on the RAI measurement process, data collection and analysis. These presentations and more details on the content of the workshop can be found in the Workshop Report, available on the ReCAP website.

15.7 RAI future measurement paper for PIARC

A paper presenting potential options for the future measurement of RAI was also submitted to PIARC as part of the RAI workshop. This paper was titled: 'Potential for measurement of the rural access index in the future', and explored technologies that are existing and could be used in the future to assist with measurement of the RAI. This paper, and all ReCAP presented materials are available for download on the dedicated PIARC WRC webpage on the ReCAP website.

15.8 UNESCAP conference

The ReCAP PMU presented on the RAI project at the UNESCAP Expert Meeting on Enhancing Rural Transport Connectivity in Bangkok, Thailand in July 2019. The outcomes of this event, including a whole section dedicated to the ReCAP RAI research, is due to be published in 2020 as part of the UNESCAP Monograph Series on Sustainable and Inclusive Transport, titled 'Enhancing Rural Transport Connectivity to Regional and International Networks in Asia and the Pacific.'

15.9 RAI paper for GISAfrica

A peer reviewed paper was also written for the AfricaGIS conference in Rwanda in November 2019. AfricaGIS is the largest geospatial, science and technology conference on the African Continent, and is focused on SDGs and Geographical Information Systems (GIS), reaching a broader audience than traditional roads conferences. The paper was titled: 'How to use GIS to measure Rural Access for SDG 9.1.1'. A special issue journal will publish papers presented at the conference in 2020.

15.10 RAI presentation at the SSATP AGM

The Africa Transport Policy Programme (SSATP) held its Annual General Meeting (AGM) at Victoria Falls from 25 to 29 November 2019. ReCAP jointly sponsored a one-day Specialised Technical Session on Sustainable Transport (STSST) at this event, held on Monday 25th November 2019. The RAI team were invited to present on RAI, as well as on the ReCAP satellites project, which included some potential technologies for measuring RAI in the future. This was a good opportunity to disseminate the results from the project to a wider audience of practitioners and policy makers.

15.11 IRF conference

The ReCAP PMU attended the International Road Federation's (IRF) 3rd International Conference on Sustainable Mobility in Marrakesh, Morocco on 29th November 2019. The theme of the conference was Sustainable Road Transport and Mobility for a Sustainable Future, and ReCAP were able to make a presentation on the RAI study, and to demonstrate the RAI Measurement Tool to participants, who were largely represented by the private sector, many of whom are affiliated to the SuM4All initiative. IRF have also put the team I touch with potential sponsors for future RAI work, including LaFarge, who the team met with at the PIARC World Road Congress. This contact, and others such as the Michelin Foundation and Shell Foundation, are useful contacts for the future as potential supporters of RAI.

15.12 ieConnect workshop

An 'Informing Transport Investments through Data Systems and Evidence' workshop was held by the ieConnect programme of the World Bank from 3 to 6 December 2019 in Marrakesh, Morocco. The workshop launched Phase III of ieConnect, through which the programme will be adding a number of impact evaluations in 2020. The RAI team gave a presentation on RAI which included an overview of the Supplemental Guidelines, introduction to the proof of concept RAI measurement tool developed by Azavea, recommendations relating to OpenStreetMap, potential use of Mobile Phone Network data for rural transport projects, introduction to the UN Global Platform, and use of HD Imagery and Machine Learning as potential tools for asset management and safety assessments. The RAI team also sat on the panel for this session, and discussed recent RAI calculations with representatives from Vietnam and Rwanda. The workshop included several presentations from current World Bank projects in rural transport, and developed proposals for Impact Evaluation on a range of other projects. The RAI can certainly be one of the indicators used to evaluate the impact of a programme, although a typical rural roads programme will also include transport service indicators, plus other secondary indicators such as reduction in poverty, increased agricultural productivity, greater competition etc. for which supplemental interventions may also be applied to ensure that the project objectives have every opportunity to succeed.

15.13 African Union policy

At the PIARC World Road Congress in Abu Dhabi a representative from the African Union (AU) expressed interest in including the RAI methodology in AU policy for rural roads. This was followed up, and TRL prepared a presentation and sent it to the AU for sharing at the Programme for Infrastructure Development in Africa (PIDA) conference in November 2019. The overall aim of PIDA is the promotion of socio-economic development and poverty reduction in Africa through improved access to integrated regional and continental infrastructure networks and services. PIDA has Sector Studies,

which assist in developing a vision on Africa's infrastructure based on strategic objectives and sector polices; prioritised regional and continental infrastructure investment programmes, including Transport, over the short, medium, and long term, up to the year 2030. The Sector Studies will recommend the required institutional arrangements, legal frameworks, and financing mechanisms for the implementation and monitoring of the programmes.

To include the RAI in PIDA would be a boost for sustainable implementation in Africa as countries take their lead from AU policy and this should motivate countries to start measuring RAI regularly. To include the RAI in PIDA would be a boost for sustainable implementation in Africa as countries take their lead from AU policy and this should motivate countries to start measuring RAI regularly. The TRL team intend to actively pursue this line of enquiry during TG3, as it is crucial to the long-term sustained implementation of RAI as a development metric on the African continent.

15.14 RAI working group and TT2020

The latest RAI Working Group meeting was held at the World Bank offices on 14th January, during the same week as the Transforming transportation 2020 event in January 2020. TRL presented the progress of the project and the Supplemental Guidelines to DFID, the World Bank (representatives from the Transport Practice and Development Economics Vice Presidency) and UN Statistics Division. Azavea also demonstrated the RAI Measurement Tool. TG3 activities were discussed, and agreement that close collaboration with the World Bank on their proposed RAI 2020 Initiative and digital platform should continue. The ReCAP PMU had an exhibition stand at the TT2020 event, at which the RAI Measurement Tool was also demonstrated to participants.

15.15 Other meetings

A number of other meetings were held with key stakeholders in the RAI process, including:

- UK ONS: Meetings in Rwanda and at DFID offices in UK, regarding the UN Global Platform and support to NSOs to measure SDGs, in particular Ghana.
- SuM4All: Nancy Vandycke and the SuM4All team, in Washington to discuss the early development of RAI and its relevance to SuM4All, especially the secondary indicators for motorcycles and waterborne transport.
- WorldPop: The Team Leader and the Database Specialist visited WorldPop in Southampton to learn more about their methodology and how the population maps are generated.
- World Bank: Several meetings have been held with the Transportation and Data departments, both in Washington during two visits and remotely.
- ReCAP: The team have had several meetings with ReCAP.
- Azavea: Several meetings have been held with Azavea remotely during the development of the RAI calculation tool.

16 Conclusions and Recommendations

This section discusses conclusions arising out of activities on TG2 and gives recommendations for going forward to further embed the RAI and scale up its implementation across UN member countries to consolidate its position at Tier II and eventually move to Tier I in the classification of the SDGs. It also gives recommendations for activities to be carried out under TG3, the next phase of ReCAP support to this project.

16.1 Conclusions from TG2

16.1.1 RAI as an Indicator

a) The RAI is the only indicator in the SDGs that pertains to rural access. It has been calculated for at least 34 countries since 2016, and the project has identified ongoing efforts in at least 8 other countries. The promotion from Tier III to Tier II in December 2018 has provided extra motivation for countries to calculate RAI on a regular basis, and the Supplemental Guidelines developed under this project, along with the continued promotional efforts of World Bank as the custodian and ReCAP, will likely help move RAI towards Tier I status. This report presents a number of ideas to help raise awareness and promote the RAI even further by making the outputs of the measurement transparent and more relevant for policy. These include the formal recording of metadata, presenting the RAI as absolute numbers, promoting the by-products of accessibility maps, and improving reconciliation of open source data with country data.

b) Achieving the main goal (to get every country regularly measuring RAI) will still require commitment from the custodian and partner agencies to raise awareness and motivate the NSOs and roads agencies to collect the data. The Supplemental Guidelines outline a simple and sustainable process to achieve this. Some countries can, and have, collected RAI through their own efforts, but it is likely that other countries will still require additional assistance to interpret the guidelines, merge existing data, conduct additional road network mapping, identify accessibility factors, and calculate and publish RAI and its supporting data and metadata.

c) Many countries will collect RAI if it is a Tier I indicator, or if they suspect it might become a Tier I indicator in the near future. Uptake by any given country will help raise the profile of RAI among neighbouring countries, and will help ensure sustainability.

d) The availability of the online RAI Measurement tool as described in Section 11 to calculate a 'default' RAI for each country will also help in encouraging countries to measure RAI themselves.

16.1.2 Embedment

a) Many important lessons were learned from the trial countries with regard to embedment. It is clear that the National Statistical System (NSS) in a country is vitally important for sustained RAI measurement. If the RAI is established in the NSS, then it will be measured and published as a matter of course. The importance of this system cannot be overlooked, it is the foundation for all statistical efforts in a country.

b) The resources needed to collect RAI are quite small, so long as detailed road condition data is not required on a regular basis. It does however need dedication, which will be easier to motivate if policy, and in particular the NSS, include RAI measurements.

c) Small efforts to improve coordination among the necessary agencies in a country to measure RAI can be very beneficial. In general, improving the links between NSOs and transport agencies helps the transport agencies' statistical capacity and encourages sharing of information, tools and technologies, particularly in the relation to big data and online data sources.

d) The RAI is one of the SDGs. Any efforts in a country to promote SDGs will be beneficial in promoting the RAI.

16.1.3 Road network data

a) Accessibility factors are an important and sustainable alternative to road condition for the all-season status of a road network. Countries typically do not collect condition data on unpaved roads on a regular basis, and countries should not be given the burden of collecting additional data that they may not use, just to measure an SDG indicator.

b) In-country data will inevitably be of variable quality, however the building blocks (mapping of national roads, OSM, the OSM community, satellite data, etc.) exist, and most countries have the necessary mapping skills to bring their data up to a level that would give a higher degree of confidence in RAI. In addition, there is considerable research going on in this field using machine learning technologies (such as the RapID tool released by Facebook) which can speed up the population of OSM to fill in any gaps in road network data, and it is anticipated that the coverage and quality of road network data in OSM will improve as a result.

16.1.4 Population data

a) WorldPop is an excellent tool to assist in the measurement of RAI, as well as many other SDG indicators. It provides a geospatial distribution of population for every country in the world, and is available freely online.

b) WorldPop engages with local statistical offices where they can, but they do not have the resources to contact every office individually. The figures need to be checked against the official country data and projections to ensure consistency and allow the government to confirm RAI results that use WorldPop. It is important for users to carefully check the WorldPop metadata, and for national agencies to engage effectively with WorldPop.

c) It is also important that country NSOs engage with WorldPop to ensure that the population data published on the WorldPop platform is correctly reconciled to the latest national census and is reconciled with the lowest level of aggregation available.

d) Other tools (such as Facebook population density maps) are also under development, and it is important for the RAI custodian to keep up-to-date with these and consider them for possible future inclusion in the RAI methodology.

16.1.5 Urban/rural boundaries

a) The lack of a clear and accepted definition of 'rural' for international statistical purposes has been considered as an issue for RAI in the past because the definition of rural and urban can differ greatly between countries. The UN Expert Group on Statistical Methodology for Delineating Cities and Rural Areas is investigating, with a view to providing a global definition.

b) There are open source sites, however, which can provide urban and rural boundaries globally. In the meantime, the UN recommends that every country defines its own rural/urban boundaries, which is straightforward in terms of using approved data.

16.2 General Recommendations

16.2.1 Publish the supplemental guidelines

a) ReCAP should continue to liaise with World Bank regarding publication of the Supplemental Guidelines as an accompaniment to the World Bank 2016 methodology, both on the World Bank Data Catalog and the UN SDG website.

16.2.2 Publicise and coordinate RAI

a) ReCAP should continue to liaise with World Bank on raising the profile of the RAI, to emphasise / market / publicise RAI to the NSOs, Planning Agencies and Roads Agencies, with a view to motivating more countries to measure RAI.

b) ReCAP should continue to liaise with World Bank to encourage involvement of co-partners, including for example the Islamic Development Bank and Inter-American Development Bank. Efforts should also be continued to involve additional regional organisations such as the African Union.

c) All stakeholders should promote RAI at regional conferences and events, and fully explain the publication process. Many countries do not know about RAI, or are focused solely on existing Tier I indicators and so have not considered RAI.

d) Part of the promotion / coordination should be to work with any SDG monitoring or promotion activities to encourage national statistical offices to actively consider 9.1.1 as part of their statistical development plans. One potential role model is the Philippine Statistical Authority, which in 2017 published a resolution to include all Tier I indicators in the Philippine Development Plan, and "to address gaps for Tier II and III global SDG indicators in the 2017-2023 Philippine Statistical Development Plan".

e) There are many existing SDG development efforts. If any development partner (UN, UK-ONS, DFID, WB etc. etc.) is undertaking any project relating to SDGs or the reporting platforms this represents an opportunity for coordination and cooperation regarding RAI. It would be beneficial to liaise with such initiatives to let them know the status of RAI, documentation, training materials, default RAI tool etc. and, if possible, add an extra 1 – 2 weeks of consultancy for an in-country visit specifically on RAI.

f) There are many other ongoing initiatives such as the GRID3 (Geo-Referenced Infrastructure and Demographic Data for Development) project that have developed a clear workflow and solutions for community-based mapping and which are absolutely

committed to mapping of populations and physical infrastructure. Such initiatives should be exploited where possible.

g) Such support should not be confined simply to indicator projects, RAI should also piggy-back onto existing Roads Projects (especially rural roads projects). Co-partners can help to identify these and motivate cooperation.

h) SDGs Indicator Baseline Reports are available on the SDG website for a number of countries. This is an important place to start when considering whether and how to measure RAI in a country, regarding how RAI can be 'piggy-backed' onto existing reporting mechanisms.

i) A list of countries with links to their online reporting platforms is maintained by the UN ECE Task Force on National Reporting Platforms, but that only covers UN ECE countries, and requires searching through these websites country-by-country. SDG 9.1.1 is not currently covered in the global Sustainable Development Goals Report because at the time of last publication it only covered Tier I and Tier II indicators (RAI was only promoted to Tier II in December 2018). WB and partner agencies should conduct a survey of NSOs / planning agencies to determine which of them are collecting, or planning to collect, SDG 9.1.1.

j) Develop video material. In order to support the measurement and reporting of RAI, a series of videos should be available on an online platform. Such videos would provide guidance on the data collection, processing and analysis necessary for RAI measurement, as well as a detailed GIS guide for the calculation.

16.2.3 Document and record metadata

a) Documentation and recording of the method of calculation of RAI is a fundamental principle of statistics in order to ensure transparency and repeatability. The custodian should look to store metadata in the World Bank Data Catalog.

16.2.4 Road network mapping

a) WB and partner agencies should provide in-country support to improve road network mapping as part of on-going road projects. Road network mapping data is important not only for RAI, but for many other planning and statistical functions. Support should include efforts to improve coordination among the various agencies to ensure that there are no overlaps or omissions, and that common standards are followed. A definitive online map of the road network in any country provides a wealth of benefits to national and international organisations, government and non-government agencies, to local businesses, and to the general public. This can be achieved very easily (perhaps 3-6 months of effort within a country). Initial assessment of the need in a country might only take 1 week.

b) For many reasons, not only for RAI, it would be helpful for such mapping to be published in OSM. The World Bank / DFID already provide direct support for this in many projects. First and foremost, there should be coordination among the various roads agencies in a country to collate and improve their data sets (irrespective of whether it gets into OSM or not). It is noted that in a few cases the road network is considered as sensitive data and it may not be possible to reconcile with OSM.

16.2.5 WorldPop

a) Country NSOs should engage with WorldPop to ensure that the population data published on the WorldPop platform is correctly reconciled to the latest national census and is reconciled with the lowest level of aggregation available. Endorsement of any data source by the NSO is important for any indicator to be published as an official data source. The custodian (and UN partner agencies) should assist in this effort through encouraging NSOs to engage with WorldPop.

b) Also recommended is further targeted engagement with roads agencies to demonstrate the availability of such data for planning and prioritisation purposes. The by-products of this geospatial methodology for RAI are potentially important for future rural development planning and road network planning, but roads agencies are typically not aware of the availability and use cases for such data. NSOs cannot be solely relied upon to provide that outreach.

16.2.6 Keeping up-to-date with new technologies

a) It is recommended that the custodian review the RAI methodology every 3-5 years – to take account of new tools, technologies, platforms – Facebook, UN Global Platform, and the Azavea RAI Measurement Tool etc.

b) The UN Expert Group on Statistical Methodology for Delineating Cities and Rural Areas is looking at a universal way to define rural and urban areas, any recommendations from that group in future should be carefully considered in relation to RAI and other SDGs.

16.2.7 Further development of the Azavea Tool

a) The RAI Measurement tool developed by Azavea is a powerful tool and should be used to promote RAI and to encourage countries to collect their own data. TG2 has provided some suggestions for further development of the tool, including integration into the UN Global Platform, and extending it to include RAI calculation at sub-national level. Exposure on the UN Global platform as a demonstration tool would also motivate feedback on its use and enable further development to suit the requirements of measuring RAI. There are also potential uses for other indicators that could be explored through this route.

16.2.8 Further Research on RAI

a) It is recommended that further research on RAI is conducted. There have been several studies in the past that demonstrated correlation between RAI and poverty, for example. However, with a refined RAI methodology and with other global data sources becoming available, further study is warranted. This could include studies to compare RAI and the Human Development Index (HDI), which is a composite measure of health, education and income.

16.3 Recommendations for TG3

The main TG3 activities stated in the TOR are:

- Liaise with ReCAP member countries for collection of RAI data.
- Continue to identify and secure financial support for broader and sustained implementation of the RAI measurement framework in non-ReCAP countries.
- Implement uptake and embedment in all 17 ReCAP countries.
- Support uptake and embedment in up to 30 countries (ReCAP and non-ReCAP).

RAI measurement needs to be sustainable, repeatable and as accurate as possible. In order to be sustainable the RAI measurement should be simple, easy and resource friendly. Data quality and completeness needs to be carefully monitored and managed by the custodian, in line with the Supplemental Guidelines. The process proposed and trialled in TG2 is in line with this philosophy, so that where road condition is available it can be used as per the original 2016 geospatial methodology, but where it is not available the 'Accessibility Factor' approach can be used as an alternative.

