How to use GIS to measure Rural Access for SDG 9.1.1

Robin Workman
20th November, 2019
Establishment of the RAI in 2006

**Definition**

**Rural Access Index** = ‘the proportion of the rural population living within 2 km of an all-season road’.

All-season = “a road that is motorable all year round by the prevailing means of rural transport (often a pick-up or a truck which does not have four-wheel-drive), with some predictable interruptions of short duration during inclement weather (e.g., heavy rainfall) allowed.”
SDG Target 9.1
Develop quality, reliable, sustainable and resilient infrastructure

SDG Indicator 9.1.1
Proportion of the rural population who live within 2 km of an all-season road.

World Bank is the “custodian” of SDG Indicator 9.1.1
2015/2016

UKAid funding, through ReCAP, to update method of measuring the RAI. Pilot measurements in 8 ReCAP countries. Support moving SDG Indicator 9.1.1 to Tier II

Geospatial Approach to the RAI

- Population distribution: Where do people live?
- Road network: Where do roads exist?
- Road condition: All-season roads?
Comparison of 2006 and 2016 results

<table>
<thead>
<tr>
<th>Country</th>
<th>RAI 2006</th>
<th>RAI 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>37</td>
<td>87</td>
</tr>
<tr>
<td>Nepal</td>
<td>54</td>
<td>17</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>Kenya</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>Mozambique</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Tanzania</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>Uganda</td>
<td>53</td>
<td>25</td>
</tr>
<tr>
<td>Zambia</td>
<td>17</td>
<td>64</td>
</tr>
</tbody>
</table>
2019 – RAI Consolidation & Revision

- Scale-up RAI and **advance SDG 9.1.1 from Tier III to Tier II**
- Refine, propose, and agree on **harmonised approach** to data collection and measurement of RAI
- **Refine the measurement framework to:**
  - Meet international standards
  - Provide a clear framework for data validation
  - Ensure consistent and rigorous data collection
- **Trial proposed measurement framework** in 4 ReCAP countries
SDG Indicator “Tier” system *(Note: Abbreviated)*

Tier I: Regularly produced for at least 50% of countries.

Tier II: Conceptually clear, established methodology, but not regularly produced.

Tier III: No internationally established methodology or standards, but they are being developed.

*Current rating of SDG Indicator 9.1.1, the RAI*
- Conducted country trials in:
  - Ghana, Malawi, Myanmar, Nepal
- Engaged with NSO and roads organisations
- Reviewed data for completeness and quality
- Analysed data in GIS format
- Supported local partners to measure RAI
GIS process

1. Download Road Network
   - Map of Road Network
2. Classify, Filter and apply 2 km Buffer to Road Network
   - Buffered Map of Rural Population
3. Download Population Data
   - Map of Total Population
4. Subtract Urban Areas
   - Map of Rural Population
5. Subtract Road Network Buffer
   - Map of Rural Population Living > 2km away from an All-Season Road
6. Apply Accessibility Factors
   - RAI
Population Data
WorldPop, Rural / Urban boundaries
WorldPop data

**NSO Census:** GPS-points corresponding to level of household

**NSO** provide aggregated data of population by enumeration area or other low-level boundary

**WorldPop:** update and publish population by 100 m square based on interpretation of imagery and other ancillary data, reconciled to boundaries provided by NSO
Road Network Data

Open Street Map – almost the *de facto* standard for mapping of road network, buildings, health centres, schools etc.
Network processing

Save road networks as separate layers (example from Malawi)

Separate out paved and unpaved roads (treated separately in terms of all-season status)
Combine population and roads

Clip urban rasters out to create a raster of rural population

Buffer roads, produce a raster of rural population outside 2km of a paved/unpaved road
Summary

Total Population  Rural Population  Rural pop. >2km paved  Rural pop. >2km tot.
Ambiguity surrounding the definition and measurement of an ‘all-season’ road:

• Countries do not typically collect data on which roads were impassable and for how long
• Any attempt to collect it retrospectively per road would be subjective and very time-consuming
• Even if a given road flooded once in, say, 2015, does that mean that it is still “not all-season” in 2019?
Accessibility factor as a proxy for ‘all-season’

Alternative approach based on “accessibility factors” defined by each country, to be used where road condition is unavailable or unreliable. Ground truth the accessibility factors.

