



NATIONAL COMMUNICATIONS AUTHORITY

Quality of Service (QoS) Monitoring of Cellular Mobile Voice Services-NORTHERN REGION

[August 2016]

[Communications for Development]

**QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN
REGION, AUGUST 2016**

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Background

In pursuance of Annexure D1 and D2 of the Cellular Mobile Licence of Telecommunication Operators, the user perspective of the quality of voice services are tested to ensure the compliance of Operators with the obligations on service quality to the user.

The report is based on findings on quality of service in Northern Region from 6th August to 1st September 2016 for all Operators except Espresso due to technical challenges.

What we measure

As per the Cellular Mobile licence obligations, the QoS indicators and their respective threshold for compliance under assessment considering the user's perspective are;

- **Stand-Alone Dedicated Control Channel (SDCCH) Congestion Rate**
- **Call Setup Time (CST)**
- **Call Congestion Rate**
- **Call Drop Rate (CDR)**
- **Call Completion Rate (CCR)**
- **Voice Call Audio Quality**
- **Coverage**

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Findings

The results for the district capitals within Northern Region tested during the period are as below:

a) Stand-alone Dedicated Control Channel (SDCCH) Congestion Rate

SDCCH Congestion is defined as the probability of failure of accessing a stand-alone dedicated control channel during call set up.

For analysis and calculations,

$$\text{SDCCH Congestion [\%]} = \frac{\text{Number of connect fails due to Immediate Assignment Failures}}{\text{MOC call attempts}} \times 100\%$$

SDCCH Congestion Rate should be equal or less than one per cent (1%).

The results for the cities and towns tested in August are as below:

Table 1 Signalling Congestion Rate, Cellular Mobile Voice Service, August 2016

| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|------------|-----|----------|------------|------------|------------|
| August | Bimbilla | 0% | 0% | 0% | 0% | No Network |
| August | Bole | 0% | 0% | 0% | 0% | No Network |
| August | Buipe | 0% | 0% | No Network | 0% | No Network |
| August | Bunkpurugu | 0% | 0% | 0% | 0% | No Network |
| August | Chereponi | 0% | 0% | 0% | 0% | No Network |
| August | Daboya | 0% | 0% | No Network | No Network | No Network |
| August | Damongo | 0% | 0% | 0% | 0% | No Network |
| August | Gambaga | 0% | 0% | 0% | 0% | No Network |
| August | Gushiegu | 0% | 0% | 0% | 0% | No Network |
| August | Karaga | 0% | 0% | 0% | 0% | No Network |
| August | Kumbungu | 0% | 0% | 0% | 0% | 0% |
| August | Saboba | 0% | 0% | 1.41% | 0% | No Network |
| August | Sagnarigu | 0% | 0% | 0% | 0.002% | 0% |
| August | Salaga | 0% | 0% | 0% | 0% | No Network |
| August | Sang | 0% | 0% | 0% | 0% | No Network |
| August | Savelugu | 0% | 0% | 0% | 0% | 0% |
| August | Sawla | 0% | 0% | 0% | 0% | No Network |
| August | Tamale | 0% | 0% | 0% | 0.004% | 0% |
| August | Tatale | 0% | 0% | 0% | 0% | No Network |
| August | Tolon | 0% | 0% | 0% | 0% | 0% |
| August | Walewale | 0% | 0% | 20.97% | 0% | No Network |
| August | Yagaba | 0% | 0% | 0% | No Network | No Network |

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| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|---------|-----|----------|-------|--------|------------|
| August | Yendi | 0% | 0% | 2.06% | 0% | No Network |
| August | Zabzugu | 0% | 0% | 0% | 0% | No Network |

REMARK:

- ❖ All Operators except Tigo were in compliance with the signalling congestion threshold of less than 1 percent (1%) in all the available District Capitals tested.
- ❖ Tigo recorded high SDCCH Congestion in Saboba, Walewale and Yendi.

b) Call Setup Time (CST)

Call Setup Time is the period of time elapsing from the sending of a complete destination address (target telephone number) to the setting up of a call to the receiving terminal;

$$\text{Call set - up time [s]} = t_{\text{alerting-signal}} - t_{\text{address-sending}}$$

$t_{\text{alerting signal}}$ – Moment when an alerting signal is sent to the called terminal

$t_{\text{address sending}}$ – Moment user presses the SEND button on the calling terminal

CST should be less than ten seconds (<10secs) in 95% of cases.

Table 2 Call Setup Time, Cellular Mobile Voice Service, August 2016

| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|------------|---------|----------|------------|------------|------------|
| August | Bimbilla | 7.26sec | 8.41sec | 8.73sec | 6.63sec | No Network |
| August | Bole | 7.66sec | 3.68sec | 5.34sec | 6.73sec | No Network |
| August | Buipe | 6.70sec | 7.64sec | No Network | 13.85sec | No Network |
| August | Bunkpurugu | 7.11sec | 3.51sec | 8.11sec | 5.48sec | No Network |
| August | Chereponi | 6.94sec | 3.94sec | 5.41sec | 7.09sec | No Network |
| August | Daboya | 5.87sec | 6.95sec | No Network | No Network | No Network |
| August | Damongo | 6.42sec | 5.54sec | 5.99sec | 6.86sec | No Network |
| August | Gambaga | 6.15sec | 3.28sec | 9.65sec | 7.20sec | No Network |
| August | Gushiegu | 6.70sec | 5.66sec | 8.02sec | 15.41sec | No Network |
| August | Karaga | 8.39sec | 7.8sec | 5.27sec | 5.34sec | No Network |
| August | Kumbungu | 6.76sec | 6.15sec | 9.15sec | 15.45sec | 22.69sec |
| August | Saboba | 7.67sec | 4.76sec | 6.11sec | 5.21sec | No Network |
| August | Sagnarigu | 8.38sec | 9.16sec | 9.31sec | 10.23sec | 7.50sec |
| August | Salaga | 7.91sec | 6.87sec | 6.70sec | 5.45sec | No Network |
| August | Sang | 5.65sec | 5.75sec | 7.39sec | 8.50sec | No Network |
| August | Savelugu | 8.89sec | 6.36sec | 23.98sec | 6.77sec | 21.71sec |

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| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|----------|---------|----------|----------|------------|------------|
| August | Sawla | 7.13sec | 3.97sec | 5.78sec | 7.27sec | No Network |
| August | Tamale | 8.42sec | 9.10sec | 24.92sec | 11.65sec | 8.39sec |
| August | Tatale | 8.25sec | 6.27sec | 6.57sec | 8.81sec | No Network |
| August | Tolon | 7.50sec | 8.52sec | 7.17sec | 5.94sec | 17.04sec |
| August | Walewale | 8.81sec | 7.33sec | 12.93sec | 5.70sec | No Network |
| August | Yagaba | 5.65sec | 6.08sec | 16.59sec | No Network | No Network |
| August | Yendi | 6.80sec | 7.08sec | 9.23sec | 12.05sec | No Network |
| August | Zabzugu | 7.33sec | 4.48sec | 5.68sec | 12.05sec | No Network |

REMARKS:

- ❖ All Operators except MTN and Vodafone failed to meet the parameter threshold in certain localities.
- ❖ Tigo had Call Setup Time delays at Savelugu, Tamale, Walewale and Yagaba.
- ❖ Airtel had Call Setup Time delays at Buipe, Gushiegu, Kumbungu, Sagnarigu, Tamale, Yendi and Zabzugu.
- ❖ Glo had Call Setup Time delays at Kumbungu, Savelugu and Tolon.

c) Call Congestion Rate

Call Congestion Rate is the probability of failure of accessing a traffic channel during call setup;

$$\text{Call Congestion } [\%] = \frac{\text{Number of Connect failed calls}}{\text{Total number of call attempts}} \times 100\%$$

Traffic Channel Congestion should be equal or less than one per cent (1%).

Table 3 Call Congestion Rate, Cellular Mobile Voice Service, August 2016

| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|------------|-----|----------|------------|------------|------------|
| August | Bimbilla | 0% | 0% | 0% | 0% | No Network |
| August | Bole | 0% | 0% | 0% | 0% | No Network |
| August | Buipe | 0% | 0% | No Network | 0% | No Network |
| August | Bunkpurugu | 0% | 0% | 0% | 0% | No Network |
| August | Chereponi | 0% | 0% | 0% | 0% | No Network |
| August | Daboya | 0% | 0% | No Network | No Network | No Network |
| August | Damongo | 0% | 0% | 0% | 0% | No Network |

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| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|-----------|-----|----------|-------|------------|------------|
| August | Gambaga | 0% | 0% | 0% | 0% | No Network |
| August | Gushiegu | 0% | 0% | 0% | 0% | No Network |
| August | Karaga | 0% | 0% | 0% | 0% | No Network |
| August | Kumbungu | 0% | 0% | 0% | 0% | 0% |
| August | Saboba | 0% | 0% | 0% | 0% | 0% |
| August | Sagnarigu | 0% | 0% | 0.19% | 0.56% | 0.39% |
| August | Salaga | 0% | 0% | 0% | 0% | No Network |
| August | Sang | 0% | 0% | 0% | 0% | No Network |
| August | Savelugu | 0% | 0% | 0% | 0% | 0% |
| August | Sawla | 0% | 0% | 0% | 0% | No Network |
| August | Tamale | 0% | 0% | 0% | 0% | 2.89% |
| August | Tatale | 0% | 0% | 0% | 0% | No Network |
| August | Tolon | 0% | 0% | 0% | 0% | 0% |
| August | Walewale | 0% | 0% | 0% | 0% | No Network |
| August | Yagaba | 0% | 0% | 0% | No Network | No Network |
| August | Yendi | 0% | 0% | 0% | 0% | No Network |
| August | Zabzugu | 0% | 0% | 0% | 0% | No Network |

REMARK:

- ❖ All Operators except Glo were in compliance with the licence threshold of less than one percent (1%) in all available District Capitals tested.
- ❖ Glo recorded high Call Congestion at Tamale.

d) Call Drop Rate (CDR)

Voice Call Drop Rate is the probability of a call terminating without any of the users' will;

$$\text{Drop Rate [\%]} = \frac{\text{Number of calls terminated unwillingly}}{\text{Total number of call attempts}} \times 100\%$$

Call drop rate should be equal or less than three percent (3%).

Table 4 Call Drop Rate Cellular, Mobile Voice Service, August 2016

| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|------------|-----|----------|------------|--------|------------|
| August | Bimbilla | 0% | 0% | 0% | 0% | No Network |
| August | Bole | 0% | 0% | 0% | 0% | No Network |
| August | Buipe | 0% | 0% | No Network | 0% | No Network |
| August | Bunkpurugu | 0% | 0% | 0% | 0% | No Network |

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| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|-----------|-----|----------|------------|------------|------------|
| August | Chereponi | 0% | 0% | 0% | 0% | No Network |
| August | Daboya | 0% | 0% | No Network | No Network | No Network |
| August | Damongo | 0% | 0% | 0% | 0% | No Network |
| August | Gambaga | 0% | 0% | 0% | 0% | No Network |
| August | Gushiegu | 0% | 0% | 0% | 0% | No Network |
| August | Karaga | 0% | 0% | 0% | 0% | No Network |
| August | Kumbungu | 0% | 0% | 0% | 0% | 0% |
| August | Saboba | 0% | 0% | 0% | 0% | 0% |
| August | Sagnarigu | 0% | 0% | 0% | 0% | 0% |
| August | Salaga | 0% | 0% | 0% | 0% | No Network |
| August | Sang | 0% | 0% | 0% | 0% | No Network |
| August | Savelugu | 0% | 0% | 0% | 0% | 0% |
| August | Sawla | 0% | 0% | 0% | 0% | No Network |
| August | Tamale | 0% | 0% | 0% | 0% | 0% |
| August | Tatale | 0% | 0% | 0% | 0% | No Network |
| August | Tolon | 0% | 0% | 0% | 0% | 0% |
| August | Walewale | 0% | 0% | 0% | 0% | No Network |
| August | Yagaba | 0% | 0% | 0% | No Network | No Network |
| August | Yendi | 0% | 0% | 0% | 0% | No Network |
| August | Zabzugu | 0% | 0% | 0% | 0% | No Network |

REMARK:

- ❖ All Operators were in compliance with the Call Drop Rate licence threshold of less than three percent (3%) in the available District Capitals tested.

e) Call Completion Rate (CCR)

Call Completion Rate is defined as the probability that a call has, after being successfully set up, be maintained during a period of time and ending normally.

$$\text{Call Completion [\%]} = \frac{\text{Number of normally ended calls}}{\text{Total number of call attempts}} \times 100\%$$

Call Completion Rate should be equal or better than seventy percent (70%).

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Table 5 Call Completion Rate, Cellular Mobile Voice Service, August 2016

| Month | Town | MTN | Vodafone | Tigo | Airtel | Glo |
|--------|------------|--------|----------|------------|------------|------------|
| August | Bimbilla | 100% | 100% | 100% | 100% | No Network |
| August | Bole | 100% | 100% | 98.75% | 98.75% | No Network |
| August | Buipe | 100% | 100% | No Network | 100% | No Network |
| August | Bunkpurugu | 100% | 100% | 98% | 100% | No Network |
| August | Chereponi | 100% | 100% | 100% | 100% | No Network |
| August | Daboya | 92.31% | 100% | No Network | No Network | No Network |
| August | Damongo | 98.02% | 100% | 100% | 100% | No Network |
| August | Gambaga | 100% | 100% | 100% | 100% | No Network |
| August | Gushegu | 100% | 100% | 100% | 98.4% | No Network |
| August | Karaga | 100% | 100% | 100% | 100% | No Network |
| August | Kumbungu | 100% | 100% | 100% | 94.59% | 88.24% |
| August | Saboba | 100% | 100% | 97.18% | 100% | No Network |
| August | Sagnarigu | 98.72% | 100% | 99.43% | 97.77% | 92.47% |
| August | Salaga | 100% | 100% | 98.77% | 100% | No Network |
| August | Sang | 100% | 100% | 100% | 100% | No Network |
| August | Savelugu | 91.67% | 100% | 89.09% | 100% | 77.78% |
| August | Sawla | 100% | 100% | 100% | 100% | No Network |
| August | Tamale | 100% | 99.44% | 74.19% | 98.5% | 81.64% |
| August | Tatale | 100% | 100% | 100% | 98.5% | No Network |
| August | Tolon | 100% | 100% | 100% | 100% | 100% |
| August | Walewale | 100% | 100% | 77.42% | 100% | No Network |
| August | Yagaba | 100% | 100% | 100% | No Network | No Network |
| August | Yendi | 100% | 100% | 97.94% | 100% | No Network |
| August | Zabzugu | 100% | 100% | 100% | 100% | No Network |

REMARKS:

- ❖ All Operators were in compliance with the Call Completion Rate licence threshold of less than seventy percent (70%) in all localities tested.

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f) Voice Call Audio Quality

It is the perceptibility of the conversation during a call. Voice Call Audio Quality is measured by a parameter called the Mean Opinion Score (MOS) which categorizes speech samples in ranges from 0 to 5.

| Range | Colour Code | Rating |
|-------------|-------------|-----------|
| [0 – 2.5) | | Poor |
| [2.5 – 3.5) | | Fair |
| [3.5 – 4.1) | | Good |
| [4.1 – 5) | | Excellent |

Table 5 Speech Quality Mean Opinion Score Northern Region, August 2016

| Northern Region | MTN | Vodafone | Tigo | Airtel | Glo |
|-----------------|------|----------|------|--------|------|
| MOS | 3.35 | 3.65 | 3.78 | 3.39 | 3.79 |

REMARK:

- ❖ Vodafone, Tigo and Glo were assessed to give GOOD speech quality.
- ❖ MTN and Airtel were assessed to give FAIR speech quality.

REMEDIES

- ❖ The NCA has notified Operators of these findings and has directed to improve their coverage in some localities by **December 31, 2016**.
- ❖ Glo has been sanctioned for the failure in Call Setup Time and Call Congestion obligations in the Northern Region.
- ❖ Tigo has been sanctioned for failing Call Setup Time in the Northern Region.

APPENDICES

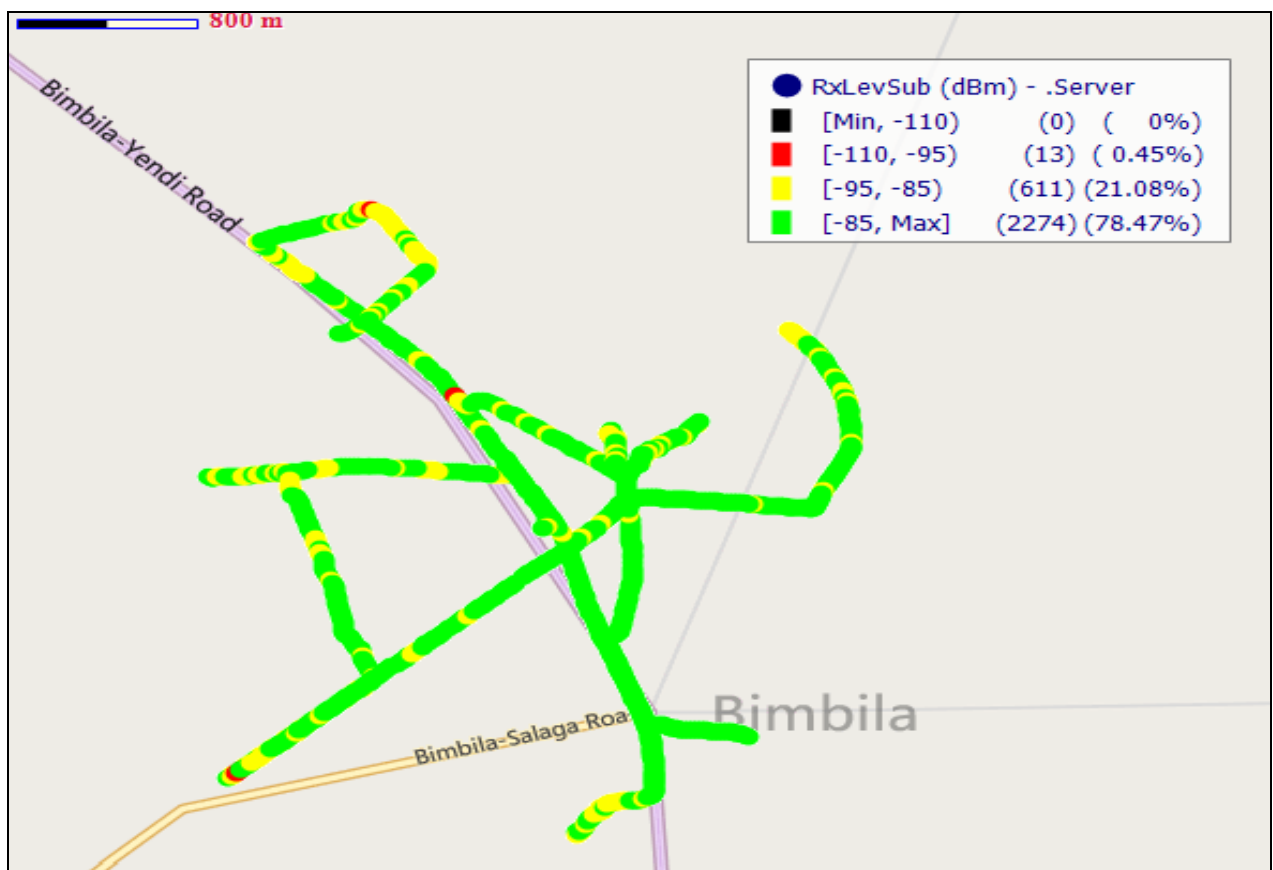
COVERAGE AND SPEECH MAPS

The Maps below show the coverage level and speech quality in the various towns where monitoring was performed. The coverage map is a combination of both 2G and 3G network signal strength. In each plot is a legend to indicate definitions of signal strength and quality range attain by operators during measurement. Coverage levels in green falls in the range of -85dBm and above are considered good. Those between -85 and -95dBm are considered average and are indicated in yellow. The red samples represent worse coverage in the range of -95 to -105dBm. The black samples represent areas with no coverage. The speech quality was assessed with Mean Opinion Score (MOS) which ranges from 5 to 1.

APPENDIX I

COVERAGE AT BIMBILLA

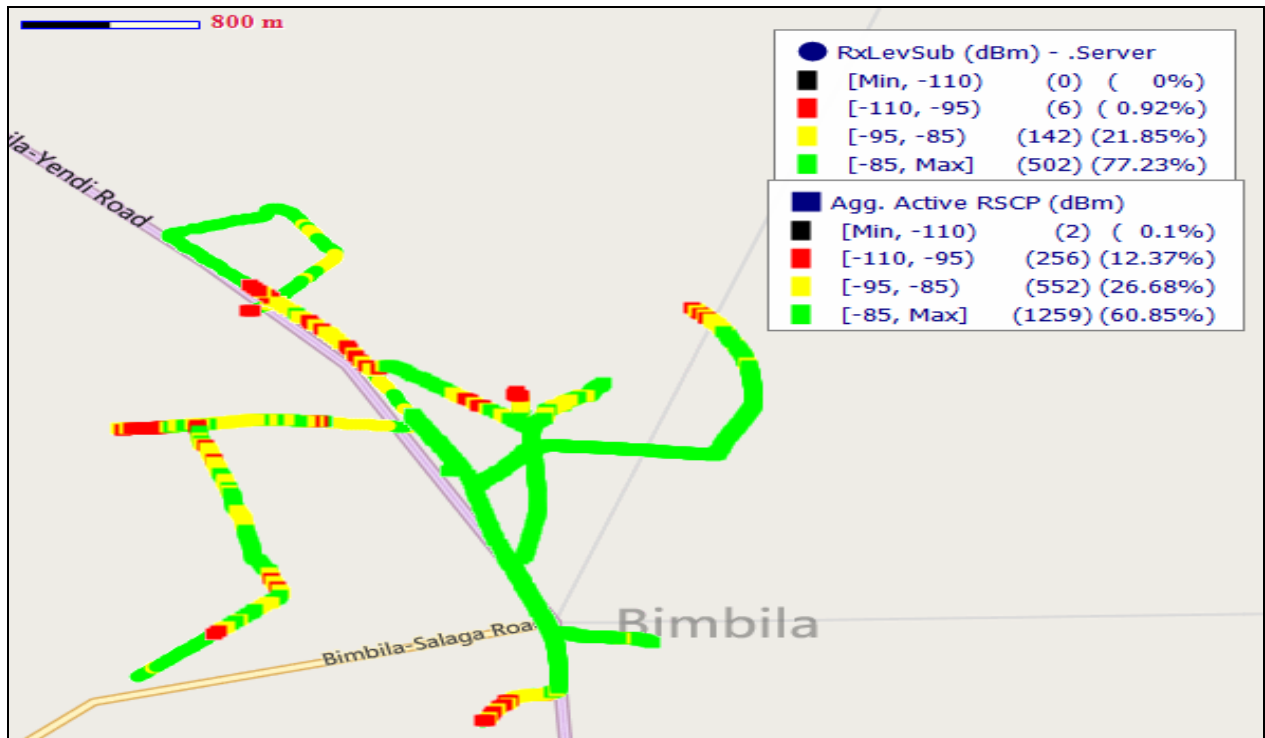
Fig 1. MTN Network Coverage Map, Bimbilla – August 2016



Remarks: Good network coverage at Bimbilla.

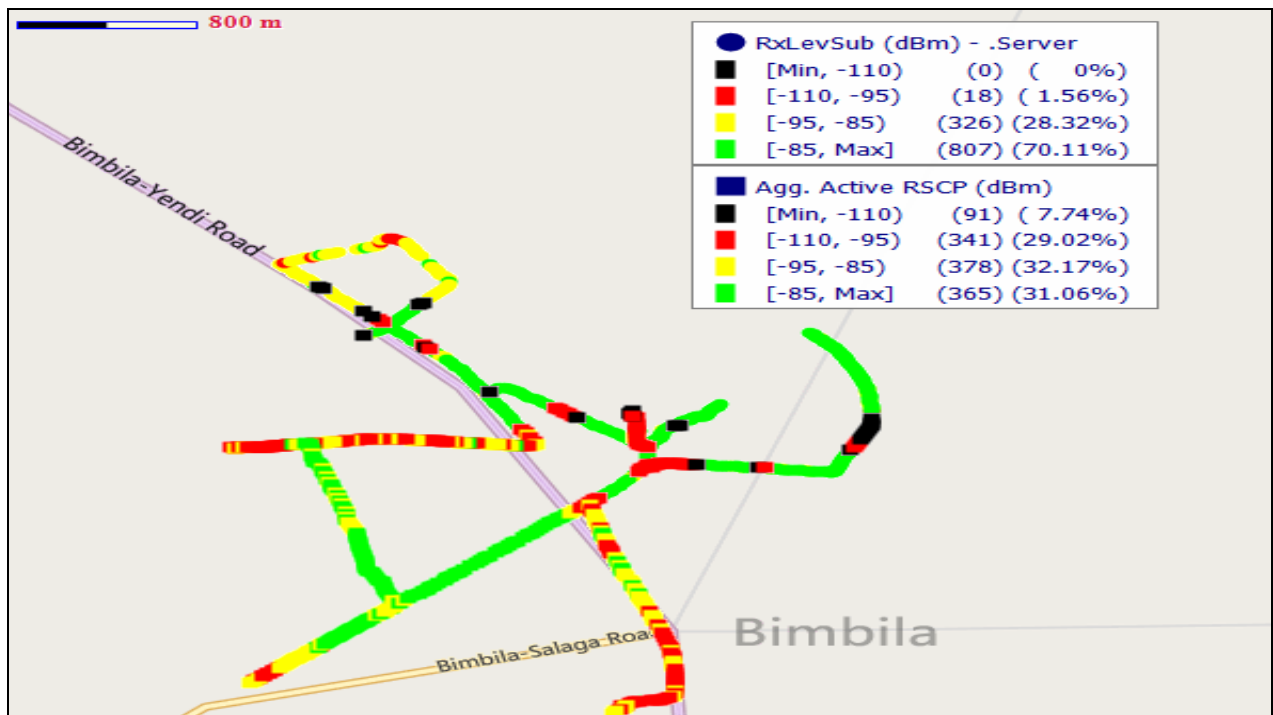
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Fig 2. Vodafone Network Coverage Map, Bimbilla – August 2016



Remarks: Good network coverage in Bimbilla however improvement is needed at the District Assembly Office, Alurarin and Masaka.

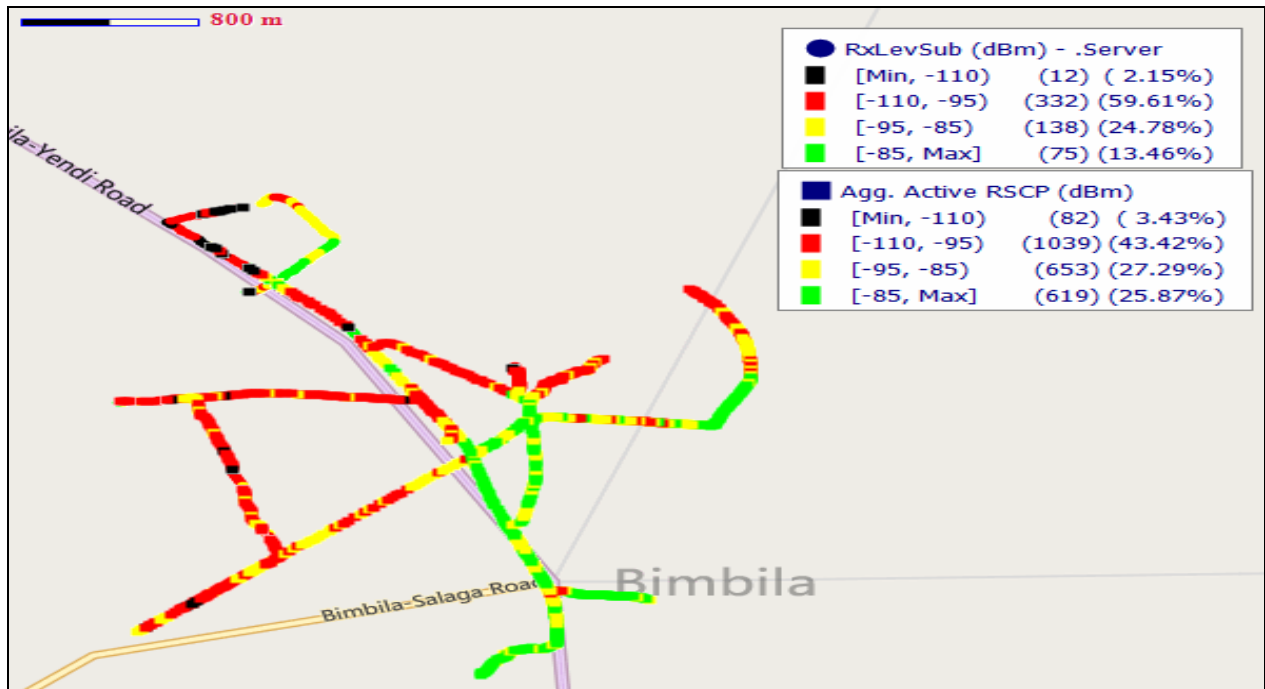
Fig 3. Tigo Network Coverage Map Bimbilla – August 2016



Remarks: Fair network coverage in Bimbilla which require improvement at the District Assembly Office, Alurarin and Masaka.

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Fig 4. Airtel Network Coverage Map Bimbilla – August 2016

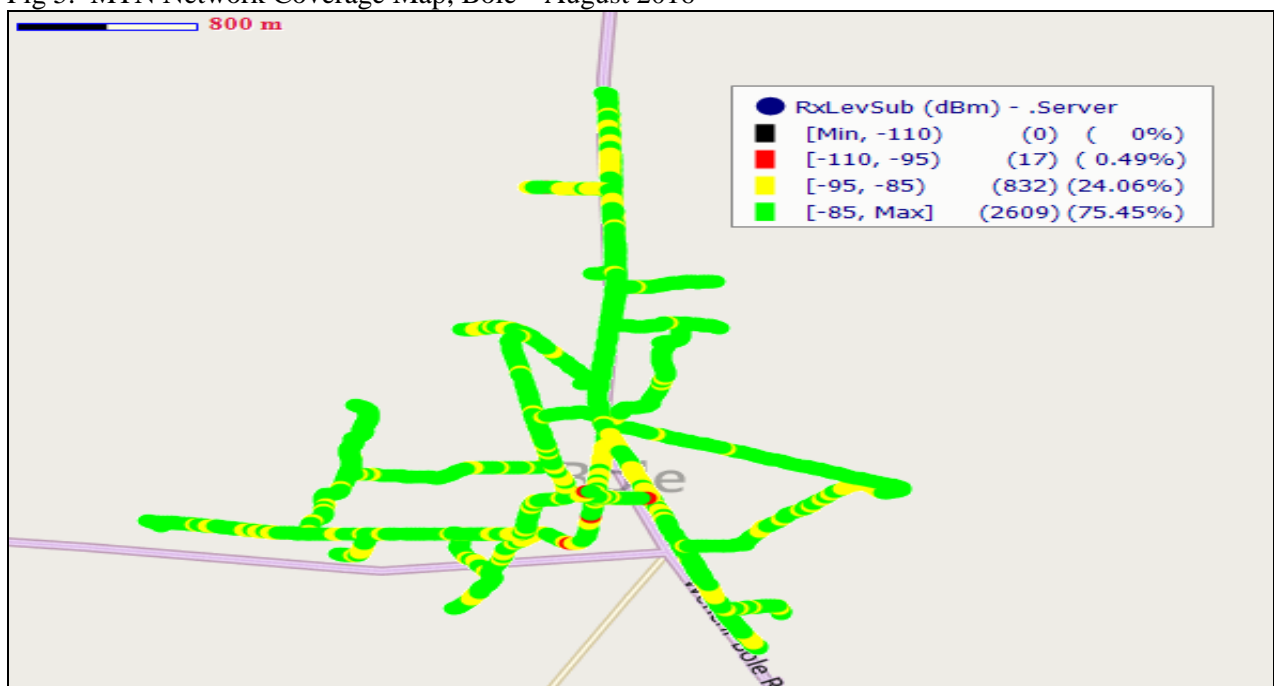


Remarks: Fair network coverage in Bimbilla. Major improvement is needed at Bimbilla Training College, Masako, District Hospital, District Assembly and Kunkuna.

***Glo had no service in Bimbilla at the time of the test.**

COVERAGE AT BOLE

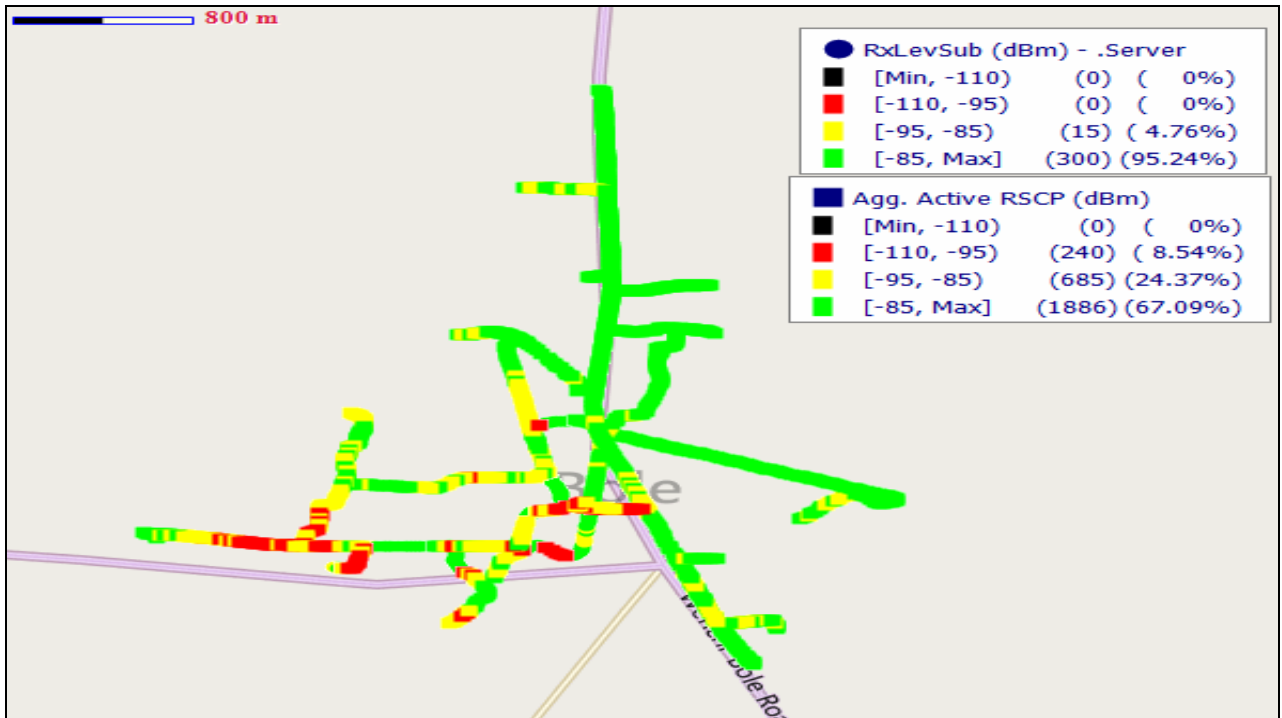
Fig 5. MTN Network Coverage Map, Bole – August 2016



Remarks: Good network coverage across Bole.

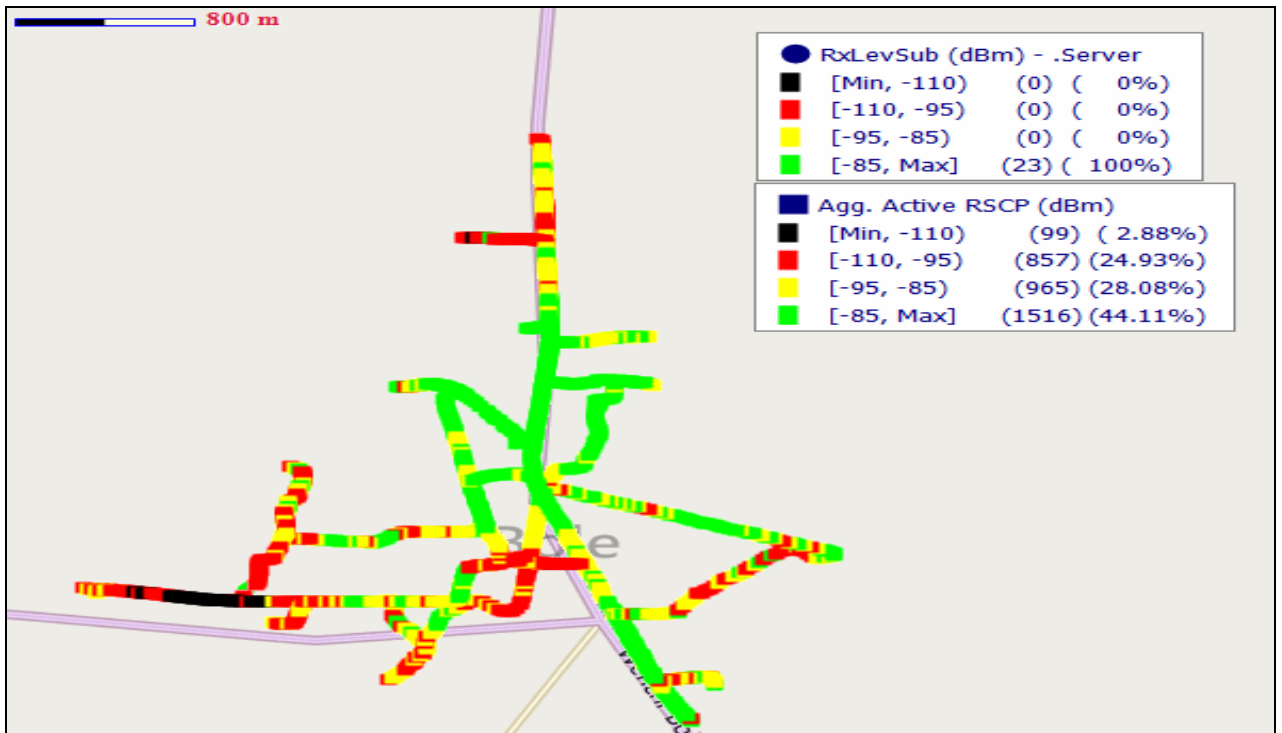
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Fig 6. Vodafone Network Coverage Map, Bole – August 2016



Remarks: Good network coverage across Bole however improvement is needed at Mangoline, Hospital, COCOBOD Guest House and Bole Senior High School.