The promotion and implementation of uptake and embedment is key to the success of TG3. In the potential absence of TG3 funding for direct support to individual countries, the team is proposing an input that will raise awareness of the RAI, support policy development at high level, and be able to support countries remotely to measure RAI, using guideline documents supplemented by online tools. This approach would forego the need for intensive in-country support, as was included in TG2, and would be an appropriate test for the uptake and embedment of the enhanced process of RAI measurement towards the achievement of Tier I status in the longer term.

The following approach is therefore proposed to provide minimal support and liaison from donors and external consultants. It places emphasis on the efforts of individual countries to implement RAI as part of their wider SDG reporting efforts. Proposed activities include the following:

a) Policy development and RAI embedment in National Statistical Systems

Policy is a key enabler for RAI measurement. If countries can incorporate RAI into policy, it will greatly enhance the chances of regular measurement and reporting. The team would liaise with joint partners to support the development of policy for RAI: these would include ADB, AfDB, UNEP/UNECE and other regional organisations such as AU and ASANRA.

The AU are interested in including RAI in their rural roads policy. This will be actively pursued with AU as the most positive potential impact in encouraging African countries to measure RAI. It is likely that influence from the custodian, ReCAP or DFID will be needed to help bring about such changes in policy.

The ADB is also interested in RAI as it supports their Strategy 2030 Operational Plan. The fifth operational priority of Strategy 2030 is Promoting Rural Development and Food Security, with a focus on rural roads, market infrastructure, and agri-logistics centres and networks to enable the integration of producers, agri-businesses, and consumers in the national, regional, and global food systems. Linking with this strategy should motivate Asian countries to measure RAI, with the active involvement of ADB as a new co-partner to RAI. If other regional MDBs could follow suit the chances of reaching Tier I would be greatly improved.

There is a possibility to include RAI in the World Bank's International Development Association (IDA) 19, devised to pool and leverage funds to achieve greater development impact in IDA countries. Between July 2017 and June 2018 IDA built 5,931 km of roads, so there is a recognition that accessibility has an influence on poverty. The IDA 19 is focused on the SDGs and extreme poverty, much of which is rural. To include the RAI in IDA 19 would raise its profile and assist in motivating countries to measure RAI. This has already been proposed to World Bank and it seems it will be challenging to include it, but the proposal will be actively pursued during TG3.

Another key focus of TG3 should be to develop a strategy that will encourage countries to include the RAI in their NSS. At country level this will put the onus on NSOs or their equivalent to put in place plans to measure RAI on a regular basis. In general, when an activity is embedded in the NSS, it is undertaken as a matter of course.

It should therefore be an aim for any RAI measurement in trial countries in TG3 to have RAI incorporated into the NSS, but this should also be made a requirement for all countries measuring the SDGs. This would require active motivation from the UN, most likely via the IAEG-SDG group who have the status to influence how countries measure the SDGs. Help of the custodian, co-partners and regional organisations such as AU would also be enlisted to support this initiative by persuading them to include monitoring of country reports of RAI in their policy, agendas and results frameworks.

The strategy document in c) below would include policy recommendations and, where necessary, detailed guidelines that will facilitate the inclusion of RAI into policy at all levels by the time the next round of SDG indicator revisions is due.

b) Explore opportunities for additional countries to measure and verify RAI

The team would undertake a process to test the feasibility of measuring RAI in additional countries within the timescale of TG3, using minimal resource requirements. The priority would be to identify 'Quick Win' countries where the RAI could easily and quickly be measured. This would include a proportion of High Income Countries (HIC) and Medium Income Countries (MIC).

The first step will be to undertake a survey of countries that are measuring, or planning to measure, RAI, and how. This should be managed through the custodian or partners whose contacts will be vital for the success of such a survey, but with TRL taking the lead and managing the planning, administration and collation of results of such a survey. This would enhance the existing database of RAI held within the World Bank and would provide a list of key contacts in countries who are interested in measuring RAI.

It will be necessary to establish initial contacts with NSOs, Planning Agencies, Roads Agencies and other stakeholders in a country; hold introductory video conferences; review SDG Baseline Reports; and review online data sources. There may also be an opportunity to coordinate with other World Bank initiatives such as Data4Now and ieConnect, which have shown an interest in the RAI and that could provide contacts and introductions in new countries.

A summary would be made of countries that could easily measure RAI using minimal resources. This would include ReCAP countries where possible, but all countries would be considered. Some LICs with good road network data and cooperative roads authorities have already been identified as potential trial partners, such as Namibia and Tanzania. Countries would be invited to undertake RAI measurement, primarily using their own resources and data where possible, but with remote support from the RAI team. This will be an appropriate test of the Supplemental Guidelines, to assess to what extent countries are able to measure RAI with minimal external support.

c) Strategic Roadmap to achieve Tier I status

A strategic Roadmap for the promotion of RAI to Tier I on the IAEG-SDG monitoring scale will be developed in TG3. This will aim to achieve measurement of SDG 9.1.1 in sufficient countries (at present 98) to achieve Tier I status by 2025. This will be presented in the form of a Roadmap for RAI measurement worldwide, based on the guidelines and resources developed in TG2 and TG3.

To achieve Tier I the goal is to measure RAI in 50% of countries and populations in each region where it is relevant. Some investigation is required into the exact meaning of 'relevant', but at present it is assumed that RAI is relevant in every Region, so it can include HICs and MICs, some of whom are already measuring it. In the Roadmap it would be prudent to aim for say 60% as it is inevitable that some countries will not be able to achieve the measurement on time, for whatever reason.

The meaning of 'regularly' also needs to be defined. In TG2 it was recommended that RAI is measured at a frequency of between 3 and 5 years, depending on the situation of the country, because it takes large changes in the road network and its condition, or large population movements, to make any significant difference to the RAI.

Awareness raising and promotion of RAI is a key factor in broadening the knowledge of RAI and what it represents. Social media can play an important role in this, so TRL will promote RAI through its own social media connections, as well as through other traditional media such as press releases. The team will also liaise with the custodian and co-partners to promote RAI through their connections, country offices and other linkages. This is essential to maintain the momentum that has been built up for the RAI over the past few months.

The Roadmap will also include liaising with HIC organisations, such as the EU and FEHRL, which should be able to disseminate information on the RAI through their networks. The UNECE and UNEP as co-partners should also be able to assist in awareness raising through their own contacts. The team will make contact with these organisations and provide the necessary information for them to disseminate, which is likely to include links to the 2016 report and the RAI calculation tool, as well as a soft copy of the guidelines.

The RAI calculation tool is also a good demonstrator of how RAI can be measured and presented. It can be a very powerful visual aid to a presentation or promotion of the RAI and will be built into the Roadmap for achieving Tier I. At present the tool is available online to view and test, so practitioners can be encouraged to learn about RAI by using the tool.

Policy development as mentioned in a) will be key to increasing the scope of countries measuring RAI. If the RAI can be included in policy by regional or international organisations, then it is highly likely that countries will follow. This is especially true of organisations such as the African Union. Policy and strategy development should go hand in hand with awareness and promotion of RAI, because the experience so far is that measurement is not consistent, and some countries are not even aware that there is an established methodology for measurement. This can be achieved partly by promotion during TG3, as shown in e), but in the longer term it should be included in policy and strategy documentation, motivated through the custodian, co-partners and other regional institutions. The custodian also has an RAI 2020 initiative, which will be taken into account during TG3.

The RAI Supplemental Guidelines will be the core document that guides countries in how to measure RAI. This also needs to be disseminated and have supporting documentation that ensures consistent and evaluable measurement of the RAI.

Close liaison would be maintained with World Bank/SuM4All – it is expected that a visit to Washington to make an internal presentation on the RoadMap and progress on policy development would be necessary towards the end of TG3.

d) Produce Regional Video Webinars and develop these for future training

Two regional video webinars (in developing countries, ideally Africa and Asia if partner countries can be found) would be held to raise awareness of the RAI process and to gauge interest from potential 'Quick Win' countries, both in LICs and HICs. This would include instruction on the measurement of RAI using QGIS, aimed at the key agencies with responsibility to measure and report SDG 9.1.1, principally NSOs or their equivalent and roads authorities. The partner country would need to be willing and able to undertake RAI with their own resources, and would need to have good quality data available, as shown in the Supplemental Guidelines.

These webinars could be held from TRL head office, or from a regional event such as T2, which would at least allow some participants to attend in person. It is essential to include NSOs and other relevant stakeholders in such events, as they will have the responsibility to measure RAI and include it in their NSS. The conferences could also be held in a different country and recorded remotely.

These webinars would be recorded, edited and made available for other countries interested in measuring RAI to view online. In the long term these could be used as a basis for developing the measurement support tools mentioned in f).

If a specific interested country can be identified and is prepared to measure RAI in this way, it would be beneficial for the team to visit in person to carry out the training. If this is the case, it will be proposed to ReCAP for additional funding to be provided to facilitate this. Contacts made in TG2 suggest that countries such as Namibia, Jordan and Tanzania could be ready for this type of interaction.

Assuming that ReCAP hold an IRIM as planned in 2020, this would also provide a good opportunity to hold an inter-regional webinar/conference that would include Asia and Africa. Although it will be held at a ReCAP event with ReCAP countries, the event could be made available to other countries in Asia and Africa.

e) Promote RAI at regional conferences and events

Promote uptake and embedment at various events. A key aspect of uptake and embedment is to raise awareness of the RAI, its importance and how it can be used to monitor accessibility of the poorest rural communities. The RAI team has made presentations and held workshops/seminars at high-profile events in TG2, but there is limited time to write papers and present them within the 5 months of TG3. It could also be possible to have an RAI stand at an event, if exposure is broad enough and appropriate.

The most appropriate event to attend is the Second Global UN Sustainable Transport conference in Beijing (May 2020). This event is principally by invitation, but the private sector is invited to register, and there is potential opportunity to include RAI material in a side event following submission of a two page proposal.

Some other examples of potential appropriate events for presentation/exposure are:

- The Geospatial World Forum in Amsterdam in April 2020; although it is too late to present, it could be beneficial to have an RAI stand or poster.
- The third National SDG Conference in Bergen: Action/Inaction – Technologies and Partnerships, from 5–7 February 2020. This is organised by Norwegian Universities and is likely to be too narrow to be beneficial to SDG 9.1.1 promotion, although it does involve several low-income countries.

The RAI team already has a paper submitted to the T2 conference in Mozambique in May 2020, developed under TG2. There are minimal details available on T2 at present, but this would be an appropriate forum to promote RAI. This could include one visit.

Continued liaison with other organisations supporting RAI would be necessary, such as WorldPop, UK-ONS and UN for the UN Global Platform. It is assumed that this could be managed remotely.

This would also require maximising the influence of the custodian and other co-partners. A minimal number of days has been allowed for identifying relevant events and facilitating promotion of the RAI where possible.

f) Deliverables

It is recommended that the deliverables are adjusted as follows:

- Scientific Paper submitted to ReCAP for comments
- Draft Roadmap and Policy guide document
- Draft Final Report and Policy Brief for RAI

- Final Report

g) Future recommendations

The following recommendations were considered for TG3, but will not be proposed due to financial constraints. However, they are potentially useful inputs for the future that would help with the promotion, consolidation and expansion of RAI.

Planning for online support

A package of RAI measurement tools could include the following online support:

- A more detailed GIS manual for calculating RAI that could be tailored to different situations and levels of expertise
- Videos to be available on YouTube (30 minutes per video) on subjects such as:
  - RAI Guidelines and how to use them
  - GIS Procedures for measuring RAI
  - Accessibility Factors and how to establish them, including ground-truthing
- A set of Frequently Asked Questions (FAQs) to assist in RAI measurement
- Recommendations for a Helpline to assist countries who have problems with data collection, processing, or measurement of the RAI.

Development of the Online Measurement Tool

Phase 1 of the RAI measurement tool project has been completed, having established the tool to measure a 'default' RAI for every country in the world for 2019, using the established methodology form 2016 with open source data. Actual data from three countries has been incorporated and has facilitated a comparison with the open source data for the RAI measurement. The next steps would be to have this as a demonstration tool on the UN Global Platform and to continue to develop it in line with feedback and requirements from the stakeholders.

Development of Secondary Indicator (motorcycles and navigable waterways)

The secondary indicator should continue to be developed and should continue to be consistent with the SuM4All documentation. Initially it should be discussed with the custodian and disseminated more widely to practitioners and stakeholders in the sector. When feedback has been received and analysed it should be included in the strategy for 2025, either as an aspect of the RAI or as a parallel indicator.

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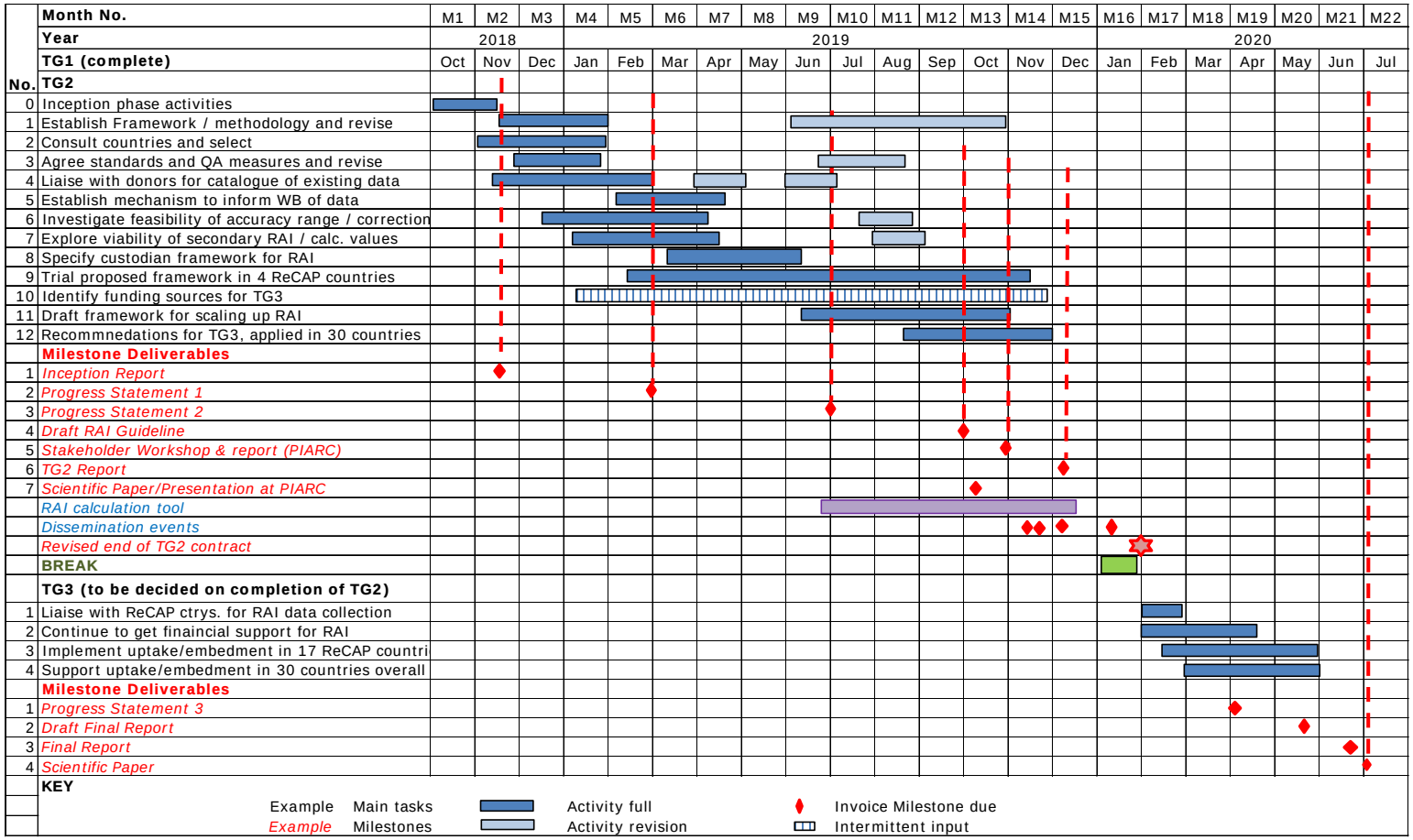
Annex A: Work Programme

ACTIVITY and MILESTONE SCHEDULE

TITLE: Consolidation, revision and pilot application of the Rural Access Index (RAI)



Annex B: RAI Data Identified

UN Member State (as of January 2019)	RAI published (or calculated, but not yet published)														Project-Level	Targeted	Source	Note
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019				
Afghanistan	22														Afghanistan Rural Roads Project ("Number of rural people with access to an all-season road")	√	3, 4, 11	
Albania	31																11	
Algeria	59																11	
Andorra																		
Angola	42																11	
Antigua and Barbuda																		
Argentina	77															√	3, 11	
Armenia	80											66				√	1, 3, 11	
Australia																		
Austria	95																11	
Azerbaijan	67															√	3, 11	
Bahamas	82																11	
Bahrain	99																11	
Bangladesh	37										87						1	
Barbados	100																11	
Belarus	64																11	
Belgium	100																11	
Belize	78																11	
Benin	32					v *											2, 11	
Bhutan	47															√	3, 11	
Plurinational State of Bolivia	48															√	3, 11	
Bosnia and Herzegovina	81																11	
Botswana	79																11	
Brazil	53														Road Rehabilitation and Maintenance Project - 2nd Phase ("Share of rural population with access to an all-season Road")		4, 11	
Brunei Darussalam	81																11	
Bulgaria	98																11	
Burkina Faso	25																11	
Burundi	19										24.9					√	1, 3, 11	
Cabo Verde	82																11	
Cambodia	81																11	
Cameroon	20															√	3, 11	
Canada																		
Central African Republic																		
Chad	5															√	3, 11	
Chile	76																11	
China	97														Guiyang Rural Roads Project (P129401) ("Number of people with access to an all-season road")		4, 11	
Colombia	78															√	3, 11	
Comoros	73																11	
Congo	48																11	
Costa Rica	82																11	
Côte d'Ivoire	56															√	3,11	
Croatia	84																11	
Cuba	81																11	