<table>
<thead>
<tr>
<th>Climate</th>
<th>Terrain</th>
<th>Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk (e.g. Dry Season)</td>
<td>Low Risk (e.g. Flat, Rolling) 1</td>
<td>Low Risk (e.g. Flat, Rolling) 1</td>
</tr>
<tr>
<td>High Risk (e.g. Wet Season)</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>High Risk (e.g. Mountainous) 1</td>
<td>High Risk (e.g. Mountainous) 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Accessibility Factor applied
(example Myanmar)

Accessibility factor map: Unpaved roads

Accessibility factor table for unpaved roads (from Figure 1)

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<tr>
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<th>High Risk (e.g. Mountainous)</th>
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<tr>
<td>Low Risk (e.g. Flat, Rolling)</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>High Risk (e.g. Wet Season)</td>
<td>0.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Assessment Framework for countries’ readiness and capacity to calculate and publish RAI:
2020 – Next Steps for RAI

RAI Calculation Tool (by Azavea)

Rural Access Indicator
This map, developed in partnership with ReCAP, Cardno, TRL, and Azavea is a proof of concept tool that displays the Rural Access Indicator (RAI) for all countries. It utilizes three open datasets (OpenStreetMap, WorldPop, GRUMP) to provide a rough estimation of the RAI which is also the UN SDG Indicator 9.1.1: the proportion of a country’s rural population that is within two kilometers of an all-season road. This score is provisional because it is based on open datasets that have not been confirmed by every country.

Three countries working with the ReCAP program (Nepal, Malawi, and Myanmar) have submitted country specific data that is of greater accuracy to generate their RAI score.
RAI Calculation Tool

This map shows the proportion of a country’s population that is within 2km of an all-season road in support of SDG Indicator 9.1.1.
**Rural Access Indicator**

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## RAI with Absolute Numbers

<table>
<thead>
<tr>
<th>Region</th>
<th>Total (millions)</th>
<th>Rural (millions)</th>
<th>Living &gt;2 km away from an all-season road</th>
<th>RAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>1,317.7</td>
<td>908.4</td>
<td>421.1</td>
<td>53.6</td>
</tr>
<tr>
<td>Americas</td>
<td>1,057.3</td>
<td>222.7</td>
<td>71.0</td>
<td>68.1</td>
</tr>
<tr>
<td>Asia</td>
<td>4,632.8</td>
<td>2,590.6</td>
<td>658.9</td>
<td>74.6</td>
</tr>
<tr>
<td>Europe</td>
<td>757.1</td>
<td>190.6</td>
<td>19.8</td>
<td>89.6</td>
</tr>
<tr>
<td>Oceania</td>
<td>37.4</td>
<td>12.8</td>
<td>7.4</td>
<td>42.2</td>
</tr>
<tr>
<td>World</td>
<td>7,802.3</td>
<td>3,925.0</td>
<td>1,178.2</td>
<td>70.0</td>
</tr>
</tbody>
</table>
Conclusions

• Accurate, replicable and sustainable method of measuring SDG 9.1.1 in the future, to ensure its continued use
• Sustainability depends on the data collection being kept simple and undemanding on local resources
• Maximise the use of GIS software and tools
• Define the all-season status of the road without putting extra burden on countries to collect additional data
• Specialist expertise and extensive experience in GIS should not be necessary
• The calculation tool being developed on the UN Global Platform will make measurement simple and quick
• More funding necessary for Phase 3
Thank you for your attention

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