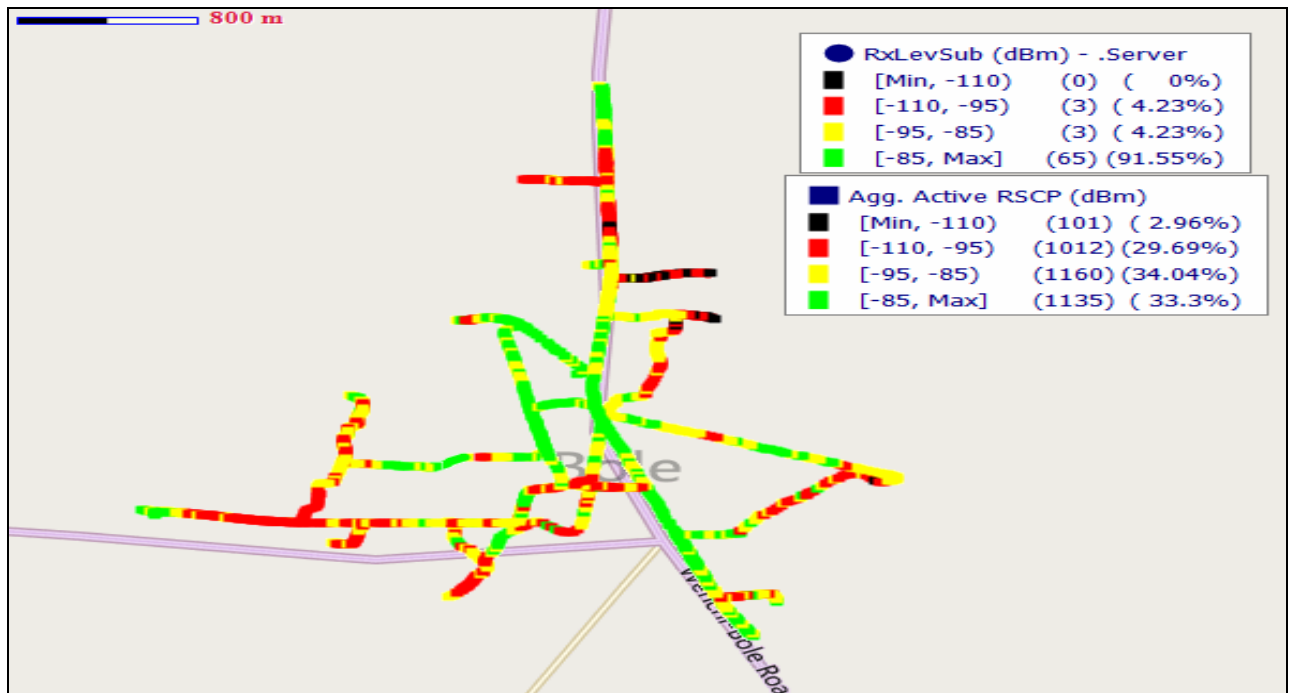
Fig 7. Tigo Network Coverage Map, Bole – August 2016



Remarks: Fair network coverage with improvements needed at Domeabra, Bole Hospital, COCOBOD Guest House and Bole Senior High School.

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Fig 8. Airtel Network Coverage Map, Bole – August 2016

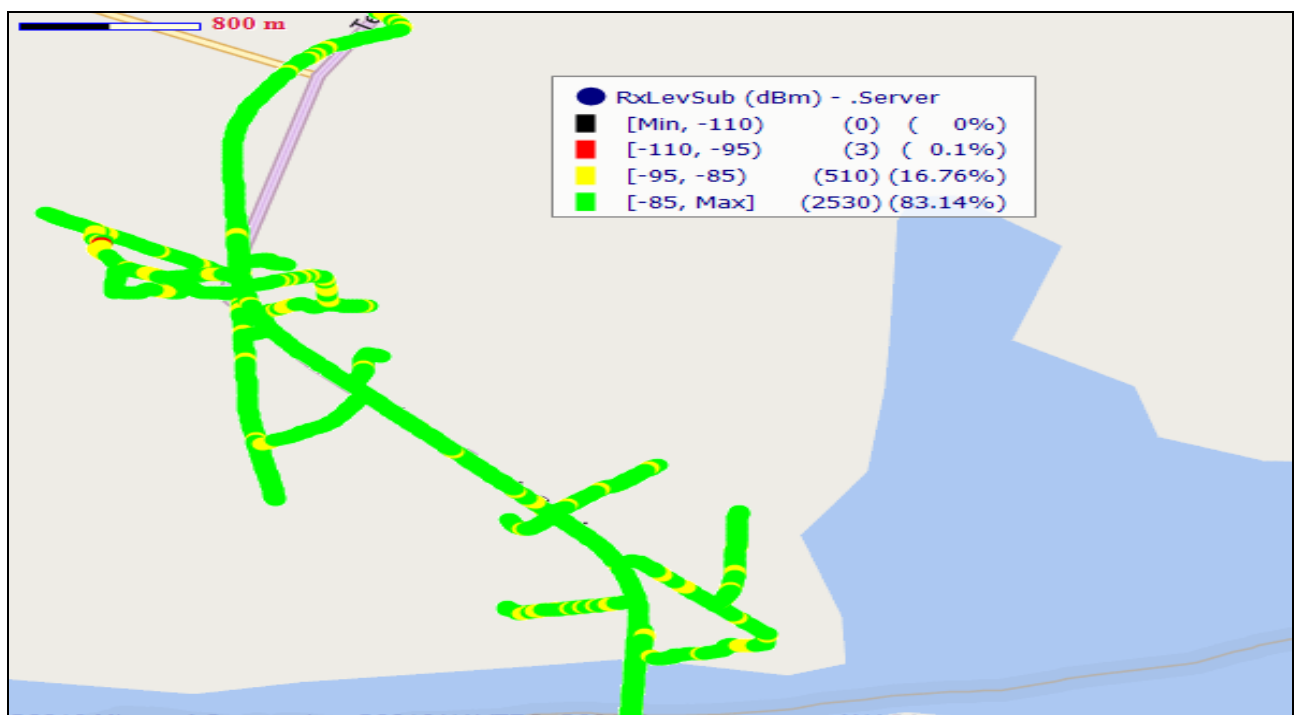


Remarks: Fair network in Bole with improvement needed at COCOBOD Guest House, Bole District Hospital and Bilinsen.

***Glo had no service in Bole at the time of the test.**

COVERAGE AT BUIPE

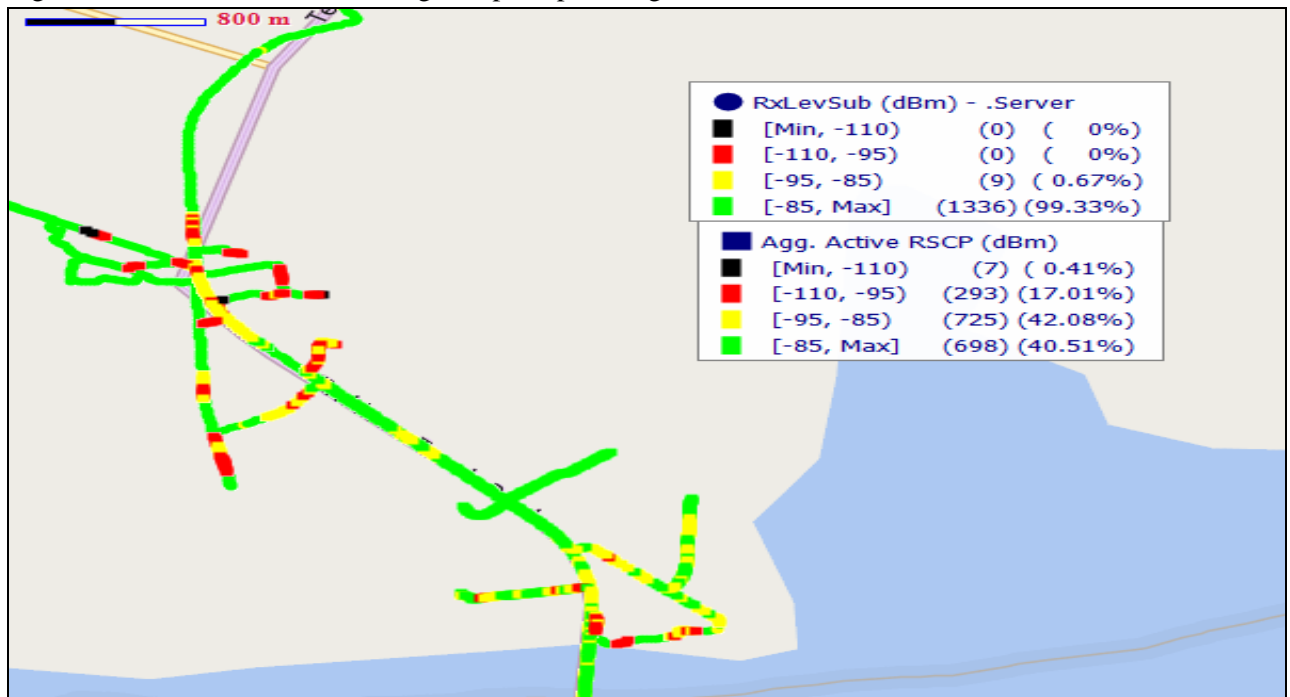
Fig 9. MTN Network Coverage Map, Buipe – August 2016



Remarks: Good network coverage at Buipe.

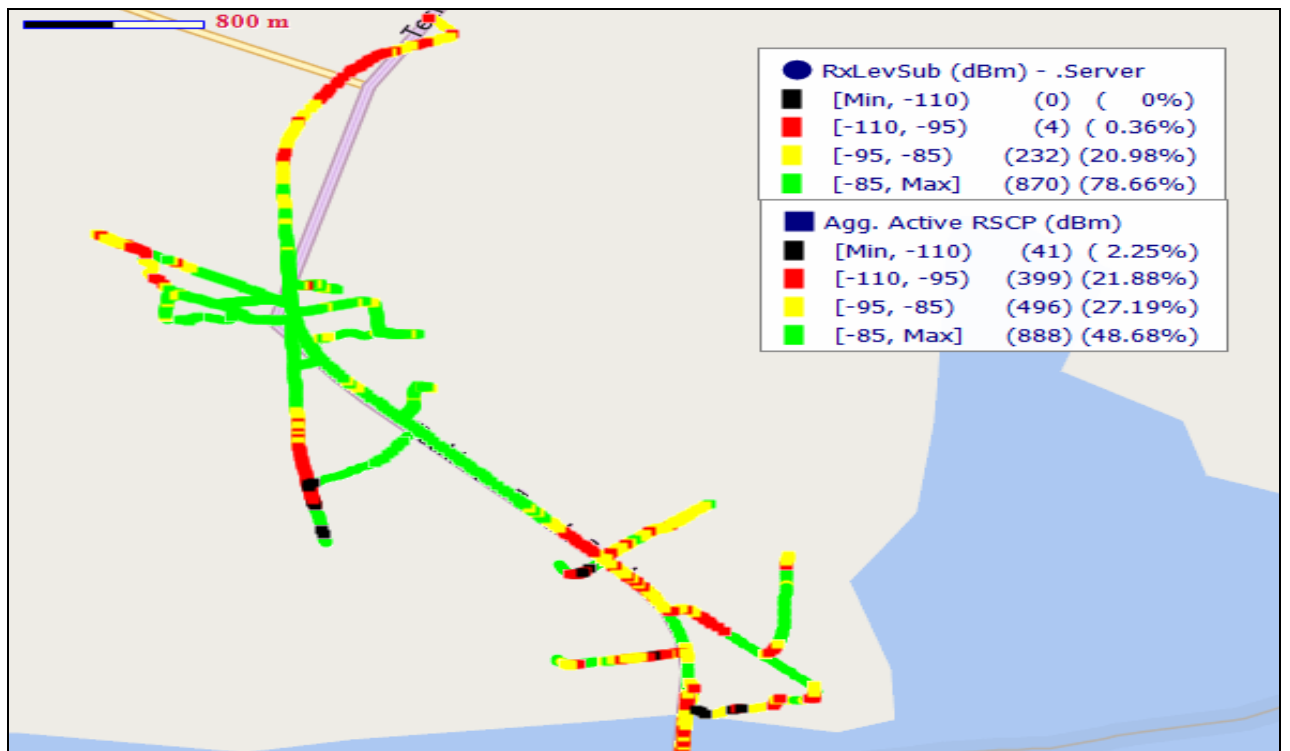
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Fig 10. Vodafone Network Coverage Map Buipe – August 2016



Remarks: Good network coverage across Buipe but areas around Wolonto, Boduwase and Yipala needs to be improved.

Fig 11. Airtel Network Coverage Map Buipe – August 2016



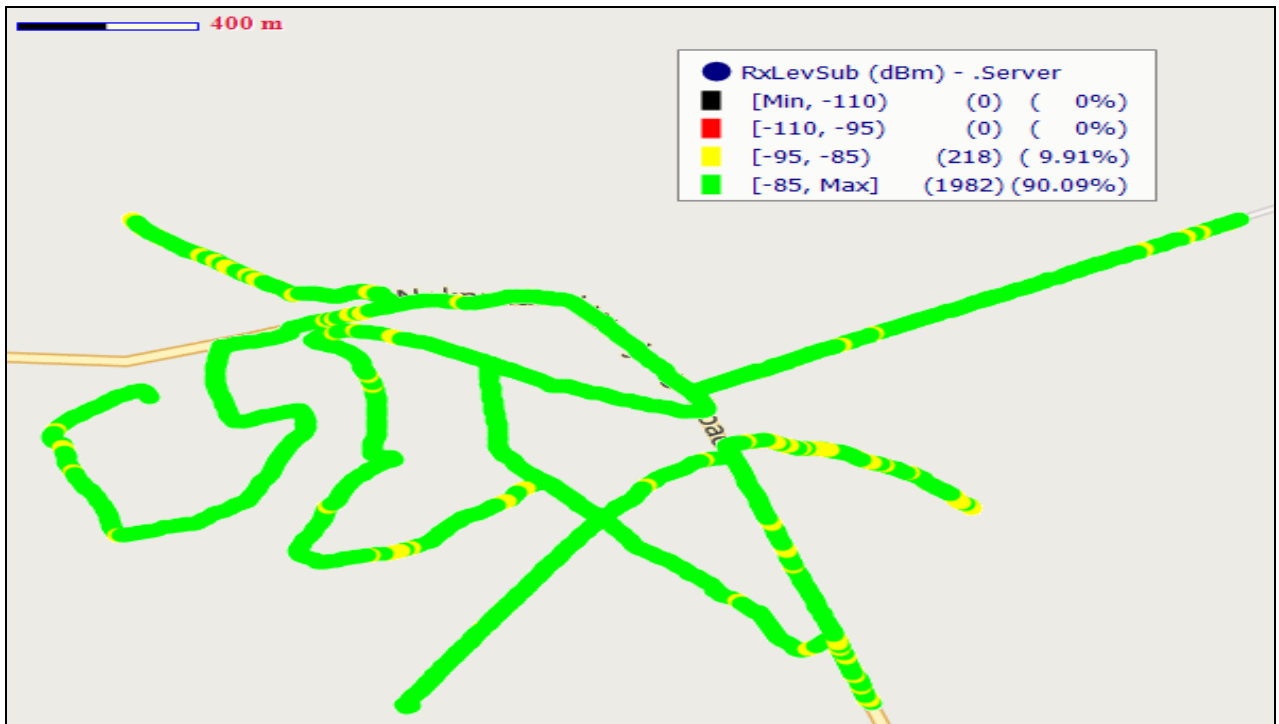
Remarks: Good network coverage in Buipe but improvement is needed at the District Assembly Office, Boduwase, Bridge and Wolonto.

***Tigo and Glo had no service in Buipe at the time of the test.**

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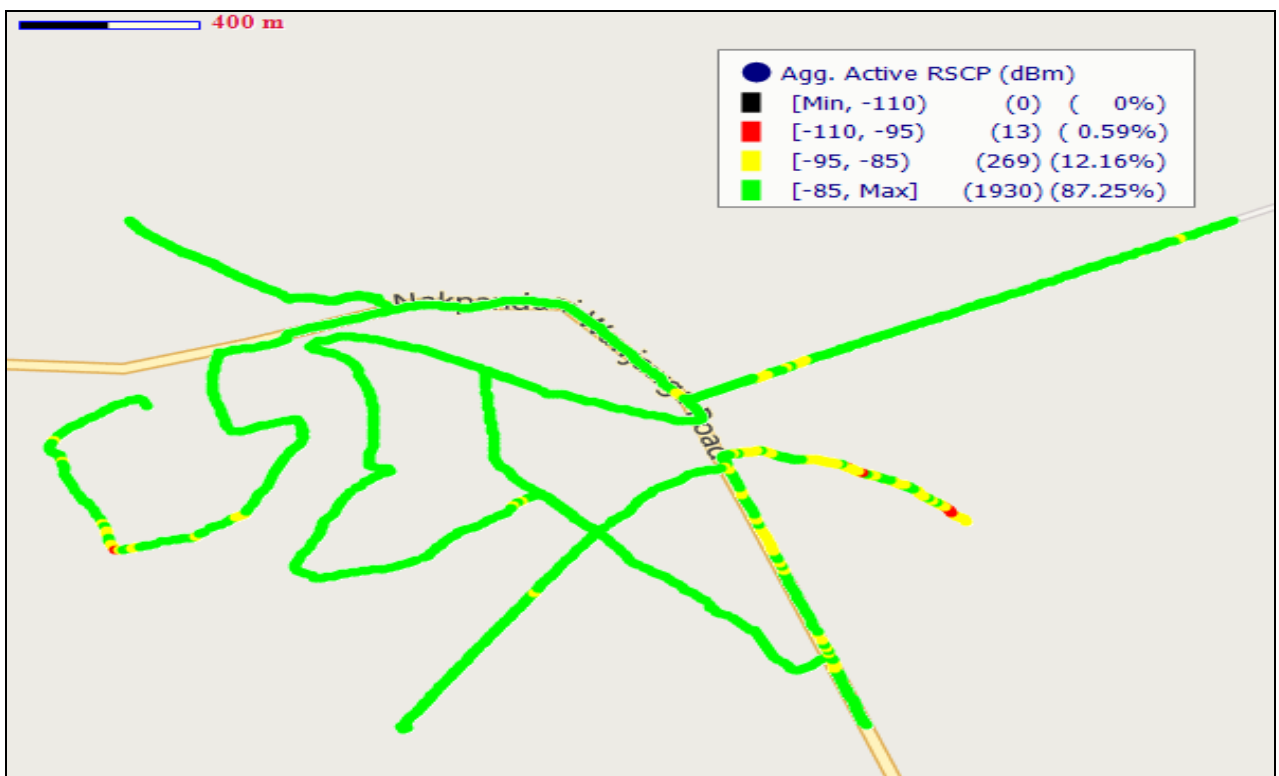
COVERAGE AT BUNKPURUGU

Fig 12. MTN Network Coverage Map, Bunkpurugu – August 2016



Remarks: Good network coverage across Bunkpurugu.

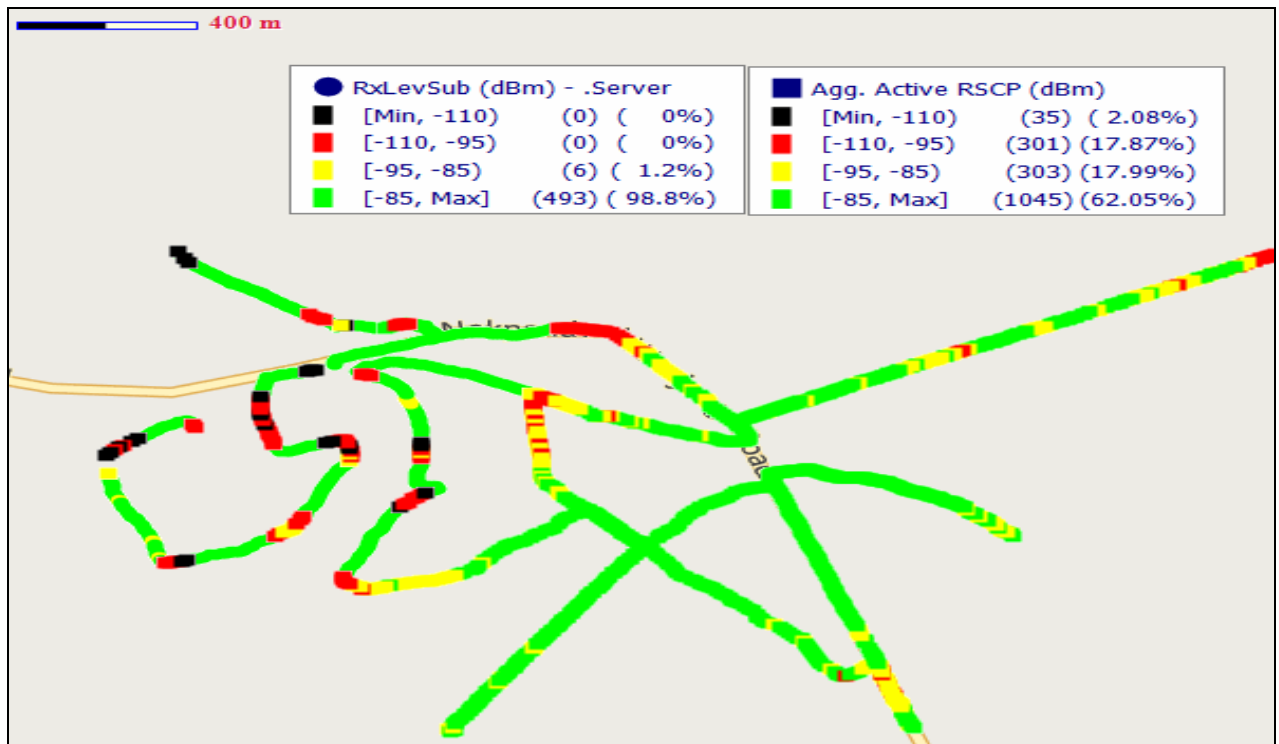
Fig 13. Vodafone Network Coverage Map, Bunkpurugu – August 2016



Remarks: Good network coverage within Bunkpurugu.

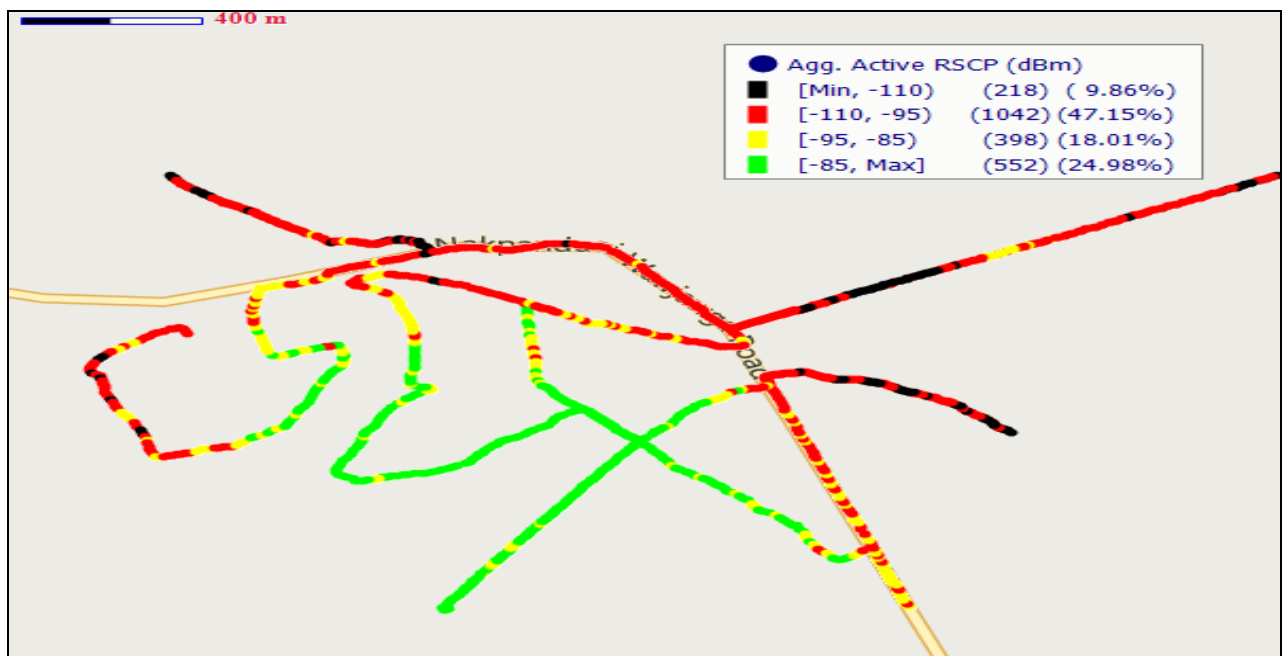
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Fig 14. Tigo Network Coverage Map, Bunkpurugu – August 2016



Remarks: Good network coverage in Bunkpurugu with bad spots which require improvement.

Fig 15. Airtel Network Coverage Map Bunkpurugu



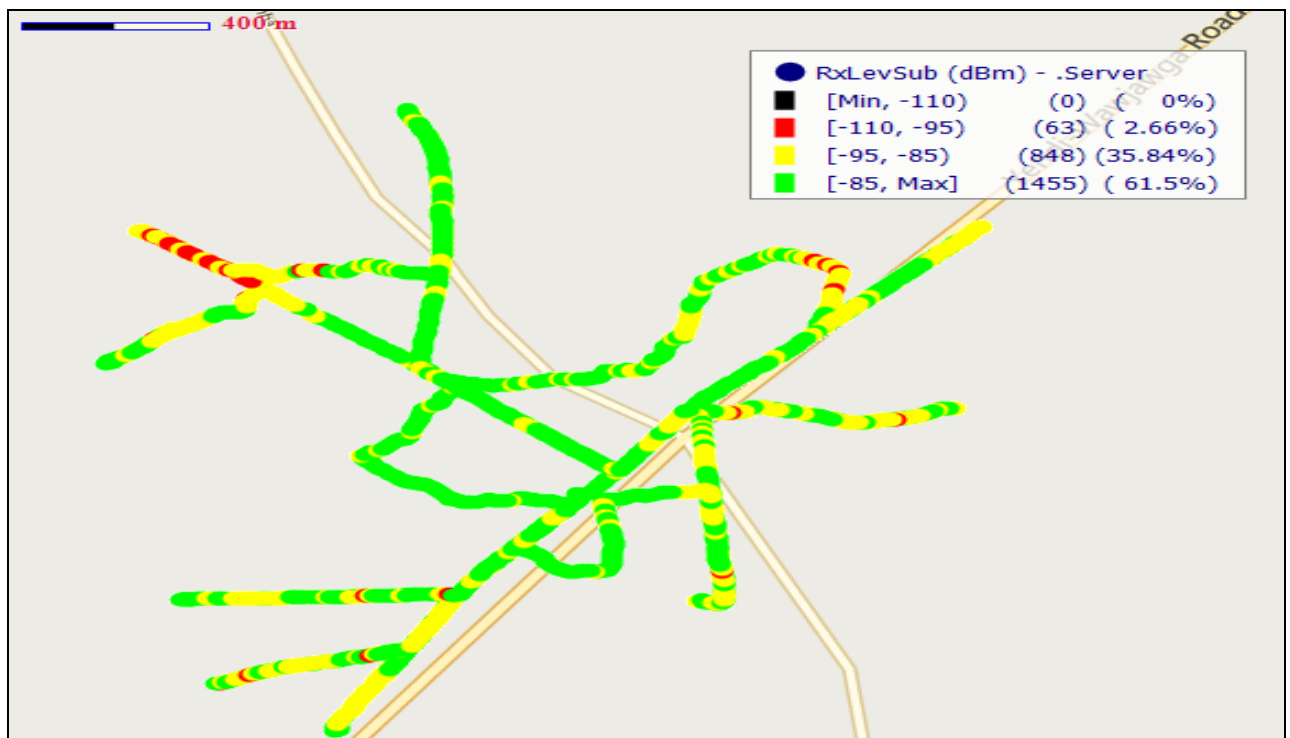
Remarks: Poor coverage in Bunkpurugu. Major improvement is needed at Bunkpurugu Health Center, Rabito Clinic, areas around the District Assembly Office and Market.

***Glo had no service in Bunkpurugu at the time of the test.**

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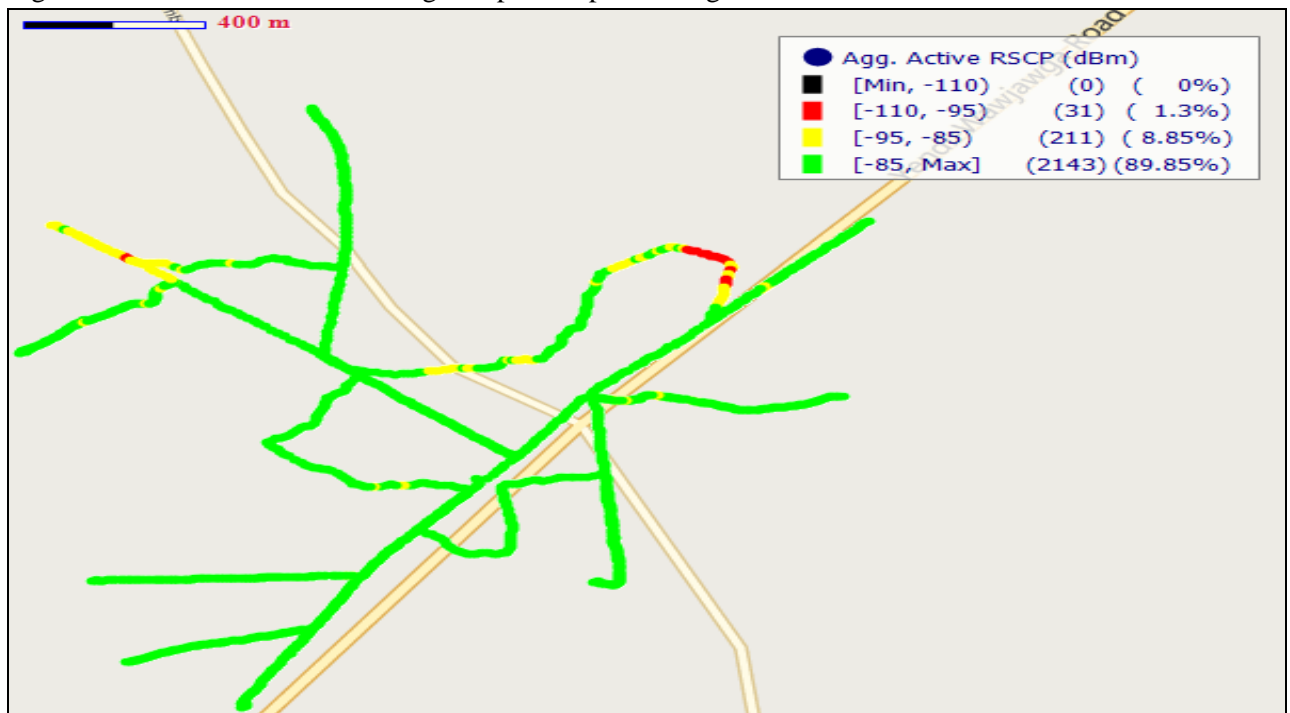
COVERAGE AT CHEREPONI

Fig 16. MTN Network Coverage Map Chereponi – August 2016



Remarks: Good network coverage in Chereponi however improvement is needed at Chereponi Senior High and St. Brigid’s Catholic Church.

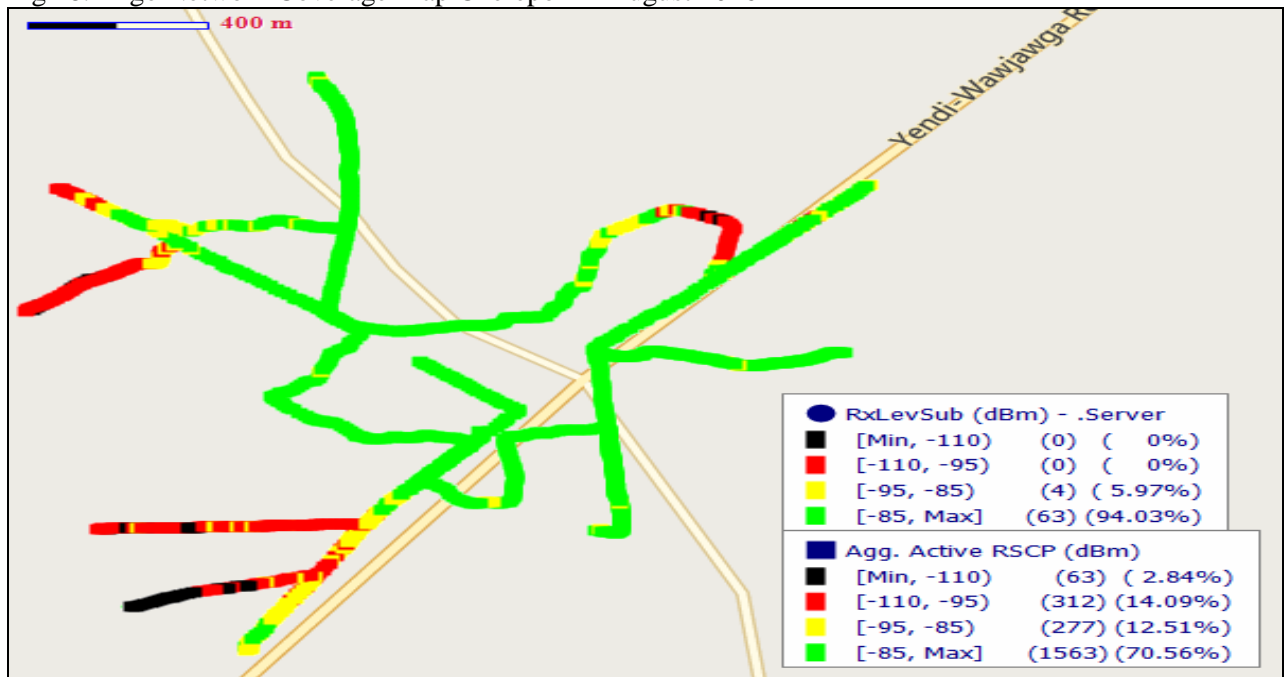
Fig 17. Vodafone Network Coverage Map Chereponi – August 2016



Remarks: Good network coverage at Chereponi.

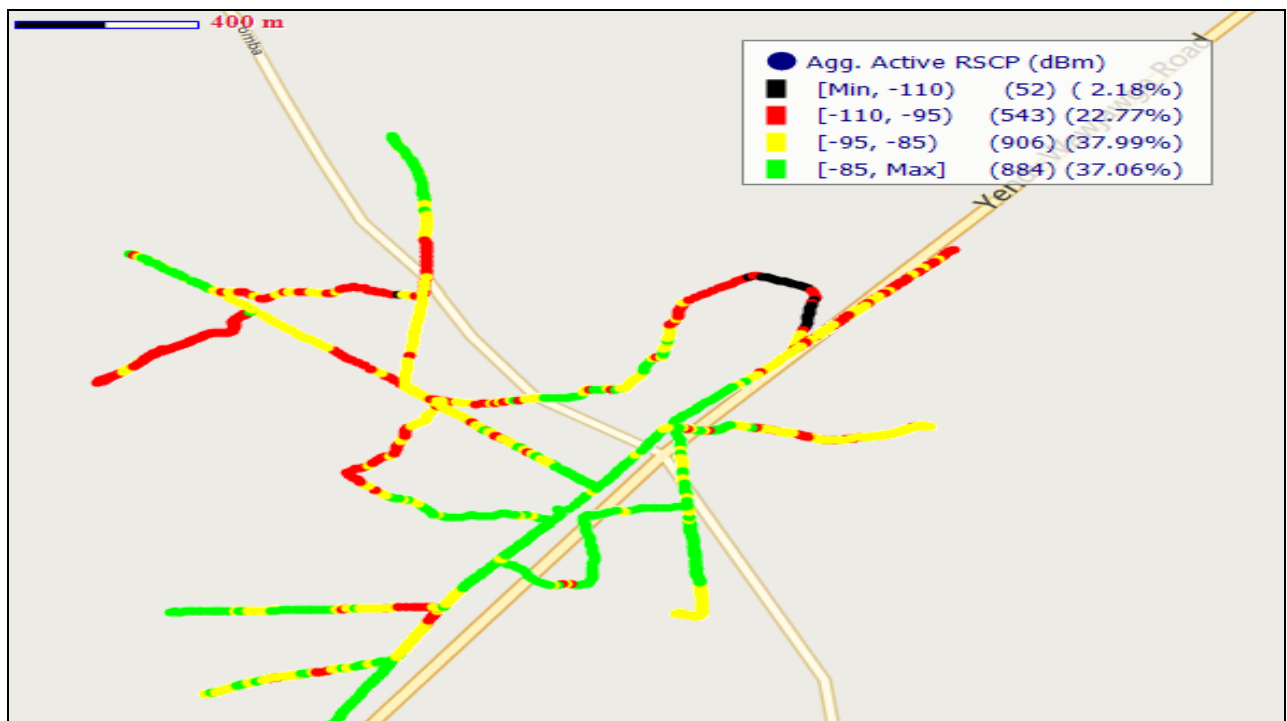
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 18. Tigo Network Coverage Map Chereponi – August 2016



Remarks: Good network coverage within Chereponi however, areas in the outskirts like Chereponi Senior High, St. Brigid’s Catholic Church, Chereponi Government Hospital and St. Jude Vocational Training Institute needs to be improved.

Fig 19. Airtel Network Coverage Map Chereponi. - August 2016



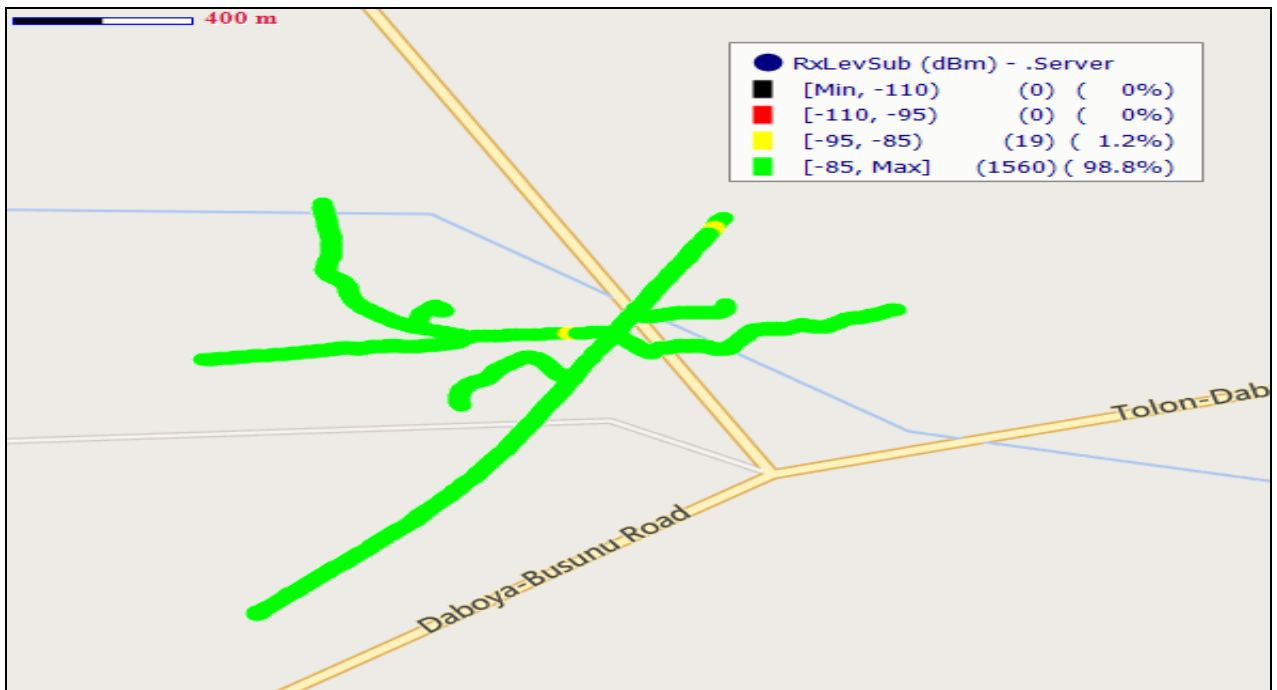
Remarks: Fair network coverage at Chereponi with improvement needed at Chereponi Senior High, Market, St. Brigids Catholic Church and Sikafuoambantem.