UN Member State (as of January 2019)	RAI published (or calculated, but not yet published)																	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Project-Level	Targeted	Source	Note
Cyprus	89																11	
Czech Republic	97																11	
Democratic People's Republic of Korea	44																	
Democratic Republic of the Congo	26																11	
Denmark	99																11	
Djibouti	81																11	
Dominica	88																11	
Dominican Republic	62																11	
Ecuador	73															√	3, 11	
Egypt	77																11	
El Salvador	64																11	
Equatorial Guinea	53																11	
Eritrea	29																11	
Estonia	86																11	
Eswatini																		
Ethiopia	32										22						1, 11	
Fiji	76																11	
Finland	82																11	
France	99																6, 11	As per IAEG Meeting December
Gabon	45																11	
Republic of The Gambia	77																11	
Georgia	82															√	3, 11	
Germany	89																11	
Ghana	61															√	3, 5, 11	
Greece	90																11	
Grenada	98																11	
Guatemala	55																11	
Guinea	22																11	
Guinea-Bissau	52																11	
Guyana	46																11	
Haiti	28															√	3, 11	
Honduras	40															√	3, 11	
Hungary	98																11	
Iceland	81																11	
India	61																11	
Indonesia	94											√					8, 11	
Islamic Republic of Iran	66																11	
Iraq	58										63.4						1, 11	
Ireland	93																11	
Israel	88																11	
Italy	98																11	
Jamaica	93																11	
Japan	99																11	
Jordan	79						71.4										1, 11	
Kazakhstan	77																11	
Kenya	44			57							56						1, 10, 11	2009 RAI from source 10
Kiribati																		
Kuwait	82																11	
Kyrgyzstan	76															√	3, 11	
Lao People's Democratic Republic	64															√	3, 11	
Latvia	90																11	
Lebanon	87										92.6						1, 11	

UN Member State (as of January 2019)	RAI published (or calculated, but not yet published)														Project-Level	Targeted	Source	Note
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019				
Lesotho	67										18				Lesotho Transport Infrastructure and Connectivity Project		1, 4, 11	
Liberia	66										41.9				Liberia Road Asset Management Project ("Share of rural population with access to an all-season road")	√	1, 4,11	
Libya	78																11	
Liechtenstein																		
Lithuania	97																11	
Luxembourg																		
Madagascar	25											11.4				√	1, 3, 11	
Malawi	38										23.1			64		√	1, 3, 5, 11	
Malaysia	82																11	
Maldives																		
Mali	14											22.3			Rural Mobility and Connectivity Project ("People provided with an all-season road")		1, 4, 11	
Malta	100																11	
Marshall Islands																		
Mauritania	31																11	
Mauritius	70																11	
Mexico	61															√	3, 11	
Federated States of Micronesia	82																11	
Monaco																		
Mongolia	36																11	
Montenegro	74																11	
Morocco	36															√	3, 11	
Mozambique	27				19						20						1, 10	2010 RAI from source 10
Myanmar	23										36			62		√	5, 9, 11	ADB estimates
Namibia	57																11	
Nauru																		
Nepal	17										54			69	Strengthening the National Rural Transport Program (SNRTP) ("Percentage of population within 2 and 4 hours walking distance in the participating terai and hill districts respectively from an all-weather road")	√	1, 4, 5	
Netherlands	100																11	
New Zealand	83																11	
Nicaragua	28										√ **				Rural and Urban Access Improvement Project ("Share of rural population with access to an all-season road")	√	1, 4, 11	
Niger	37																11	
Nigeria	47*								25.5							√	1, 11	
Norway	83																11	
Oman	81																11	

UN Member State (as of January 2019)	RAI published (or calculated, but not yet published)																	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Project-Level	Targeted	Source	Note
Pakistan	61																11	
Palau																		
Panama	77																11	
Papua New Guinea	68																11	
Paraguay	54															√	3, 11	
Peru	43										37.2					√	1, 11	
Philippines	80													√			11	
Poland	95																11	
Portugal	88																11	
Qatar	81																11	
Republic of Korea	89																11	
Republic of Moldova	66															√	3, 11	
Romania	89																11	
Russian Federation	81																11	
Rwanda	52										55.3			√	Feeder Roads Development Project ("Share of Rural Population with Access to an All-Season Road")	√	1, 3, 4, 11	
Saint Kitts and Nevis	89																11	
Saint Lucia	89											56.7 **					1, 11	
Saint Vincent and the Grenadines	97																11	
Samoa	71																11	
San Marino																		
São Tomé and Príncipe	83																11	
Saudi Arabia	75																11	
Senegal	29																11	
Serbia	74																11	
Seychelles																		
Sierra Leone	65											31.5 **				√	1, 3, 11	
Singapore																		
Slovakia																		
Slovenia	95																11	
Solomon Islands	77																11	
Somalia	40										31.2						1, 11	
South Africa	21																11	
South Sudan																		
Spain	95																11	
Sri Lanka	92															√	3, 11	
Sudan	5																11	
Suriname	79																11	
Sweden	86																11	
Switzerland																		
Syrian Arab Republic	49																11	
Tajikistan	74															√	3, 11	
Thailand	33																11	
The former Yugoslav Republic of Macedonia	78															√	3, 11	
Timor-Leste	90	21								49							7, 11	
Togo	22				√												2, 11	
Tonga	86																11	
Trinidad and Tobago	91																11	
Tunisia	39																11	
Turkey	69																11	
Turkmenistan	66																11	
Tuvalu																		

UN Member State (as of January 2019)	RAI published (or calculated, but not yet published)														Project-Level	Targeted	Source	Note
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019				
Uganda	27										53						2	
Ukraine	56																11	
United Arab Emirates	76																11	
United Kingdom of Great Britain and Northern Ireland	96												99.7 **				6, 11	UK ONS
United Republic of Tanzania	38										25			√			2, 11	
United States of America	86												√				11	
Uruguay	84																11	
Uzbekistan	57																11	
Vanuatu	77																11	
Bolivarian Republic of Venezuela	78																11	
Vietnam	84											86				√	3, 12	
Yemen	21																11	
Zambia	64										17						2	
Zimbabwe	65																11	
Total No of Measurements	**172**	**1**	**0**	**1**	**2**	**1**	**1**	**0**	**1**	**1**	**19**	**7**	**2**	**6**	**9**	**36**		
Grand Total Measurements to Date											**No of measurements since 2006 -->**			**214**				
											No of measurements since 2016 -->			**34**				

Sources:

1. Measuring Rural Access Update (WB, 2018)
2. RAI Activities in AfDB Countries (AfDB, 2018)
3. Targeted in WB presentation to IAEG SDGs (2018)
4. Indicators in WB Rural Road Projects (Greenwood, 2018)
5. Calculated under ReCAP RAI TG 2
6. Other
7. Timor-Leste Rural Acces Index Technical Paper (ILO / R4D, 2017)
8. The Relationship between Rural Accessibility and Development (Sosesco, 2016)
9. Myanmar Transport Sector Policy Note (ADB, 2016)
10. World Development Indicators (WB, 2016): http://documents.worldbank.org/curated/en/805371467990952829/pdf/105051-PUB-ADD-DOI-ISBN-PUBLIC-World-Development-Indicators-2016.pdf
11. Rural Access Index (WB, 2006): https://datacatalog.worldbank.org/dataset/rural-access-index-rai
12. Obtained from World Bank Office, Vietnam, November 2019

Notes

* Selected districts only

** Not yet officially published

Annex C: Ghana RAI Analysis

C.1. Introduction

This RAI assessment is based on several visits to Ghana plus additional desktop study and analysis of online data sources. The first visit to Ghana in March 2019 included a kick-off meeting with key stakeholders including the Ministry of Roads and Highways, Department of Feeder Roads, and Ministry of Transport, and a meeting with Ghana Statistical Services (GSS). Staff from the Ghana Feeder Roads Department attended a Rural Access workshop in Malawi in September 2019 under this project, in order to gain insight into calculation of RAI in other countries. A further visit to Ghana was conducted in September 2019, which included field trips to several rural roads in order to develop accessibility factors for RAI calculation.

There are several ongoing assistance projects in Ghana. The Kwame Nkrumah University of Science and Technology (KNUST) is being funded by World Bank to research rural access. GSS is also receiving assistance from the UK Office of National Statistics (UK-ONS) for measurement of the SDGs, and have a dedicated department for that purpose. Training is also being provided by NASA (National Aeronautics and Space Administration) on use of geospatial techniques.

C.2. RAI Calculation for year 2019

It had been hoped to calculate RAI for Ghana under this project, using road network mapping data to be provided by relevant agencies in-country. The Ministry of Roads and Highways, and Department of Feeder Roads did provide some mapping data, however they were unable to provide associated surface type information which is an important attribute for determining RAI. Also, although GSS confirmed that the definition of 'urban' in Ghana applies to settlements with over 5,000 people, it was not possible to obtain any mapping of such settlements. It was therefore not possible to measure RAI for Ghana during TG2 using country provided data.

Instead, RAI has been estimated at 63% using a combination of OpenStreetMap (OSM), WorldPop, and the Global Urban Rural Mapping Project (GRUMP) urban extent polygons. The absolute number of people living more than 2 km away from an all-season road is estimated at 7,120,000.

OSM data represents 28,353 km of classified road network, while official statistics (Ghana Government Statistics Medium Term Expenditure Framework, 2016) identify 14,873 km of trunk roads and 42,054 km of feeder roads. Therefore, it is believed that some areas of the country are under-represented in OSM, which would imply that the RAI is higher than the 63% estimated here.

C.3. RAI Embedment Assessment

Figure C.1 shows an assessment of the embedment of RAI within the relevant agencies in Ghana and their capacity to calculate and publish the Rural Access Index (RAI) (SDG 9.1.1) going forward. In general, the higher the score, the better the readiness for RAI embedment.

Figure C.1 – Ghana RAI Embedment Assessment

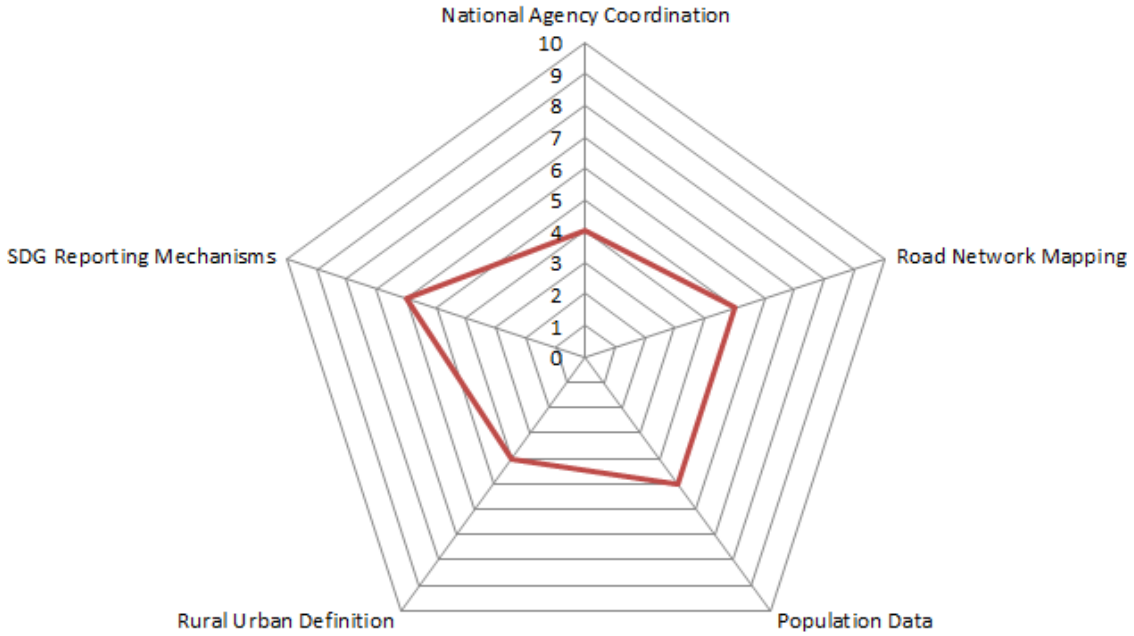


Table C.1 discusses the assessment under each of the categories shown in Figure C.1, and gives some recommendations for improvement in the process of calculating RAI going forward.

Table C.1 - Assessment and Recommendations

Criteria	Score
National Agency Coordination	**4**
• Interagency working and agreement among NSO, Roads Agencies, Survey Depts etc. There appears to be little formal working yet among the different the roads agencies (GSS, DOH, DFR) with respect to the definition or reporting of the RAI under the SDGs. According to the Ghana SDG reporting platform, the data sources for this SDG 9.1.1 have not yet been explored (as of November 2019).	
• Data Publication and Sharing Policy A geonode Ghana Road Network (main roads) managed by the World Food Program has been identified, however this appears to be simply a snapshot of data from OSM from 2016. Other geonodes as the geonode established by the Ghana EPA (Environmental Protection Agency) exist, however the only roads data sets published are "of unknown origin" from 2016, and there do not appear to be any contributors from the Department of Highways. The Ghana Open Data Initiative and Ghana Open Data for Africa contain some data published by national and local government agencies, however none of these sites appears to contain spatial data. No other official government data sharing platforms have been identified with spatial data of the road network or urban/rural boundaries.	
• Data Publication and Sharing Practice More cooperation of agencies to share their data via geonodes or other platforms is important to ensure consistency of reporting and to avoid duplication of various mapping efforts. It has not been possible to obtain definitive mapping of urban areas from GSS, nor definitive mapping of the road networks with the surface type attributes necessary to calculate RAI.	
Road Network Mapping	**5**
• Road network mapping consistent with official published statistics Official Ghana Government Statistics (2016 MTEF) report 56,927 km of trunk and feeder roads, while all mapping provided in-country provided in 2019 amounted to only 54,183 km, showing a difference of 2,744 km. Most of that difference is in the trunk road network.	
• Coordinated mapping across agencies No significant overlaps or gaps between trunk road and feeder road networks have been identified, although there are areas where it is suspected that some roads are missing when compared with satellite data.	
• Correlation with other online data sources e.g. OpenStreetMap The OSM classified network (Trunk, Primary, Secondary, Tertiary) is significantly shorter than either the published statistics or available mapping. OSM classified length is 28,353 km (versus the 56,927 km of official statistics for the trunk and urban roads).	
• Correlation with available imagery There are areas where it is suspected that some roads are missing when compared with satellite data.	
• Clear definition and procedures for "all-season roads"	

An exercise to define Accessibility Factors for Ghana was carried out in selected districts in September 2019 as a trial, and was intended to be extrapolated to the rest of the country, however no feedback from Department of Feeder Roads on the extrapolation had been obtained by the time of writing this report.	
Population Data	**5**
• Is census data geo-referenced? It is not known whether population census data from 2010 was georeferenced. The next population census is scheduled for 2020.	
• Is population data available spatially on a website? Projected population data is available by regional map on the Ghana Statistical Service website, and at various levels of granularity on the Ghana Open Data Initiative and Ghana Open Data for Africa sites, however none of these appear to be downloadable.	
• Engagement with World Pop Current published WorldPop dataset for Ghana is based on CIESIN dataset and projections used for GPWv4, which estimated Ghana population in 2019 at 32,048,205 which is similar to most online estimates. However, it is recommended that GSS engage with World Pop after the 2020 census to ensure that data is reconciled to sub-national levels and published via WorldPop.	
Rural Urban Definition	**4**
• Is official definition clearly visible on website? GSS has indicated that any settlement of over 5,000 in Ghana is classed as "urban", however it was not possible to locate any definition on the GSS website. It is also noted that, applying the GRUMP boundaries to WorldPop data, the proportion of rural population is calculated at 61%, while Ghana Country Stats website indicates that rural proportion is 49% of the total.	
• Is it available and published spatially in-country? Could not locate any published mapping for such dataset.	
• Is it clearly understood and used by roads agencies for "rural" statistics? Not clear	
• Is it clearly understood and used for other statistical purposes? Not clear	
SDG Reporting Mechanisms	**6**
• Is there an existing SDG Reporting Mechanism? The National Development Planning Commission (NDPC) coordinates the SDG framework in Ghana, and has established a SDG Technical Committee.	
• Is there an existing SDG Reporting Platform? There is an existing SDG Reporting Platform although it does not reflect the current status of SDG 9.1.1 (SDG 9.1.1 was promoted to Tier II in January 2019, but is still reported as Tier III in November 2019).	

- Is RAI published as part of the SDG Reporting Platform?

  No. According to the SDG Indicator Baseline Report (2018), Ghana appears to be focusing on Tier I and Tier II indicators. Although RAI was promoted to Tier II in January 2019, Ghana does not appear to have progressed in developing or calculating the indicator, apart from the efforts made under this project.

Annex D: Malawi RAI Analysis

D.1. Introduction

This RAI embedment assessment is based on two visits to Malawi plus additional desktop study and analysis of online data sources. The first visit to Malawi was a fact-finding trip conducted in March 2019, and consisted of several meetings with Malawi Roads Authority, Ministry of Transport and Department of Surveys in Lilongwe, and the National Statistics Office in Zomba. The second visit in September 2019 included a workshop with the above agencies plus the Roads Fund Administration and Ministry of Local Government in Malawi; the workshop also included representatives from the Department of Feeder Roads in Ghana. Both visits included field trips to rural areas to get an understanding of the condition and maintenance of different classes of rural roads.

Section D.2 presents the RAI calculation RAI for Malawi for 2019. RAI is calculated as 63.1%, with 5,550,800 people in rural areas living further than 2 km from the nearest all-season road. However, there are some caveats and assumptions on this calculation as documented in Table D. 1, which should be addressed for future calculations of RAI.

Section D.3 is an assessment of the capacity among the different agencies to calculate and publish RAI in future. The summary assessment is that the skills and capacity already exist across the different organisations involved. Full embedment of RAI would require improved coordination in management of the definition and reporting processes, and explicit use of RAI as an indicator in the Malawi Growth and Development Strategy (MGDS).

The main recommendation is that this calculation should be sent by the National Statistics Office to the World Bank RAI team as the custodian of SDG 9.1.1, endorsing this calculation for publication as part of Malawi's SDG reporting.

D.2. RAI Calculation for year 2019

RAI for Malawi for 2019 is calculated at 63.1% as shown in Table D. 1.