***Glo had no service in Chereponi at the time of the test**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

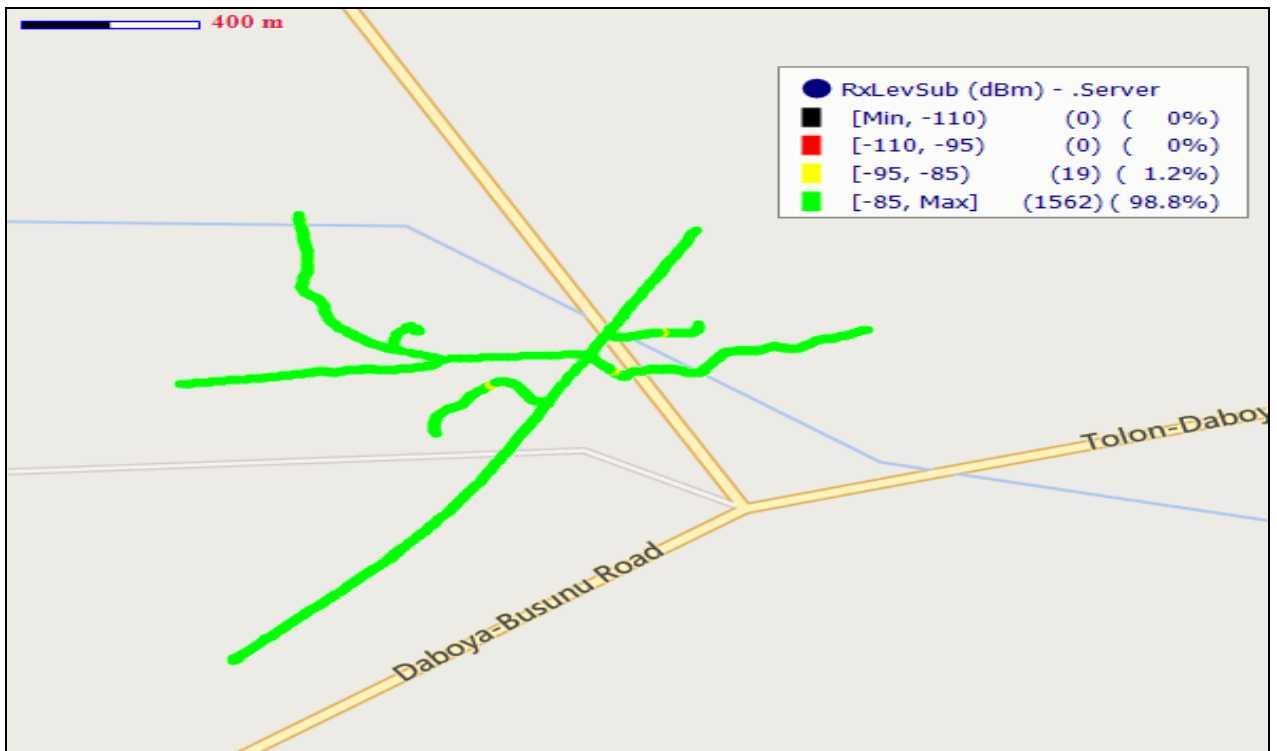
COVERAGE AT DABOYA

Fig 20. MTN Network Coverage Map Daboya – August 2016



Remarks: Good network coverage at Daboya.

Fig 21. Vodafone Network Coverage Map Daboya – August 2016



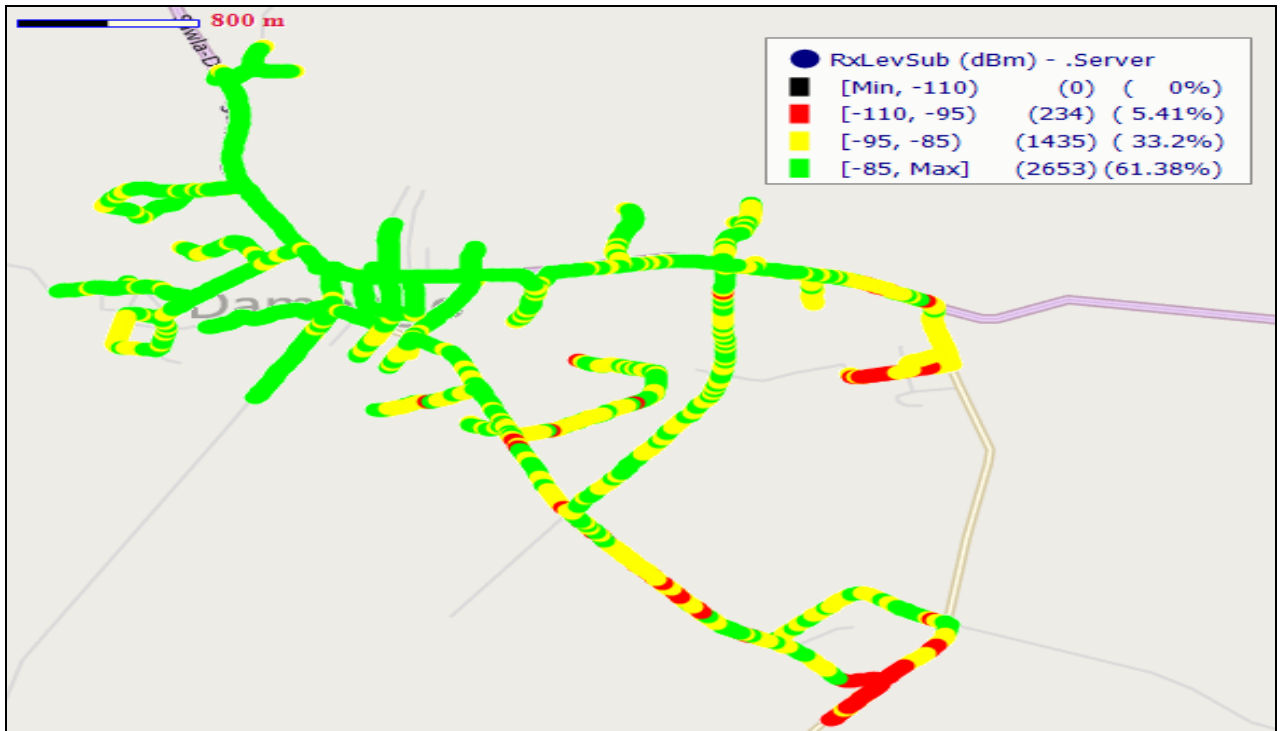
Remarks: Good network coverage at Daboya.

***Tigo, Airtel and Glo had no service in Daboya at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

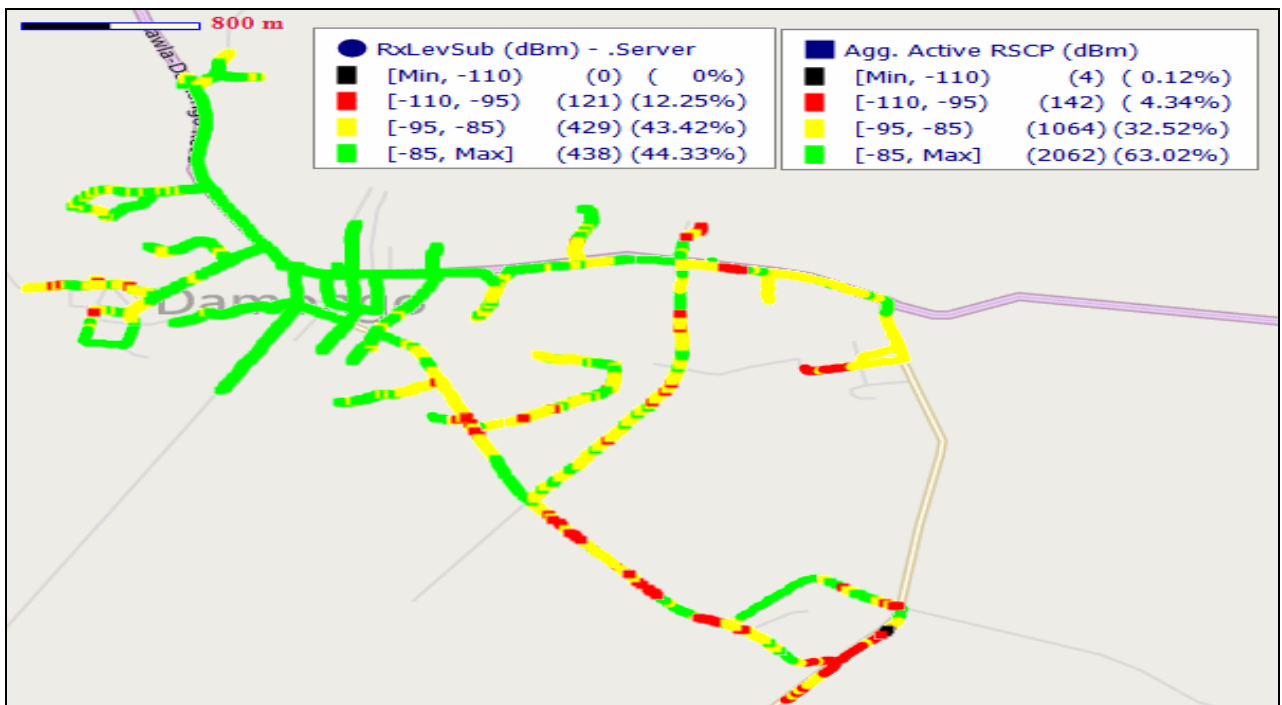
COVERAGE AT DAMONGO

Fig 22. MTN Network Coverage Map Damongo – August 2016



Remarks: Good network coverage in Damongo but improvement is needed at Canteen, West Gonja Hospital and Catholic Guest House.

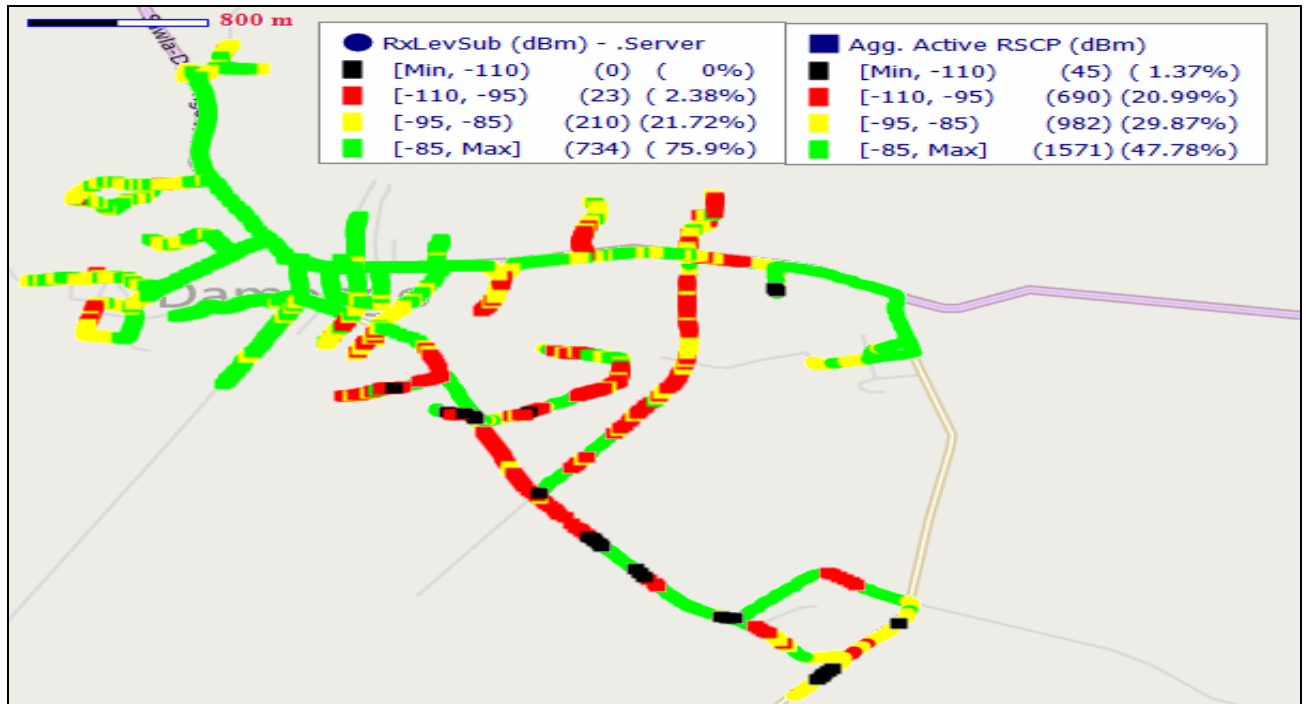
Fig 23. Vodafone Network Coverage Map Damongo – August 2016



Remarks: Good network coverage across Damongo but improvement is needed at ‘Canteen’, West Gonja Hospital and Catholic Guest House.

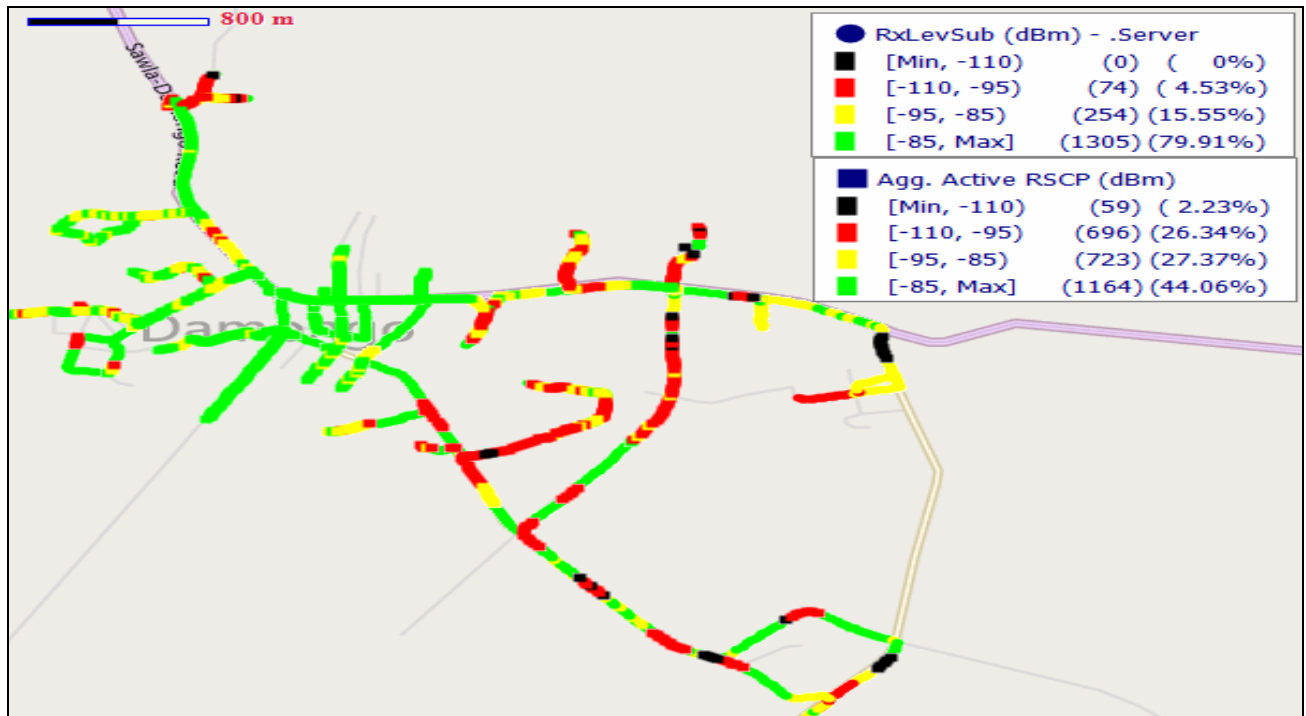
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 24. Tigo Network Coverage Map Damongo – August 2016



Remarks: Fair network coverage across Damongo. Improvement is needed at ‘Canteen’, West Gonja Hospital, Catholic Guest House, Sabo Zongo and Damongo Senior High School.

Fig 25. Airtel Network Coverage Map Damongo – August 2016



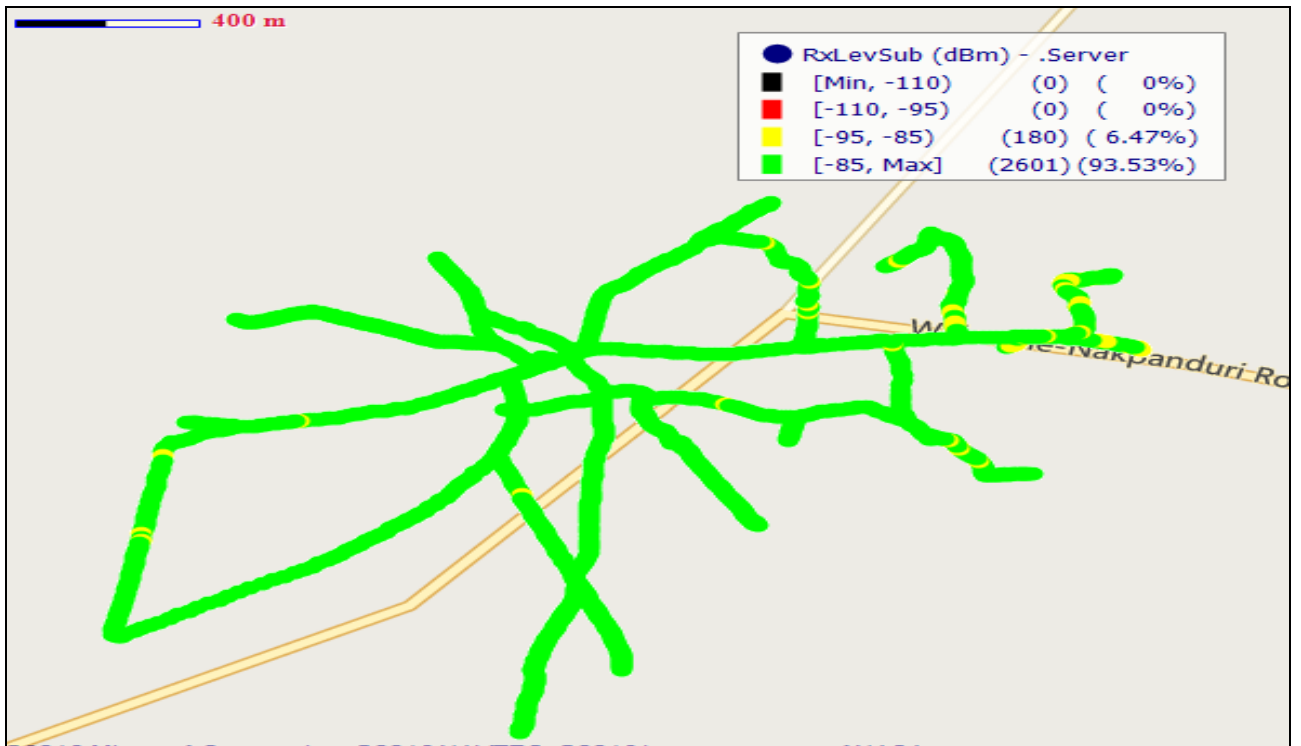
Remarks: Good coverage in Damongo with bad spots at Agric College, Catholic Guest House, West Gonja Hospital and Sabon Zongo which requires improvement.

***Glo had no service in Damongo at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

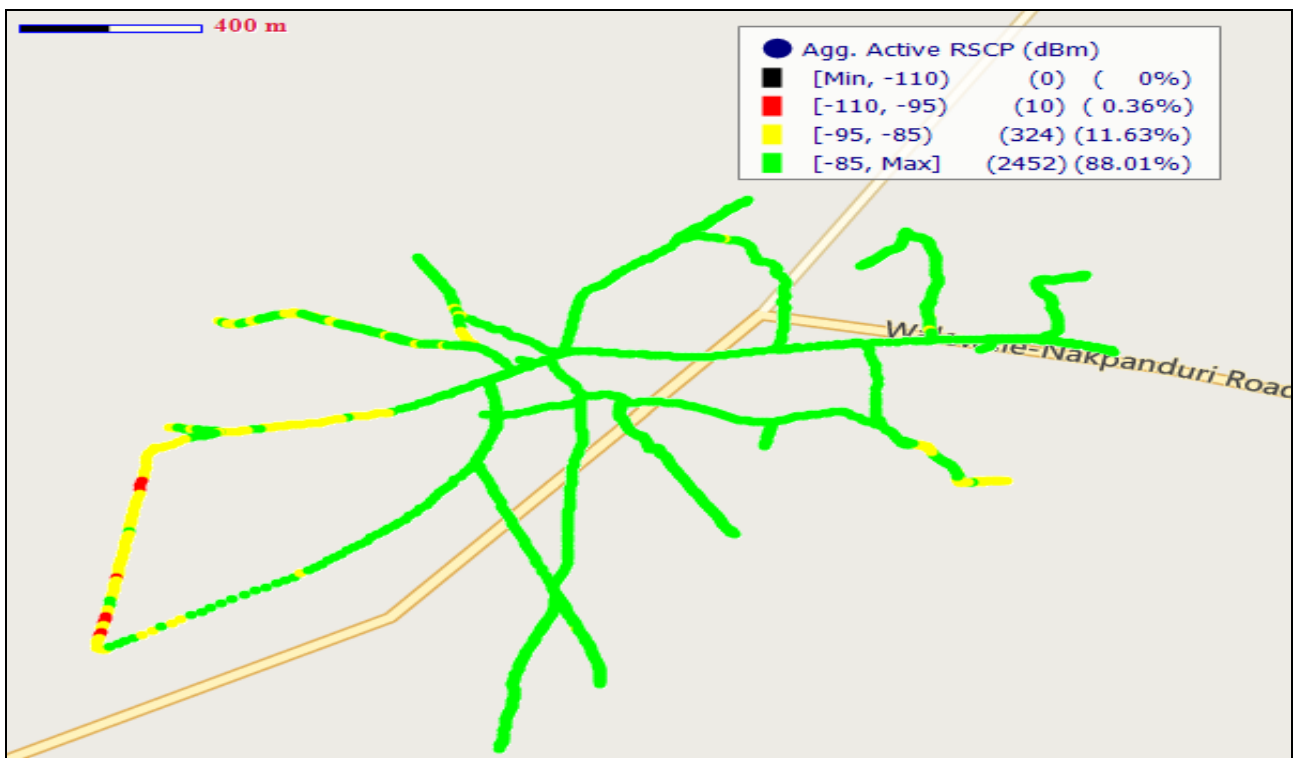
COVERAGE AT GAMBAGA

Fig 26. MTN Network Coverage Map Gambaga – August 2016



Remarks: Good network coverage in Gambaga.

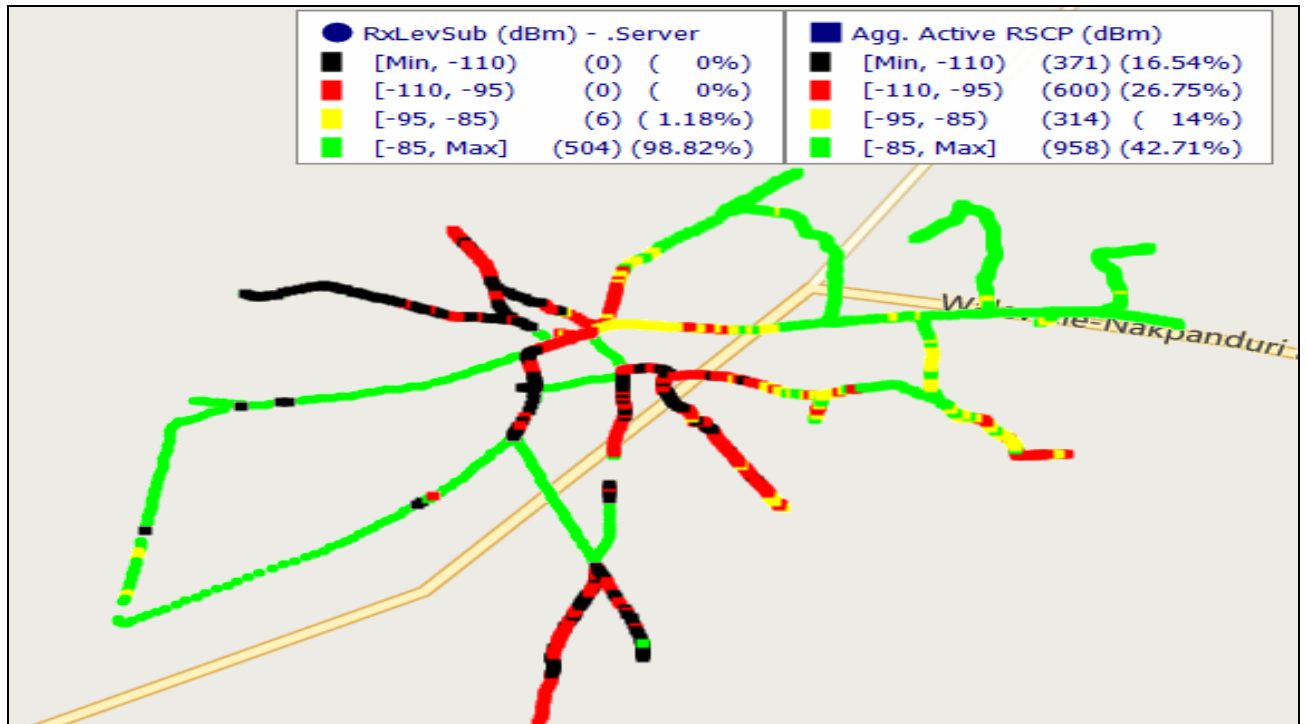
Fig 27. Vodafone Network Coverage Map Gambaga -August 2016



Remarks: Good network coverage at Gambaga.

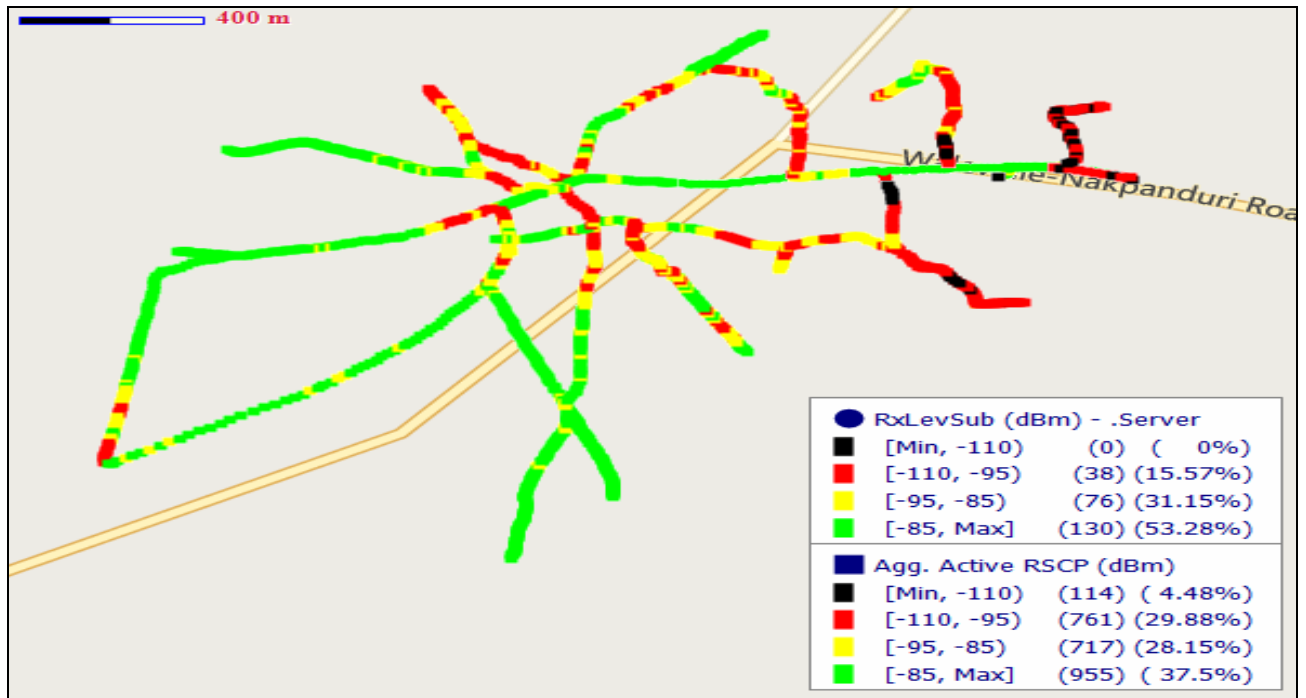
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 28. Tigo Network Coverage Map Gambaga – August 2016



Remarks: Fair network coverage which needs improvement across Gambaga.

Fig 29. Airtel Network Coverage Map Gambaga – August 2016



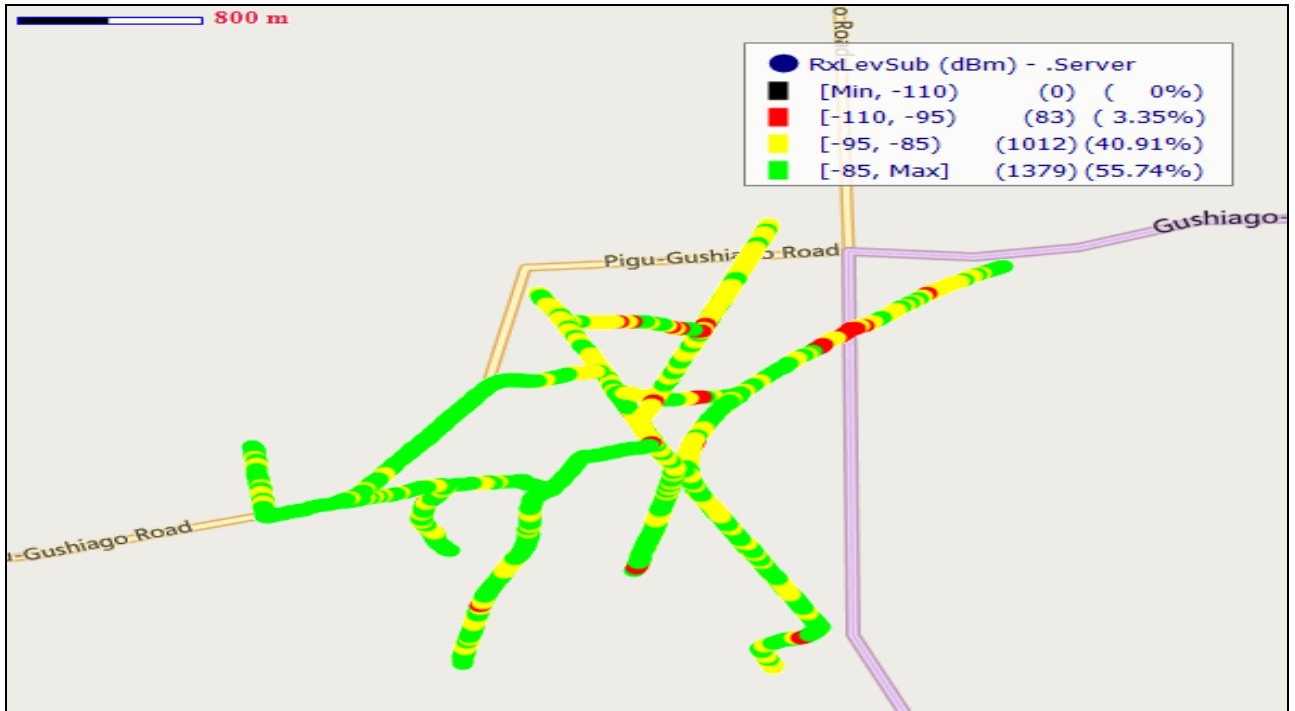
Remarks: Fair coverage in Gambaga however improvement is needed at Sibeafong, Imamfong, Bagoss and Gambaga Health Center.

***Glo had no service in Gambaga at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

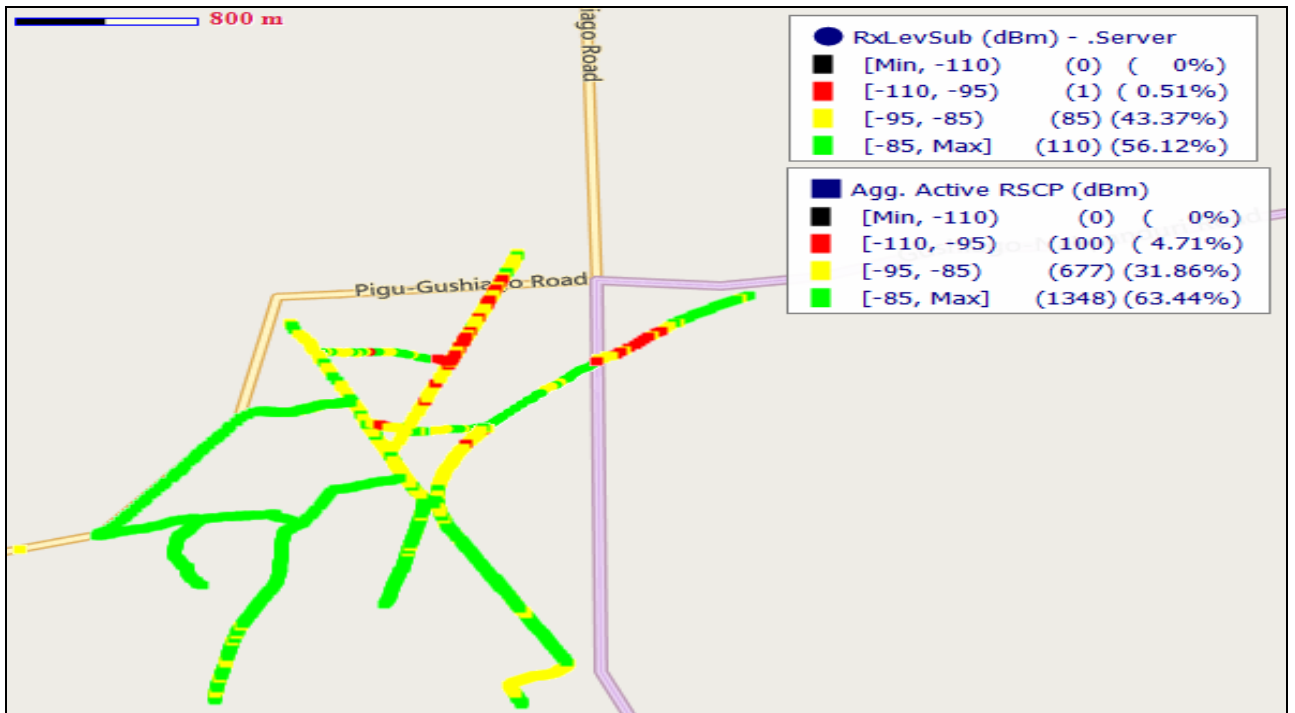
COVERAGE AT GUSHIEGU

Fig 30. MTN Network Coverage Map Gushiegu – August 2016



Remarks: Good network coverage in Gushiegu but improvement is still needed at Eastern Corridor Hotel and Gushegu Hospital.

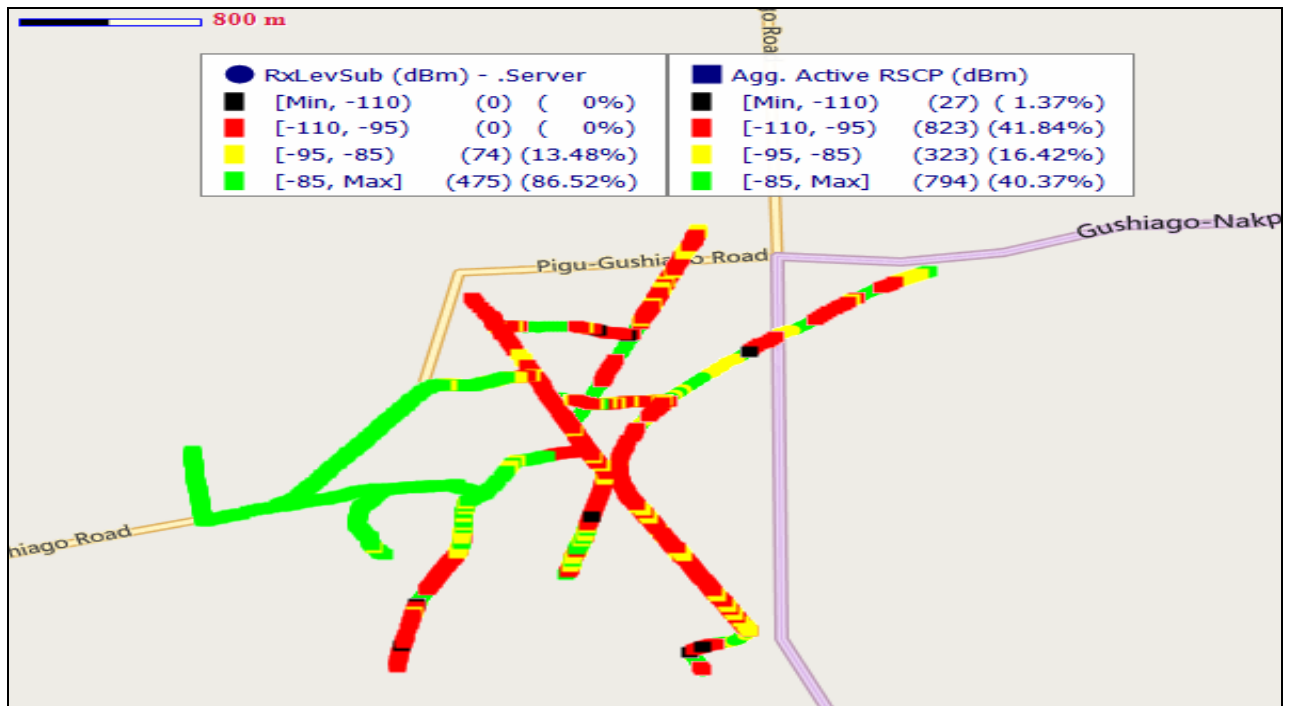
Fig 31. Vodafone Network Coverage Map Gushiegu – August 2016.



Remarks: Good network coverage in Gushiegu but improvement is still needed at Eastern Corridor Hotel and Gushegu Hospital.