Table D. 1 - RAI for Malawi 2019

Metadata Tag	Value
Rural Access Index	
RAI Value:	*63.1*
Rural population not within 2 km of an all-season road:	*5,550,800*
Level:	*National*
Date:	*2019*
Administrative Boundary	
Source:	*FAO Global Administrative Unit Layers (GAUL) dataset*
Date:	*2015*
Total Area (km^2):	*119,000*
Population	
Source:	*WorldPop individual countries data set*
Date:	*2019*
Total population:	*17,907,783*
Total rural population:	*15,031,498 (based on Urban / Rural boundaries of Dept of Surveys)*
% of rural population:	*83.9%*
Notes:	• *WorldPop 2019 projection derived from 2008 national census reconciled at national level* • *NSO has engaged with WorldPop to review WorldPop data against the recent 2018 national census. This work has allowed TRL to use population data from the 2018 census to conduct sensitivity analysis on the RAI using different WorldPop models and different sets of urban/rural boundaries. However, the calculation of RAI here is based on 2008 census projected to 2019.*
Urban / Rural Boundary	
Source:	*Department of Surveys / MASDAP*
Date:	*March 2015*
No of Urban Areas:	*30*
Total Urban Area (km^2):	*1,145*
Total Rural Area (km^2):	*118,015*
Notes:	*Urban areas defined as 4 cities and 26 towns.* *No changes made to urban/rural boundaries since 2015.*
Road Network	
Source(s):	*Malawi Roads Authority*
Date:	*July 2019*
Total Length (km):	*Total: 12,457*
Classification:	*Main: 3,357* *Secondary: 3,125*

Metadata Tag	Value
Surface Type:	*Tertiary:* *1,121* *District:* *3,506* *Urban:* *1,348* *Paved:* 4,073 *Unpaved:* *7,836*
Notes:	• *World Bank estimate of 23.1% for RAI in 2016 was based essentially on paved roads in good condition. From workshops and field observations, most of the gazetted unpaved network should also be regarded as "all-season". This 2019 calculation of RAI is based on the 12,457 km of data as described above (and applying accessibility factors as described below).* • *Official road network length is 15,451 km, therefore at least 2,994 km is likely missing from above data and should be identified and included in future RAI calculations.* • *Based on field observations and workshops, it is likely that several thousand additional km of mainly unpaved roads are providing an important rural access function and should therefore be included in future RAI calculations. TRL has made recommendations for MRA to coordinate with Roads Fund Administration, Dept of Surveys and NGOs to consolidate this data and upload to OpenStreetMap, and to perform additional ground-truthing so that this network can be published and made available to all agencies and NGOs in Malawi, and for future statistical purposes including RAI.*
Accessibility Factors	• *MRA does not typically conduct condition surveys of unpaved roads, and does not track which roads are passable/impassable at different times of year. Instead, accessibility factors for unpaved roads were determined for each District. MRA produced hardcopy maps of national roads in each District, and asked District Engineers to identify those roads which were deemed to be not all-season (i.e. which were likely to have been impassable for more than 7 days in the last year). The lengths of the identified roads were determined in relation to the total unpaved network in the District, and Accessibility Factors were calculated and applied as follows.* • *As per workshop and responses from MRA District Engineers in September 2019:* o *Paved roads: all paved roads assumed to be accessible all-year round* o *Unpaved roads: See table below. All other Districts were assigned Accessibility Factors of 1 for the Unpaved Gazetted network).*

Metadata Tag	Value
	Accessibility Factors for Unpaved Roads:

District	Total Length (Unpaved)	Length of Roads All-Season	Length of Roads Not All-Season	Accessibility Factor
Chikwawa	442	83	359.2	0.19
Mulanje	201	97	103.9	0.48
Nsanje	236	164	71.6	0.70
Thyolo	323	110	213.0	0.34

Mapping Projection	
Mapping Projection:	*UTM Zone 36 S*

D.3. RAI Embedment Assessment

Figure D.1 shows an assessment of the embedment of RAI within the relevant agencies in Malawi and their capacity to calculate and publish the Rural Access Index (RAI) (SDG 9.1.1) going forward. In general, the higher the score, the better the readiness for RAI embedment.

Figure D.1 - Malawi RAI Embedment Assessment

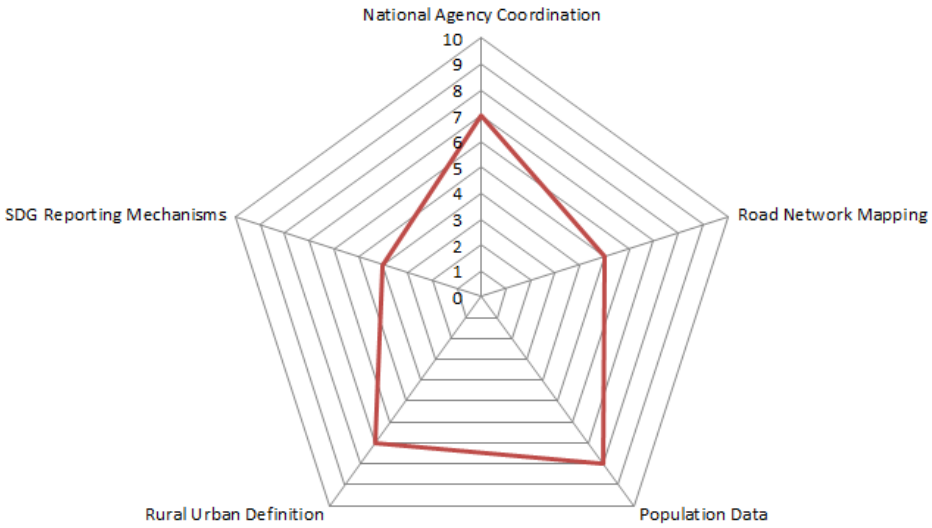


Table D.1 discusses the assessment under each of the categories shown in Figure D.1, and gives some recommendations for improvement in the process of calculating RAI going forward. The summary assessment is that:

> *"The skills and capacity exist across the different organisations involved. Full embedment of RAI would require improved coordination in management of the definition and reporting processes, and explicit use of RAI as an indicator in the Malawi Growth and Development Strategy (MGDS)".*

Table D.1 - Assessment and Recommendations

Criteria	Score
National Agency Coordination	**7**
• Interagency working and agreement among NSO, Roads Agencies, Survey Depts etc. Ministry of Transport and Public Works, Malawi Roads Authority, National Statistics Office, Surveys Department and Roads Authority recognise the need for cooperation in the definitions, publication and reporting of RAI. More formal reporting procedures and inclusion of RAI under existing MOT/NSO Technical Working Group is needed for full embedment of RAI.	
• Data Publication and Sharing Policy There are a number of online data sharing platforms, including MASDAP established and maintained by the National Spatial Data Centre in the Department of Surveys, under the Open Data for Resilience (OpenDRI) initiative. The Malawi Land Act 2016 empowers the Malawi Geographic Information Council (Magic) to coordinate acquisition and sharing of geoinformation among producers and users and to encourage the development of a National Spatial Data Infrastructure (NSDI).	
• Data Publication and Sharing Practice More awareness among agencies, and cooperation to share their data via MASDAP or other platforms is important to ensure consistency of reporting and to avoid duplication of various mapping efforts.	
Road Network Mapping	**5**
• Road network mapping consistent with official published statistics GIS mapping available from Malawi Road Authority is reasonably consistent with official statistics for the National Road Network although there are some observed discrepancies, also some recently completed major roads are not included in either official statistics or mapping. There is no official mapping or inventory of roads outside the national network, some of which are maintained by MRA, and some of which are managed through NGO agreements.	
• Coordinated mapping across agencies Some effort would be required to fully reconcile mapping and official road network statistics, for the gazetted and non-gazetted network. TRL recommends that some of the non-gazetted network be included for purposes of RAI. Road Fund Administration may be able to assist to coordinate activities of NGOs.	
• Correlation with other online data sources e.g. OpenStreetMap The OSM classified network (Trunk, Primary, Secondary, Tertiary) corresponds reasonably well with MRA mapping data for the gazetted network, although there are some discrepancies. In some cases, OSM is more up-to-date. TRL recommends reconciliation and proper tagging of national road network in OSM. TRL recommends review of the non-gazetted network in OSM as part of a future OSM mapping effort.	
• Correlation with available imagery TRL recommends review of the non-gazetted network against available satellite imagery.	

• Clear definition and procedures for “all-season roads” This project piloted accessibility factors for unpaved roads. There is general agreement that these can be used for purposes of RAI calculation, although that decision should be formally approved as part of the national statistical system and upon approval of the RAI (SDG 9.1.1) custodian.	
Population Data	**8**
• Is census data geo-referenced? Yes, Malawi population census from 2018 is georeferenced	
• Is population data available spatially on a website? MASDAP contains district-level maps of population data, as provided by Malawi National Statistics Office. Maps of population by enumeration area are available from NSO, however have not been published on MASDAP.	
• Engagement with World Pop Malawi NSO engaged with World Pop in 2019 with a view to endorsing World Pop as a source of data for RAI, and provided district-level mapping to enable better granularity on World Pop generated data. Reconciliation at the level of enumeration area would be preferred.	
Rural Urban Definition	**7**
• Is official definition clearly visible on website? Could not find definition available on Malawi NSO website or in any of the various publications there, required meeting with NSO to determine the definition.	
• Is it available and published spatially in-country? Available upon request from Department of Surveys, only recently published on MASDAP website.	
• Is it clearly understood and used by roads agencies for “rural” statistics? Unknown	
• Is it clearly understood and used for other statistical purposes? Unknown	
SDG Reporting Mechanisms	**4**
• Is there an existing SDG Reporting Mechanism? NSO currently reports on SDGs	
• Is there an existing SDG Reporting Platform? No	
• Is RAI published as part of the SDG Reporting Platform? No	

Overall Assessment
The skills and capacity exist across the different organisations involved. Full embedment of RAI would require improved coordination in management of the definition and reporting processes, and explicit use of RAI as an indicator in the MGDS. RAI is not explicitly used as an accessibility indicator in current Malawi Growth and Development Strategy (MGDS), however the Ministry of Transport indicated willingness to use it if a clear methodology can be agreed among the different national agencies.

D.4. Sample Unpaved Roads in Malawi

Figure D.3 shows some sample unpaved roads in Malawi, taken during a field trip in September 2019. They demonstrate the passability of these classified roads at that time of year, and discussions with District Engineers of the Malawi Roads Authority confirmed that they remained passable all-year round and therefore warranted inclusion in the RAI. The photographs also show some unclassified roads in the vicinity which *might* also be deemed all-season, although these have not been included in the RAI measurement at this time because of concerns on the quality and coverage of the mapping.

Figure D.3- Sample unpaved roads in Malawi

Annex E: Myanmar RAI Analysis

E.1. Introduction

This RAI assessment is based on three visits to Myanmar in 2019 plus additional desktop study and analysis of online data sources. The first visit to Myanmar was a fact-finding trip conducted late February/early March 2019 and included meetings with the counterpart agency Department of Rural Development (DRD). A second visit to Myanmar in June 2019 included a visit to the Central Statistics Organisation (CSO) in Naypyidaw, and field visits to some rural roads. Mapping of the DRD and MOBA networks was obtained at that time from DRD. A third visit in September 2019 included further discussions with DRD and review of Department of Highway network data obtained from the Myanmar Information Management Unit (MIMU) geonode.

Section E.2 gives some background on accessibility calculations in Myanmar to date, and the status of SDGs in general.

Section E.3 presents an RAI estimate for Myanmar for 2019. RAI is estimated at 62.2%, although there are many caveats and assumptions in this calculation as documented below.

Section E.4 is an assessment of the capacity among the different agencies to calculate and publish RAI in future.

Section E.5 gives recommendations on calculation, publication and inclusion of RAI as part of the Myanmar national statistical system and SDG reporting framework.

E.2. Background

The Myanmar Sustainable Development Plan (2018-2030) (Ministry of Planning and Finance (MOPF)) expresses the national development vision, and lists several goals and pillars with associated indicators. It aligns the MSDP action plans with global SDG targets. It relates these indicators to the SDGs, although SDG 9.1.1 (RAI) is not explicitly included.

There are various analyses of rural access available, but none directly equivalent to RAI itself. The Myanmar National Strategy for Rural Roads and Access (Government of the Republic of the Union of Myanmar, 2017) reports an indicator "percentage of rural population in villages connected by all-season rural road or higher level road" at 58% in 2016. It may be similar in intent to RAI, but refers to "rural population in villages", and does not include the 2 km threshold.

The Myanmar Transport Sector Policy Note (ADB, 2016) estimates "RAI" at 36%, with 24 million people living more than 2 km away from an all-season road. This estimate was based on a "village access model", but the actual methodology is not described.

Regarding the SDGs in general, there have been several recent assessments and reports, including 'Readiness of Myanmar's Official Statistics for the Sustainable Development Goals – Joint data assessment by the Central Statistical Organization and UNDP (CSO & UNDP, 2016)'; and 'Measuring Myanmar's starting point for the Sustainable Development Goals – SDG

Indicator Baseline Report (CSO & UNDP, 2017)'. The CSO is part of the MOPF. These reports identify that of the 250 indicators in the SDGs, only 44 are produced and readily available at the national level.

MOPF continues to plan for the implementation of the SDGs, as evidenced by recent workshops (May, 2019).

E.3. RAI calculation for year 2019

E.3.1. Analysis and metadata

RAI for Myanmar for 2019 is estimated at 62.2% as shown in Table E.1.

Table E.1 - RAI for Myanmar 2019

Metadata Tag	Value
Rural Access Index	
RAI Value:	*62.2%*
Rural population >2 km of an all-season road:	*14,018,463*
Level:	*National*
Date:	*2019*
Administrative Boundary	
Source:	*FAO Global Administrative Unit Layers (GAUL) dataset*
Date:	*2015*
Total Area (km^2):	*676,578 km^2*
Population	
Source:	*WorldPop individual countries data set*
Date:	*2019*
Total population:	*48,801,992*
Total rural population:	*37,055,003 (based on Global Rural Urban Mapping Project (GRUMP) database)*
% of population that is rural:	*75.9%*
Notes:	• *WorldPop 2019 projection derived from 2014 National Population and Housing Census.* • *Official 2014 Myanmar Census indicates 29.6% of the population is urban (i.e. 70.4% rural)*
Urban / Rural Boundary	
Source:	*Global Rural Urban Mapping Project (GRUMP)*
Date:	*1995*
No of Urban Areas:	*230*
Total Urban Area (km^2):	*9,653 km^2*
Total Rural Area (km^2):	*666,924 km^2*
Notes:	-

Metadata Tag	Value
Road Network Source(s):	*Department of Highways (DOH) mapping was obtained from the Myanmar Information Unit geonode; all other mapping obtained from Department of Rural Development (DRD).*
Date:	*July 2019*
Total Length (km): Classification:	*Total: 78,309* *DOH: 42,104 (all surfaces – no surface type info available)* *DRD: 34,002 (cement/bituminous/macadam/gravel only)* *MOBA: 2,203 (cement/bituminous/macadam/gravel only)*
Notes:	• *Myanmar Transport Sector Policy Note (ADB, 2016) estimates RAI at 36%, with 24 million people living more than 2 km away from an all-season road. These estimates were based on a village access model and an all-season road length of 73,503 km.* • *The Myanmar National Strategy for Rural Roads and Access (Government of the Republic of the Union of Myanmar, 2017) reports an indicator "percentage of rural population in villages connected by all-season rural road or higher level road" at 58% in 2016.* • *The RAI figure estimated here 2019 is 62%, with 14 million people, based on an all-season road length of 78,309. This figure seems compatible with the 2017 Government of Mynamar report, although there are a number of caveats associated with this analysis.* • *For purposes of this 2019 RAI estimation, all cement, bituminous, macadam and gravel roads were included in the analysis (no surface type information was available for Department of Highways roads, therefore all were included, although 4,492 km of those are reported as being earthen, which would be a very similar length as used in the ADB policy note). DRD indicated in 2019 that all "earth" roads should be regarded as "not all-season" as per RAI (i.e. not motorable for >7 days per year), and that all other roads should be regarded as "all-season".* • *Table 2 identifies the data sources considered, and identifies the particular subsets of roads used for RAI calculation in 2019. According to official statistics (2016), there are 68,030 km of roads which can be considered all-season, while 78,309 km were used for this analysis. As stated above, for the DOH network 4,492 km of earthen roads were included in this analysis, while mapping provided for the DOR all-season network is 10,340 km longer than official statistics (34,002 km v. 23,662 km); and the mapping provided for the MOBA all-season network is 7,054 km shorter than official statistics (2,203 km v. 9,257 km).* • *There are several important data quality issues identified in available mapping, as explained below.*

Metadata Tag	Value
Accessibility Factors	• *Accessibility Factors were not used for this calculation. It is important to reconcile and correct issues in the available mapping first, before looking to calculate and apply accessibility factors.*
Mapping Projection Mapping Projection:	*UTM Zone 46 N*

Table E.2: Road Network Mapping Data Selection

National Strategy for Rural Roads and Access (Myanmar, 2016)						Mapping Data provided for relevant agencies 2019					Recommendations for RAI	
Agency	Cement / Bituminous	Macadam / Gravel	Earthen	Total (km)	(Cement / Bituminous / Macadam / Gravel)	Cement / Bituminous	Macadam / Gravel	Earthen	Not specified	Total (km)	Layers to use	Length of all-season network
DOH [a]	27,806	7,305	4,492	**39,603**	**35,111**	-	-	-	42,104	**42,104**	Entire DOH layer	**42,104**
DRD [b]	4,534	19,129	52,223	**75,885**	**23,662**	23,990	10,012	70,228	70,823	**175,053**	Use Paved DRD layers	**34,002**
MOBA [c]	1,402	7,855	10,551	**19,808**	**9,257**	966	1,237	1,313	526	**4,042**	Use Paved MOBA layers	**2,203**
Total	**33,741**	**34,289**	**67,266**	**135,296**	**68,030**					**221,199**		**78,309**

a. Source: MMR_CSO, Statistical Yearbook, 2018. DOH mapping data obtained from **Myanmar Information Unit** geonode.

b. Source: National Strategy for Rural Roads and Access (Government of the Union of the Republic of Myanmar, 2016). DRD mapping data obtained from DRD September 2019, and cleansed by removing clear duplicates of DOH and MOBA networks, however many other duplicates remain.

c. Source: National Strategy for Rural Roads and Access (Government of the Union of the Republic of Myanmar, 2016). MOBA mapping data obtained from DRD September 2019.