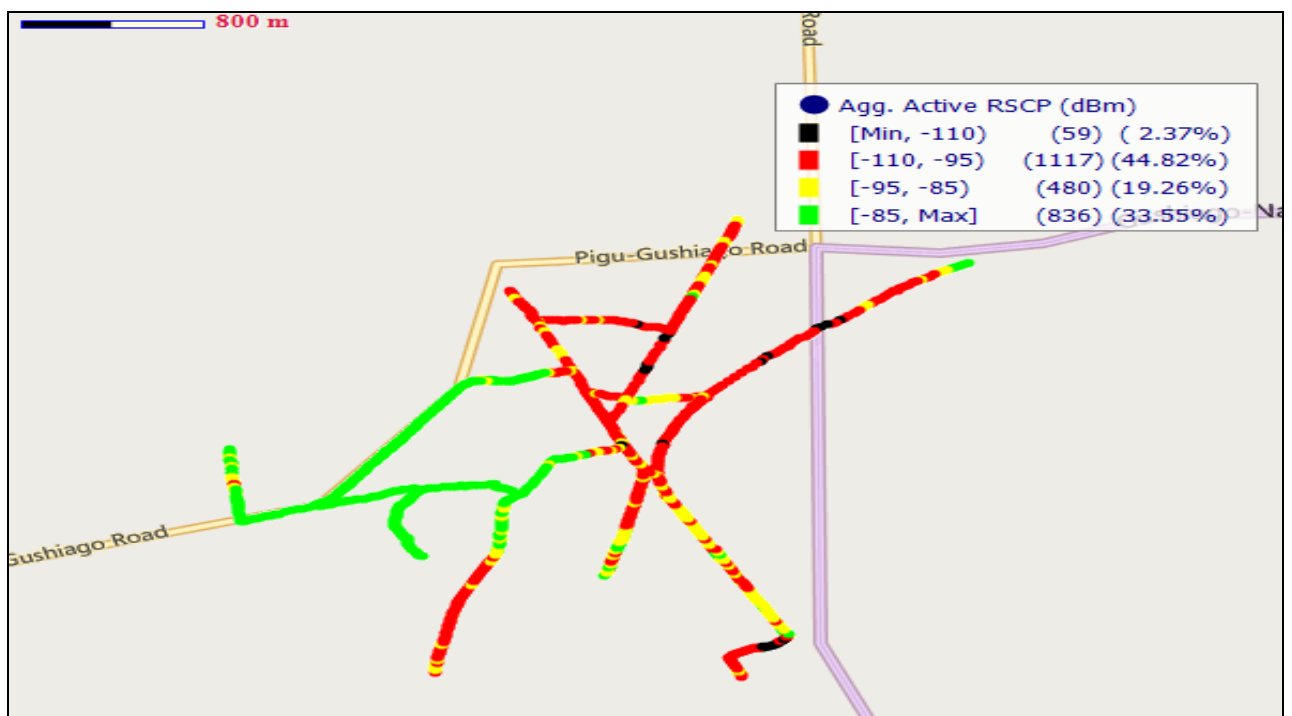
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 32. Tigo Network Coverage Map Gushiegu – August 2016



Remarks: Poor network coverage especially at Eastern Corridor Hotel, Gushiegu Hospital and Sochifong. Major improvements required.

Fig 33. Airtel Network Coverage Map Gushegu – August 2016



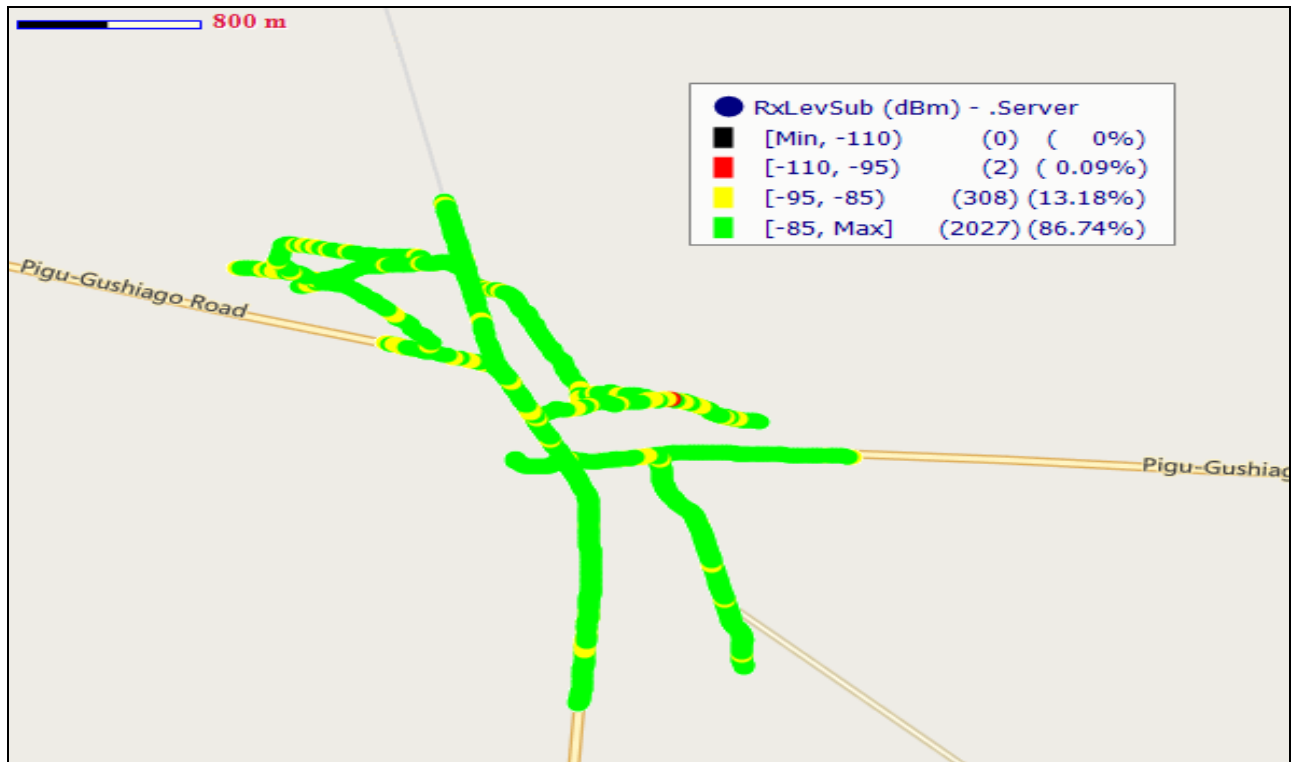
Remarks: Poor network coverage at Gushiegu. Major improvement is needed especially at Gushegu Hospital, Sochifong and Eastern Corridor Guest House.

***Glo had no service in Gushegu at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

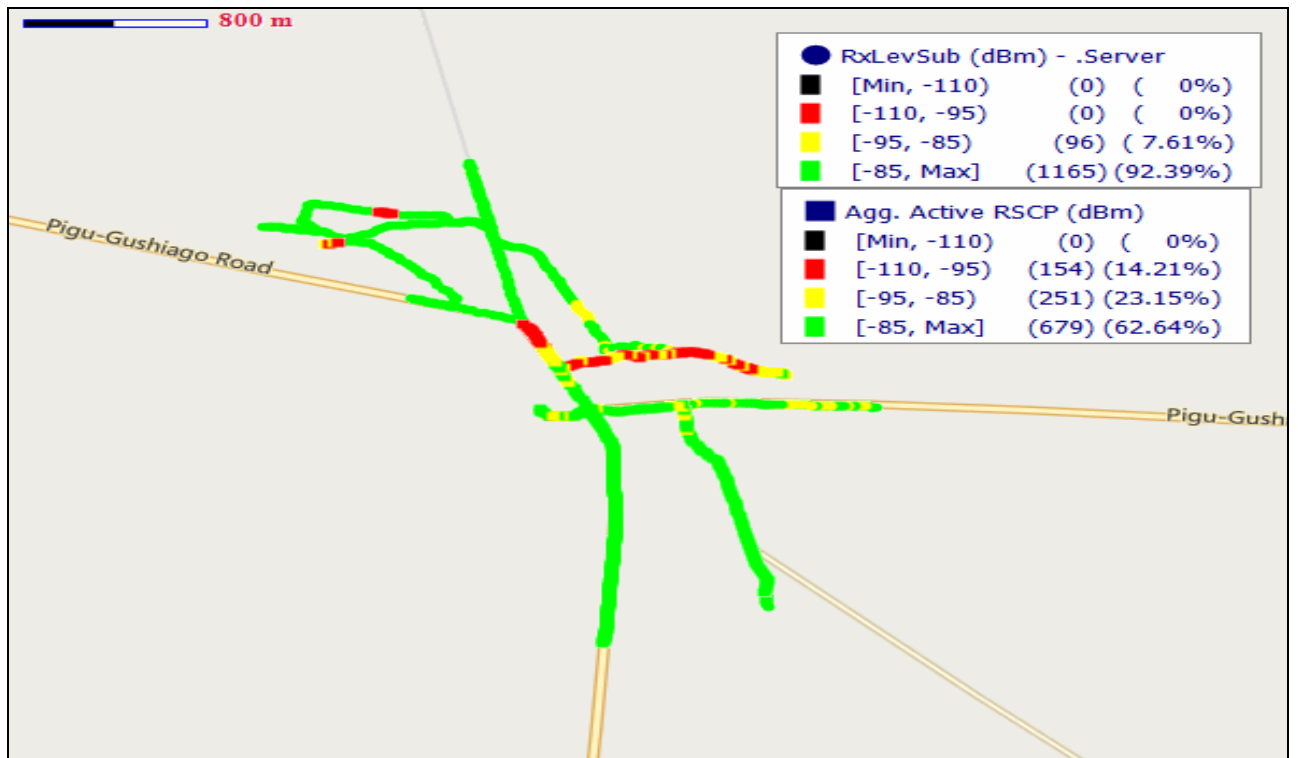
COVERAGE AT KARAGA

Fig 34. MTN Network Coverage Map Karaga –August 2016



Remarks: Good network coverage at Karaga.

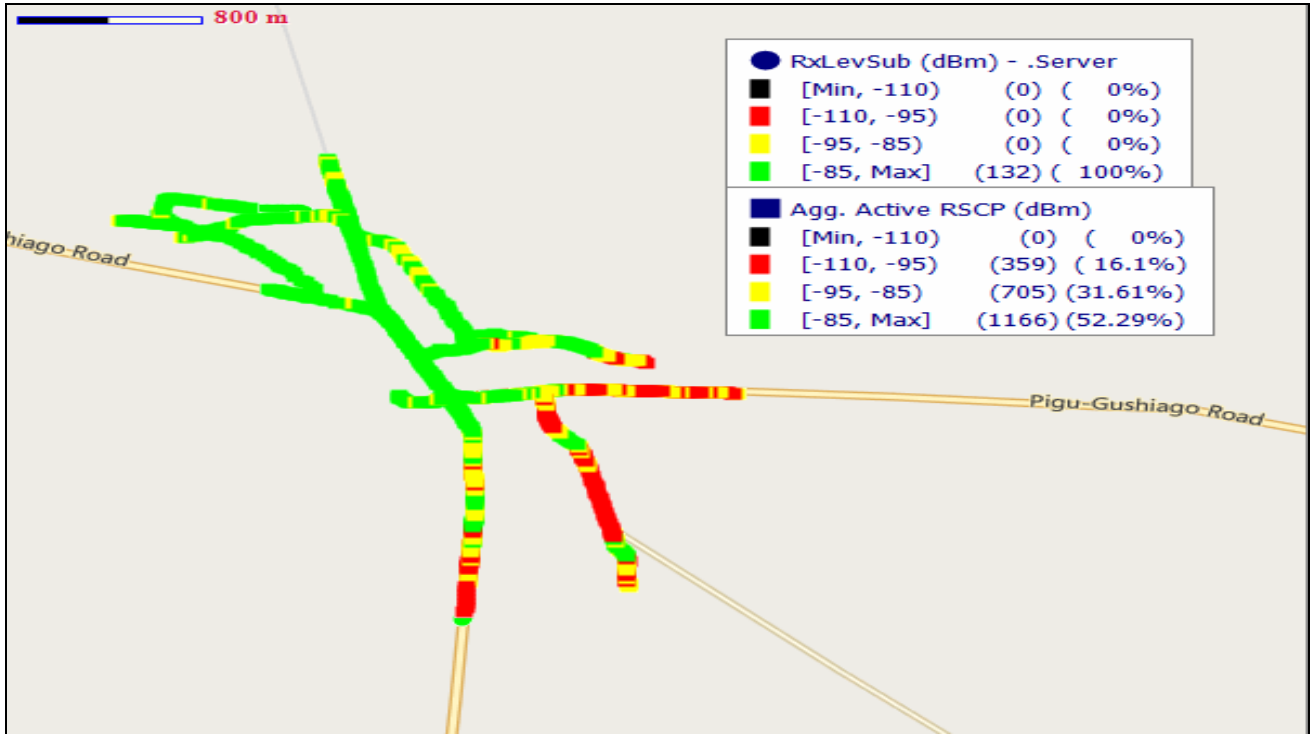
Fig 35. Vodafone Network Coverage Map Karaga – August 2016



Remarks: Good network coverage at Karaga.

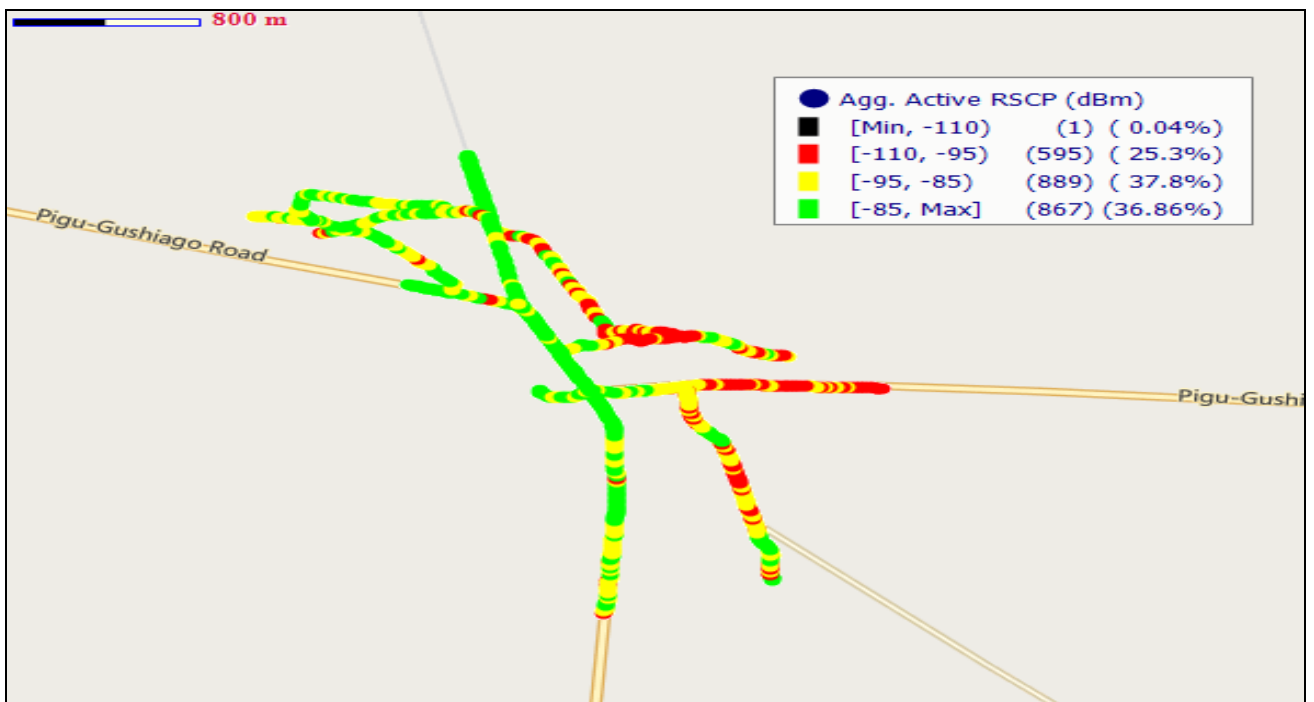
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 36. Tigo Network Coverage Map Karaga –August 2016



Remarks: Good network coverage in Karaga however improvement is needed at Karaga Hospital.

Fig 37. .Airtel Network Coverage Map Karaga – August 2016



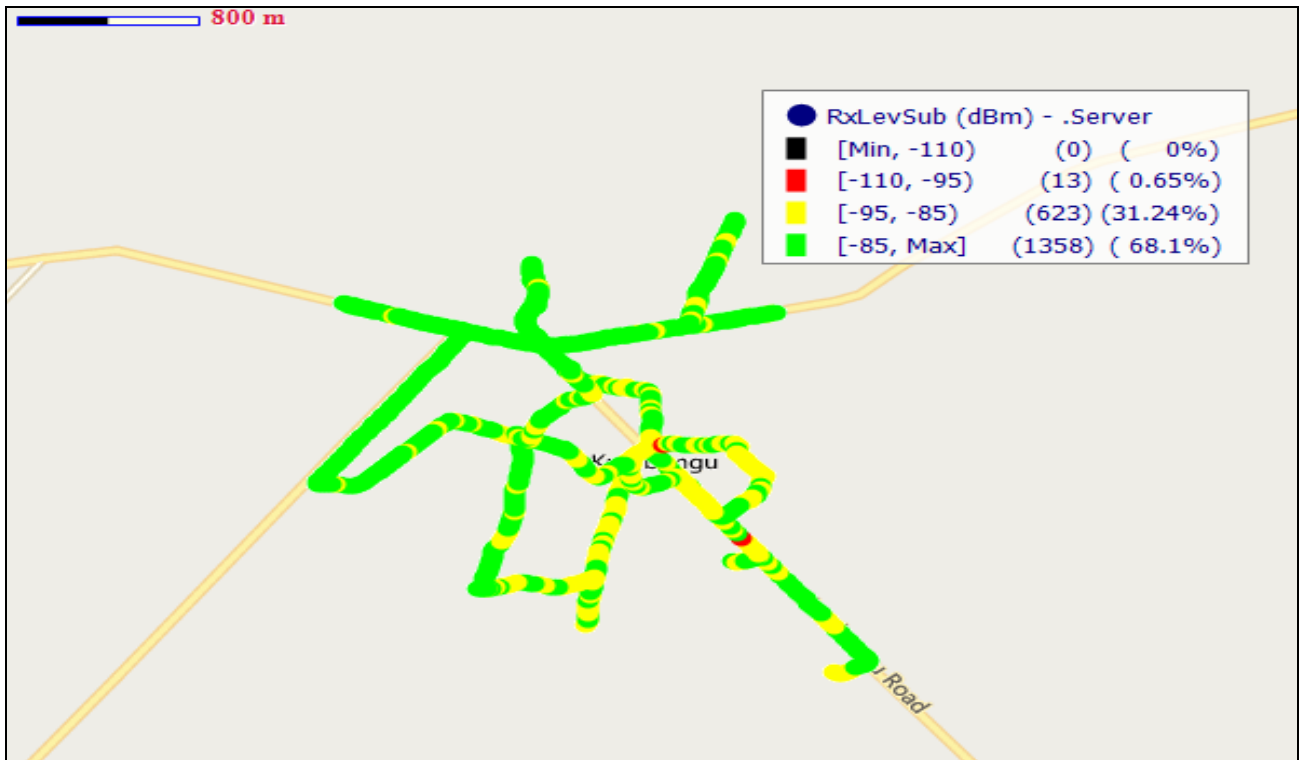
Remarks: Fair network coverage in Karaga however, improvement is needed at Old Market and Palace area.

***Glo had no service in Karaga at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

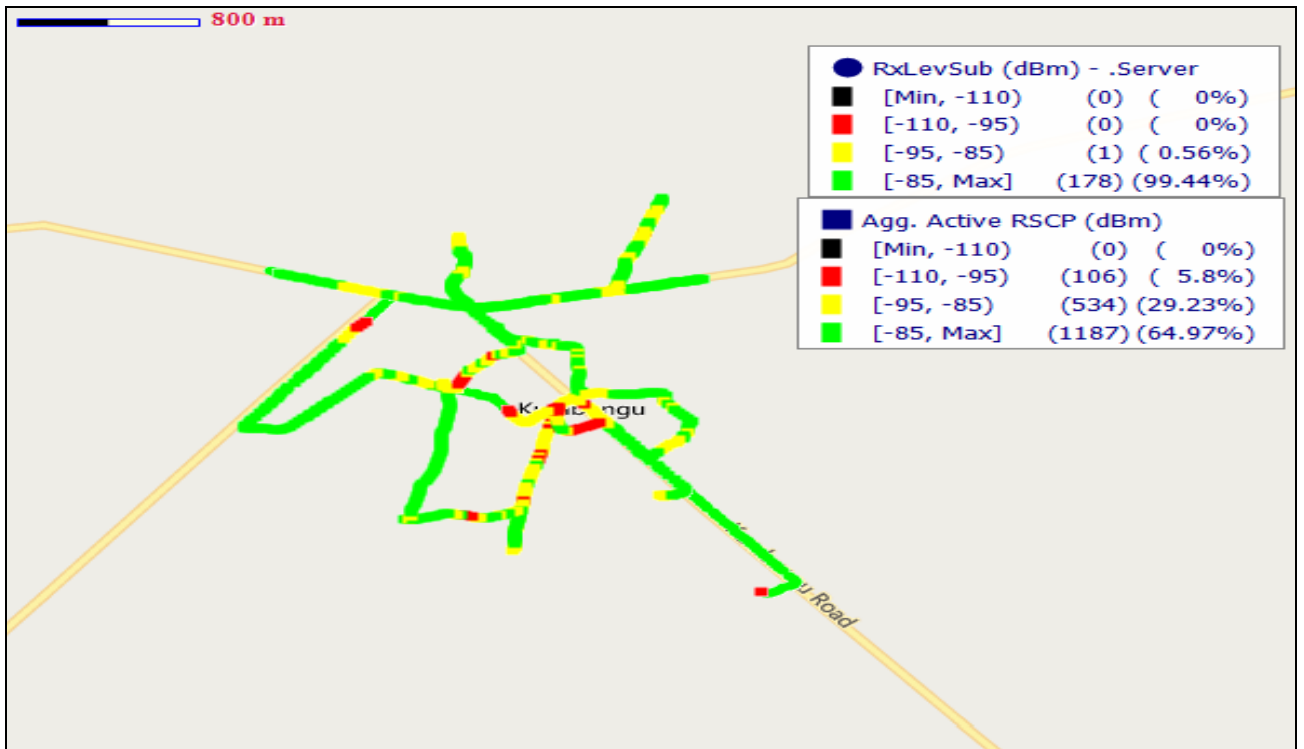
COVERAGE AT KUMBUNGU

Fig 38. MTN Network Coverage Map Kumbungu – August 2016.



Remarks: Good network coverage across Kumbungu.

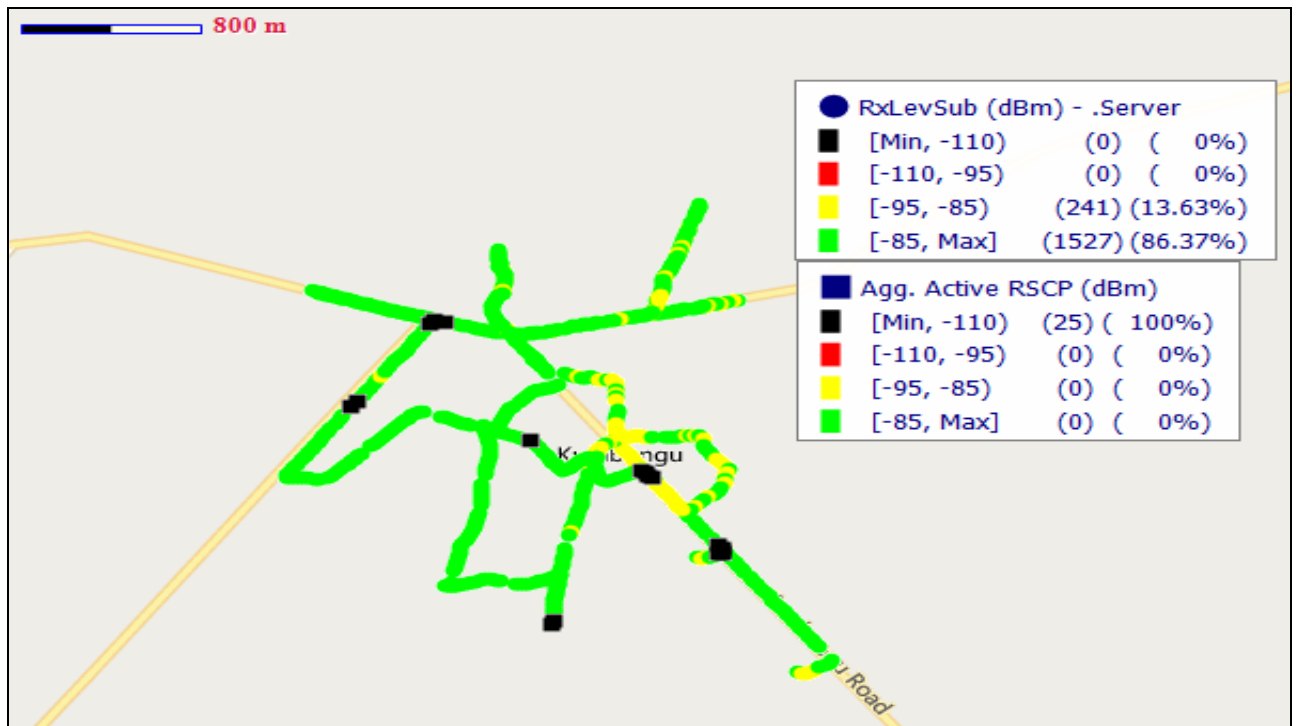
Fig 39. Vodafone Network Coverage Map, Kumbungu – August 2016.



Remarks: Good network coverage within Kumbungu however improvement is required at Market and Bonzali Rural Bank area.

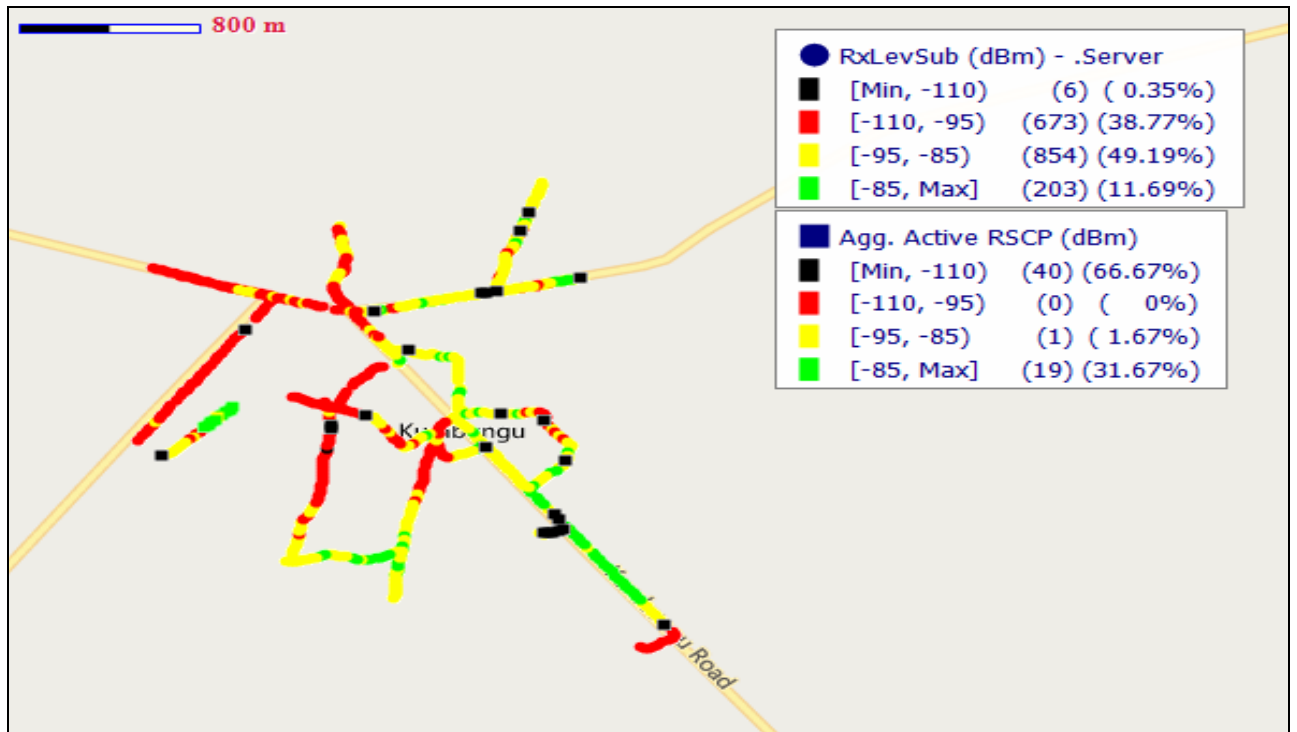
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 40. Tigo Network Coverage Map Kumbungu – August 2016.



Remarks: Good network coverage across Kumbungu.

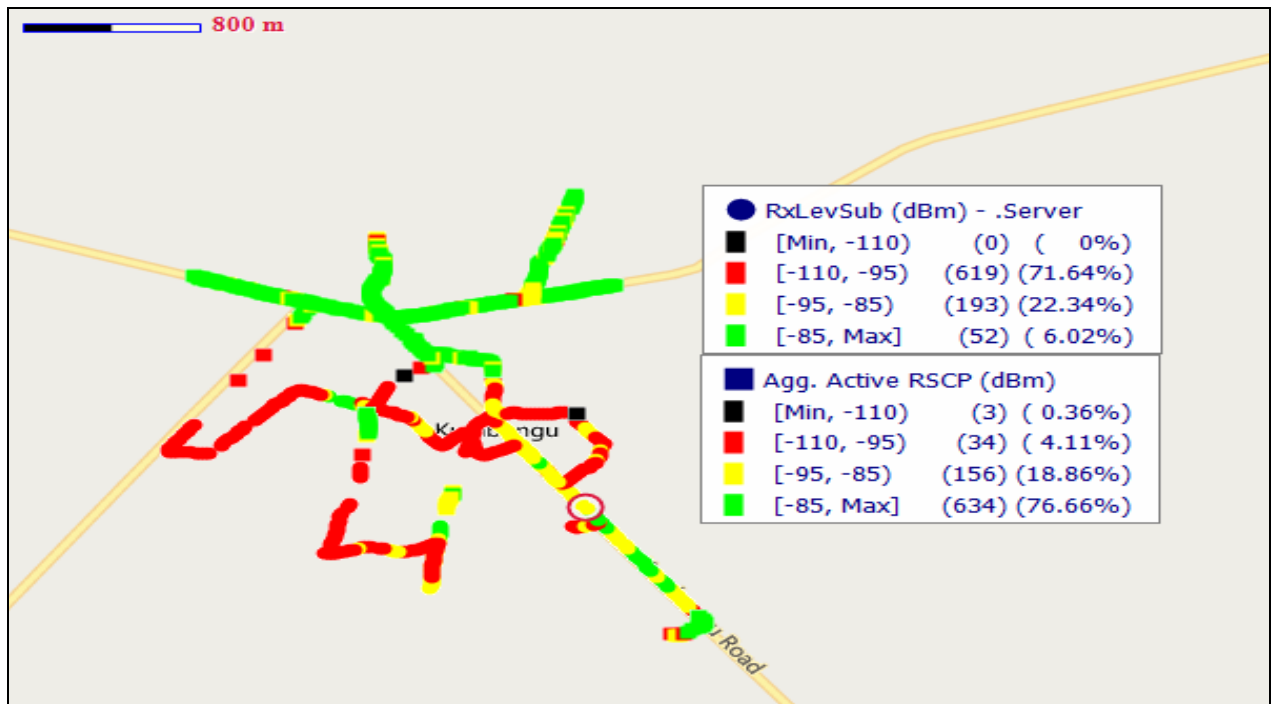
Fig 41. Airtel Network Coverage Map Kumbungu – August 2016.



Remarks: Poor network coverage. Improvement is needed across the entire Kumbungu Township.

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

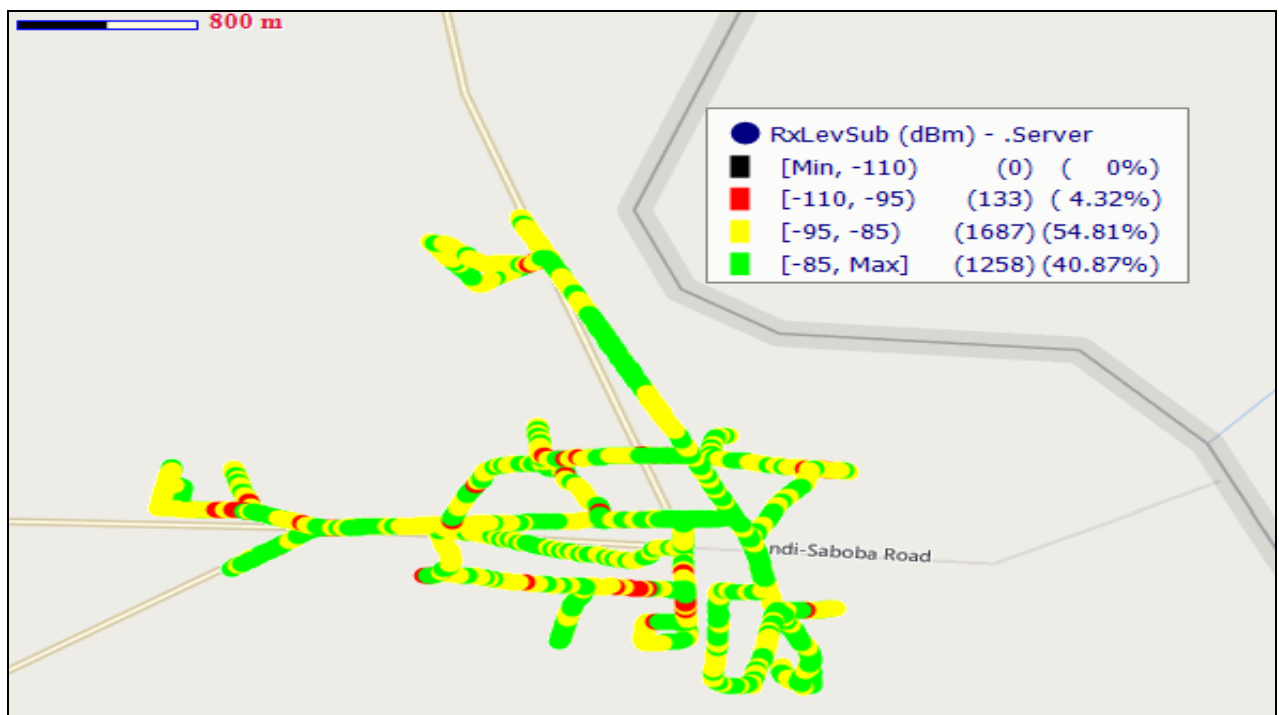
Fig 42. Glo Network Coverage Map Kumbungu – August 2016



Remarks: Poor network coverage across the entire Kumbungu Township. Major improvement needed.

COVERAGE AT SABOBA

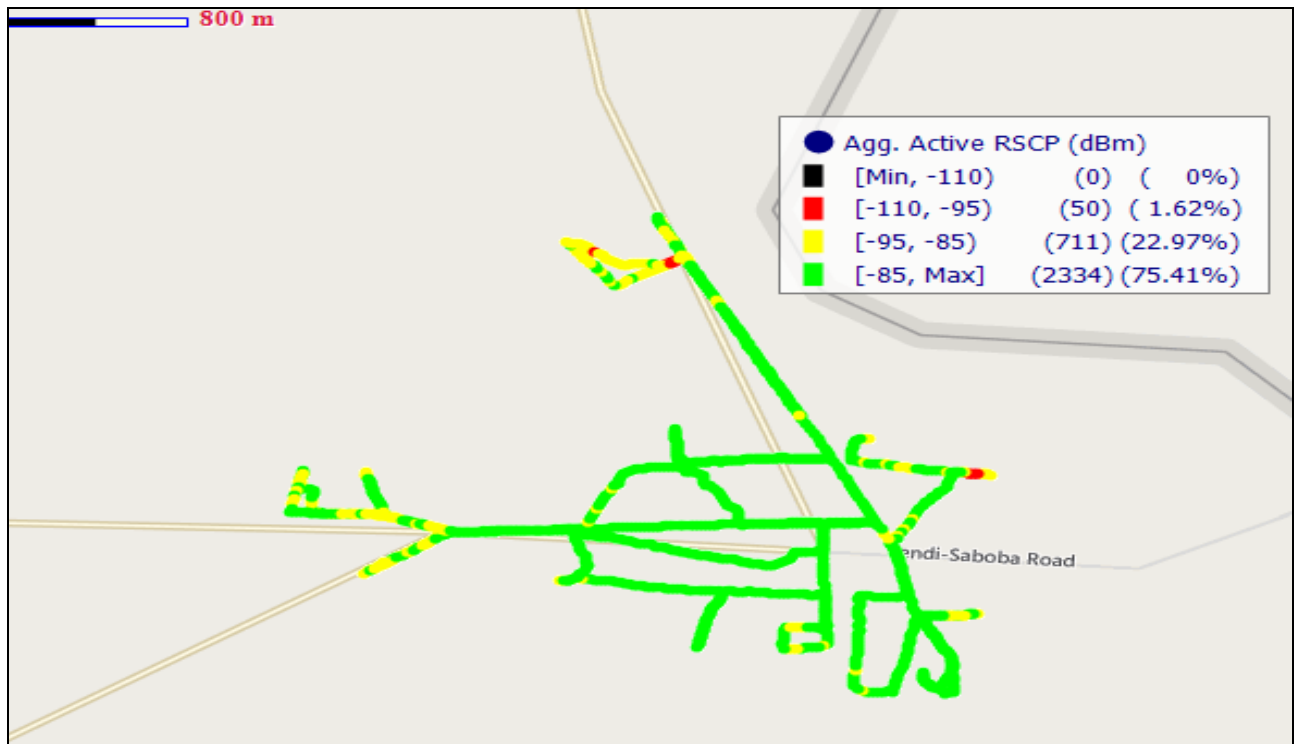
Fig 43. MTN Network Coverage Map Saboba – August 2016



Remarks: Fair 2G network coverage in Saboba however improvement is needed across the entire Saboba Township.

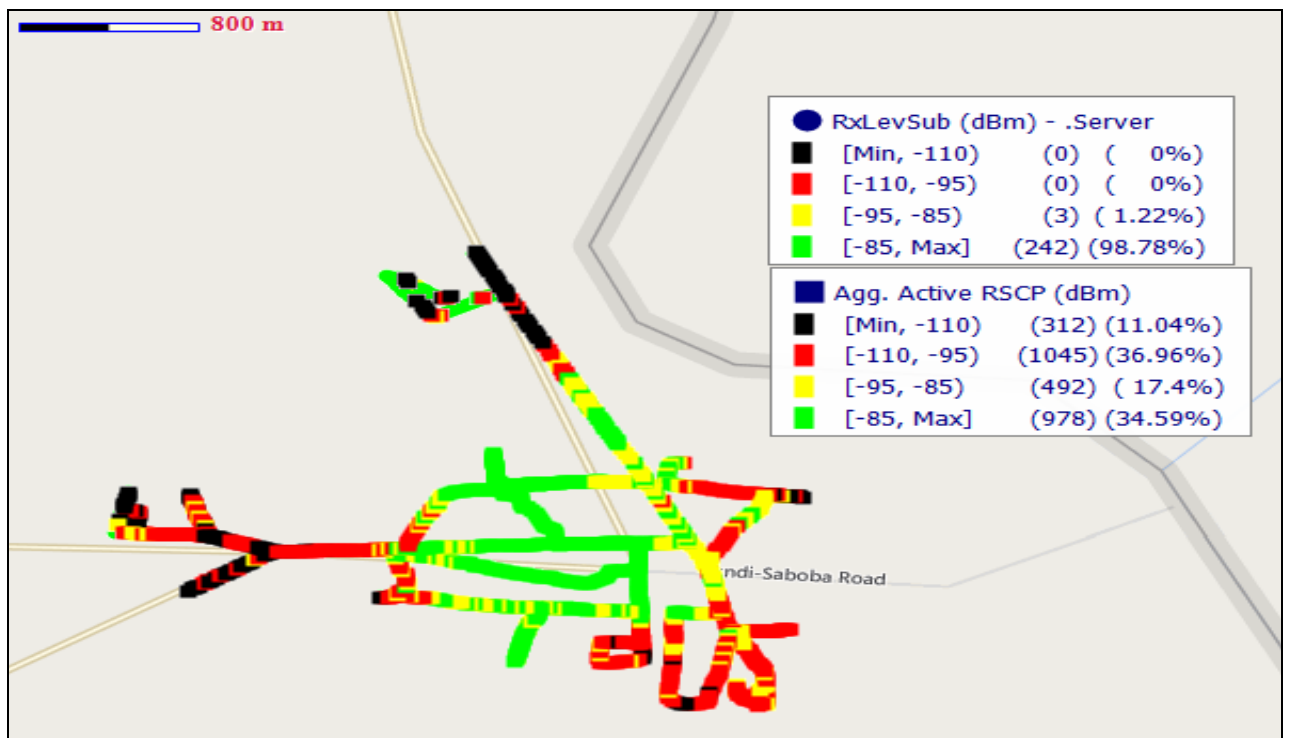
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 44. Vodafone Network Coverage Map Saboba – August 2016



Remarks: Good network coverage across Saboba Township.