E.3.2. Some mapping issues and their implications for RAI

The analysis above discusses some issues on the road network mapping data for Myanmar which make it difficult to estimate RAI with much degree of certainty (primarily because of the inclusion of 4,492 km of earthen roads on the DOH network, and the omission of 7,054 km of MOBA roads).

However, there are many other issues in the mapping, which will also have impacts on RAI in different ways, as described below in Figures E.1 through E.8.

Duplication of mapping data across roads agencies, for example, will have no impact on RAI because *the methodology identifies rural population living within 2 km of a road (any road)*.

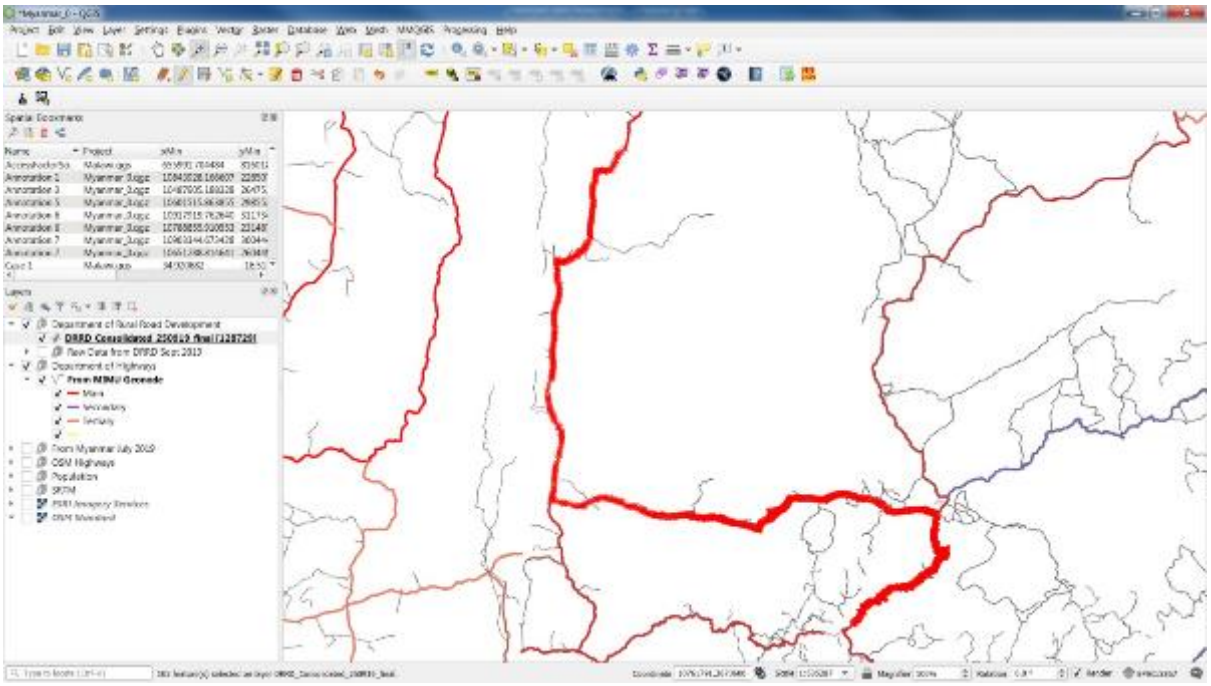
There are also significant differences between the quality and accuracy of the mapping in different areas of the country, and on different road networks. It is apparent that some areas and road networks have been digitised based on GPS survey, while others have been digitised from imagery. There would appear to be some quality control on some of the GPS data, *which would cause localised issues in RAI calculation in the sense that the methodology will pick up incorrect population data as within 2 km of the road. It is difficult to quantify the impact on RAI at this point.*

It is also apparent (and as highlighted by DRD) that some road network mapping is missing. Some missing roads may be due to the peace and order situation, but also as seen in some examples below, roads appear to have been digitised from imagery in some areas but not in others. *Any missing roads will cause RAI to be significantly underestimated in the areas affected.*

It would take many weeks or months to consolidate, analyse and rectify all of the issues with in-country cooperation, it would require involvement of several relevant agencies, and it is not clear at present which agency would take the lead in such an effort. Accurate and consolidated road network mapping is important for any country from an asset management perspective first-and-foremost, then for planning, and thereafter for statistical accuracy.

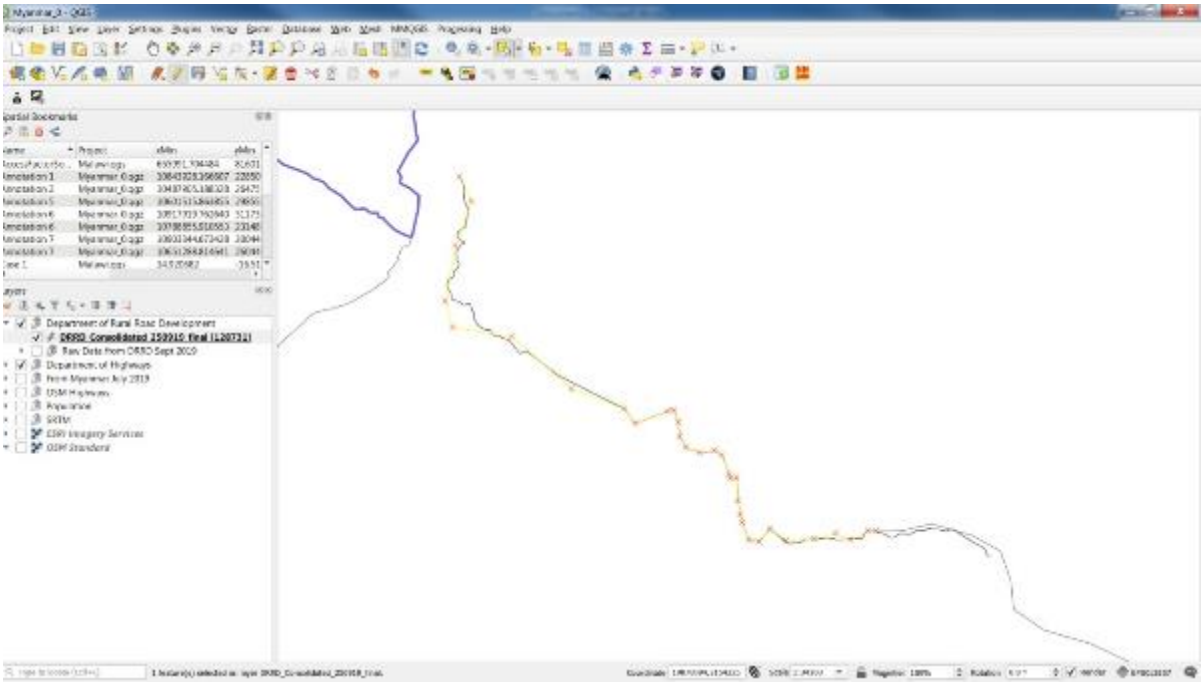
RAI can be estimated using the available data as described here, however the overall confidence level in the RAI value is classed as **low** given the issues identified.

Figure E.1: Some Data Quality Issues (1)



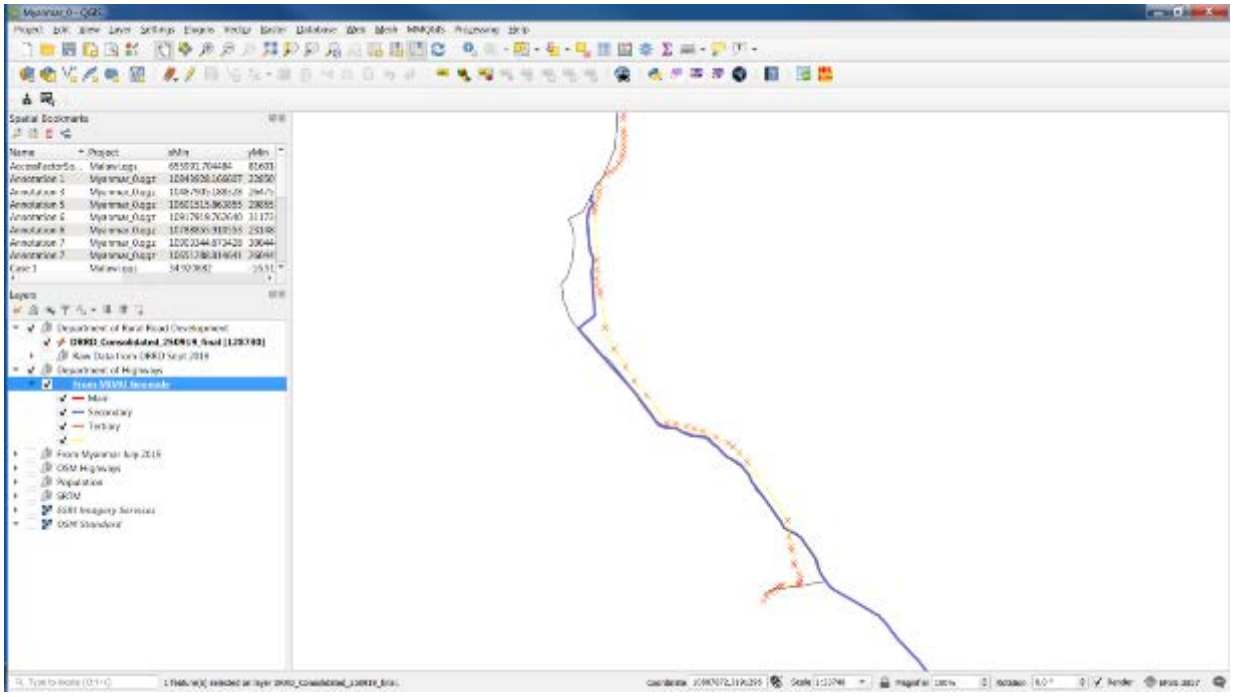
100+ km of road centreline duplicated in the Main road network and the Rural Road network (the road in the centre of the screenshot, highlighted as thick red).

Figure E.2: Some Data Quality Issues (2)



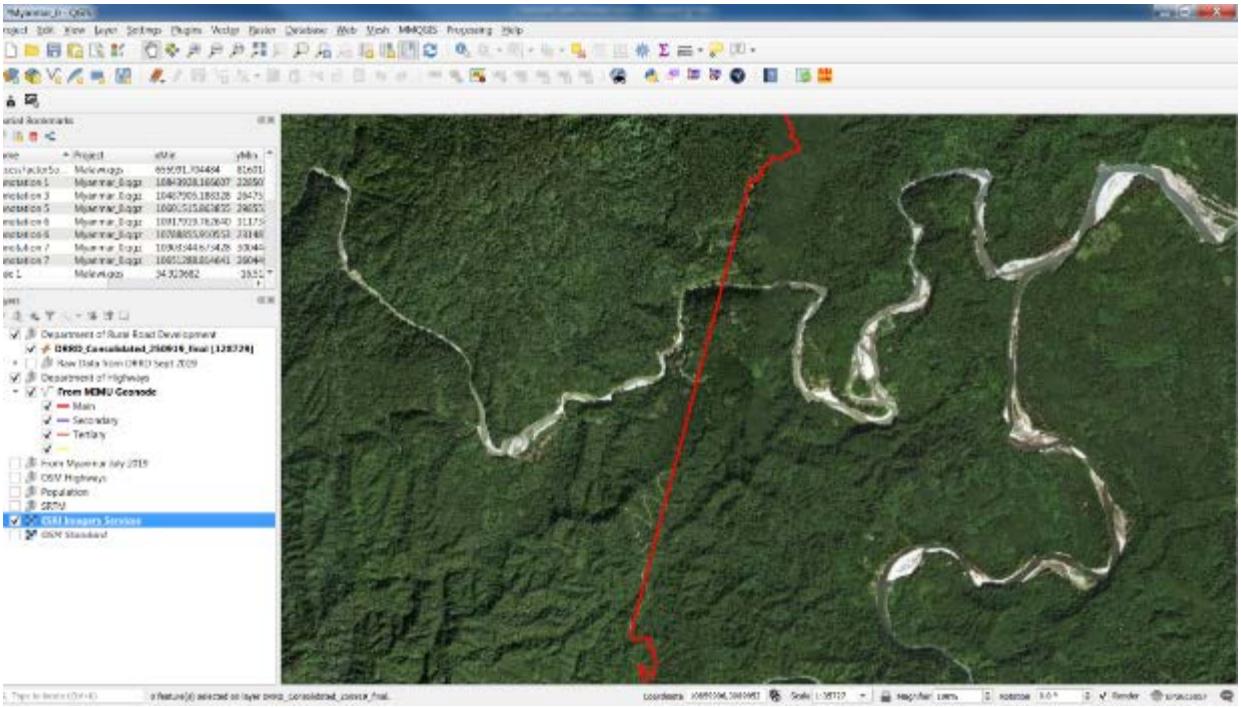
Two (2) Rural Roads side-by-side (within 10 metres of each other). Clearly these are representations of the same road.

Figure E.3: Some Data Quality Issues (3)



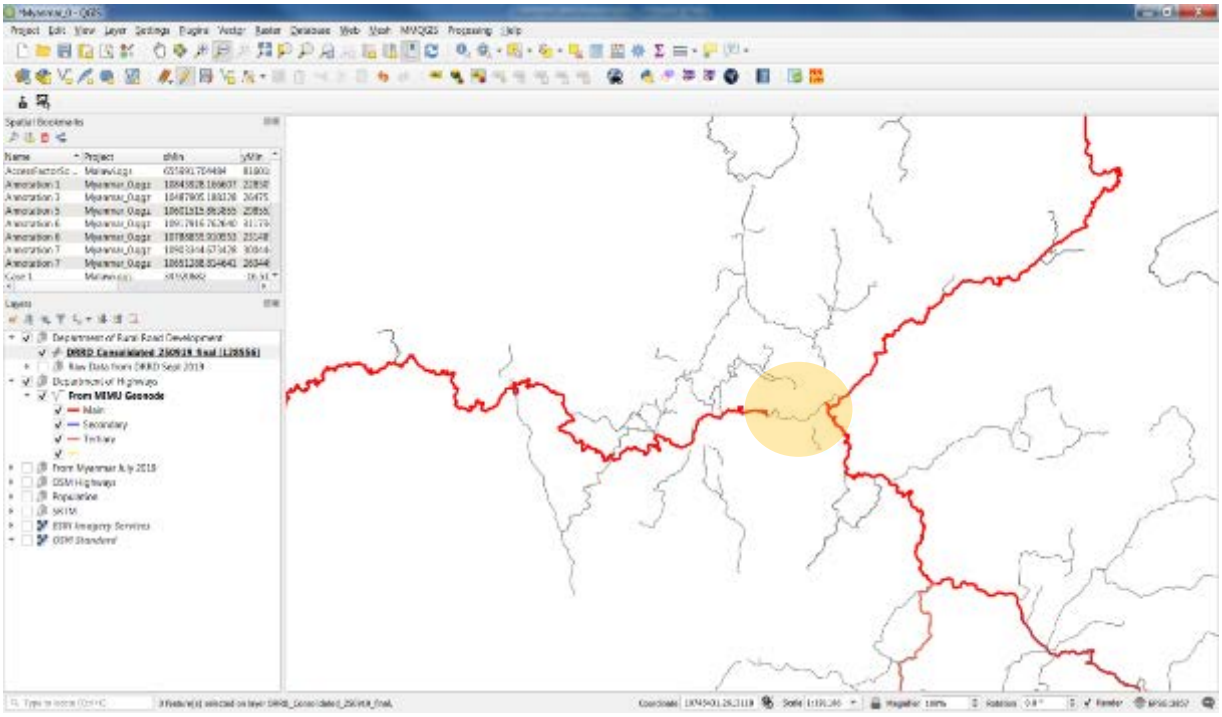
Three (3) roads side-by-side – a Main Road, plus two representations of the same rural road.

Figure E.4: Some Data Quality Issues (4)



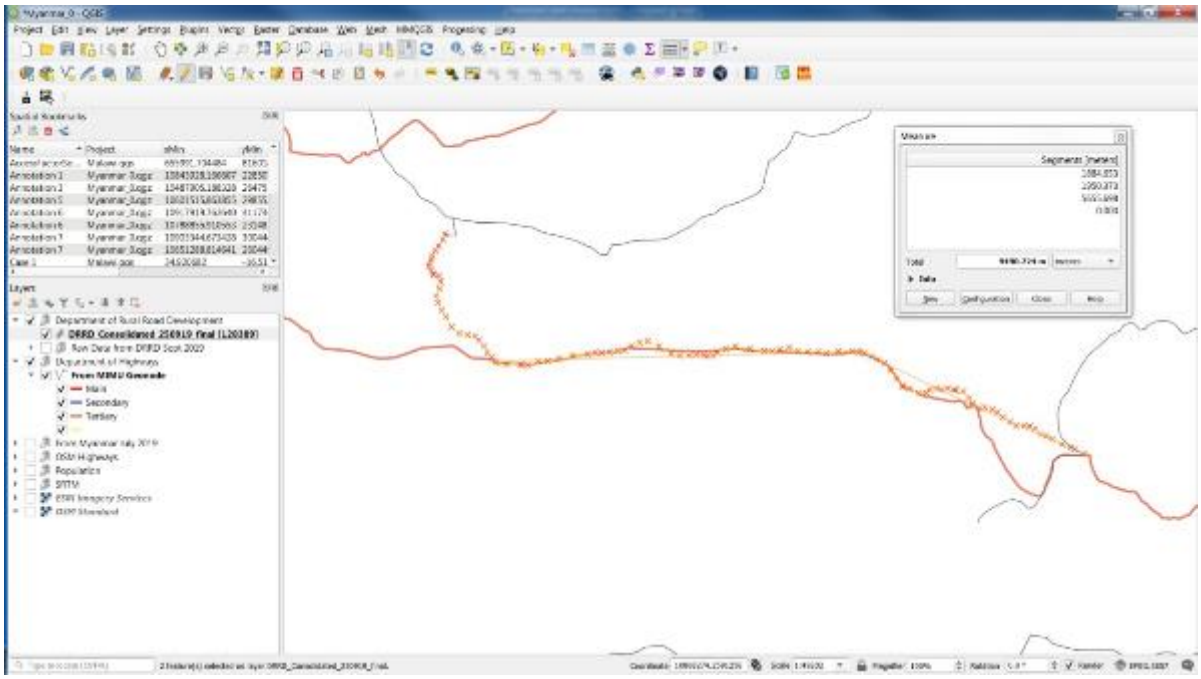
A 5 km “gap” in GPS data, connected by a straight line, with the actual alignment clearly shown on the image.

Figure E.5: Some Data Quality Issues (5)



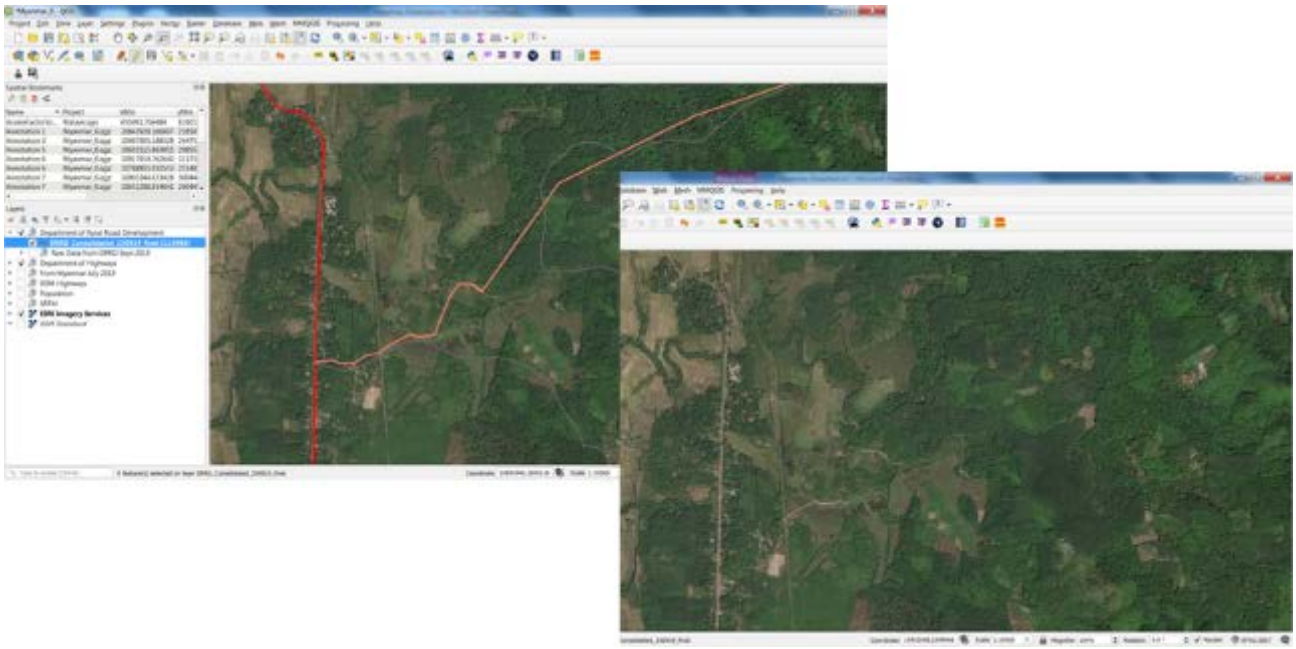
Likely the shaded area below is part of the Main Road network, but is not shown on the Main Road network map (although is classed as a Rural Road).

Figure E.6: Some Data Quality Issues (6)



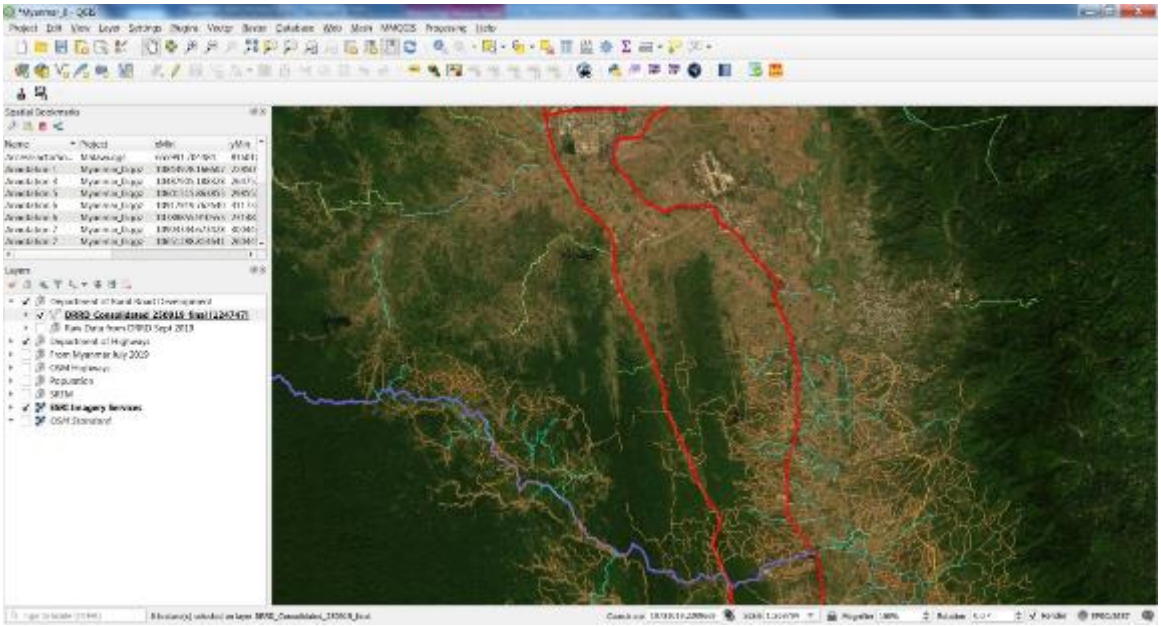
Duplicate of around 10 km between Rural roads and the Main road. Alignments are very different, one looks to have been the result of a GPS survey, the other digitised from imagery at a low resolution.

Figure E.7: Some Data Quality Issues (7)



In some areas, both the Rural Road and National Road alignments seem at odds with satellite imagery, and the true representation may be a combination of both.

Figure E.8: Some Data Quality Issues (8)



Implies that road network data has been digitised from imagery, there is a dense road network on the bottom portion of the image, but not on the top portion, likely caused by digitisation from the map tile in the south but not the north.

E.4. RAI embedment assessment

Figure E.9 shows an assessment of the embedment of RAI within the relevant agencies in Myanmar and their capacity to calculate and publish the Rural Access Index (RAI) (SDG 9.1.1) going forward. In general, the higher the score, the better the readiness for RAI embedment.

Figure E.9: Myanmar RAI Embedment Assessment

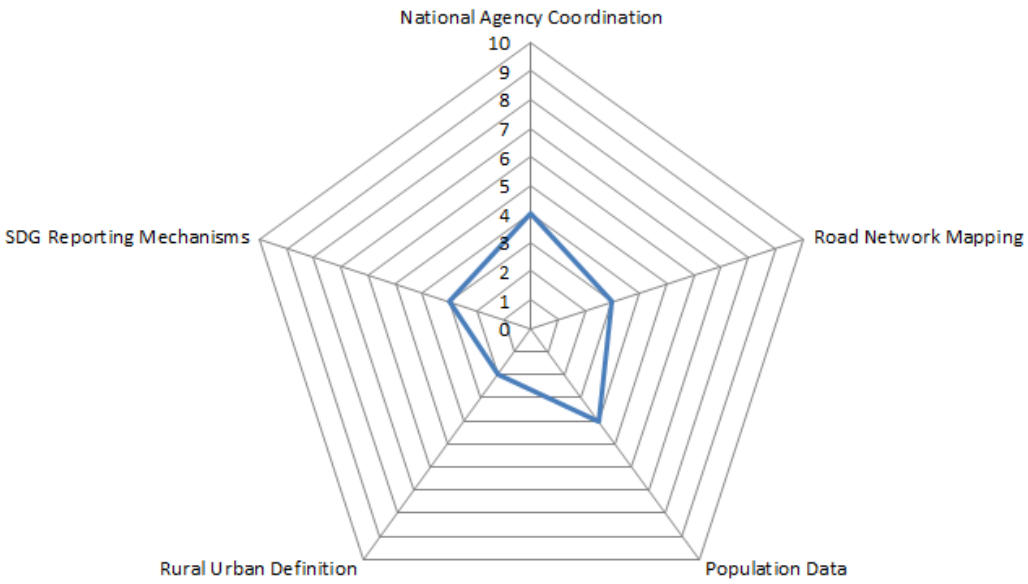


Table E.2 discusses the assessment under each of the categories shown in Figure E.9, and gives some recommendations for improvement in the process of calculating RAI going forward.

Table E.2 - Assessment and Recommendations

Criteria	Score
National Agency Coordination	**4**
• Interagency working and agreement among NSO, Roads Agencies, Survey Depts etc. There appears to be little formal working among the different the roads agencies (MOPF, DOH, DDR, MOBA) with respect to the definition or reporting of the RAI under the SDGs.	
• Data Publication and Sharing Policy There is an online data sharing platform, the *Myanmar Information Management Unit (MIMU)* geonode, which provides information management services to strengthen analysis and decision-making of the humanitarian and development community in Myanmar. However, the MIMU comes under the direct management of the United Nations Resident and Humanitarian Coordinator. All services provided are free of charge, as a result of support from Government of Canada, DFID, and UNDP. No official government data sharing platforms containing spatial data have been identified.	
• Data Publication and Sharing Practice More cooperation of agencies to share their data is important to ensure consistency of reporting and to avoid duplication of various mapping efforts, to assist in reconciliation of apparently overlapping datasets, and to improve planning in general.	
Road Network Mapping	**3**
• Road network mapping consistent with official published statistics As indicated in discussions above, there are significant anomalies, overlaps and omissions between the official statistics and available mapping.	
• Coordinated mapping across agencies Significant effort would be required to fully reconcile mapping and official road network statistics, for the different road networks. Ministry of Construction should take the lead in such an effort.	
• Correlation with other online data sources e.g. OpenStreetMap The OSM classified network (Trunk, Primary, Secondary, Tertiary) is significantly shorter than either the published statistics or available mapping. OSM length is 45,283 km (versus the 78,309 km used in this analysis).	
• Correlation with available imagery TRL recommends review of the network against available satellite imagery as part of a reconciliation exercise.	
• Clear definition and procedures for “all-season roads” There is a general perception that all paved and gravel roads area “all-season”, while earthen roads are not “all-season”.	

Population Data	**4**
• Is census data geo-referenced? It is not known whether population census data from 2014 is georeferenced.	
• Is population data available spatially on a website? 2014 population census by township is available on the MIMU Geonode, although annual projections are not available.	
• Engagement with World Pop Current published WorldPop dataset for Myanmar 2019 is based on CIESIN dataset and projections used for GPWv4, which estimated Myanmar population in 2019 at 48,801,992 which is similar to most online estimates. However, it is recommended that the Central Statistics Organisation engage with World Pop to ensure that correctly reconciled data is published.	
Rural Urban Definition	**2**
• Is official definition clearly visible on website? Could not locate definition available on CSO or other websites.	
• Is it available and published spatially in-country? Could not locate any published mapping for such dataset.	
• Is it clearly understood and used by roads agencies for "rural" statistics? DRD indicated that "earth" roads should be regarded as "not all-season", and this appeared to be confirmed by some site visits to rural roads in March 2019, although systematic ground-truthing is recommended.	
• Is it clearly understood and used for other statistical purposes? Not clear	
SDG Reporting Mechanisms	**3**
• Is there an existing SDG Reporting Mechanism? As described in the Background Section above, Myanmar is still in the early days of aligning existing indicators to the SDGs, and in planning for implementation.	
• Is there an existing SDG Reporting Platform? Not found. There is an Open Development Myanmar site established by the Open Asia Foundation, which contains some commentary on the SDGs in the Mekong region, however it does not appear to be supported, maintained or endorsed by government. There is no mention of SDGs on the CSO website although links to recent SDG planning workshops can be found.	
• Is RAI published as part of the SDG Reporting Platform? No. The only previous estimate of "RAI" identified was in the Myanmar Transport Sector Policy Note (ADB, 2016), based on a village access model.	

E.5. Recommendations

While RAI has been estimated at 62.2%, issues with the mapping (especially that of the road network) mean that little confidence can be attached to this estimate. It could take many weeks or months to consolidate, analyse and rectify the mapping issues, and any effort to do so would require good in-country cooperation with several relevant agencies.

MOC should work with MOPF to agree the inclusion of RAI into the Myanmar national statistical system and SDG reporting framework.

MOC should also work with relevant arms and other agencies (MPF, CSO, DOH, DRD, MOBA etc.) to consolidate and rectify existing centreline data to produce a consolidated road network map. This should then be used as the basis for calculating a baseline RAI, and submitted through MOPF to World Bank as the data custodian.

E.6. References

Myanmar Sustainable Development Plan (2018-2030) (Ministry of Planning and Finance, 2018)

Myanmar National Strategy for Rural Roads and Access (Government of the Republic of the Union of Myanmar, 2017)

Myanmar Transport Sector Policy Note (Asian Development Bank, 2016)

Readiness of Myanmar's Official Statistics for the Sustainable Development Goals – Joint data assessment by the Central Statistical Organization and UNDP (CSO & UNDP, 2016)

Measuring Myanmar's starting point for the Sustainable Development Goals – SDG Indicator Baseline Report (CSO & UNDP, 2017)

Annex F: Nepal RAI Analysis

F.1. Introduction

This RAI assessment is based on three visits to Nepal plus additional desktop study and analysis of online data sources. The first visit to Nepal was a fact-finding trip conducted late February/early March 2019 and included meetings with the counterpart agency Department of Local Infrastructure (DoLI) and the Rural Access Programme, with a World Bank consultant who has been involved with several research projects on accessibility in Nepal, and other local consultants. Mapping of the strategic, local and district road networks was obtained at that time. The second visit was in July 2019 when the Team Leader met the new ReCAP coordinator and had meetings with the National Planning Commission and the Central Bureau of Statistics in order to gain data on population and boundaries. The team also met with project representatives who were also to provide additional roads information. The third visit in September 2019 included discussions with National Planning Commission, Central Bureau of Statistics, Department of Roads, DoLI, and World Bank who are preparing a Strategic Connectivity project.

Section F.2 presents the RAI calculation for Nepal for 2019. Table F.1 shows RAI calculated as 66.2%, with 6,857,806 people in rural areas living further than 2 km from an all-season road. However, there are some caveats and assumptions on this calculation as documented in Table F.2 which should be addressed for future calculations of RAI.

Section F.3 is an assessment of the capacity among the different agencies to calculate and publish RAI in future.

There have been several initiatives in Nepal to address “accessibility” beyond basic RAI. This includes through World Bank, Asian Development Bank, DFID, and other funding agencies. For example walking time maps have been produced based on terrain models for use in specific programmes at many different levels including down to municipality level. These efforts are more detailed, and have been much more resource-intensive, than RAI, and are accepted indicators for their specific programmes.

While RAI can be calculated and published using the existing World Bank methodology (including the Supplemental Guidelines developed under this RAI project), other indicators using additional data (such as walking time, footbridges etc.) will continue to be used for specific programme requirements at local level. The use of walking time as opposed to distance for the RAI was raised in early documentation from the original RAI measurements in 2006, but distance has been retained as the standard measurement for all countries.

Current Nepal SDG reporting refer to and publish RAI / SDG 9.1.1 as Road Density / sq km. It is recommended that Nepal National Planning Commission changes this to the current official UN definition, and uses the figure calculated here (66.2%) as the official SDG indicator. This calculation should be sent by the National Planning Commission to the World Bank RAI team as the custodian of SDG 9.1.1, endorsing this calculation for publication as part of Nepal’s SDG reporting.

NPC should also continue to make efforts to reconcile the road network mapping among the various agencies so that definitive mapping can be made available for forthcoming Strategic Connectivity and other projects, and to improve the accuracy and repeatability of RAI and other accessibility indicators in future.