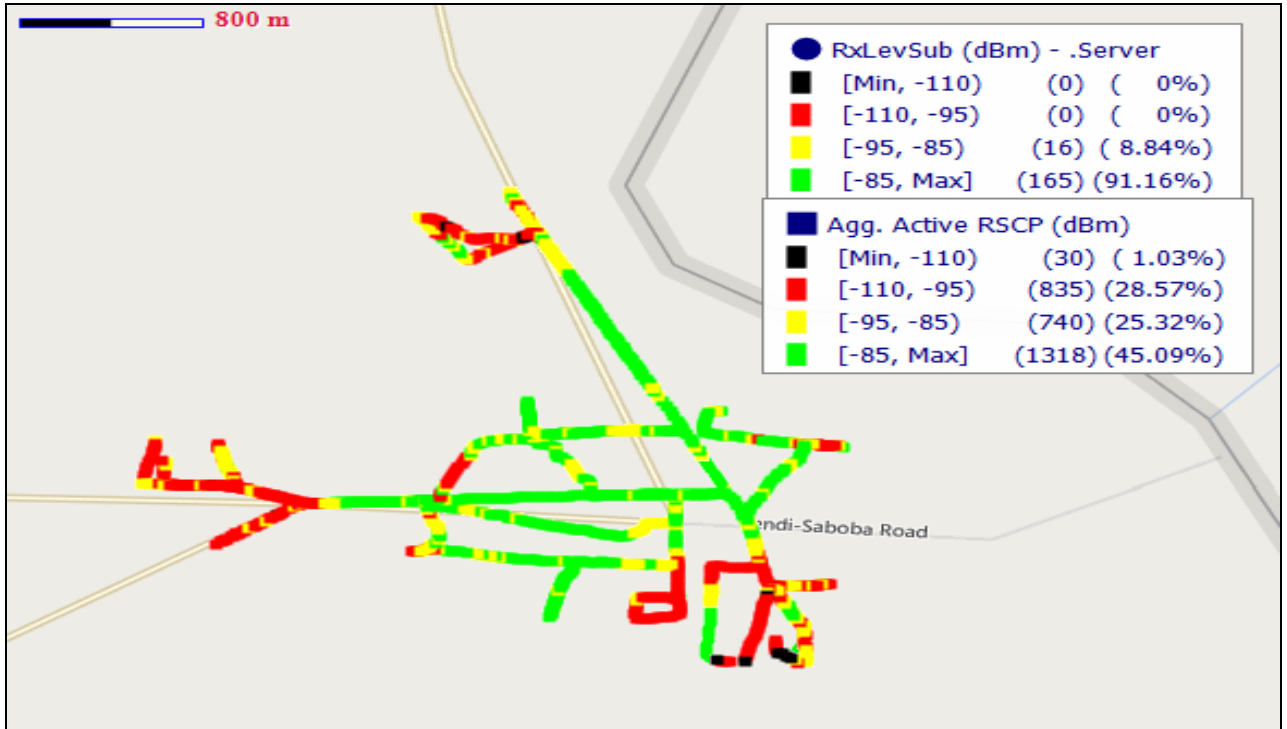
Fig 45. Tigo Network Coverage Map Saboba – August 2016.



Remarks: Poor network coverage across Saboba with major improvement needed at the DCE’s Residence, Community Center, Kpanle and EP Senior High School.

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 46. Airtel Network Coverage Map Saboba – August 2016

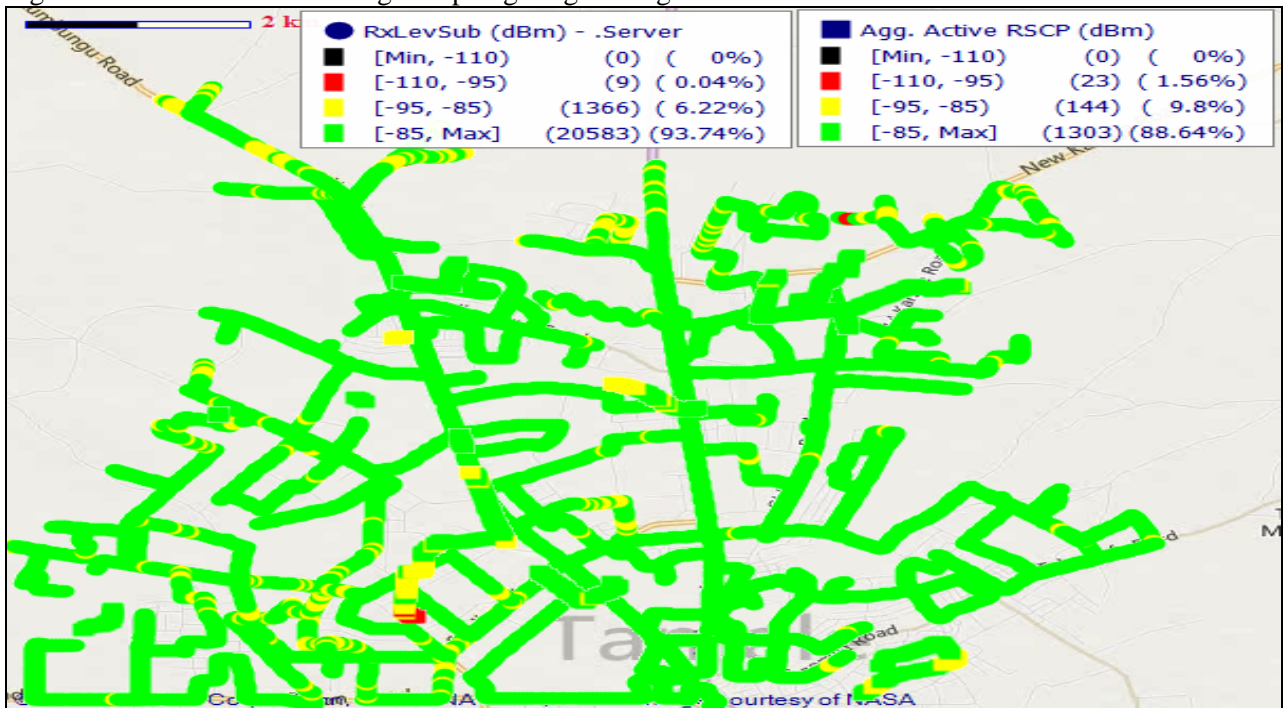


Remarks: Fair network coverage in Saboba however areas around the DCE’s residence, EP Senior High School and Community Center need improvement

*Glo had no service in Saboba at the time of the test.

COVERAGE AT SAGNARIGU

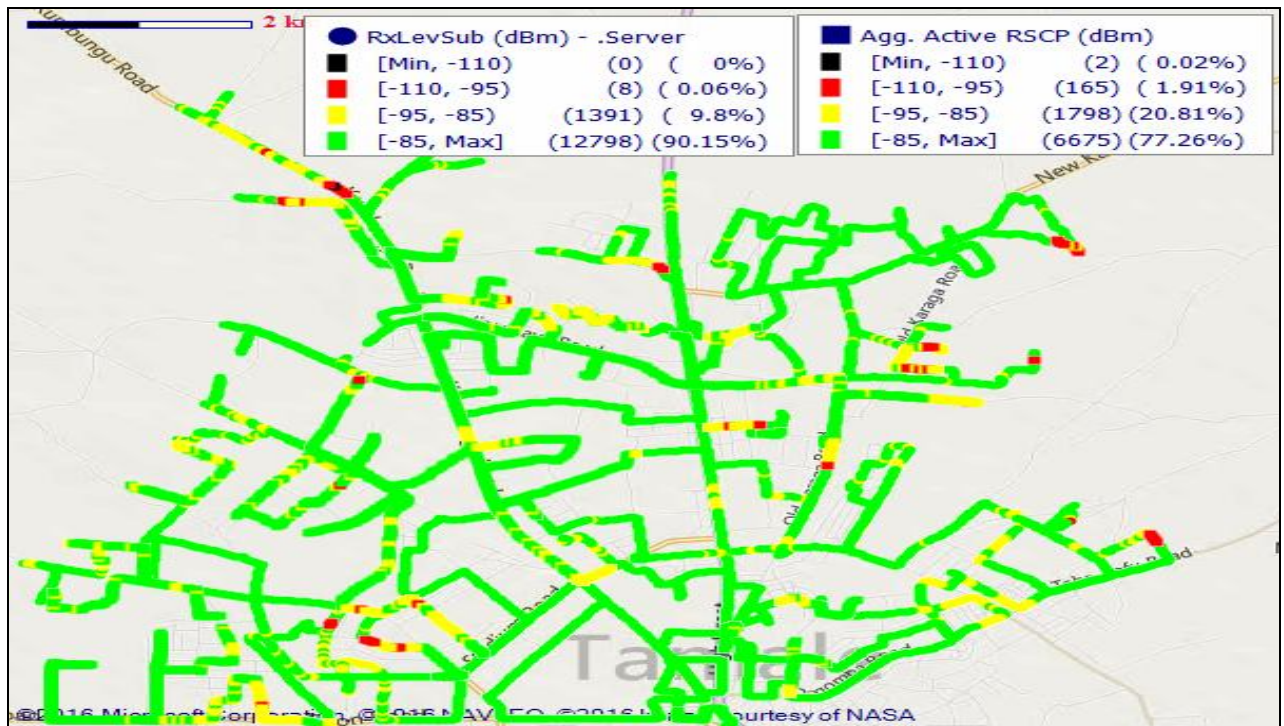
Fig 47. MTN Network Coverage Map Sagnarigu – August 2016



Remarks: Good network coverage at Sagnarigu.

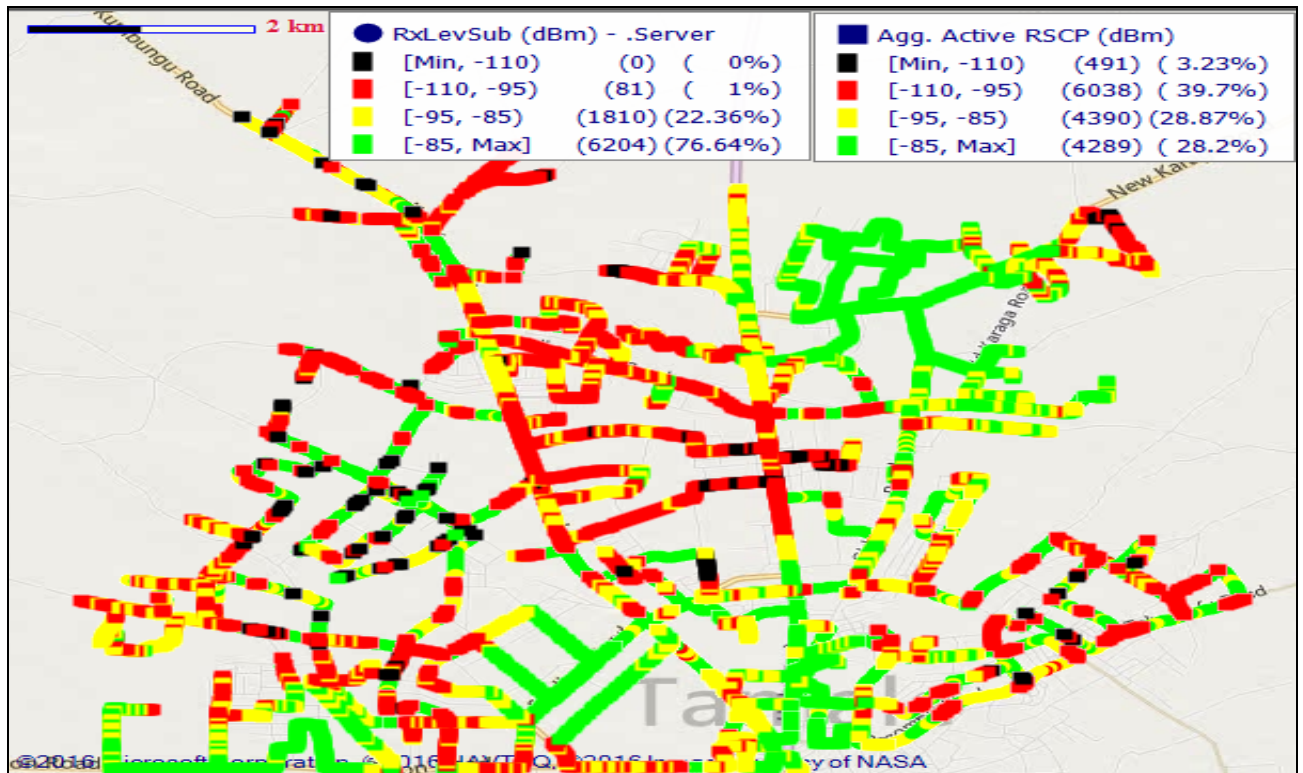
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 48. Vodafone Network Coverage Map Sagnarigu – August 2016.



Remarks: Good network coverage across Sagnarigu.

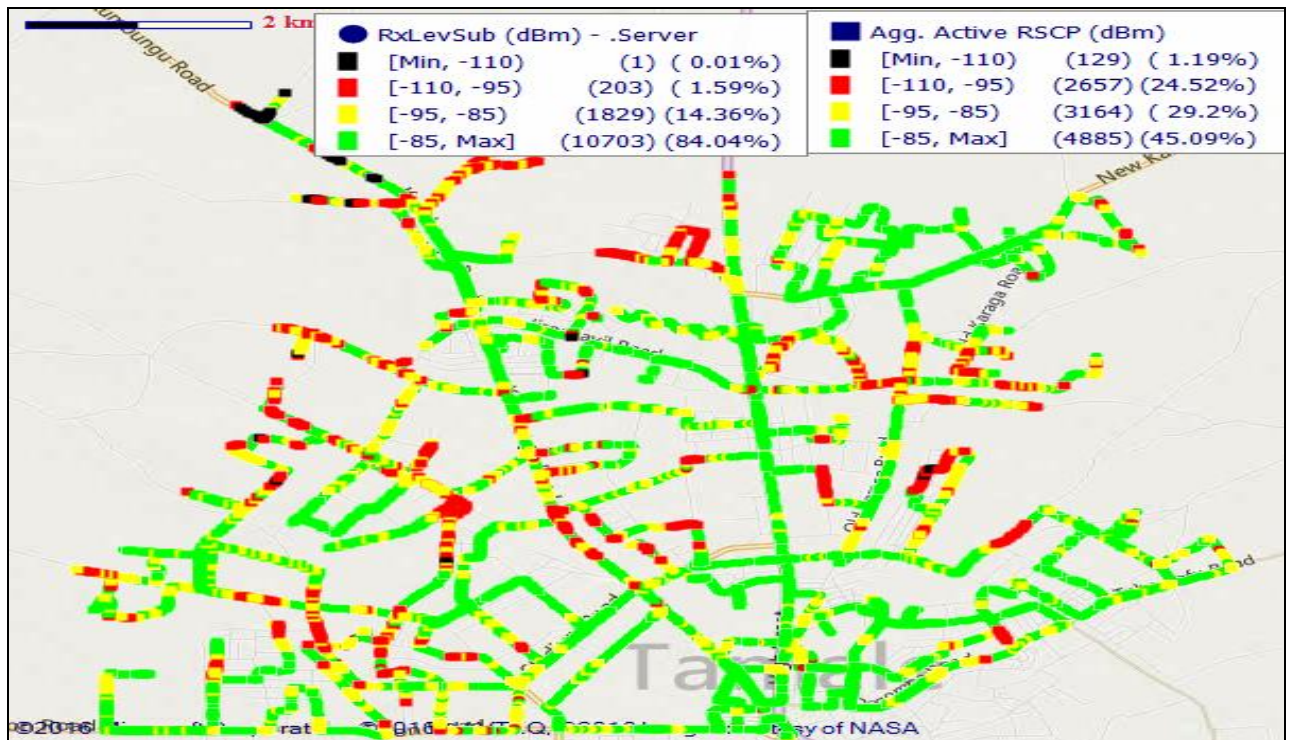
Fig 49. Tigo Network Coverage Map Sagnarigu – August 2016



Remarks: Poor network coverage across the entire Sagnarigu District. Major improvement required.

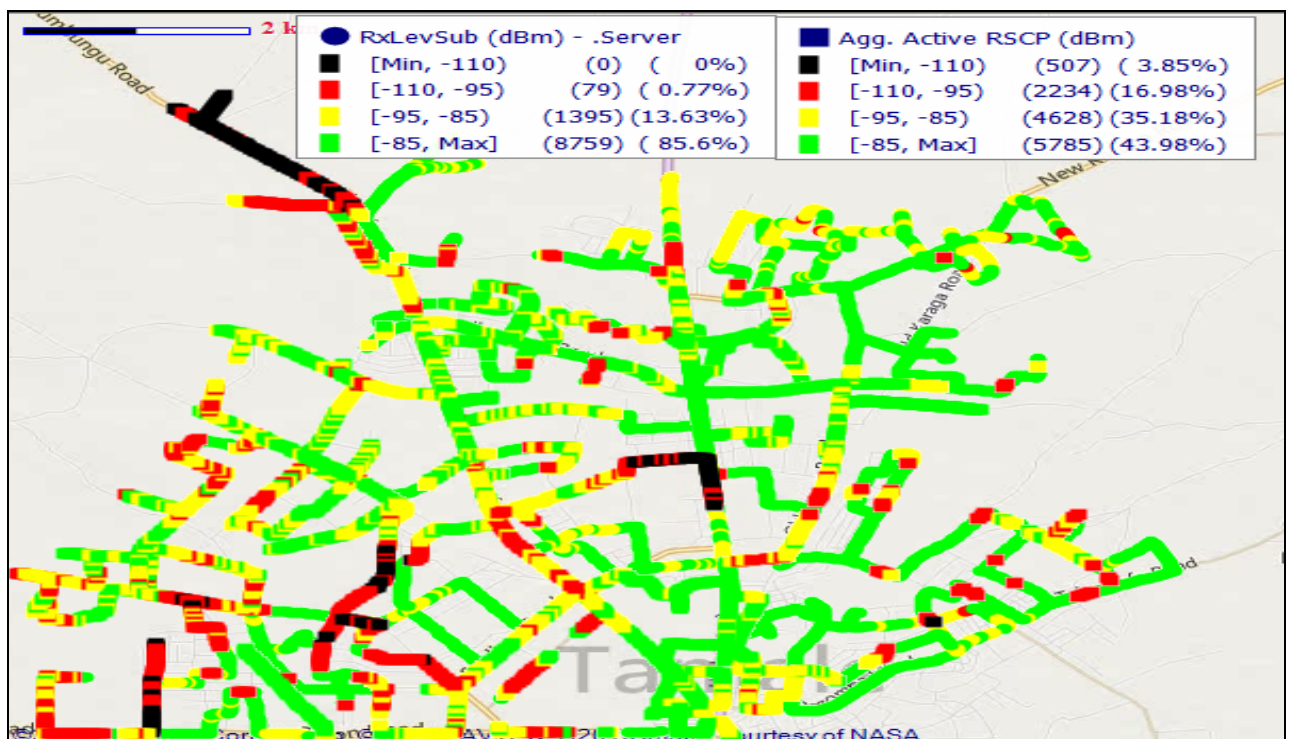
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 50. Airtel Network Coverage Map Sagnarigu – August 2016



Remarks: Good network coverage across Sagnarigu but 3G is fair and needs to be improved.

Fig 51. Glo Network Coverage Map Sagnarigu District – August 2016

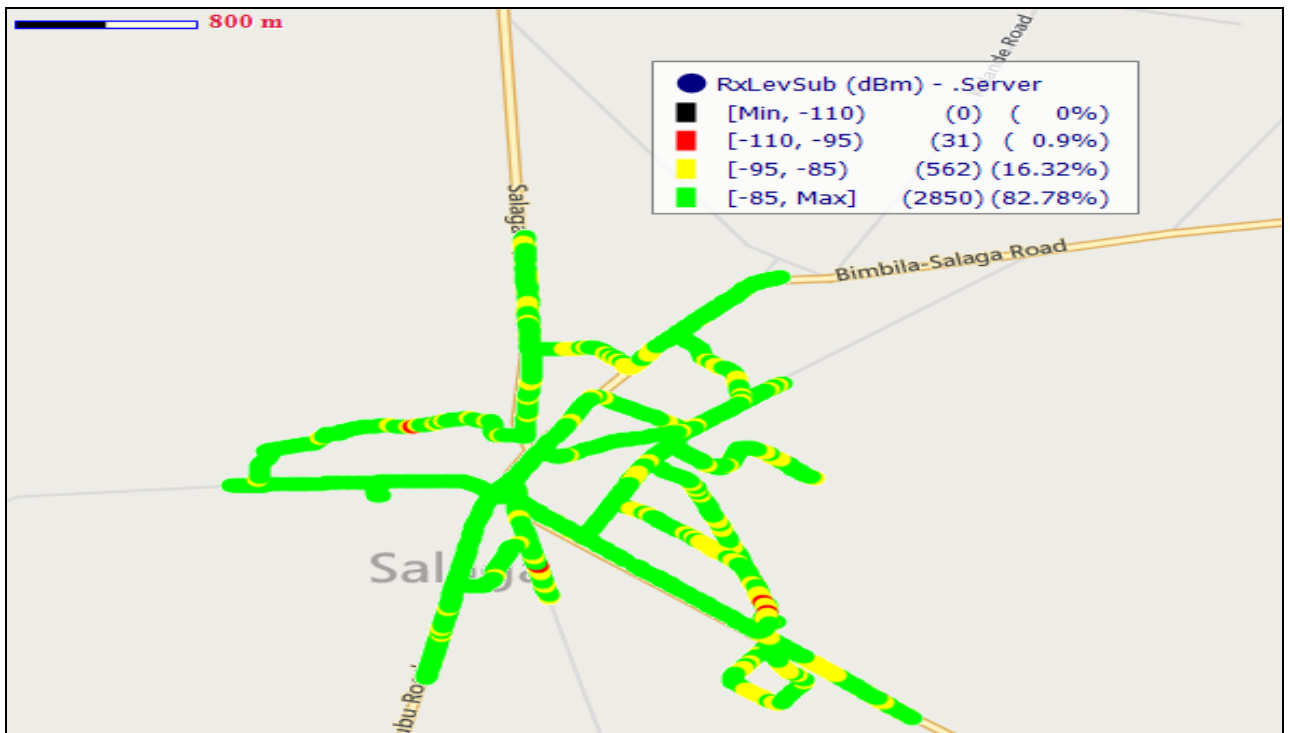


Remarks: Fair network coverage in Sagnarigu however, the entire district needs improvement.

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

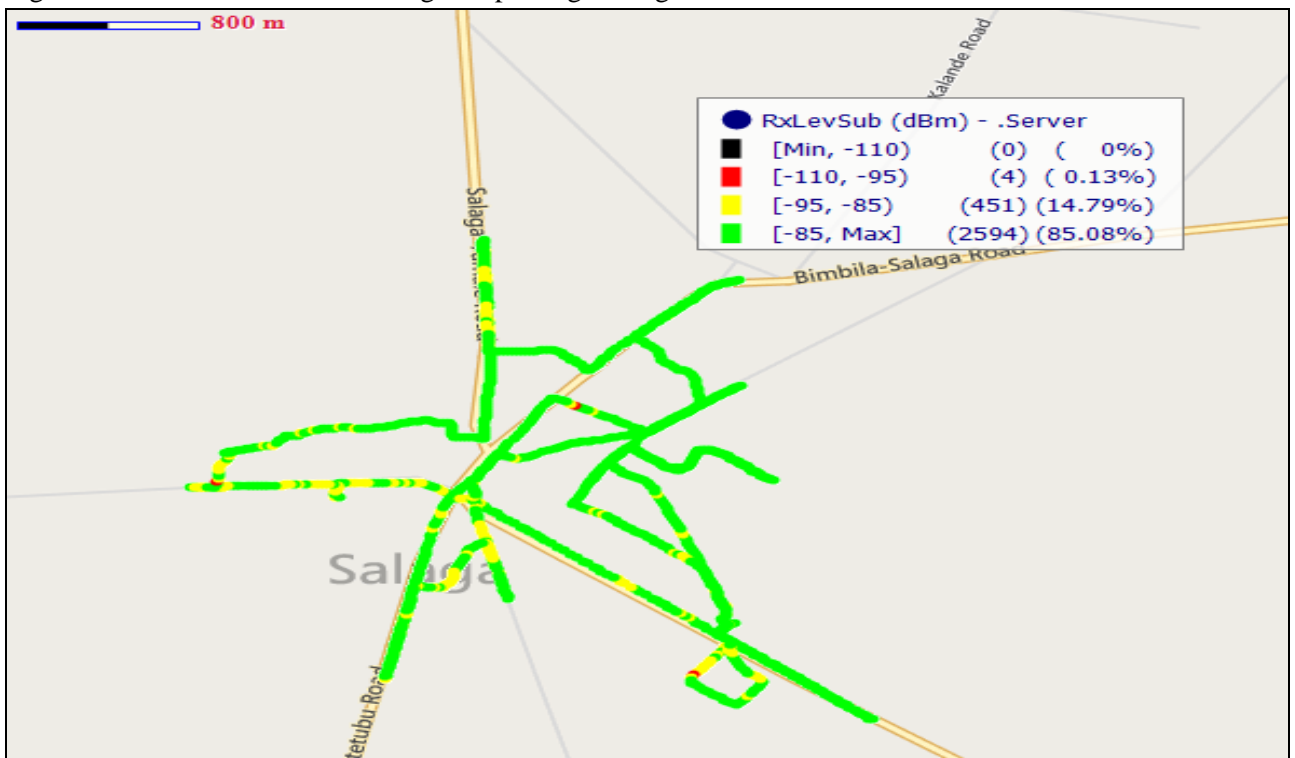
COVERAGE AT SALAGA

Fig 52. MTN Network Coverage Map Salaga – August 2016.



Remarks: Good network coverage at Salaga.

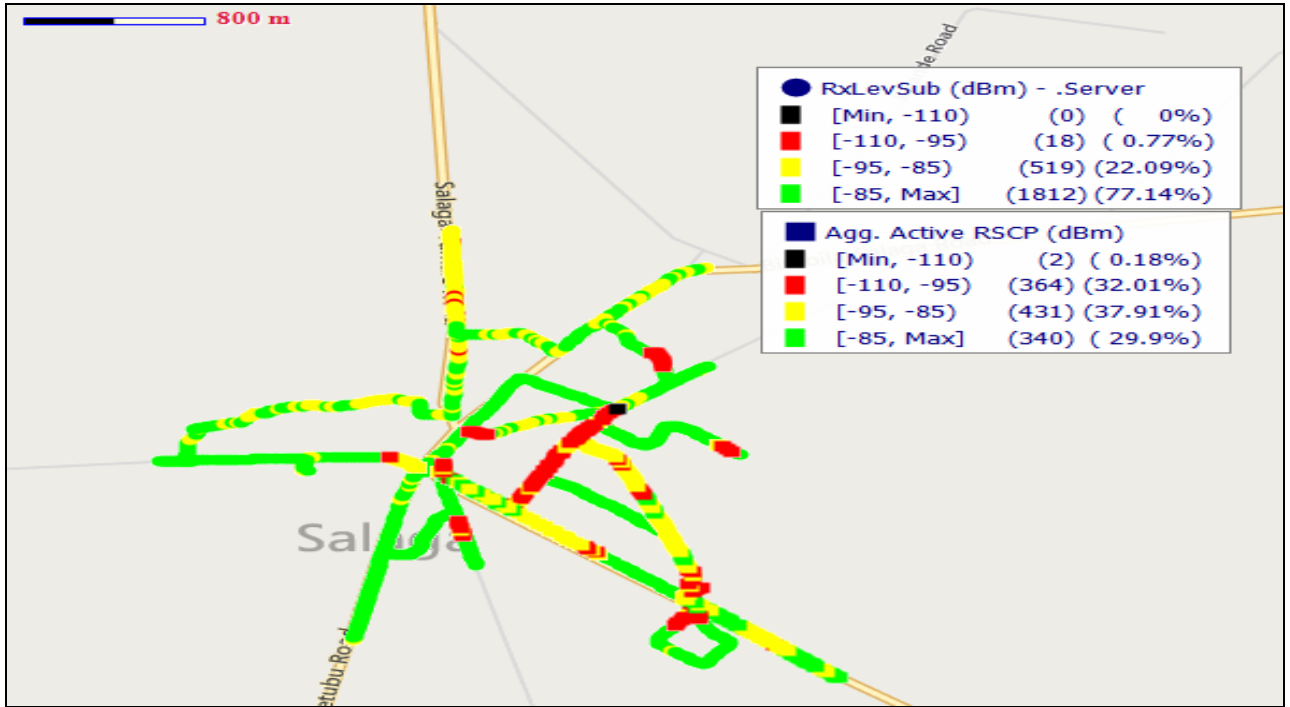
Fig 53. Vodafone Network Coverage Map Salaga - August 2016



Remarks: Good network coverage at Salaga.

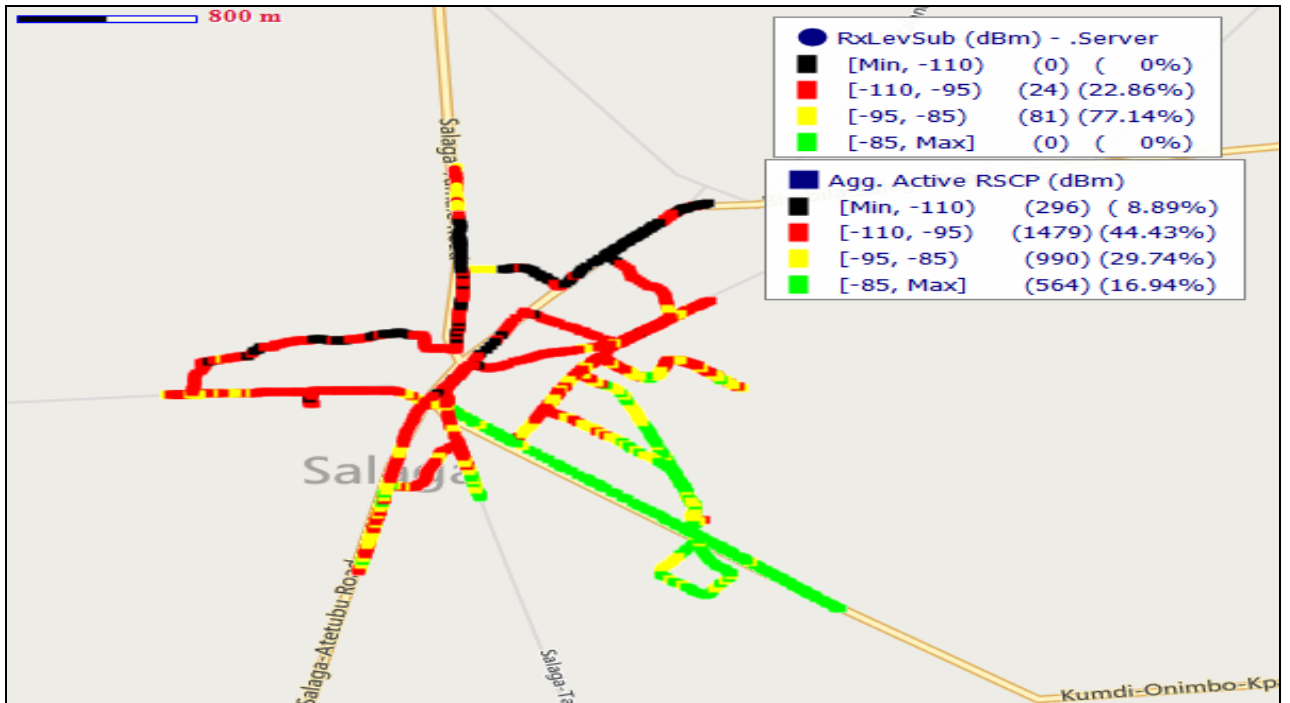
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 54. Tigo Network Coverage Map Salaga – August 2016.



Remarks: Good network coverage in Salaga however there are spots of poor coverage that needs improvement.

Fig 55. Airtel Network Coverage Map Salaga – August 2016.



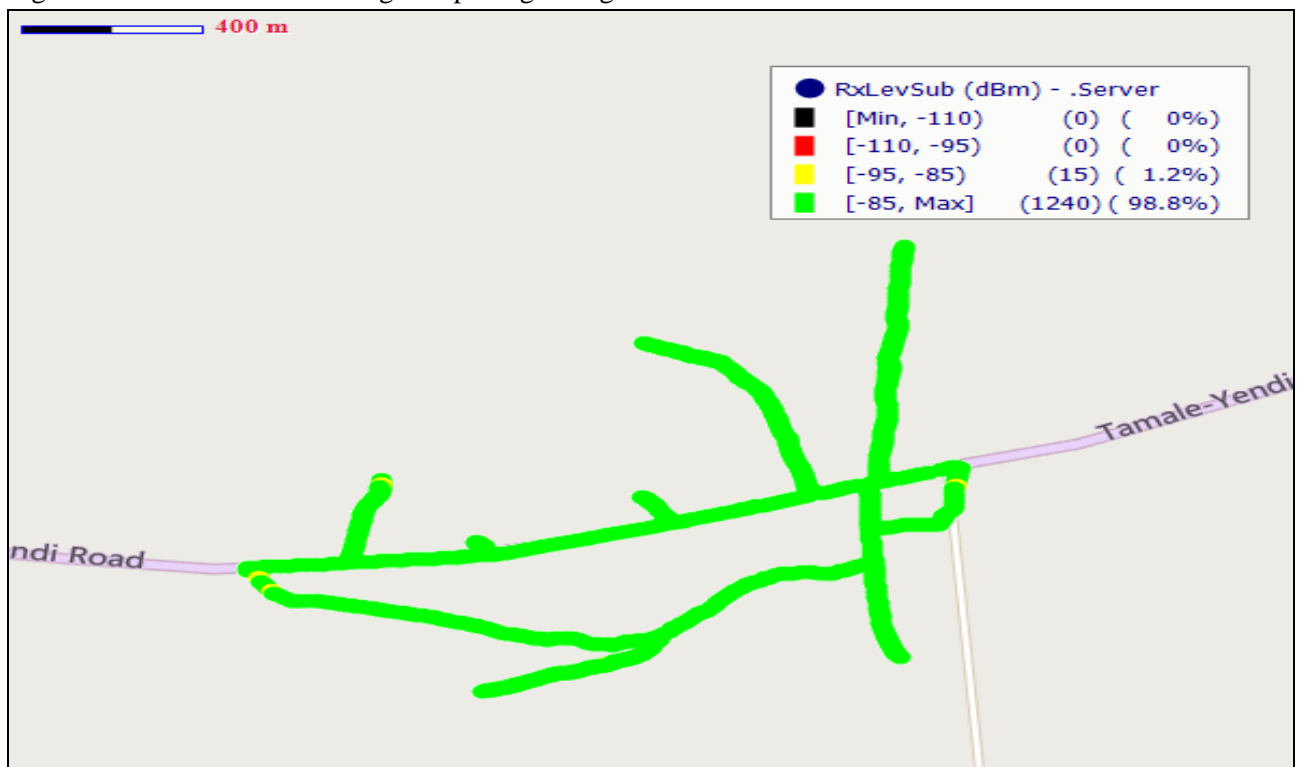
Remarks: Poor network coverage in Salaga. Major improvement is required at Idipe, Hospital, Dagombaline, Darisalam, Lorry Station and Muskayi.

***Glo had no service in Salaga at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

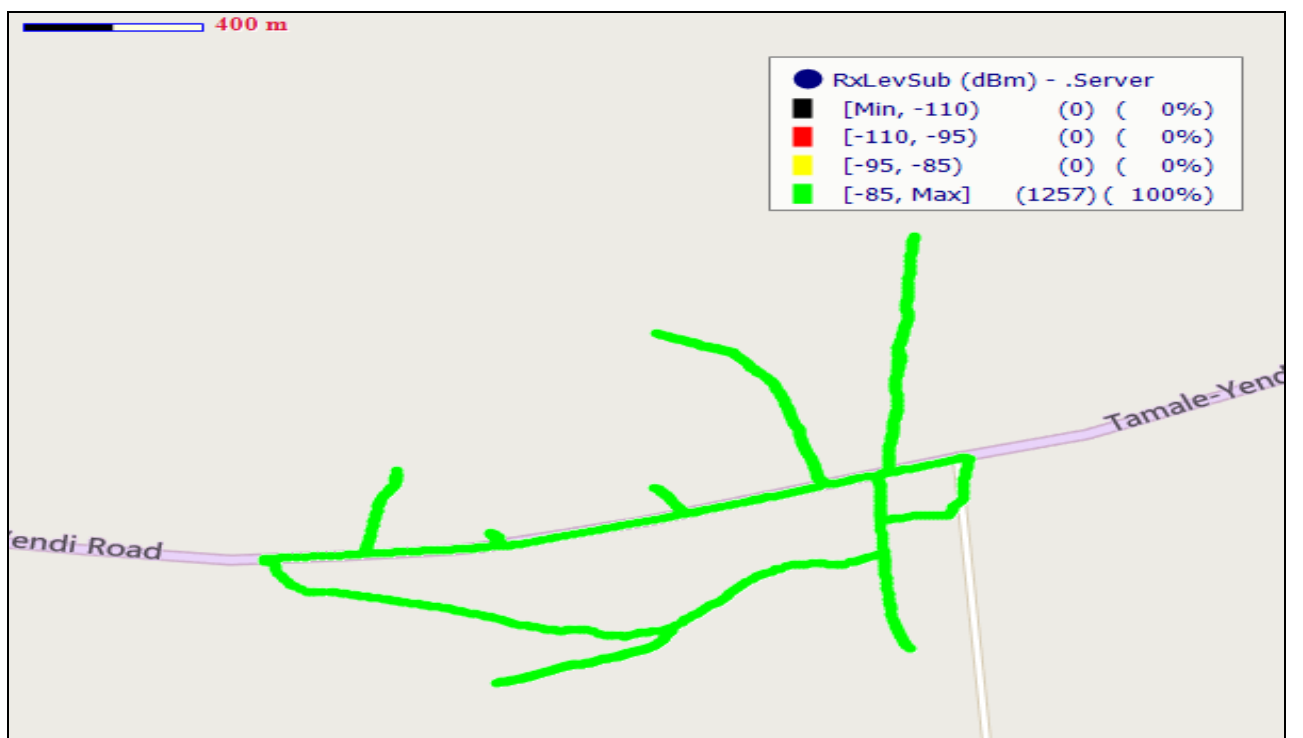
COVERAGE AT SANG

Fig 56. MTN Network Coverage Map Sang – August 2016



Remarks: Good network coverage at Sang.

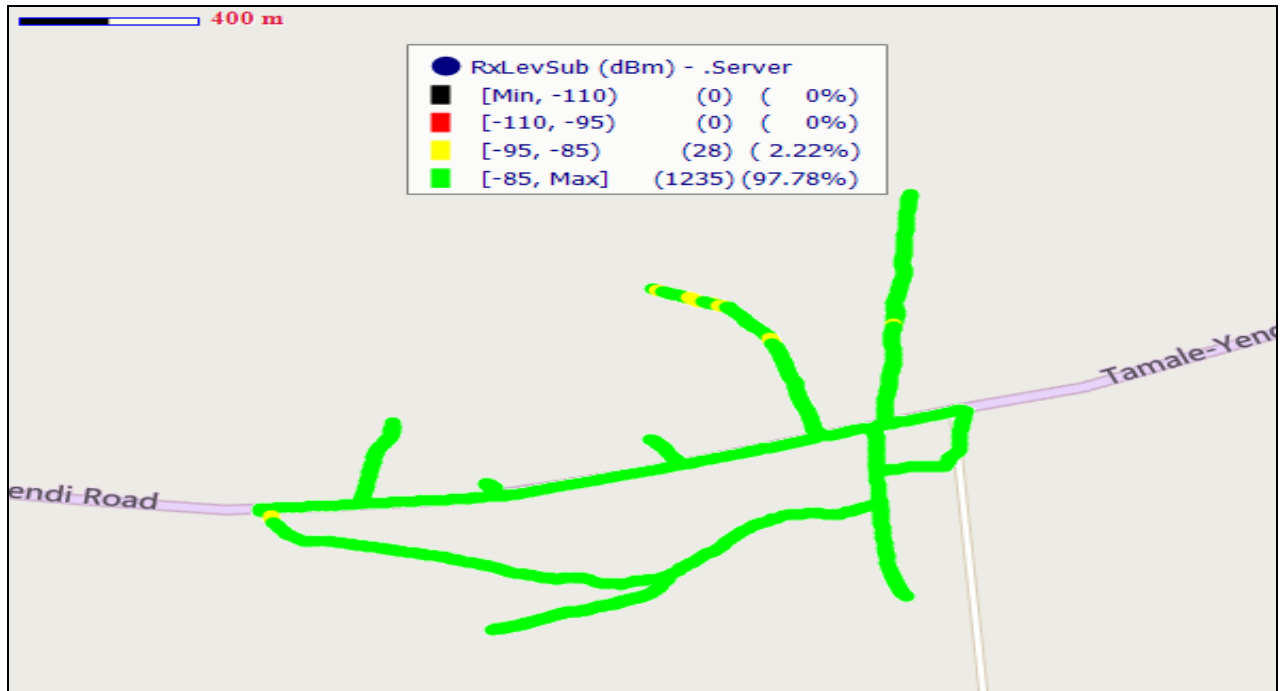
Fig 57. Vodafone Network Coverage Map Sang –August 2016



Remarks: Good network coverage in Sang.

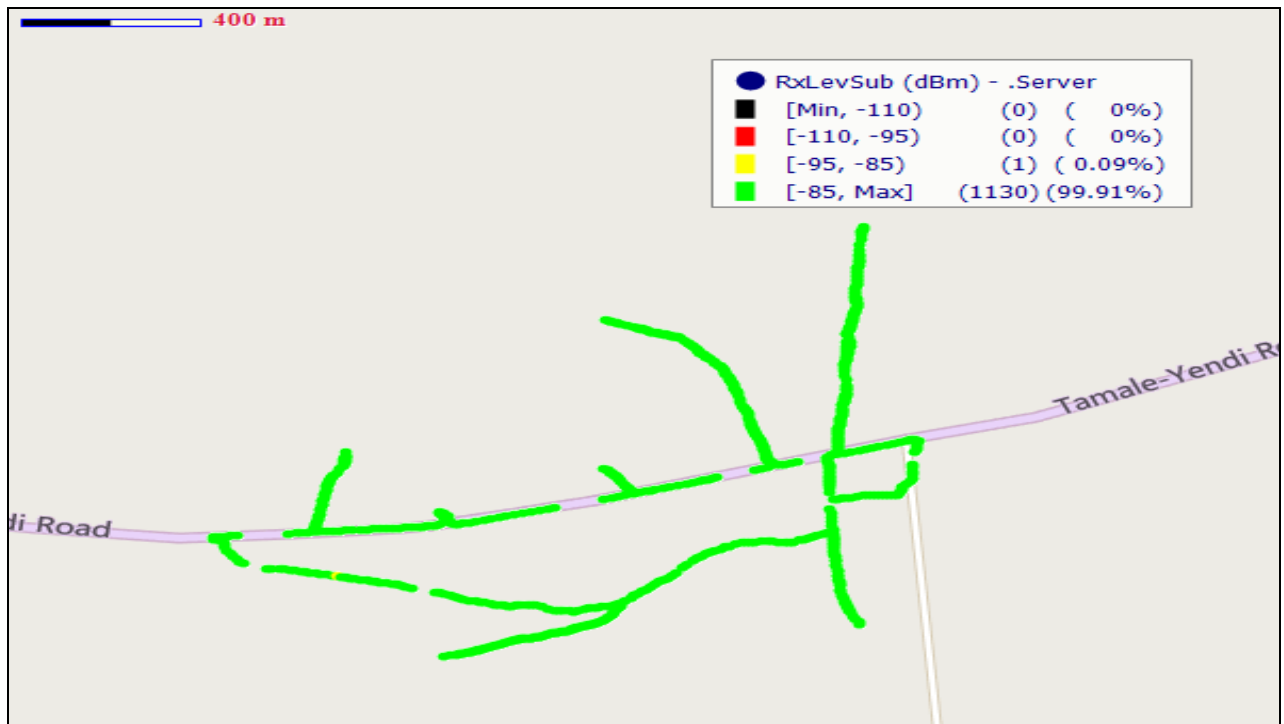
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 58. Tigo Network Coverage Map Sang– August 2016



Remarks: Good network coverage at Sang.

Fig 59. Airtel Network Coverage Map Sang– August 2016



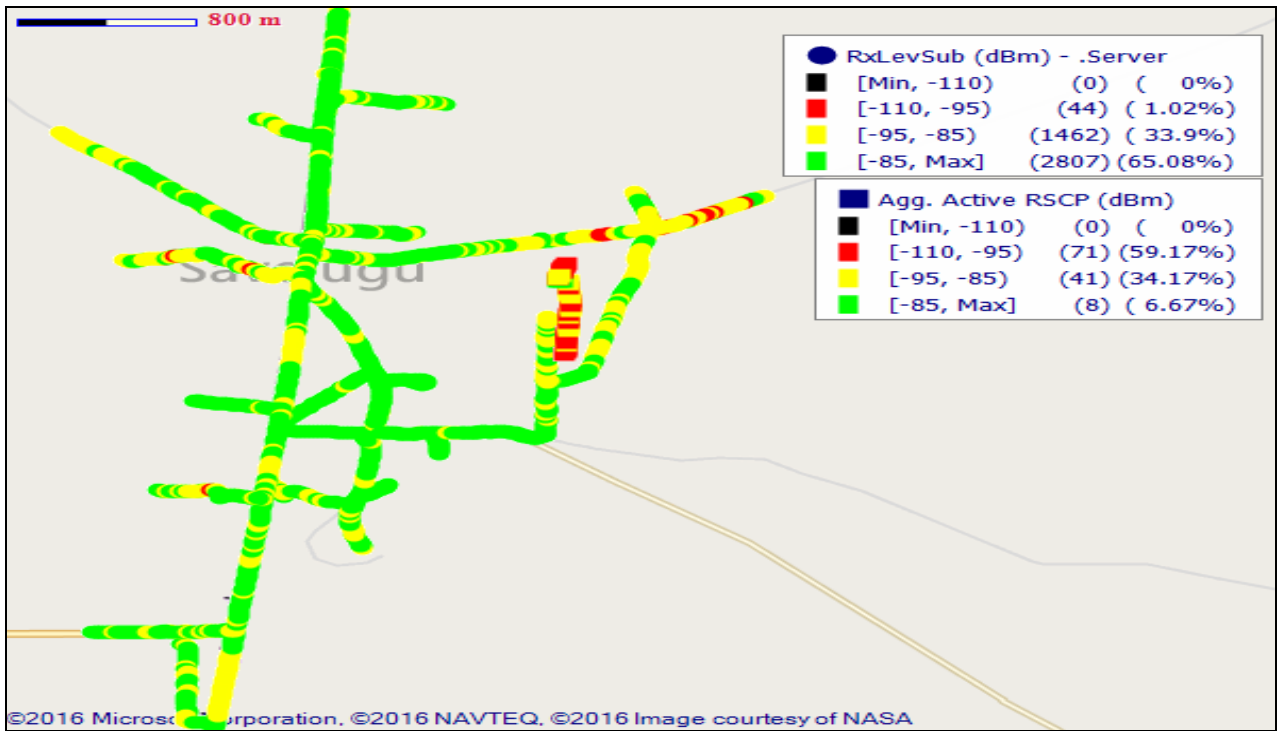
Remarks: Good network coverage across Sang.

***Glo had no service in Sang at the time of the test.**

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

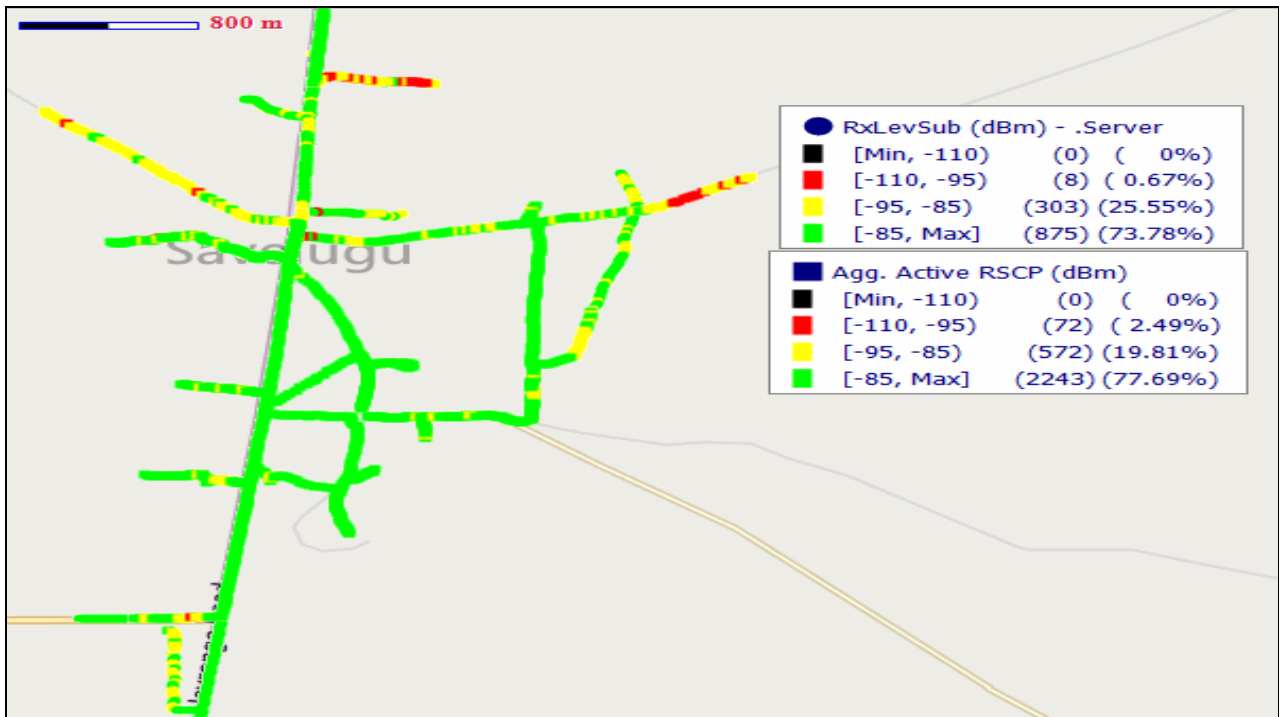
COVERAGE AT SAVELUGU

Fig 60. MTN Network Coverage Map Savelugu– August 2016



Remarks: Good network coverage in Savelugu but the 3G coverage needs improvement.

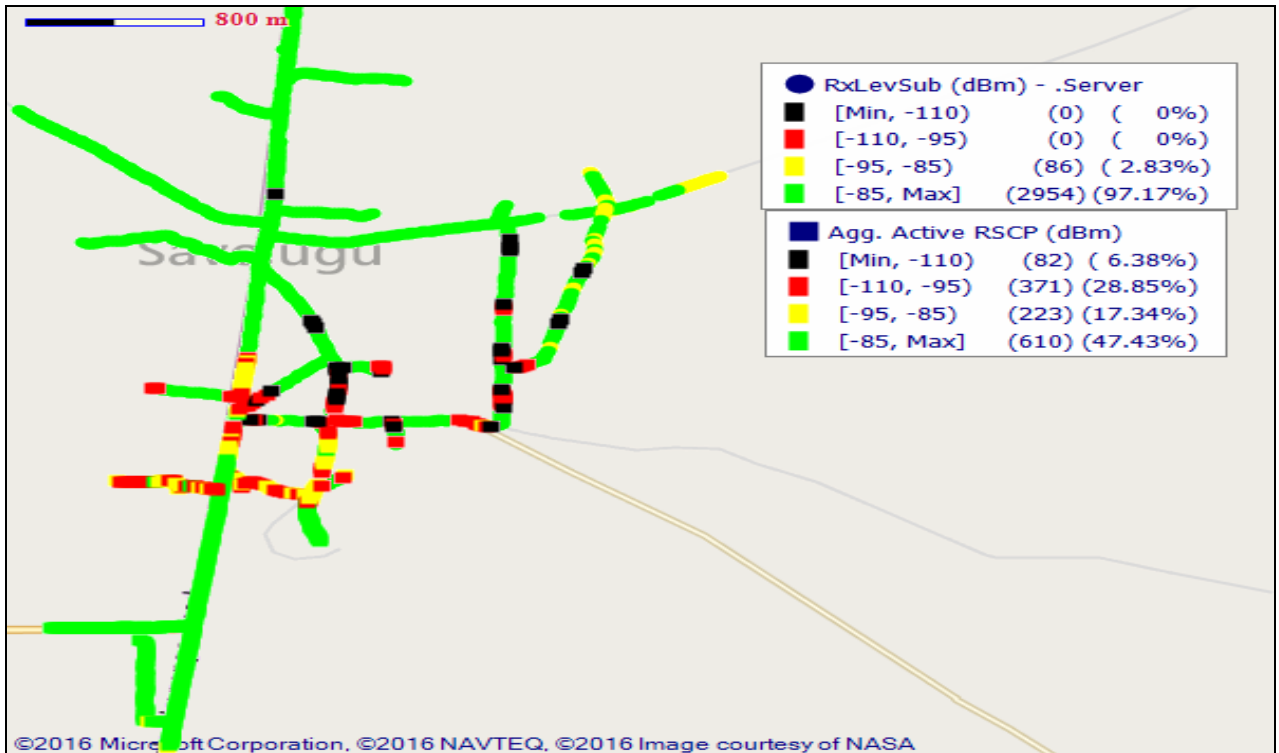
Fig 61. Vodafone Network Coverage Map Savelugu– August 2016



Remarks: Good network coverage in Savelugu with improvements needed at District Assembly, Kukuofong and Kwafong.

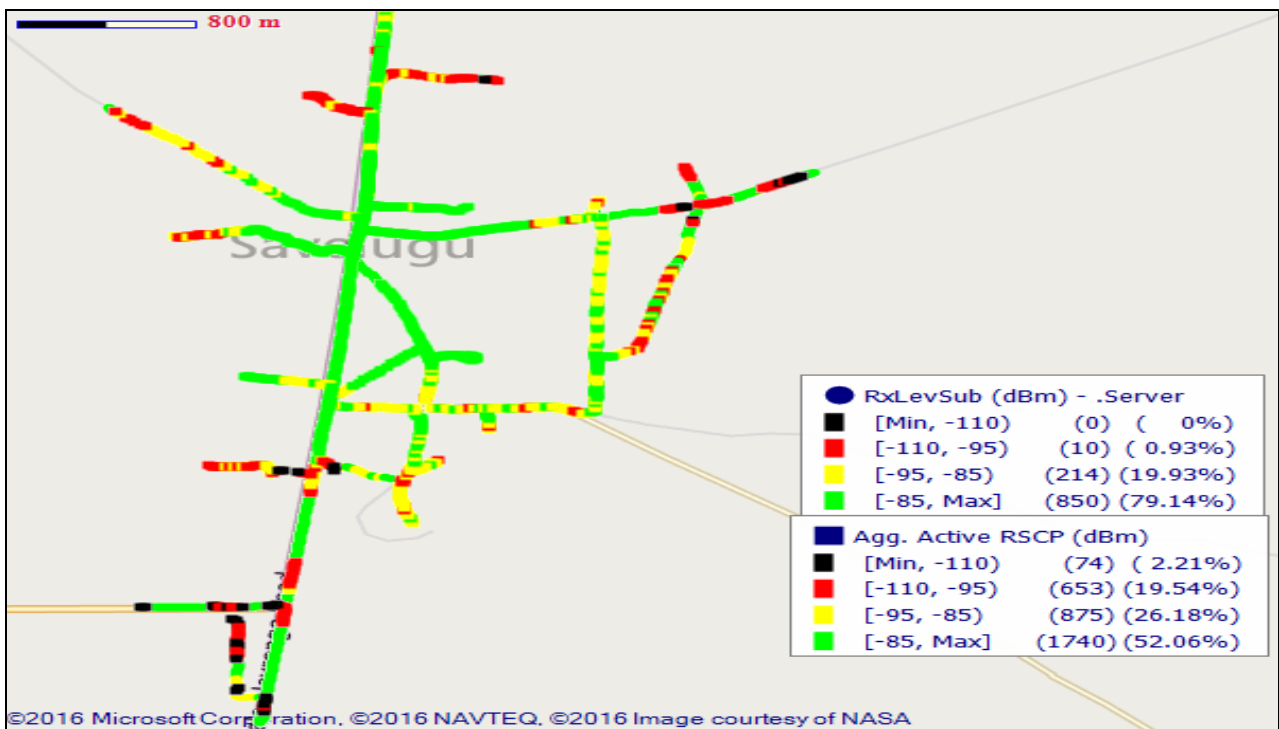
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 62. Tigo Network Coverage Map Savelugu - August 2016



Remarks: Good network coverage in Savelugu but bad spots around the District Assembly Office, Kukuofong and Kwafong needs improvement.

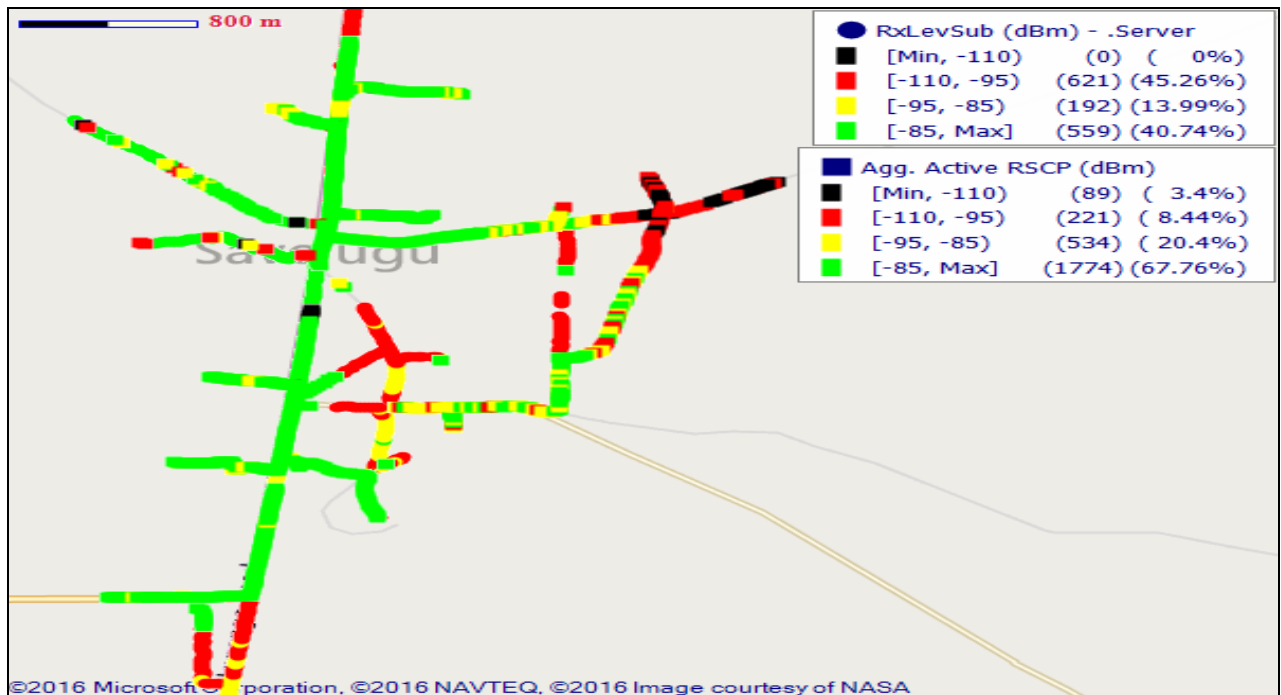
Fig 63. Airtel Network Coverage Map Savelugu– August 2016



Remarks: Good network coverage in Savelugu however, the District Assembly Office, Kambontoni, Yipala and Kwafong needs improvement.

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

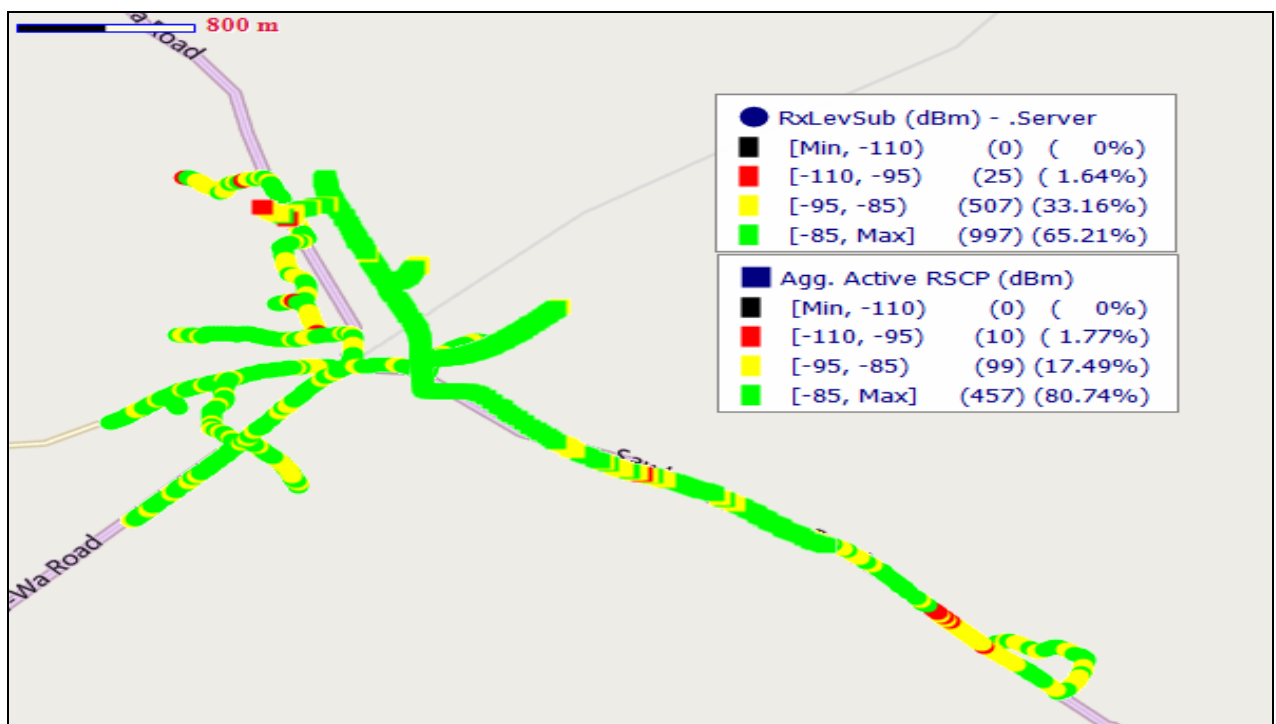
Fig 64. Glo Network Coverage Map Savelugu – August 2016



Remarks: Fair network coverage at Savelgu. Improvement is needed at the District Assembly Office, Yoo Naa’s Palace and Kwafong.

COVERAGE AT SAWLA

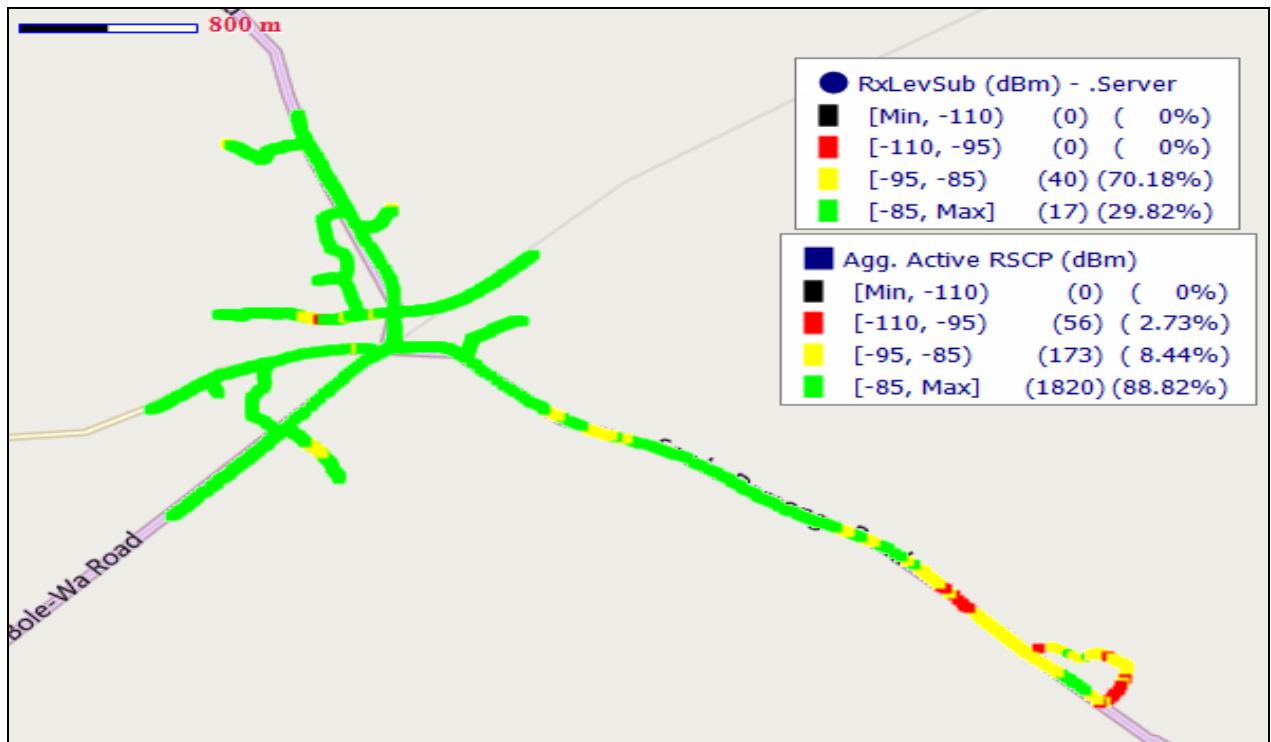
Fig 65. MTN Network Coverage Map Sawla– August 2016



Remarks: Good network coverage at Sawla.

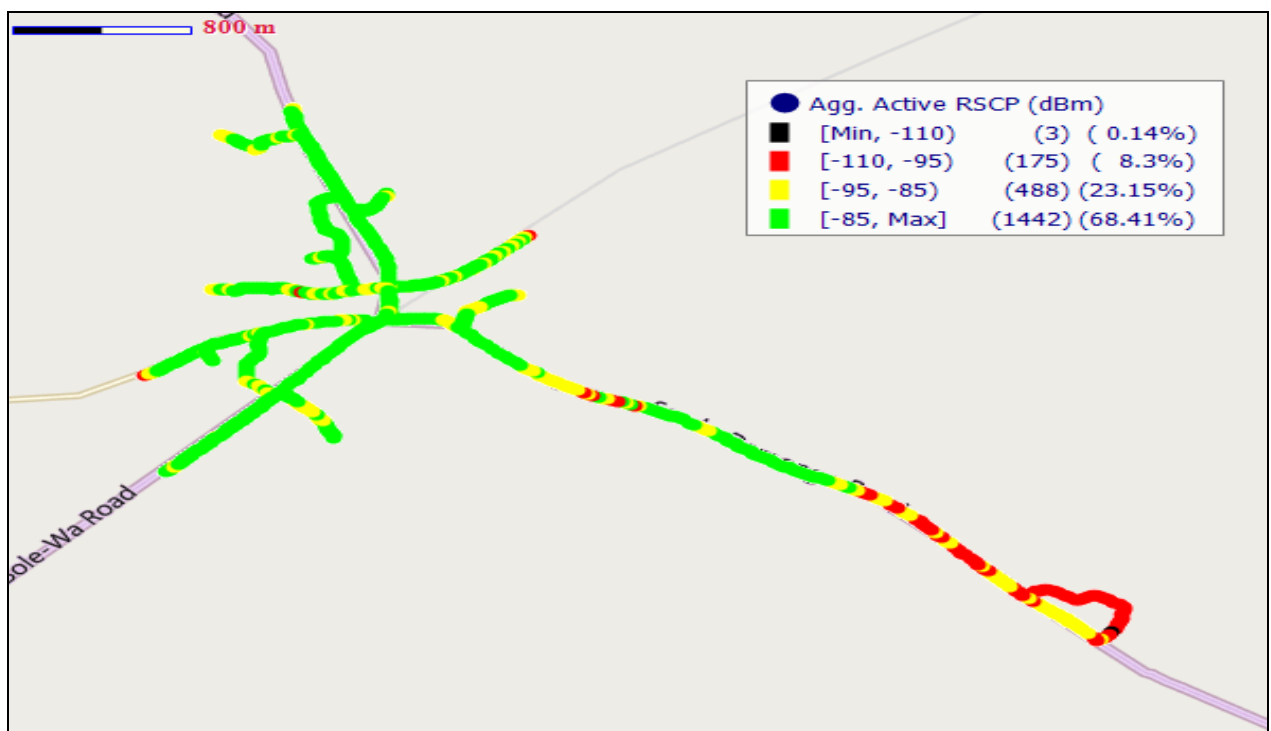
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 66. Vodafone Network Coverage Map Sawla– August 2016



Remarks: Good network coverage in Sawla however, District Assembly area requires some improvement.

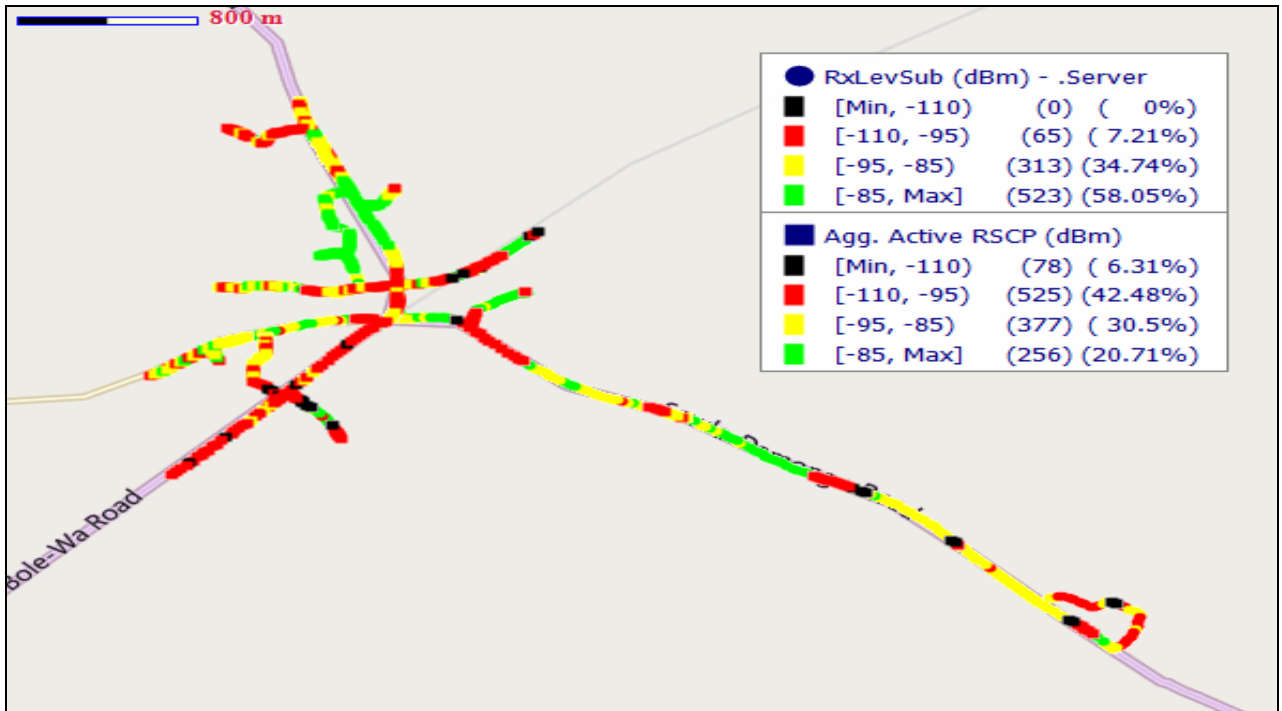
Fig 67. Tigo Network Coverage Map Sawla– August 2016



Remarks: Good network coverage at Sawla however improvement is required at the District Assembly area.

QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 68. Airtel Network Coverage Map Sawla – August 2016

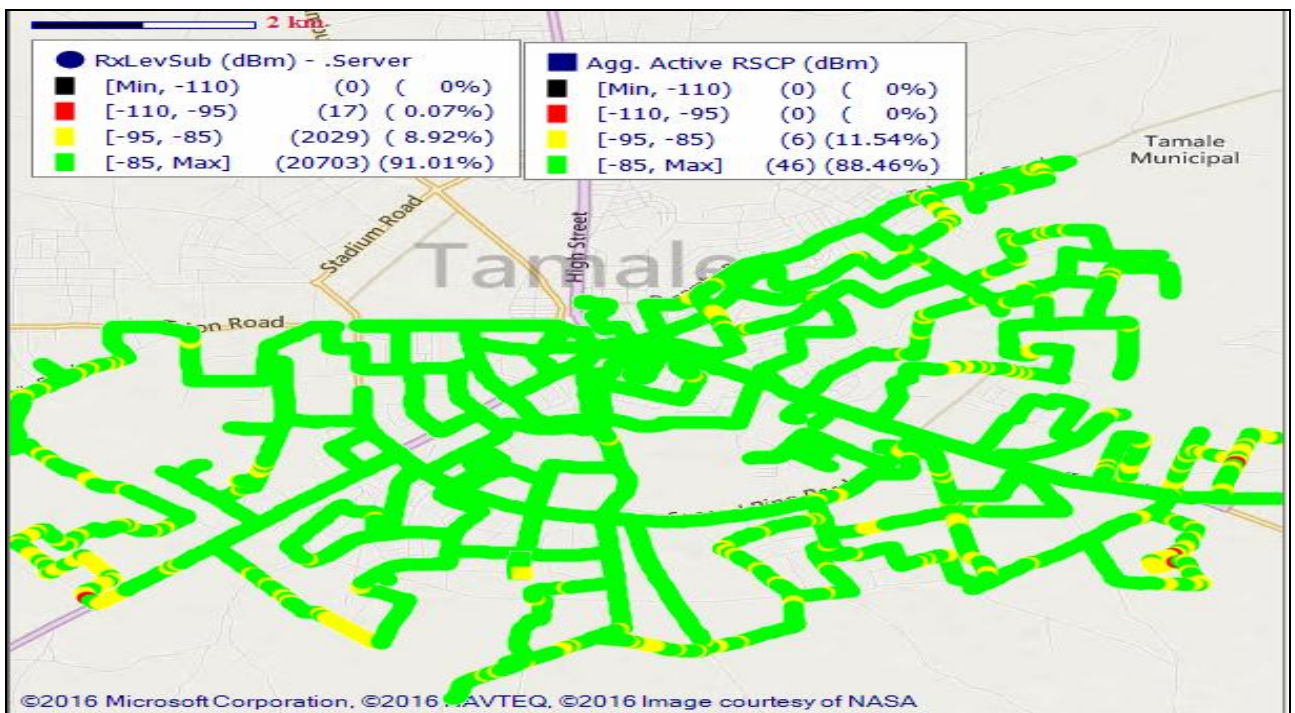


Remarks: Poor network coverage in Sawla; especially at Yipala, Sawla Children’s Home, Sindaa, Lorry Station and Chambeleduru requires major improvement.

***Glo had no service in Sawla at the time of the test**

COVERAGE AT TAMALE

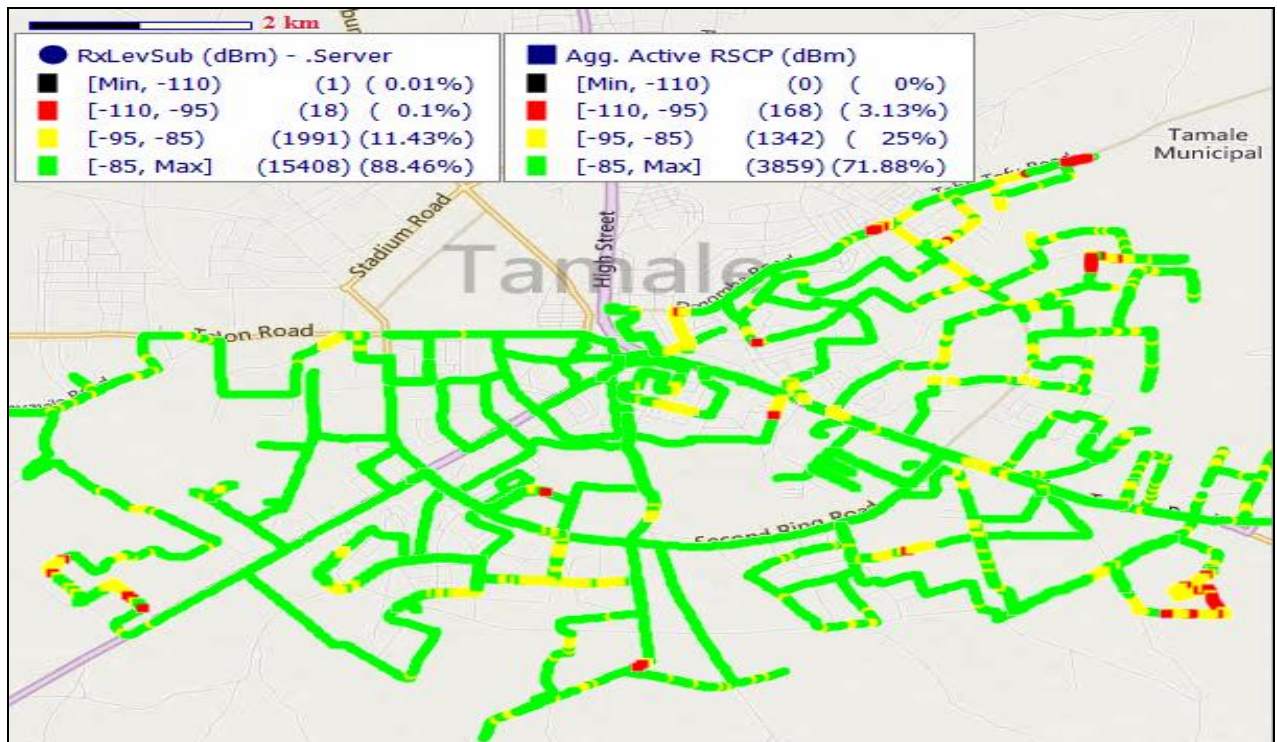
Fig 69. MTN Network Coverage Map Tamale – August 2016.