F.2. RAI Calculation for year 2019

RAI for Nepal for 2019 is calculated at 66.2% as shown in Table F.1

Table F.1 - RAI for Nepal 2019

Metadata Tag	Value
Rural Access Index	
RAI Value:	*66.2*
Rural population not within 2 km of an all-season road:	*6,857,806*
Level:	*National*
Date:	*2019*
Administrative Boundary	
Source:	*FAO Global Administrative Unit Layers (GAUL) dataset*
Date:	*2015*
Total Area (km^2):	*147,181*
Population	
Source:	*WorldPop individual countries data set*
Date:	*2019*
Total population:	*28,609,715*
Total rural population:	*20,459,198 (based on Global Rural Urban Mapping Project (GRUMP) database)*
% of population that is rural:	*71.5%*
Notes:	*WorldPop 2019 projection derived from 2011 National Population and Housing Census.*
Urban / Rural Boundary	
Source:	*Global Rural Urban Mapping Project (GRUMP)*
Date:	*1995*
No of Urban Areas:	*52*
Total Urban Area (km^2):	*3,030*
Total Rural Area (km^2):	*144,151*
Notes:	*Administrative areas in Nepal have recently undergone significant revision, but definitive rural and urban areas are not yet available*
Road Network	
Source(s):	*Department of Roads (DOR) for SRN; Nepal Geonode for DRCN and LRN*
Date:	*July 2019*
Total Length (km):	*Total: 24,854*
Classification:	*SRN: 9,120*
	DRCN: 6,067

Metadata Tag	Value
Surface Type:	*LRN: 9,667* *Blacktop: 14,295* *Gravel: 10,559*
Notes:	• *World Bank estimate of 54.2% for RAI in 2015 was based on 18,248 km of paved and unpaved roads in 'good' condition. Population without access was estimated at 10.3 million.* • *For purposes of this 2019 RAI calculation, all blacktop and gravel roads totalling* 24,854km *were used, from a combination of DOH and Nepal Geonode data. Gravel roads in Nepal tend to be all-season, while earthen roads tend to be not all-season.* • *Table 3 below identified the data sources considered, and identifies the particular subsets of roads used for RAI calculation in 2019. Highlights are:* o *DOR (SRN) data is very close to official statistics (which are for slightly earlier time period) and appears geographically correct with regards to open data sources (OpenStreetMap and satellite imagery) in most areas, although there are several major anomalies on individual roads when compared with data on the Nepal Geonode.* o *DOLI (DRCN and LRN) data contain significant differences from official statistics both in length and surface type; also contain an apparent shift eastwards in the order of 200 meters in some areas which would have made comparison with population data difficult to reconcile; also roads in some areas have been hand-digitised with limited quality control and accuracy, which also would have made comparison with population data difficult to reconcile. For these reasons, data from the Nepal Geonode was used for these networks.* Figure F.1 *and* • Figure F.2 *show examples of some data quality issues identified in available mapping. The Nepal National Planning Commission (NPC) is aware of such issues, and is looking to reconcile them. Ongoing reorganisation in DOLI however means that responsibilities for consolidated mapping may be unclear, and so responsibilities should be clarified in the longer term.*
Accessibility Factors	• *Accessibility Factors were not used for this calculation. It is important to reconcile and correct issues in the available mapping first, before looking to calculate and apply accessibility factors.*
Mapping Projection Mapping Projection:	*UTM Zone 45 N*

Official Statistics						Available Mapping						Used as "all-season" for RAI Calculation 2019	
Network	**Blacktop**	**Gravel**	**Earthen**	**Total (km)**	**Note**	**Source of Mapping data**	**Blacktop**	**Gravel**	**Earthen**	**UC / PL**	**Total Length (excluding UC / PL)**	**Notes / Recommendations**	**Length of all-season network**
SRN	6,823	2,044	4,031	**12,898**	a	SRN (DOR)	7,052	2,068	3,825	2,090	**12,945**	Use blacktop and gravel only	**9,120**
						WB Geonode	6,328	1,784	4,049	1,844	**12,162**	DOR data seems more spatially accurate	-
DRCN	1,311	5,869	18,548	**25,728**	b	WB Geonode	1,213	4,854	15,920	3,236	**21,987**	Use blacktop and gravel only	**6,067**
						DRCN (DOLI)	1,325	5,767	16,459	6,378	**23,551**	Contains significant overlaps with SRN and VRCN, also contains projection shift of up to 200 m	-
LRN	693	6,954	24,257	**31,904**	c	WB Geonode	6,030	3,638	32,072	-	**41,739**	Includes urban roads (which should not impact on RAI calculation, and which accounts for large paved network)	**9,667**
						LRN (DOLI)	1,938	12,018	30,534	-	**44,489**	Contains significant overlaps with SRN and VRCN, also contains projection shift of up to 200 m	-
Total	**8,827**	**14,867**	**46,836**	**70,530**			**14,295**	**10,560**	**51,817**		**76,671**		**24,854**

a. Statistics of Strategic Road Network 2015/2016

b. Statistics of Local Road Network (SLRN) December 2016

c. Statistics of Local Road Network (SLRN) December 2016

UC = Under Construction

PL = Planned

Table F.2: Road Network Mapping Data Selection

Figure F.1: Some Data Quality Issues (1)

#1 – apparent duplication of many roads in SRN and LRN
#2 – triplication of some roads in SRN, DRCN, LRN
#3 – offset of ~170 meters on DRCN and LRN (but not on SRN)

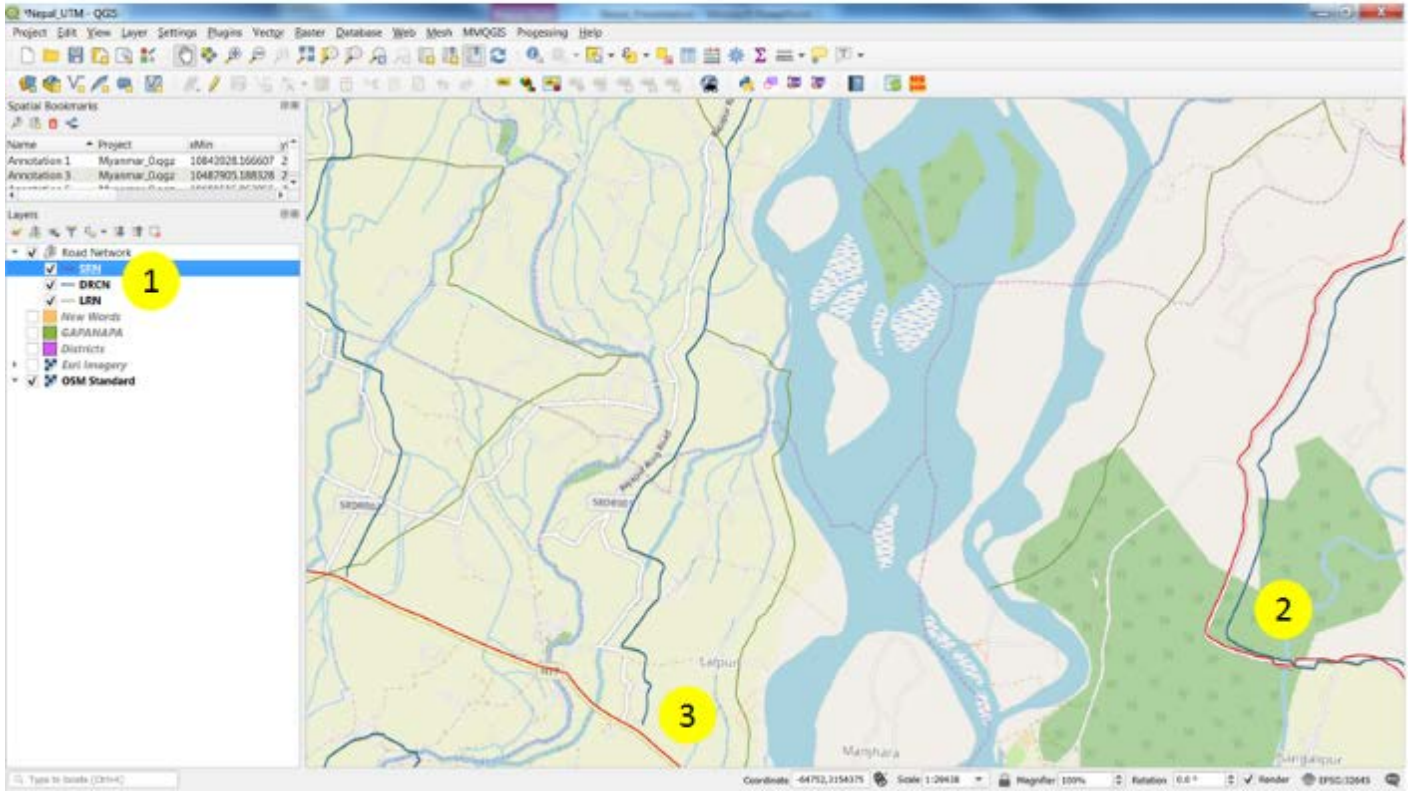
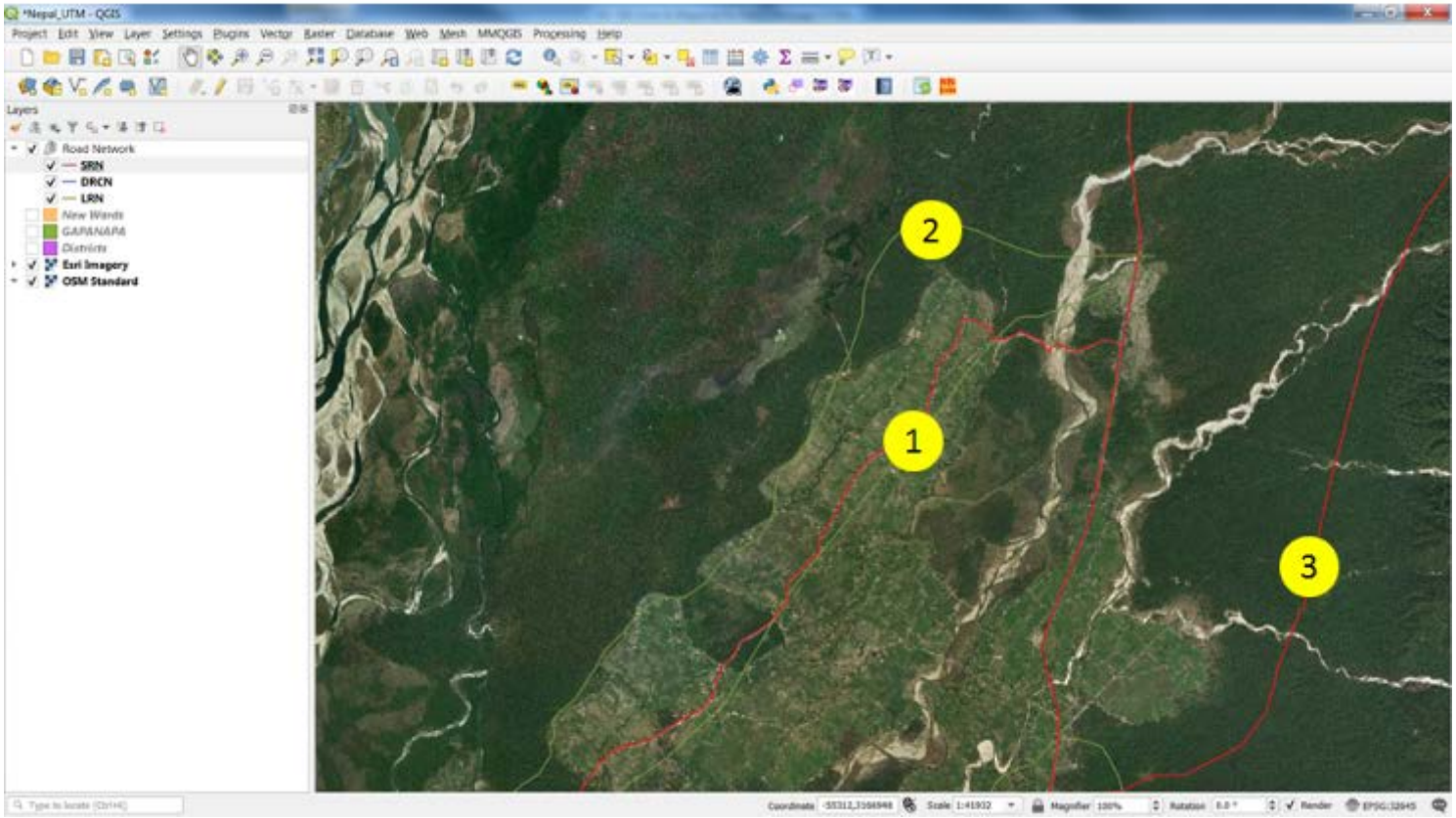


Figure F.2: Some Data Quality Issues (2)

#1 – apparent duplication of SRN and LRN (LRN appears hand-digitised)
#2 – there is some evidence of a road on imagery, but not on that alignment
#3 – there is no evidence of road on imagery



F.3. RAI Embedment Assessment

Figure F.3 shows an assessment of the embedment of RAI within the relevant agencies in Nepal and their capacity to calculate and publish the Rural Access Index (RAI) (SDG 9.1.1) going forward. In general, the higher the score, the better the readiness for RAI embedment.

Figure F.3: Some Data Quality Issues (2)

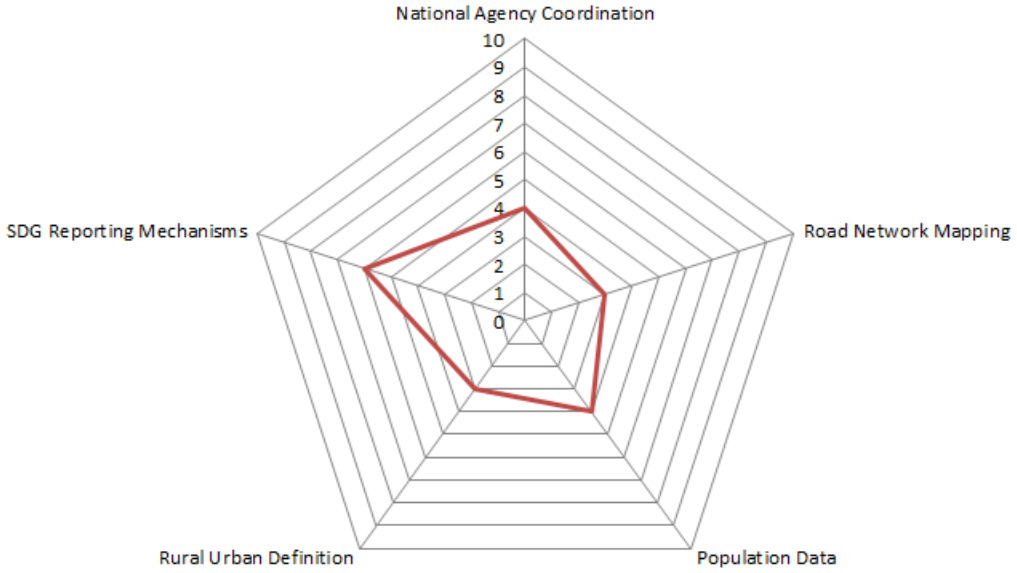


Table F.3 discusses the assessment under each of the categories shown in Figure F.3, and gives some recommendations for improvement in the process of calculating and publishing the RAI going forward.

Table F.3 - Assessment and Recommendations

Criteria	Score
National Agency Coordination	**4**
• Interagency working and agreement among NSO, Roads Agencies, Survey Depts etc. There appears to be little formal communication between the Central Bureau of Statistics and the roads agencies (DOH, DOLI) with respect to the definition or reporting of the RAI under the SDGs. As noted further below, too, the SDG Baseline Report refers to RAI as Road Density (km/sq km), and does not use the UN SDG 9.1.1. definition.	
• Data Publication and Sharing Policy There are a number of online data sharing platforms, including the Nepal Geonode which appears to be maintained by World Bank office in Nepal. There is also an Open Nepal community which aims to encourage sharing of data, although that is primarily made up of private sector and NGOs. There does not appear to be a data platform on which official geospatial data is regularly published.	

• Data Publication and Sharing Practice More cooperation of agencies to share their data via the Nepal Geonode or other platforms is important to ensure consistency of reporting and to avoid duplication of various mapping efforts, and also to assist in reconciliation of apparently overlapping datasets.
Road Network Mapping **3**
• Road network mapping consistent with official published statistics DOH mapping of the SRN is reasonably consistent with official statistics, although some anomalies have been identified. DOLI mapping of the DRCN and LRN contains significant differences from official statistics both in length and surface type; also contain an apparent shift eastwards in the order of 200 meters in some areas which would have made comparison with population data difficult to reconcile; also roads in some areas have been hand-digitised with limited quality control and accuracy.
• Coordinated mapping across agencies Some effort would be required to fully reconcile mapping and official road network statistics, for the different road networks. Nepal National Planning Commission (NPC) is aware of such issues, and is looking to reconcile them.
• Correlation with other online data sources e.g. OpenStreetMap The OSM classified network (Trunk, Primary, Secondary, Tertiary) corresponds reasonably well with the SRN, although there are some anomalies. TRL recommends reconciliation and proper tagging of national road network in OSM.
• Correlation with available imagery TRL recommends review of the network against available satellite imagery (see, for example, Figure F.1).
• Clear definition and procedures for “all-season roads” There is a general perception that all paved and gravel roads area “all-season”, while earthen roads are not “all-season”. Some project constructed ‘earthen’ roads could be classified as all-season for the initial few years, but this is unlikely to make a significant difference to the RAI.
Population Data **4**
• Is census data geo-referenced? It is not known whether Nepal population census data from 2011 is georeferenced.
• Is population data available spatially on a website? 2011 population at Level 4 boundaries is available on the Nepal Geonode, although annual projections are not available.

- Engagement with World Pop

  Current published WorldPop dataset for Nepal 2019 is based on CIESIN dataset and projections used for GPWv4, which estimated Nepal population in 2019 at 38,227,106. TRL requested WorldPop to generate a revised WorldPop dataset for use on this project with WorldPop data reconciled to World Population Prospects 2019 of 28,609,715 which is similar to most online estimates. However, it is believed that Central Bureau of Statistics has not engaged with World Pop to ensure that correctly reconciled data is published.

Rural Urban Definition	**3**

- Is official definition clearly visible on website?

  Could not locate definition available on Central Bureau of Statistics website or publications.

- Is it available and published spatially in-country?

  Could not locate any published mapping for such dataset.

- Is it clearly understood and used by roads agencies for "rural" statistics?

  Not clear

- Is it clearly understood and used for other statistical purposes?

  Not clear

SDG Reporting Mechanisms	**6**

- Is there an existing SDG Reporting Mechanism?

  The National Planning Commission reports on SDGs.

- Is there an existing SDG Reporting Platform?

  There is an SDG reporting platform, and there is a variety of documents published on the NPC website, including SDG Status and Roadmap, and a SDG Baseline Report for 2017.

- Is RAI published as part of the SDG Reporting Platform?

  SDG Baseline Report, and SDG Status and Roadmap, both include SDG 9.1.1 but refer to it and report it as Road Density (km/sq km).

Annex G: Secondary RAI Measurement Options and Methodology

G.1. Introduction

In his review of the RAI, Vincent (2018) recommended that a secondary, supplementary indicator be developed to allow countries to take into account local infrastructure that might not be included in the standard RAI measurement. One example would be motorcycle trails, and another could be navigable waterways. This has been further discussed in subsequent RAI research reports (Workman et al, 2018; Workman and McPherson, 2019a and 2019b).

Such an indicator would be voluntary (depending on the country's interests) and in addition to the standard RAI measurement required for SDG indicator 9.1.1. Like the RAI, it should be a measure related to infrastructure provision and its all-season availability. It is not possible to change the main RAI methodology at the present time because it has recently been promoted to Tier II of the IAEG-SDG scale. To incorporate these secondary modes of access would significantly change the methodology and precipitate its demotion back to Tier III, so any changes should be aimed at 2025 when the next round of revisions is due.