Remarks: Good network coverage across the entire Tamale Metropolis.

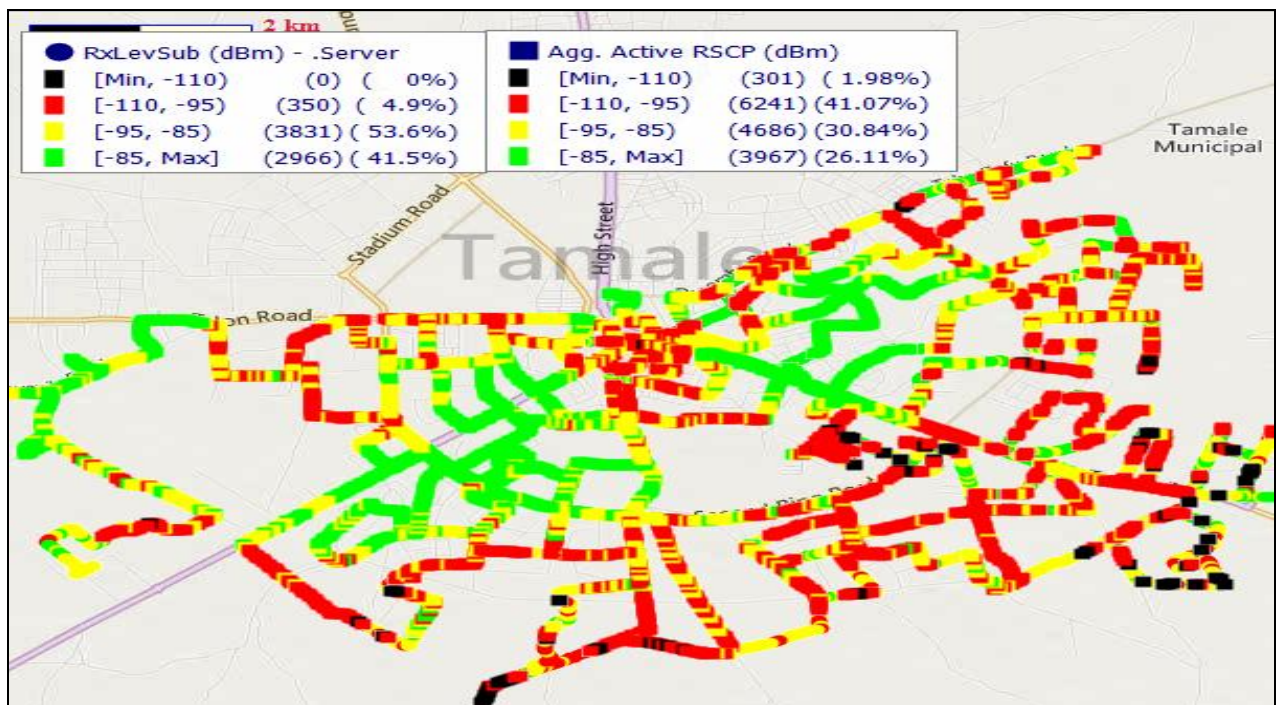
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 70. Vodafone Network Coverage Map Tamale – August 2016



Remarks: Good network coverage across the entire Tamale Metropolis.

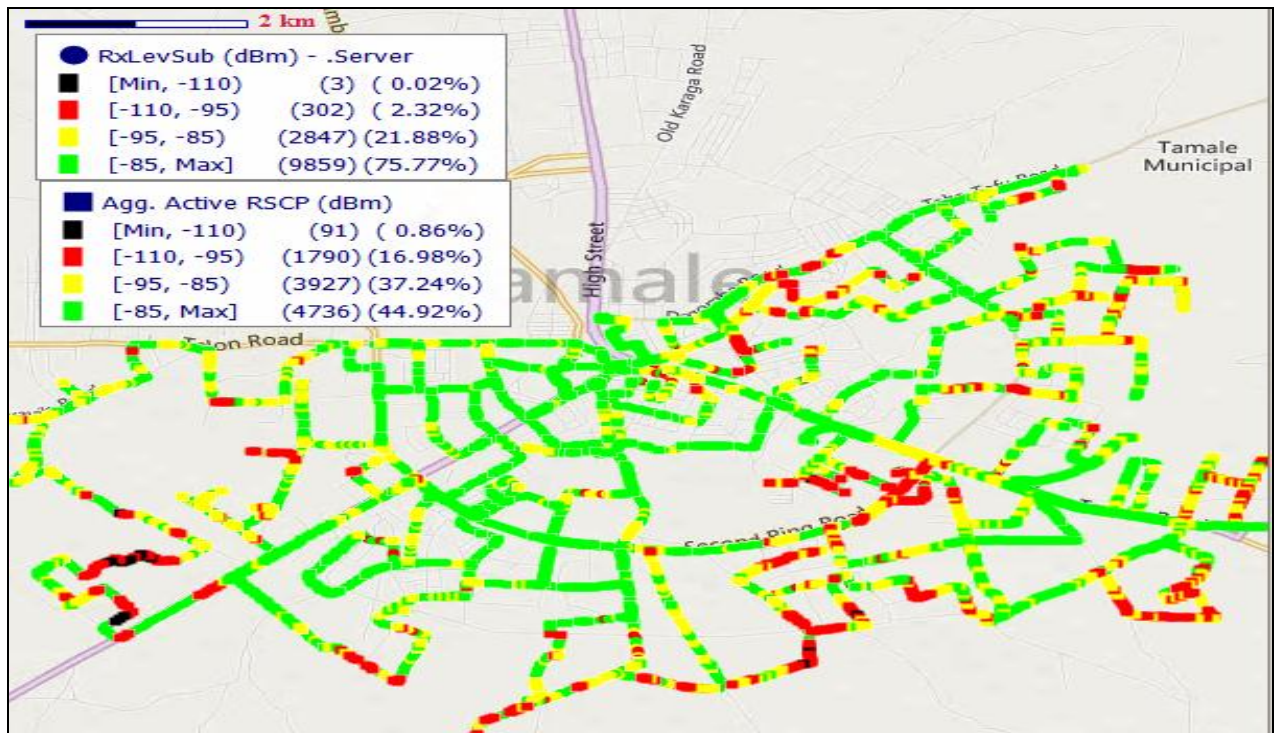
Fig 71. Tigo Network Coverage Map Tamale– August 2016.



Remarks: Poor network coverage across Tamale Metropolis. Major improvement is needed in the entire Tamale Metropolis

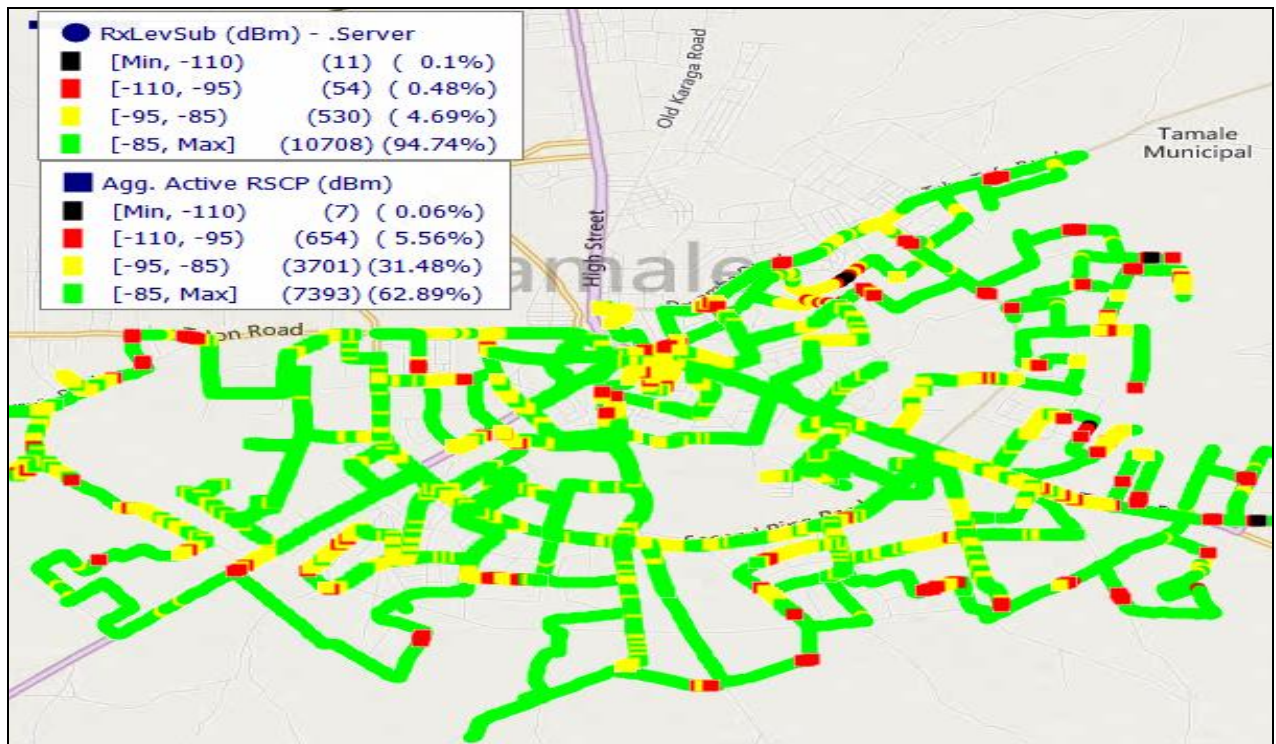
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 72. Airtel Network Coverage Map Tamale– August 2016.



Remarks: Good coverage in Tamale but the 3G network coverage at Kakpayili, Jekereyili, Vittin, Lamashegu and Banvim needs to be improved

Fig 73. Glo Network Coverage Map Tamale– August 2016

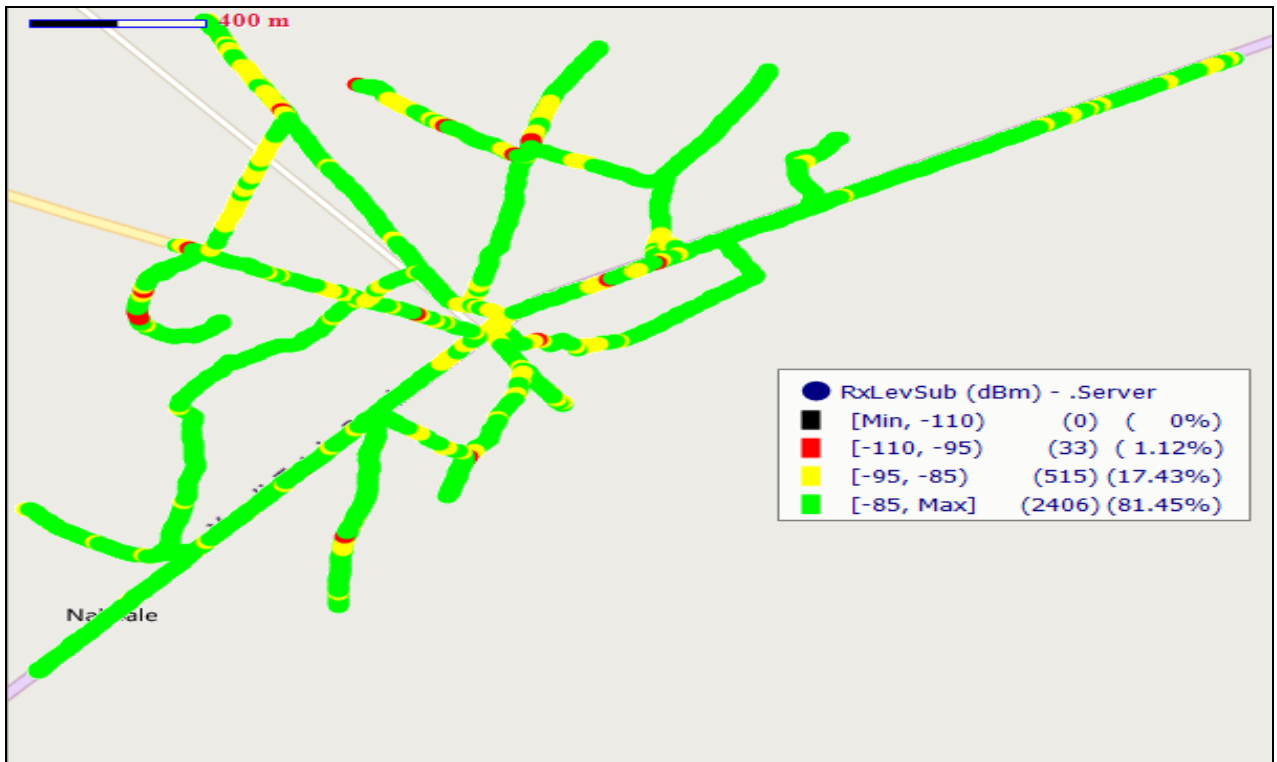


Remarks: Good network coverage in Tamale except few bad spots which requires improvement.

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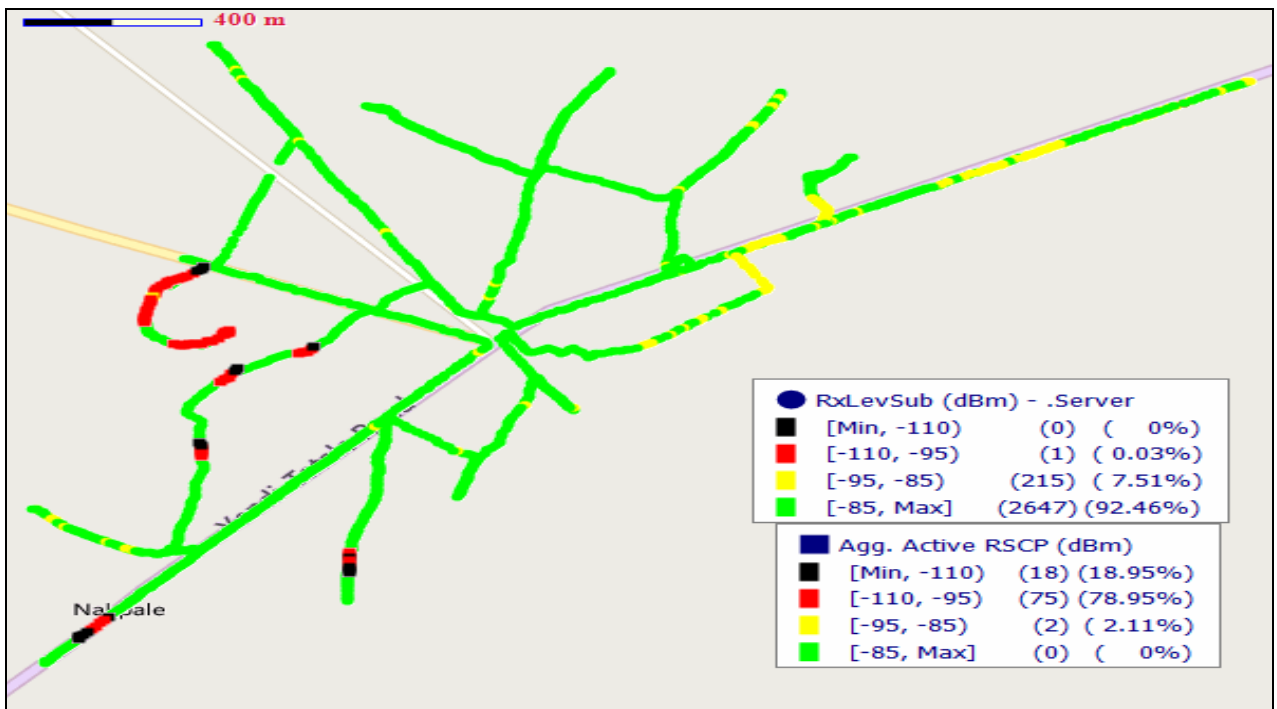
COVERAGE AT TATATLE

Fig 74. MTN Network Coverage Map Tatale– August 2016



Remarks: Good network coverage however improvement is needed in areas around the market, Agyei Nakpali and Islamic JHS.

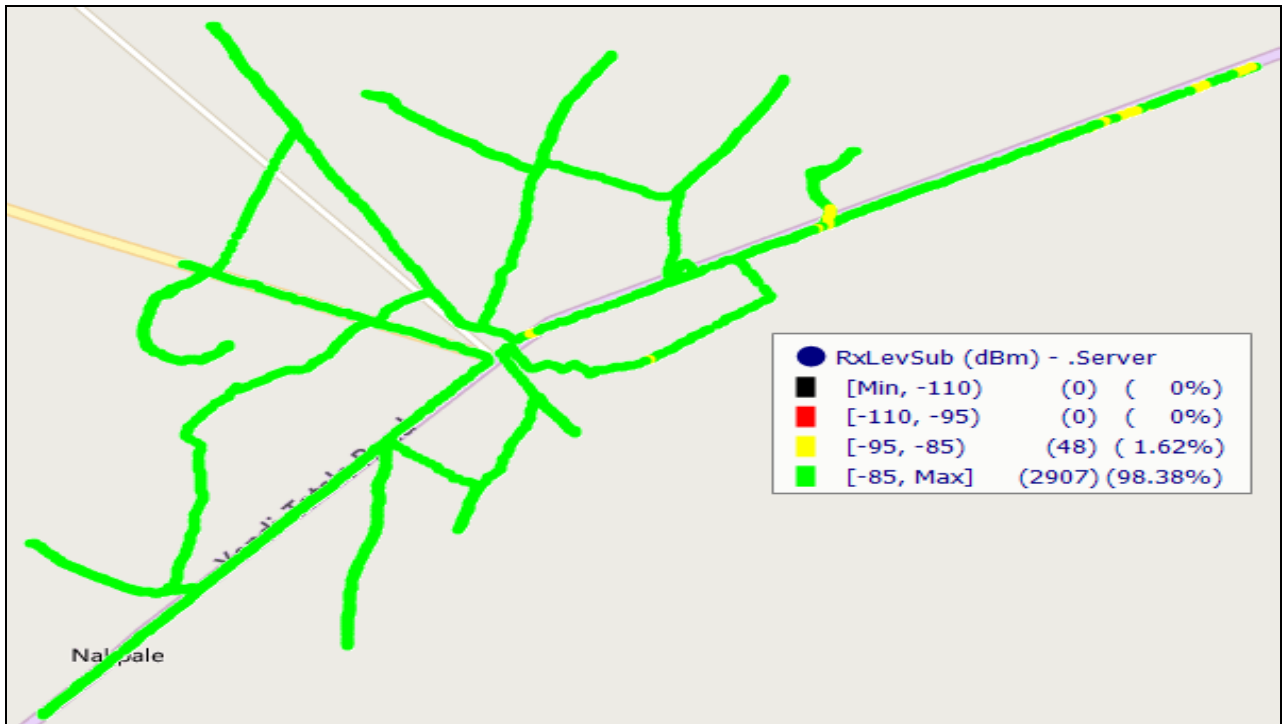
Fig 75. Vodafone Network Coverage Map Tatale– August 2016



Remarks: Good network coverage across the entire Tatale Township.

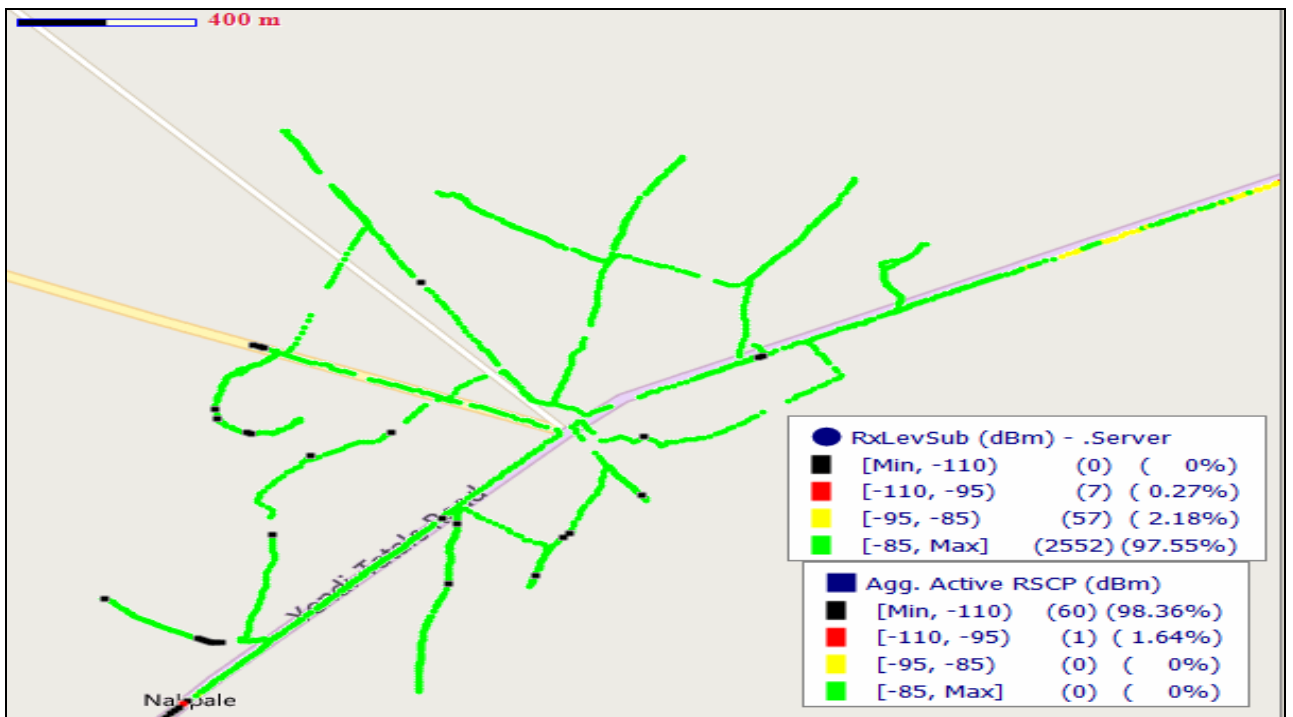
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 76. Tigo Network Coverage Map Tatale– August 2016



Remarks: Good network coverage across Tatale.

Fig 77. Airtel Network Coverage Map Tatale– August 2016



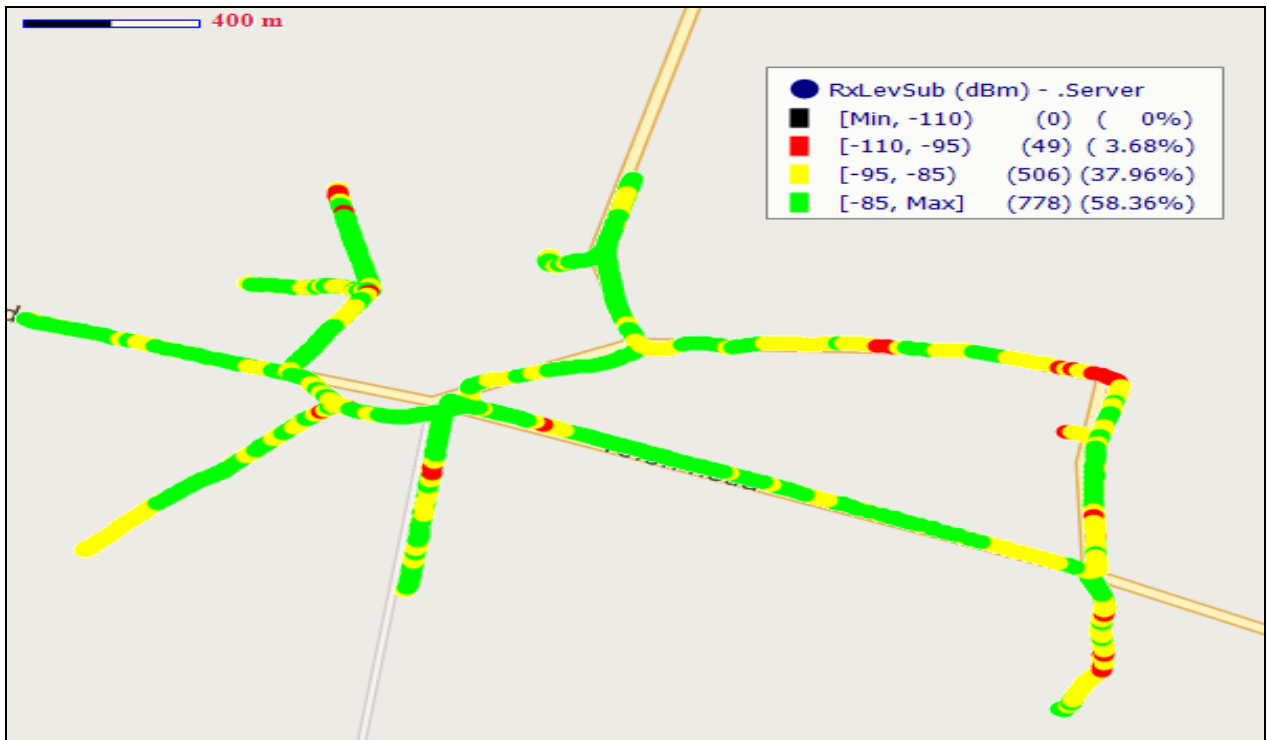
Remarks: Good network coverage across Tatale.

***Glo had no service in Tatale at the time of the test**

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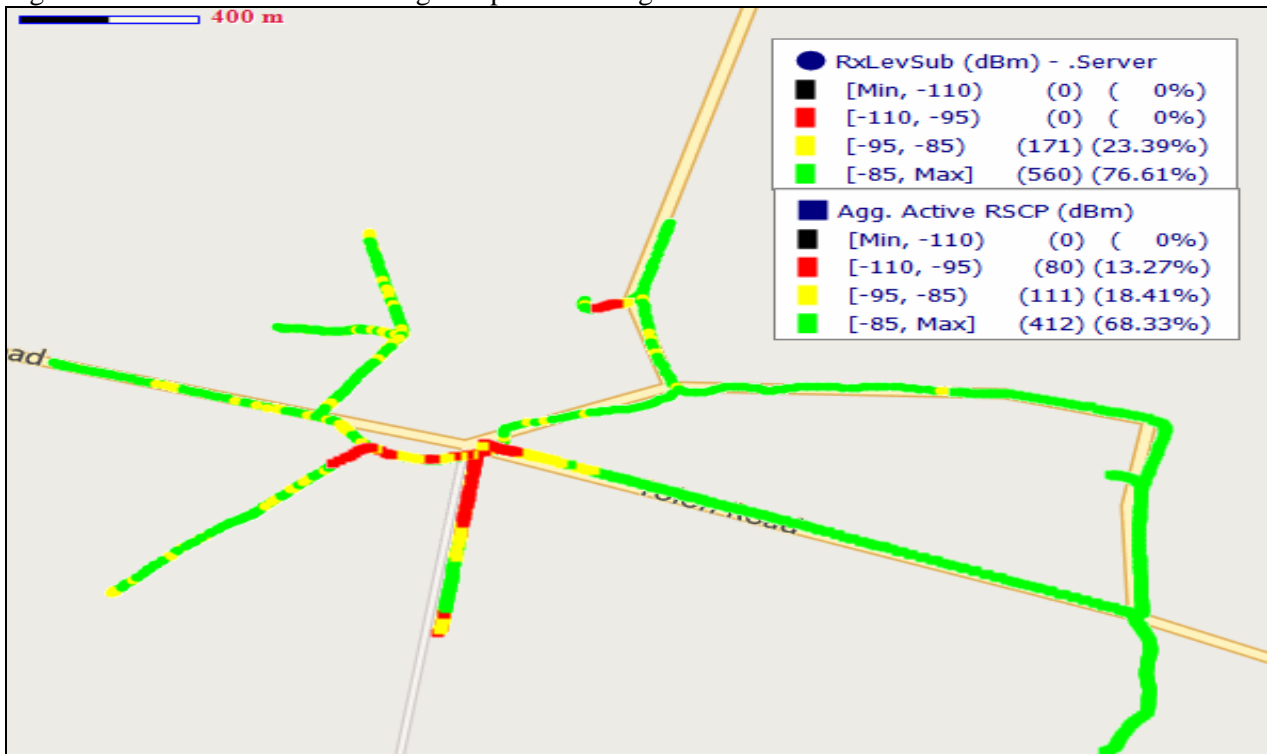
COVERAGE AT TOLON

Fig 78. MTN Network Coverage Map Tolon– August 2016



Remarks: Good network coverage in Tolon but improvement is needed at Tolon SHS, District Assembly and Irshahadya E/A Primary School.

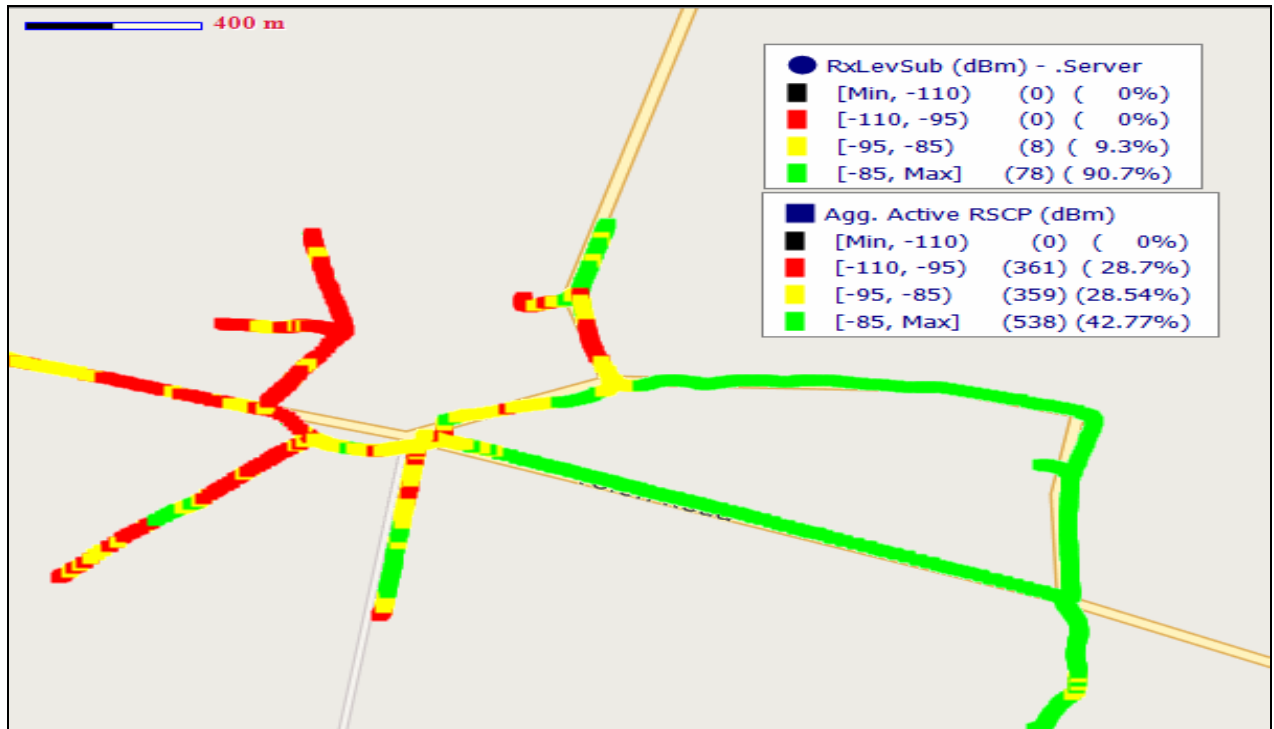
Fig 79. Vodafone Network Coverage Map Tolon - August 2016



Remarks: Good network coverage in Tolon but improvement is needed at the Market, Lorry Station and Irshahadya E/A Primary School.

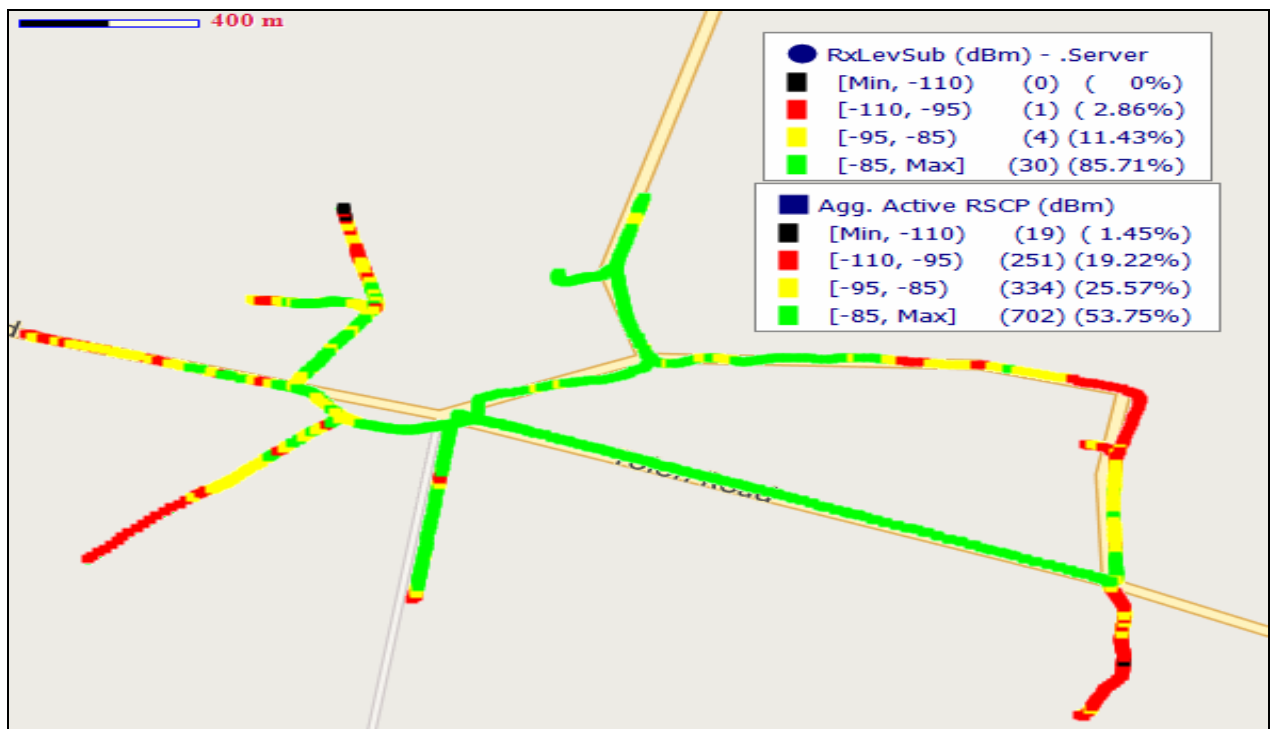
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 80. Tigo Network Coverage Map Tolon– August 2016



Remarks: Fair network coverage in Tolon but improvement is needed at the Lorry Station and Irshahadya E/A Primary School.

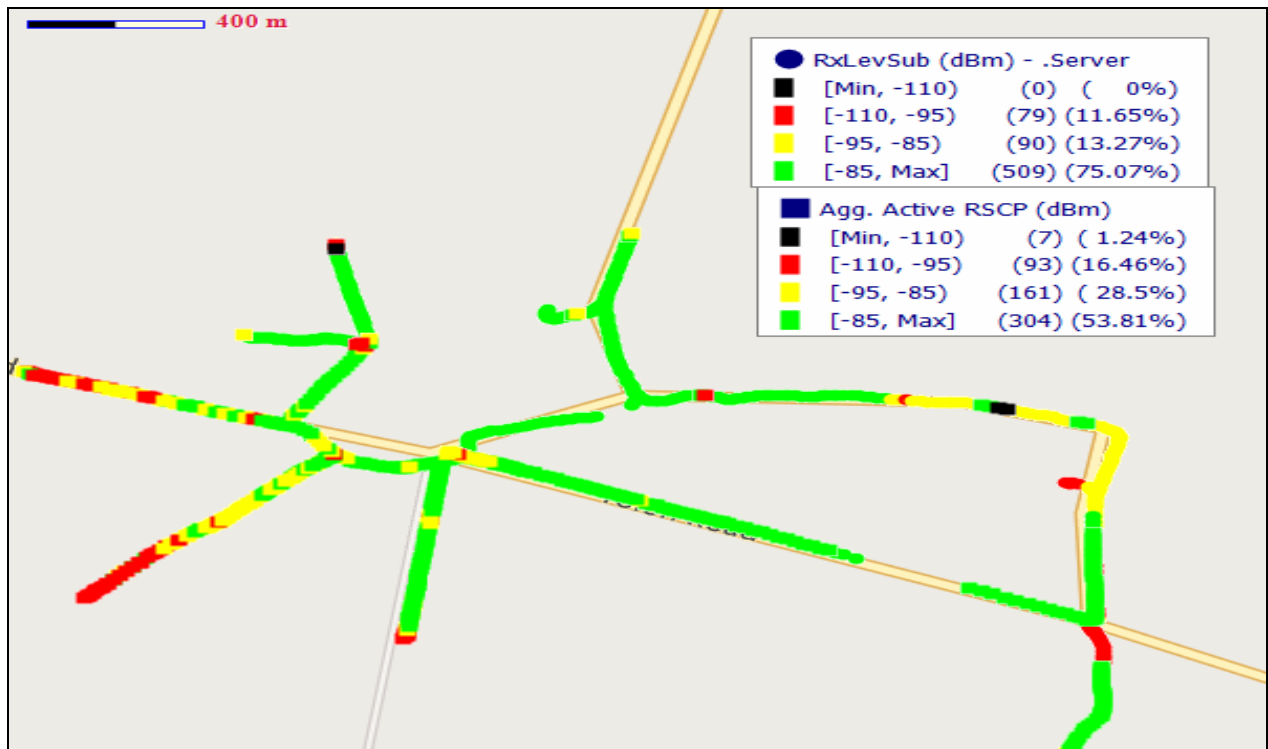
Fig 81. Airtel Network Coverage Map Tolon – August 2016



Remarks: Good network coverage in Tolon but improvement is still needed at Tolon Senior High School, District Assembly and Palace area.