G.2. Alternative rural access and mobility indicator

This annex relates to that optional secondary RAI measurement, and not to a *new* rural access indicator that relates more to rural mobility, which was another suggestion in the Vincent Scoping Report (2018). For example, an alternative indicator could be related to the time required to access medical facilities, markets or other services. For land-based transport, such an indicator would, in part, depend on road provision and condition (as the current RAI) but would also depend on the availability of transport services and/or means of transport. Such a new rural mobility indicator has merit, for 'roads are not enough': people need to access means of transport to allow them, and their goods, to reach service centres. As Vincent (2018) reported, countries are increasingly collecting data relating to mobility, and there is interest in measuring people and freight movements in rural areas among multi-lateral development banks.

The SuM4All Global Tracking Framework (GTF) for Universal Access has the RAI (SDG 9.1.1) as its principal indicator for rural access (GTF, 2019). For urban access it has SDG 11.2.1: the proportion of (the urban) population that has convenient access to public transport, by age, sex and persons with disabilities. The SuM4All Global Tracking Framework has six general, national-level supporting indicators relating to the quality of roads, rail infrastructure, air transport infrastructure, port infrastructure and passenger volumes by mode of transport, notably air and rail. All these indicators are currently being tracked, based mainly on information compiled by the World Economic Forum, the International Civil Aviation Organization and the World Bank. The GTF also has eight supporting rural indicators and thirteen supporting urban indicators, although these are not yet being tracked on the SuM4All website (GTF, 2019). The GTF supporting rural indicators are:

- Proportion of rural roads in "good and fair condition" (as developed by new RAI)
- Percentage of markets accessible by all-season road
- Percentage of national government budget spent on low volume rural transport infrastructure
- Percentage of the rural population with access to affordable and reliable passenger transport services
- Ratio of national to local passenger transport fares (collection of data on rural passenger transport US$ per km for short distance and long-distance trips which would be disaggregated by most common modes e.g. bus, motorbike, other IMT)
- Percentage of household monthly expenditure spent on transport

- Percentage of rural population with at least daily transport service – from Living Standards Surveys (LSS)
- Percentage of households that make one motorized trip per month.

These are available on the SuM4All website at http://www.sum4all.org/global-tracking-framework . The main urban access indicator relates to public transport and is disaggregated by age, gender and disability. In addition, eleven of the thirteen urban-access supporting indicators relate to transport services. In contrast, the main rural access indicator (the RAI) relates to infrastructure, and only three of the eight supporting, rural-access indicators relate to transport services. There is currently no disaggregation by gender, age or disability within the rural transport indicators, and only one indicator, the number of motorised trips made per month, that could be easily disaggregated (subject to appropriate survey questions).

Many of the current, supporting global tracking framework indicators appear to be work-in-progress ideas, rather than clearly-defined and measured indicators. Agreeing on the key parameters to measure a rural-access-and-mobility indicator, and developing a suitable methodology would be a major undertaking. It might also detract from the current importance of this RAI initiative. This current research is mandated to concentrate on the RAI. Another separate research project is being commissioned to look at SDG 9.1.2: passenger and freight volumes by mode of transport. For these reasons, this research is concentrating on the RAI itself and its supplementary, optional secondary RAI measurement that takes into account alternative transport infrastructure that is used for rural mobility. This secondary RAI indicator will be a fully-compatible derivative of the infrastructure-based RAI, using the same methodological principles, but differing in the definition of the infrastructure being measured.

G.3. Secondary, optional RAI indicator

While the standard RAI will measure the percentage of the rural population within 2 km of an all-season road, the supplementary RAI will measure *the percentage of the rural population within 2 km of an all-season transport route or waterway jetty*. This will include motorcycle trails and navigable waterways, which will be discussed in more detail in the following sections.

If the entire rural transport network were considered, the provision of railways and airstrips could be included, but this is not likely to be relevant to many situations. While railways and airstrips can be very important for rural access in certain countries, their provision is unlikely to greatly affect the overall RAI value. This is because in most circumstances, railways and aeroplanes only provide access at particular places (stations, halts and airstrips), around which there would probably be some all-season road access.

There are some countries, including Cambodia, Liberia and Madagascar, where local entrepreneurs have developed artisanally-made intermediate means of transport that can operate on little-used rail tracks (generally without authorisation). Such examples are rare and small scale, and are not likely to be considered worthy of inclusion in national access statistics. Similarly, there would be very few air-strips that are not connected to any all-season roads and yet have significant populations living within 2 km of them to affect the overall national RAI percentage. Some countries, such as Papua New Guinea, have vital rural airstrips that are not accessible from the road network. However, they have small populations living within 2 km of them, and due to the local weather conditions, few could be considered all-season infrastructure (being unusable due to poor weather for more than seven days of the year). For these reasons, the suggested secondary RAI indicator will only consider motorcycle trails and navigable waterways with jetties.

G.3.1 Motorcycle trails, tracks and seasonal roads

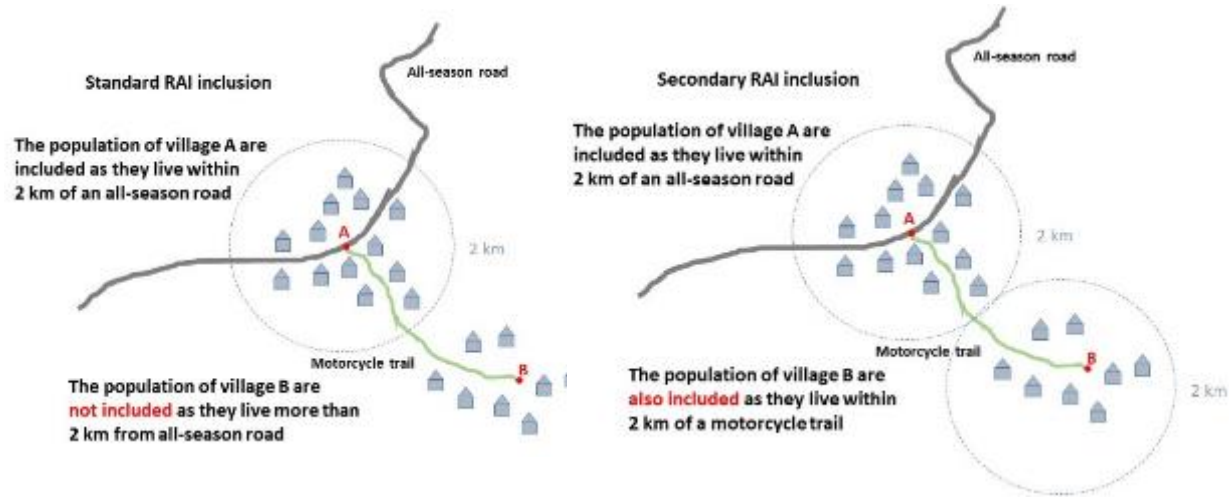
SuM4All (2019) has recognised motorcycle trails as a low-cost infrastructure option for connecting off-road villages with the road network and mainstream services. They allow personal motorcycles (and in some countries motorcycle taxis) to provide small-scale motorised transport for people and goods. Some are sufficiently wide and smooth to allow three-wheelers and/or two-wheel tractors and trailers, which can also provide small-scale passenger and freight transport (with different advantages and disadvantages). Some motorcycle trails are earth trails, but in swampy areas trails may be constructed using concrete or bricks (see Figure G.1). In many countries there are unclassified roads and tracks that are passable by motorcycles and robust vehicles. These may not be part of the official road network, but if they are passable in all seasons by motor vehicles, they provide important rural access for the local populations.

Figure G.1: Examples of brick (Bangladesh) and concrete (Myanmar) motorcycle trails

If a village is 2 km from a road, but connected by a simple track or motorcycle trail, its inhabitants have much better rural access than those villages only connected by footpaths. For villagers travelling to markets, shops, clinics and schools, if there are affordable means of transport, the potential mobility offered by simple tracks and trails can be transformational. Trails and tracks can overcome the slow and labour-intensive 'walking and carrying' required when the 'first mile' is only a footpath.

For this reason, the secondary RAI value will acknowledge this. It may be that in a country with an RAI of 60% (60% of the rural population within 2 km of an all-season road), a further 20% of people live within 2 km of an all-season motorcycle trail or track. This would give a secondary RAI value of 80%. The inclusion of villages connected by motorcycle trails is illustrated in Figure G.2.

Figure G.2 Motorcycle trail population inclusion in the standard RAI (left) and secondary RAI (right)



There may be some classified or unclassified roads that do not meet the criteria for the main RAI, but are passable throughout the year by motorcycles and robust 4-wheel drive vehicles. Indeed, in the 'ground-truthing' for the accessibility factors, it may be concluded that while 20% of roads 'fail to

qualify' for inclusion in the RAI, most (or all) of these remain open all year round for motorcycles and/or 4x4s. Examples could include roads subject to landslides that are blocked to 'conventional' traffic until heavy earth-moving equipment becomes available. Frequently, in such circumstances, motorcycles quickly find a path over the fallen debris, and keep the road open for motorcycle use. In another example, some roads develop large mud holes, causing larger-vehicles to get stuck, and such vehicles may block and further damage the roads. The larger vehicles cannot travel until conditions improve. Again, motorcycles can often negotiate routes around these problem areas, allowing the road to remain open for motorcycle traffic. Such roads, which are excluded for the main RAI, can be included in the secondary RAI.

Most countries do not record details or condition of motorcycle trails, and the burden of data collection should not be increased due to the RAI. In terms of location and length, is very likely that a good estimation of the motorcycle trail network can be identified through satellite imagery and machine learning technologies that already exist. In terms of condition, one way of including such roads can be through the accessibility factor. For example, 'ground-truthing' may suggest that 20% of roads in mountainous regions are not all-season, the accessibility factor for such roads would be 0.8 for the standard RAI. If three-quarters of these were accessible all year for motorcycles, the accessibility factor for calculating the secondary RAI would be 0.95.

Open-street map (OSM) includes several subcategories ('tags') for highways, including 'Minor/Unclassified roads', 'Service roads', 'Unmaintained track roads', and 'Paths' (OSM, 2019a). All these may be passable by motorcycles, although paths in steep terrain may not be appropriate for motorcycles. Where possible OSM should be reconciled to official country records. The process for calculating the secondary RAI will be the same as for the standard RAI, but the categories of 'highways' to be included can be increased, and the accessibility factor can be adjusted. This will allow countries that wish to include this optional secondary indicator to calculate and additional value, that will be higher than the standard RAI by taking into account the access provided by motorcycles.

G.3.2 Navigable waterways

In some countries, water transport is very important for rural access (see Figure G.3). Communities living by navigable rivers, may have access to personal craft or transport services that allow them to reach markets, clinics, schools and the road network. Similarly, communities on islands (marine or on lakes) can be linked to mainland services and the road network by small craft or larger ferries. These riverine and island communities can be included among those with access in the secondary RAI measurement, using similar criteria to those developed for the main RAI. Navigable waterways on rivers, lakes and canals are included in OpenStreetMap (OSM, 2019b).

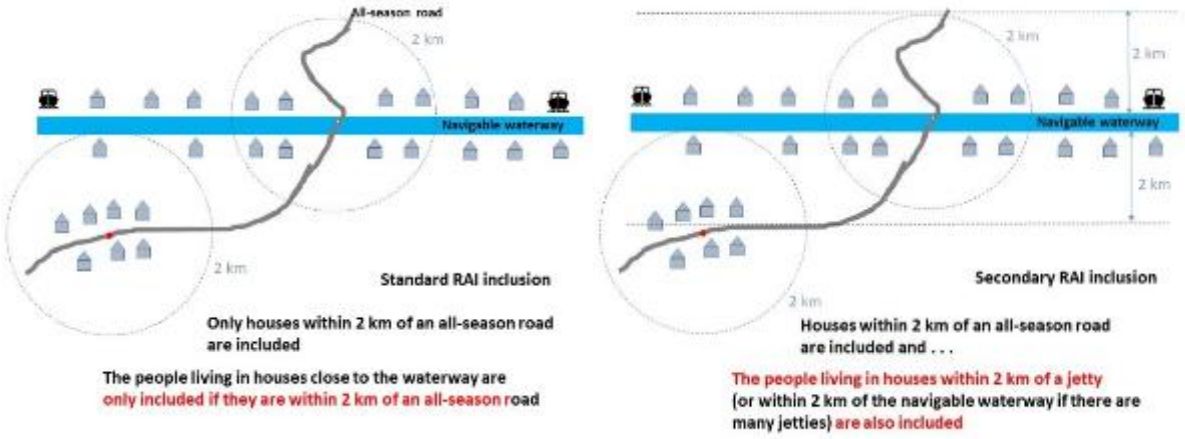
Figure G.3 Lake, canal and river-based rural transport in Cambodia, Madagascar and Myanmar

The main RAI and the secondary RAI are both measures of infrastructure provision (as opposed to the availability of transport services). Infrastructure related to water transport includes the waterway itself and the provision of jetties or docks to facilitate loading and unloading. Therefore, people can be considered as having secondary RAI access if they live within 2 km of a dock or jetty.

The definition of a jetty will depend on the country using the secondary RAI, but simple wooden jetties along waterways can be included, if they are used for the embarkation and disembarkation of people

and goods travelling along the river. For busy rivers and canals, there may be jetties every 2 km, so that the whole navigable waterway can be included, using OSM. However, some rivers are not widely used for passenger and freight transport, and on these only known jetties should be included. Small jetties are not yet included on OSM, and so information may need to be collected from the relevant water-transport authorities. Jetties nearby all-season roads would be automatically included in the standard RAI measurement, and so this secondary RAI calculation will only be applicable to navigable rivers away from the road network, and to islands (or parts of islands) without road networks. If water transport is of minor importance, and if most waterway jetties are connected to the road network, a secondary RAI value for waterways would not be very different from the standard RAI measurement. Figure G.4 shows how a secondary RAI value for waterways would include a larger population than the standard RAI.

Figure G.4: Waterway population inclusion in the standard RAI (left) and secondary RAI (right)



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Annex H: ReCAP Completion Report

<table>
<tr><td colspan="5">Logframe Indicators
(Note: The purpose of this Section of the CR is to summarise the extent to which this activity has contributed to the ReCAP's higher level objectives. Where response is YES supporting documentation is required separate to the report)</td></tr>
<tr><td>Outcome</td><td colspan="3">Question</td><td>Response
(Underline Answer)</td></tr>
<tr><td rowspan="3">Sustainability</td><td colspan="3">1.1 Did this project lead to any concrete examples of change, influenced by ReCAP research that will be applied to Km of road?</td><td>1. YES. World Bank is expected to accept the supplemental guidelines developed under this project and link them to the existing SDG 9.1.1 methodology. These supplemental guidelines shall form the basis for any future RAI / SDG 9.1.1 efforts.
2. The ability to calculate RAI at regional, national, sub-national and project-level, plus a renewed emphasis on absolute numbers of people 'disconnected', are important examples of helping to promote the use of RAI in policy, which should also promote calculation and embedment. It is anticipated that all of these efforts will help RAI become a mainstream indicator and help it move towards Tier I status.</td></tr>
<tr><td colspan="3">1.2 Were Partner Governments and/or other financiers involved in co-funding this research?</td><td rowspan="2">3. YES, Local governments were involved through Contributions in Kind (K)

4. Essentially this included arrangement and partial funding of meetings and workshops via T&S etc. All trial country governments contributed (K).</td></tr>
<tr><td>Type of Contribution:

K – Funding of Trial Sections, Staff Time, Dissemination and Training

C - Funding of Research Programme Core Costs, Research Contracts, Capacity Building and Knowledge Management</td><td>Value of Contribution (in £ m)</td><td>Source:</td></tr>
</table>

Research and Uptake	Were any Peer-Reviewed Papers made available in open access format generated due to the implementation of this project?			1.YES, 2 papers were produced for PIARC (only one published) and one for Africa GIS
	1.3. Were any National Policies, Manuals, Guidelines and/or final research outputs been fully incorporated into Governmental/Ministerial Requirements, specifications and recommended good practice as a result of engineering research conducted during this project?			1.NO. We expect the supplemental guidelines to be incorporated into the custodian framework for RAI measurement. 2. African Union, are interested in including RAI as an annex to their rural roads policy, which could have a significant impact, TRL is continuing to follow up.
	1.4. Were any National Policies, Regulations and/or practises for Rural Transport Services been modified or introduced as a result of this project?			1. NO. Custodian methodology for measuring RAI should be changed as a result.
Capacity Building	2.1. Did country-based African/Asian experts or institutions take lead roles during the implementation of this project?			1. NO
	Name	Nationality	Position	
	2.2. Was this project managed through a National Research Centre (NRC) and supported by ReCAP funding for technical assistance and capacity building?			1. NO: But country-based research centres did act as counterparts
	2.3. Were female researchers involved in providing inputs at a senior technical level?			1. YES. Sritika Choudhury (TRL) advised on Sensitivity Analysis for the project.
Knowledge Dissemination	3.1. Did this Activity result in a National Research Centre (NRC) being Linked to an electronic repository for rural transport Knowledge?			1. Not Applicable
	3.2. Did this project Generate Knowledge Presented and discussed at a high-level international development conference or debate?			1. YES. Workshop held at PIARC WRC2019 conference and poster session for RAI: October 2019. 2. Other events & seminars: a. TT19 workshop: Washington DC, January 2019 b. IRIM conference: Nepal, February 2019 c. 5th International Conference on Big Data for Official Statistics: Kigali, Rwanda May 2019Rwanda UN Big Data Conference: April 2019 d. GIS Africa event: Kigali, Rwanda, November 2019

		e. SSATP: presentation at the Specialised Technical Session on Sustainable Transport at SSATP AGM, Zimbabwe, November 2019 f. ieConnect Impact Evaluation Workshop: Marrakesh, Morocco December 2019 g. Meeting planned for TT20: Washington DC, January 2020
	3.3. Was the knowledge generated by this project disseminated through workshops or dedicated training?	1. Workshop at ReCAP IRIM conference in Nepal February 2019 attended by more than 100 persons
		2. Workshop in Malawi in September 2019 attended by 20 persons (including representatives from Ghana) 3. PIARC workshop in Abu Dhabi October 2019 attended by more than 50 persons 4. Training also provided through country visits