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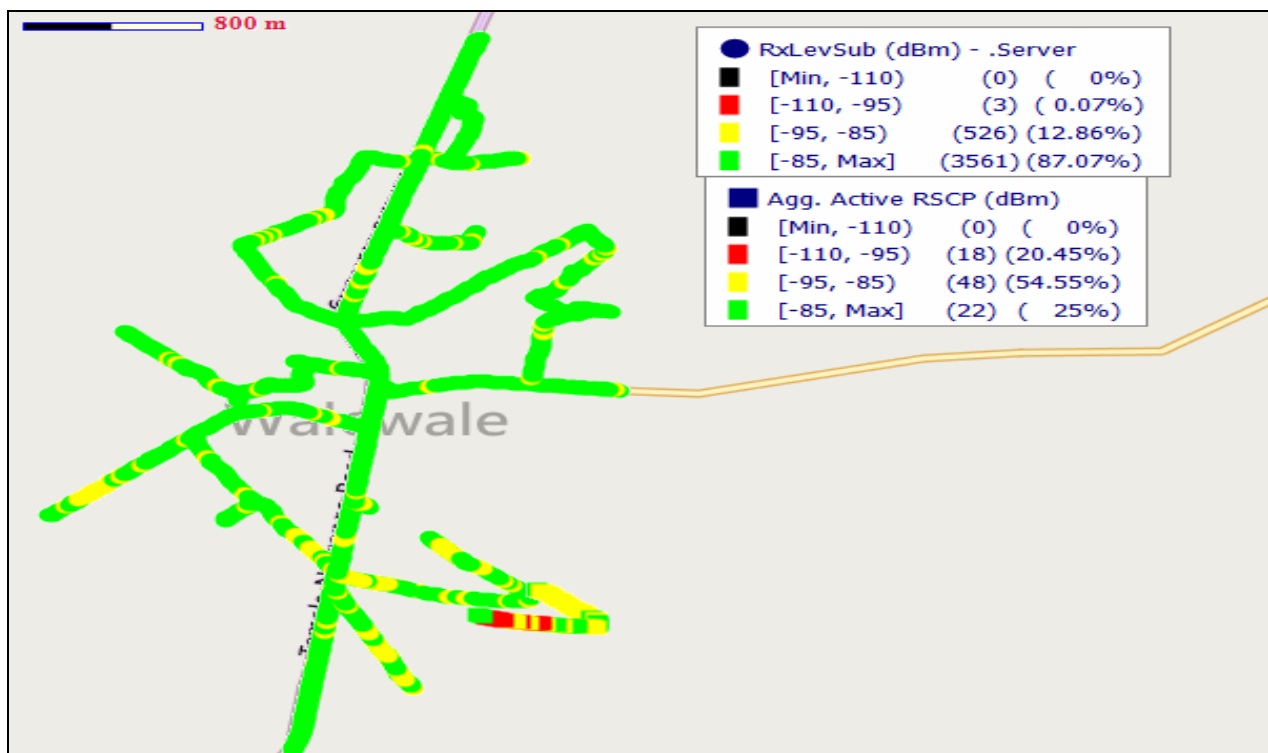
Fig 82. Glo Network Coverage Map Tolon– August 2016



Remarks: Good network coverage in Tolon.

COVERAGE AT WALEWALE

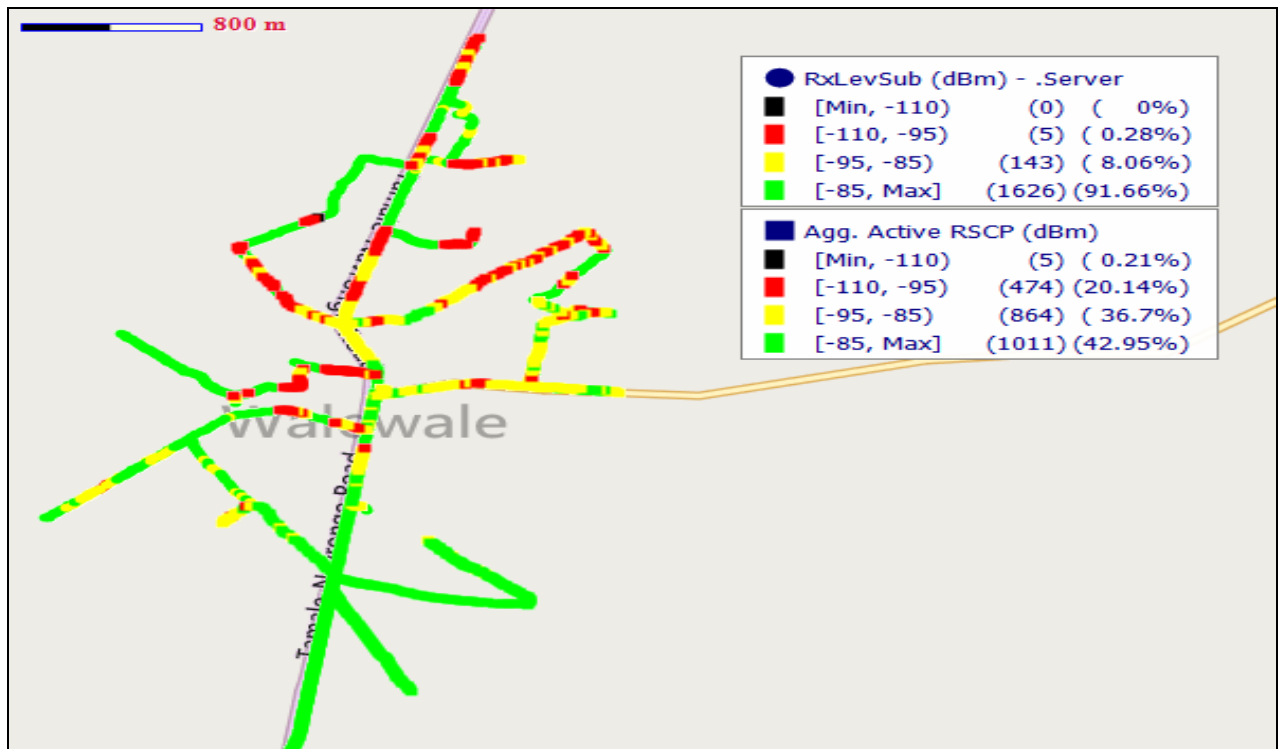
Fig 83. MTN Network Coverage Map Walewale– August 2016



Remarks: Good network coverage however, Kperiga needs improvement.

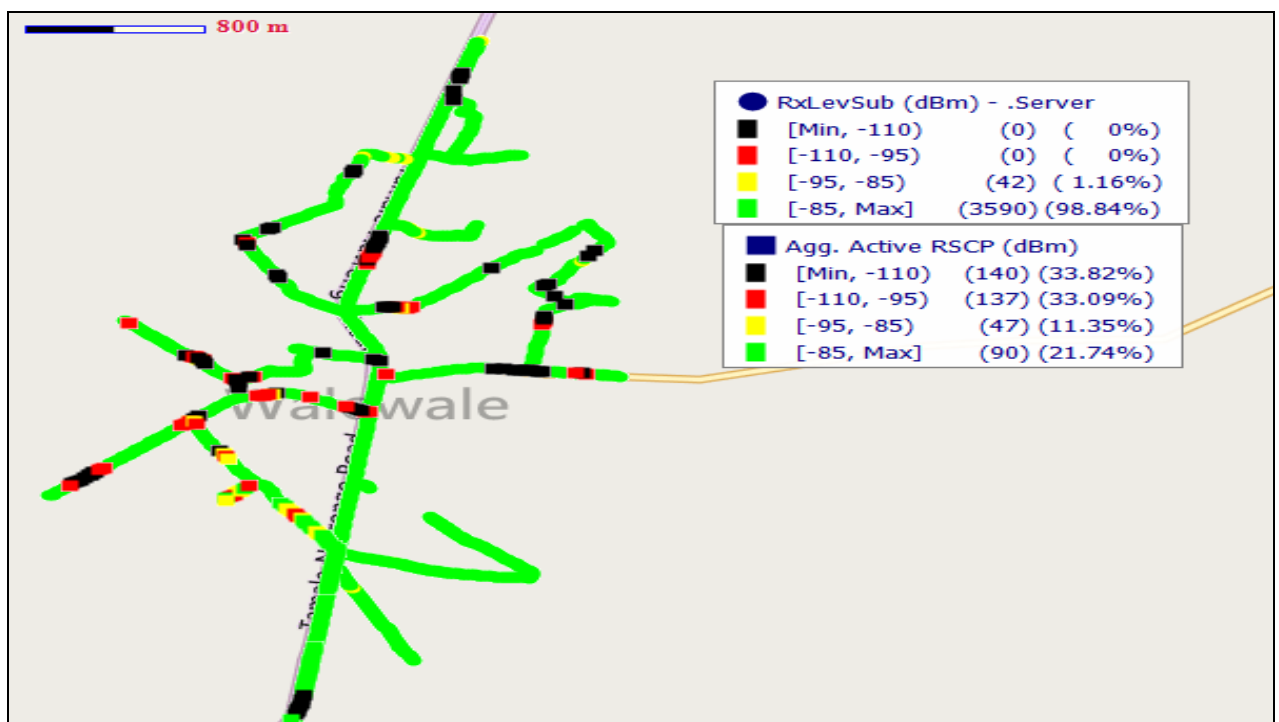
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 84. Vodafone Network Coverage Map Walewale– August 2016



Remarks: Fair network coverage which requires improvement at Kukuazugu No 1 and 2, Market, Police Head Quarters area and Eagle FM.

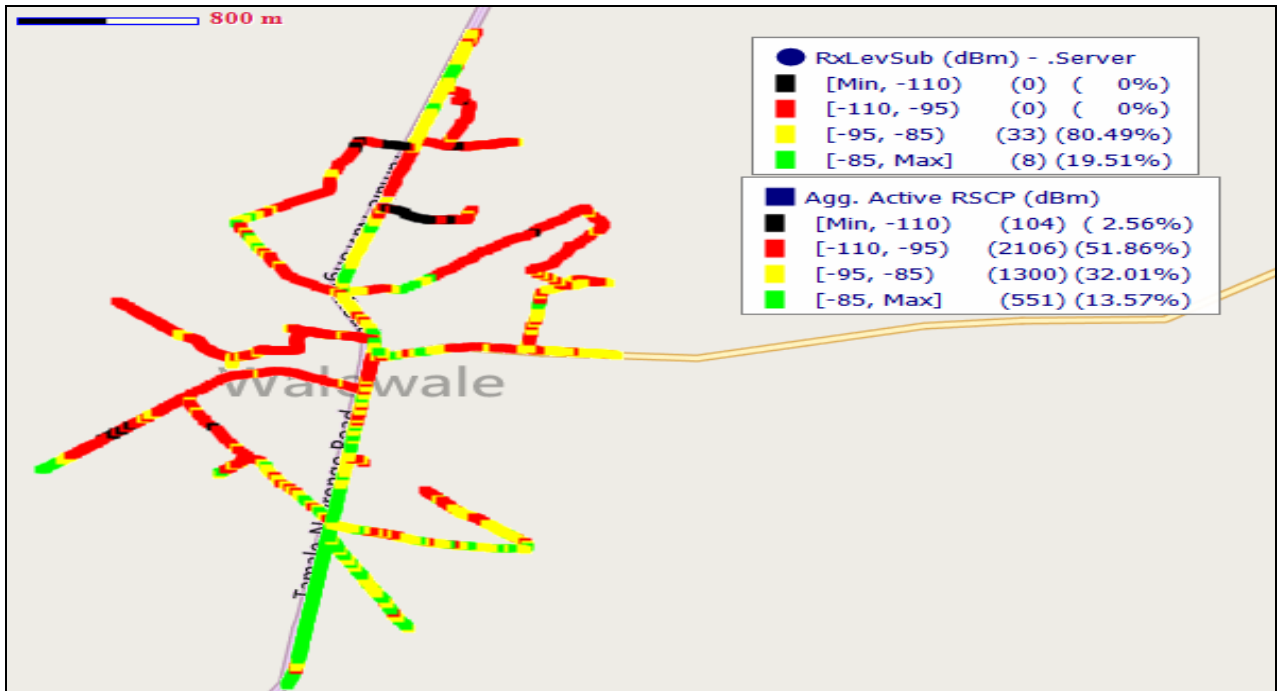
Fig 85. Tigo Network Coverage Walewale Map – August 2016



Remarks: Good network coverage across Walewale with some coverage gaps which needs improvement.

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Fig 86. Airtel Network Coverage Map Walewale– August 2016.

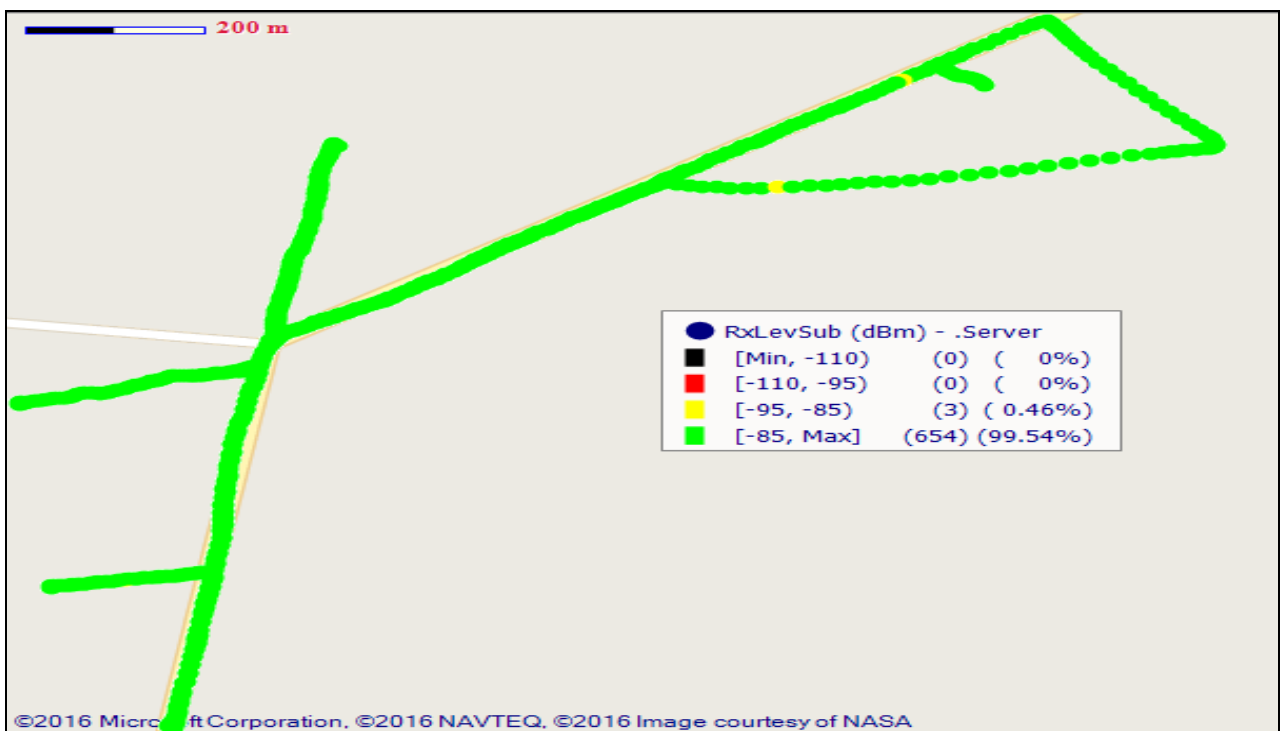


Remarks: Poor network coverage in Walewale. Major improvement is required at Hospital, Lorry Station, Kukuazugu No 1 and 2, Market and Kperiga.

***Glo had no service in Walewale at time of the test**

COVERAGE AT YAGABA

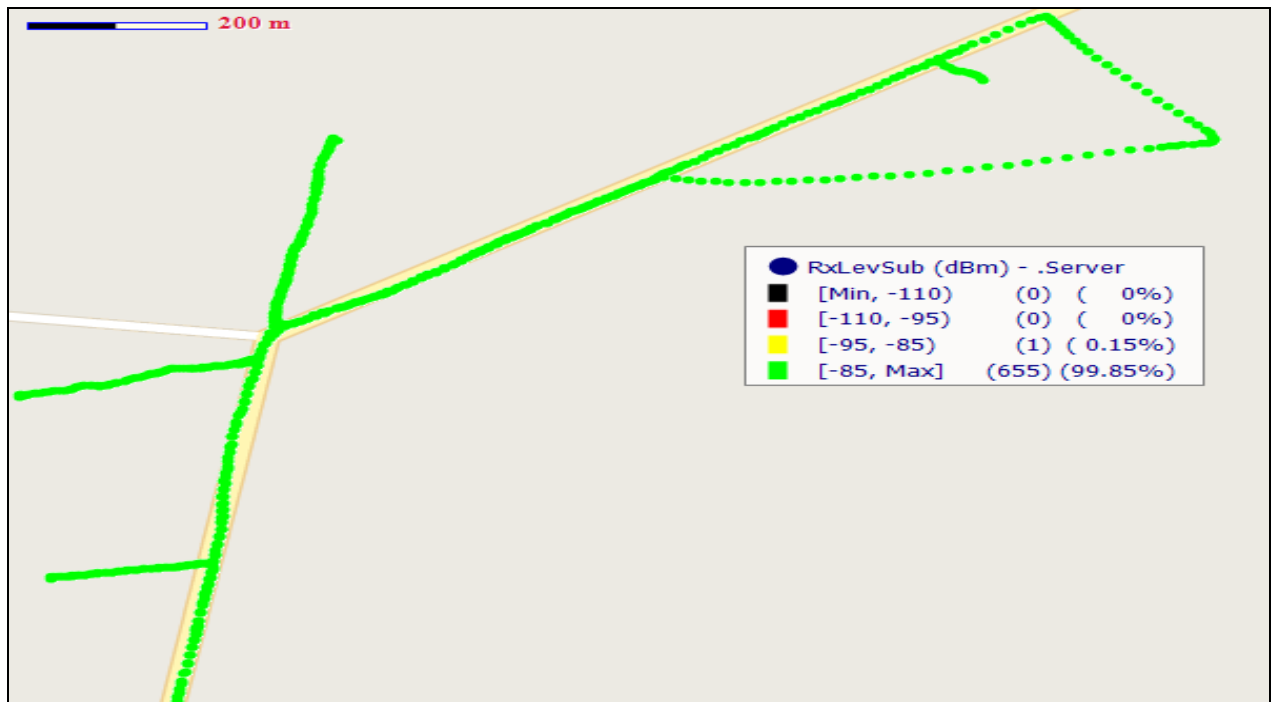
Fig 87. MTN Network Coverage Map Yagaba– August 2016.



Remarks: Good network coverage at Yagaba.

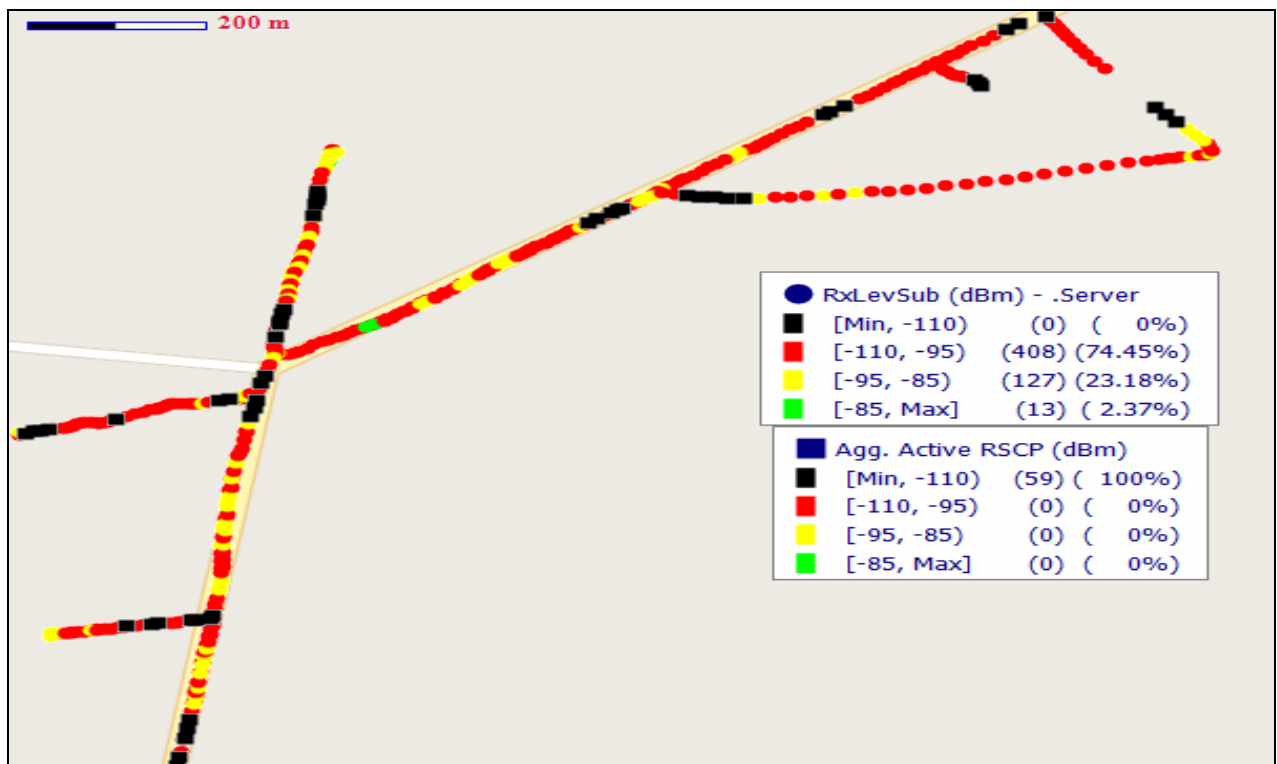
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 88. Vodafone Network Coverage Map Yagaba – August 2016.



Remarks: Good network coverage at Yagaba.

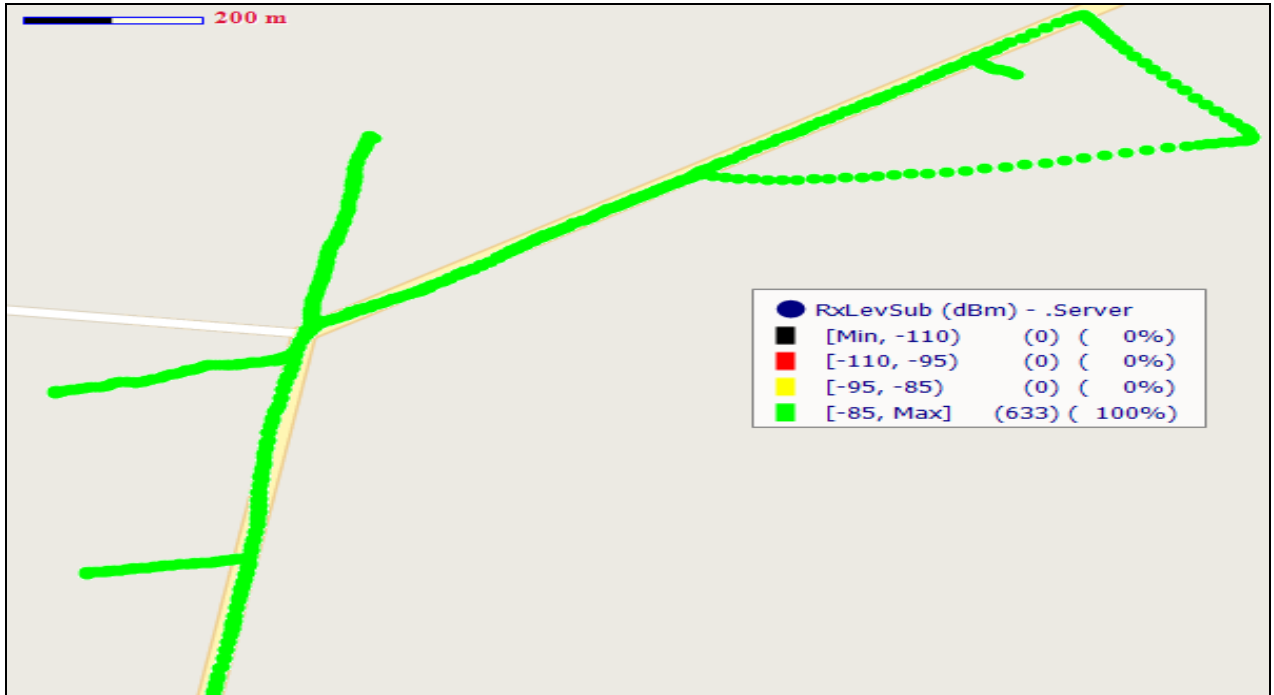
Fig 89. Tigo Network Coverage Map Yagaba– August 2016



Remarks: Poor network coverage in Yagaba. Major improvement is required across the entire Yagaba.

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Fig 90. Airtel Network Coverage Map Yagaba– August 2016

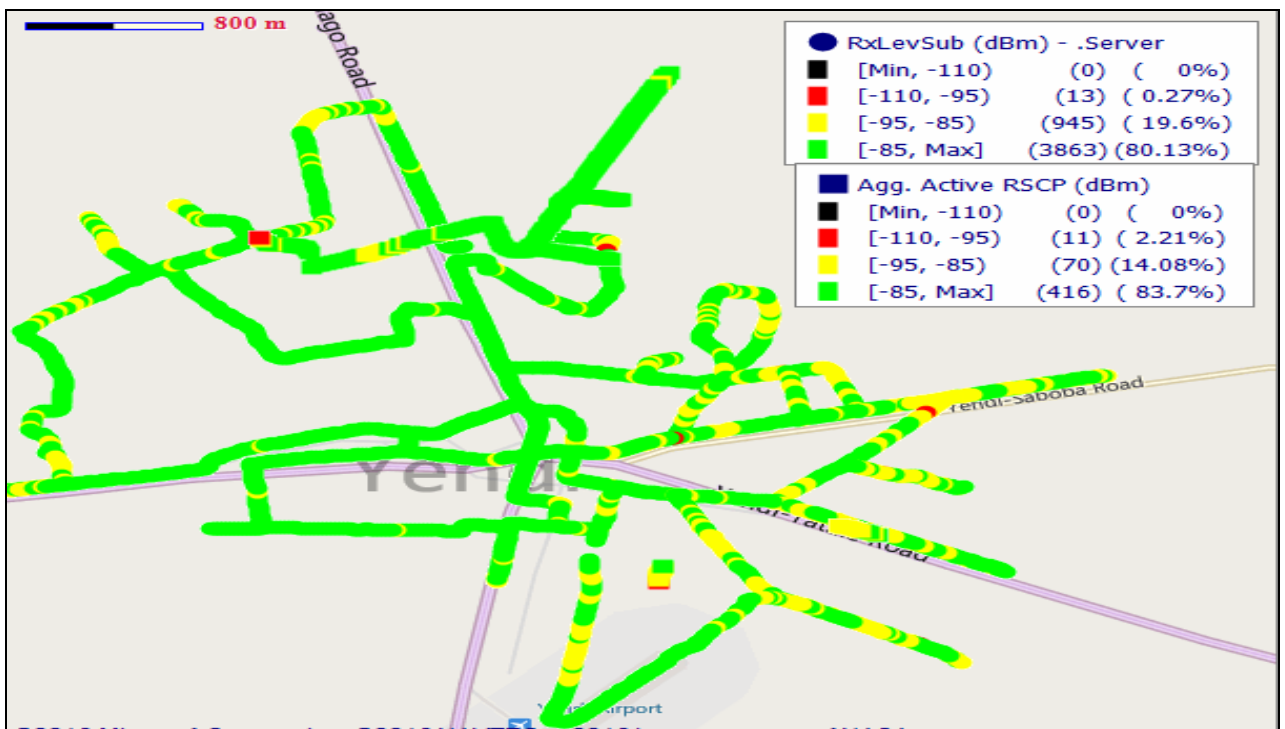


Remarks: Good 2G network coverage at Yagaba.

***Glo had no service in Yagaba at the time of the test.**

COVERAGE AT YENDI

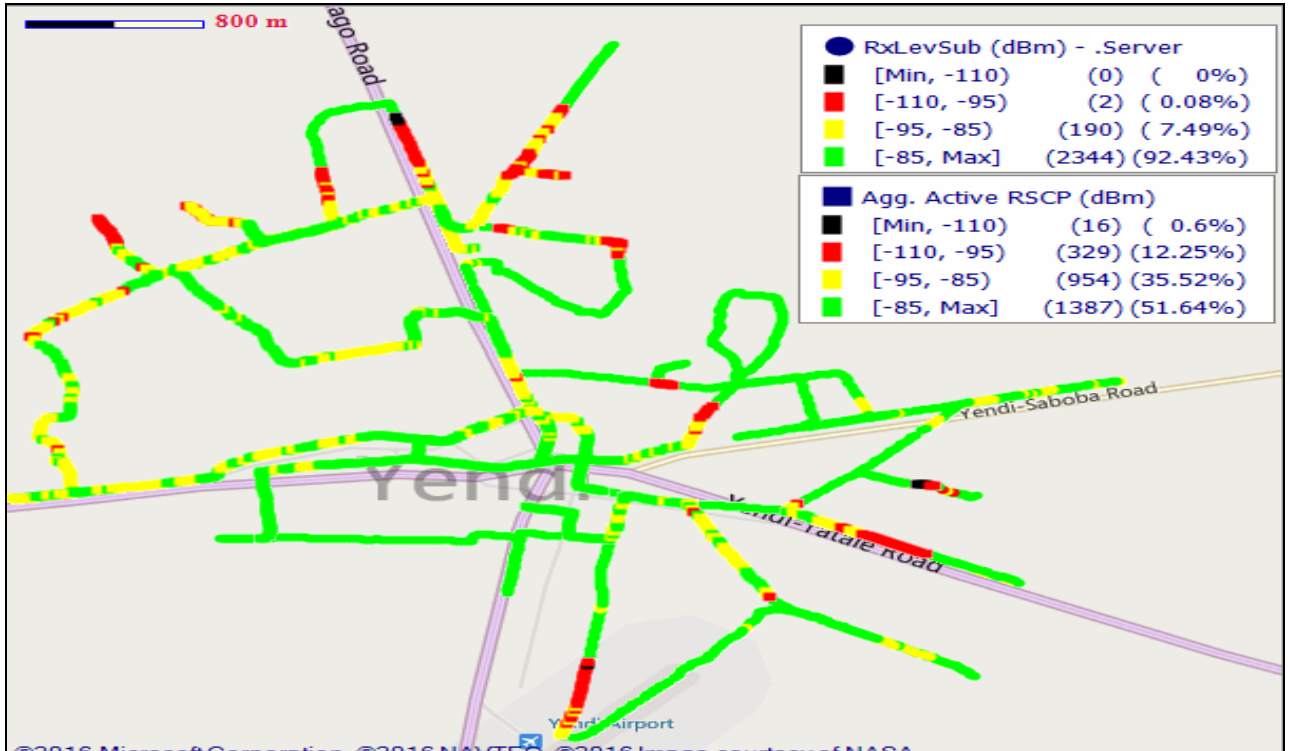
Fig 91. MTN Network Coverage Map Yendi– August 2016



Remarks: Good network coverage at Yendi.

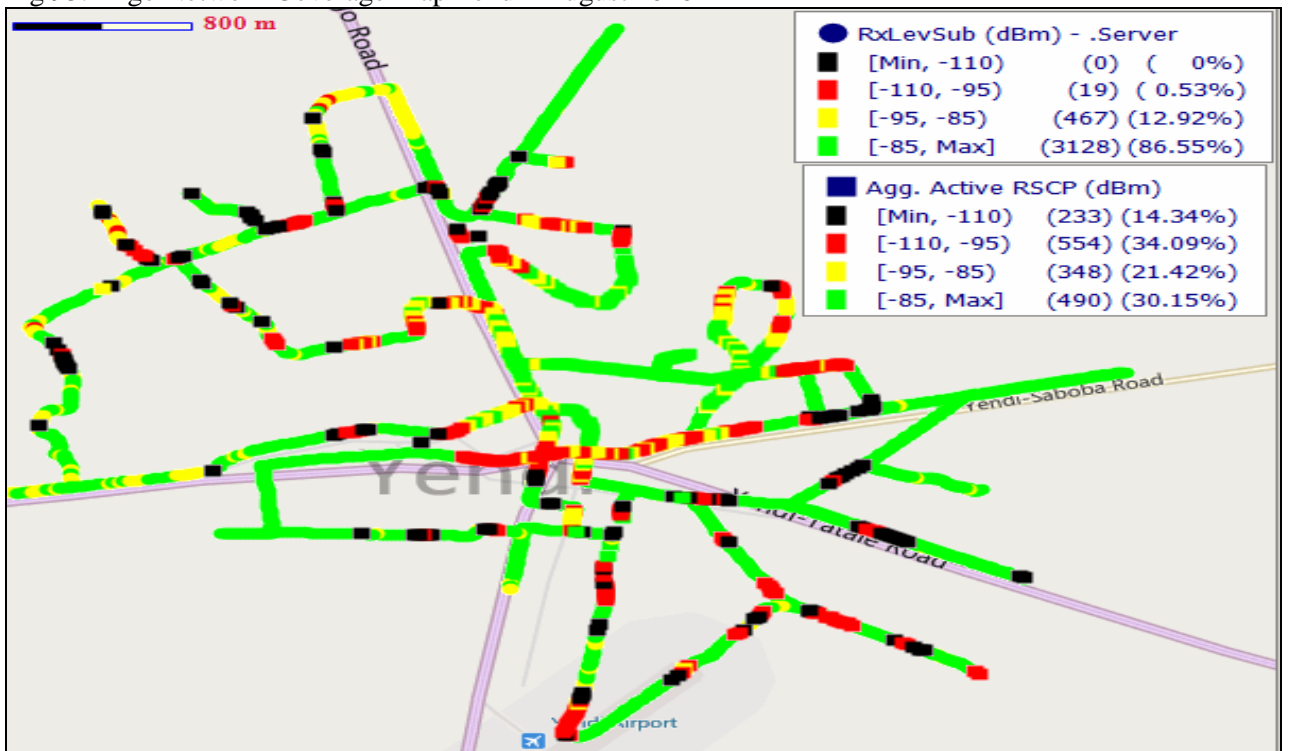
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 92. Vodafone Network Coverage Map Yendi – August 2016



Remarks: Good network coverage in Yendi but 3G coverage requires improvement at Gundogo, Guntangli, District Assembly and Sikafuo.

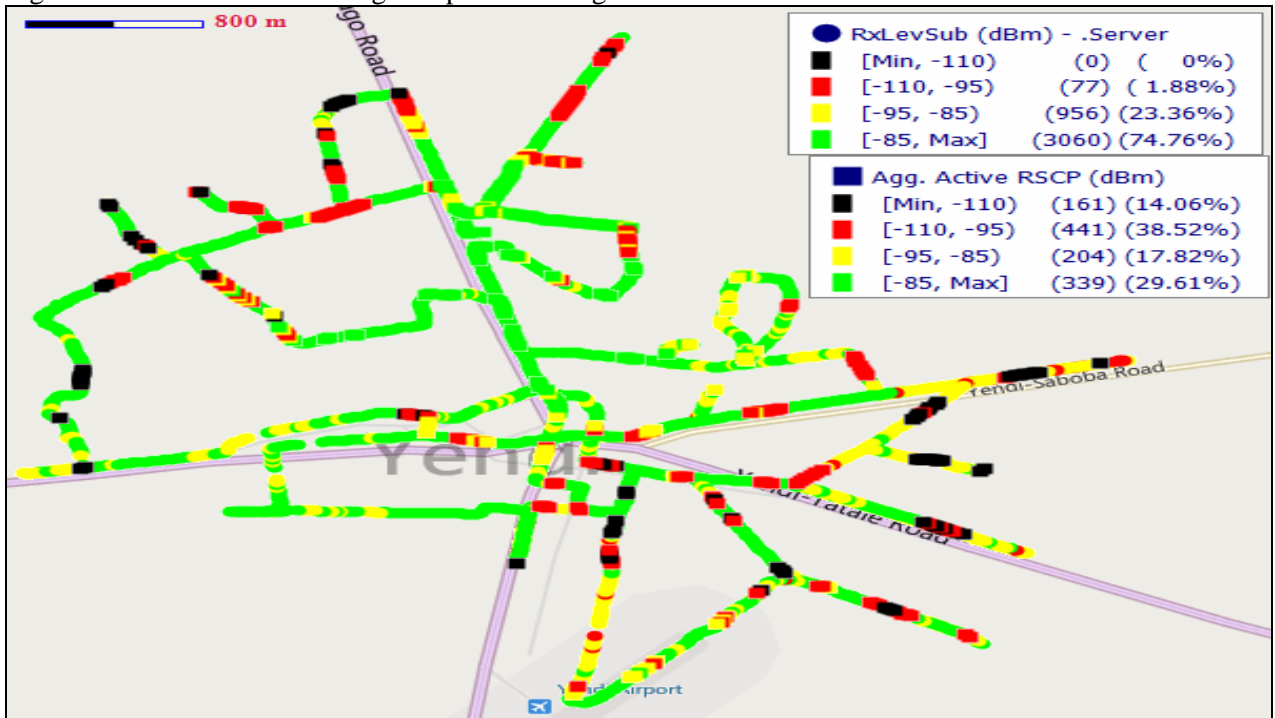
Fig 93. Tigo Network Coverage Map Yendi– August 2016



Remarks: Good network coverage but 3G coverage requires improvement across the entire Yendi Township.

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Fig 94. Airtel Network Coverage Map Yendi– August 2016

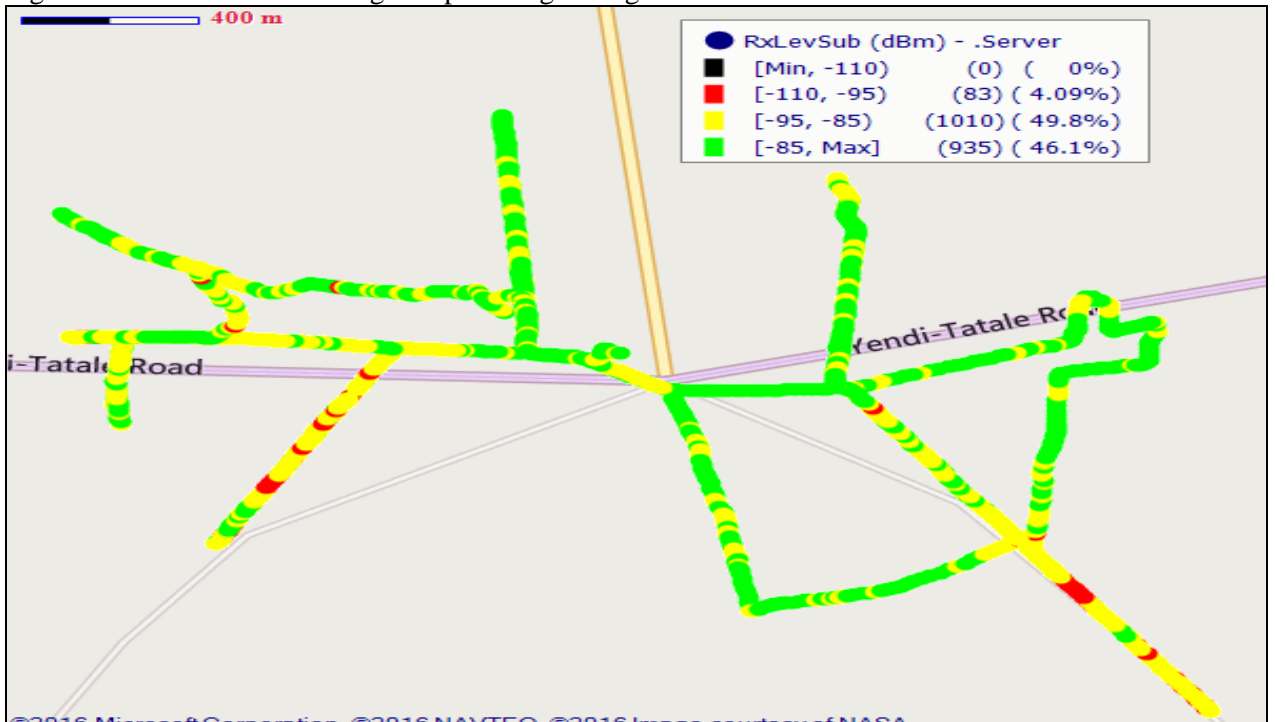


Remarks: Fair network coverage in Yendi but the 3G needs improvement at Guntangli, Dagbon State Senior High, Yendi Senior High, Mendogo and Catholic Guest House.

***Glo had no service at Yendi at the time of the test.**

COVERAGE AT ZABZUGU

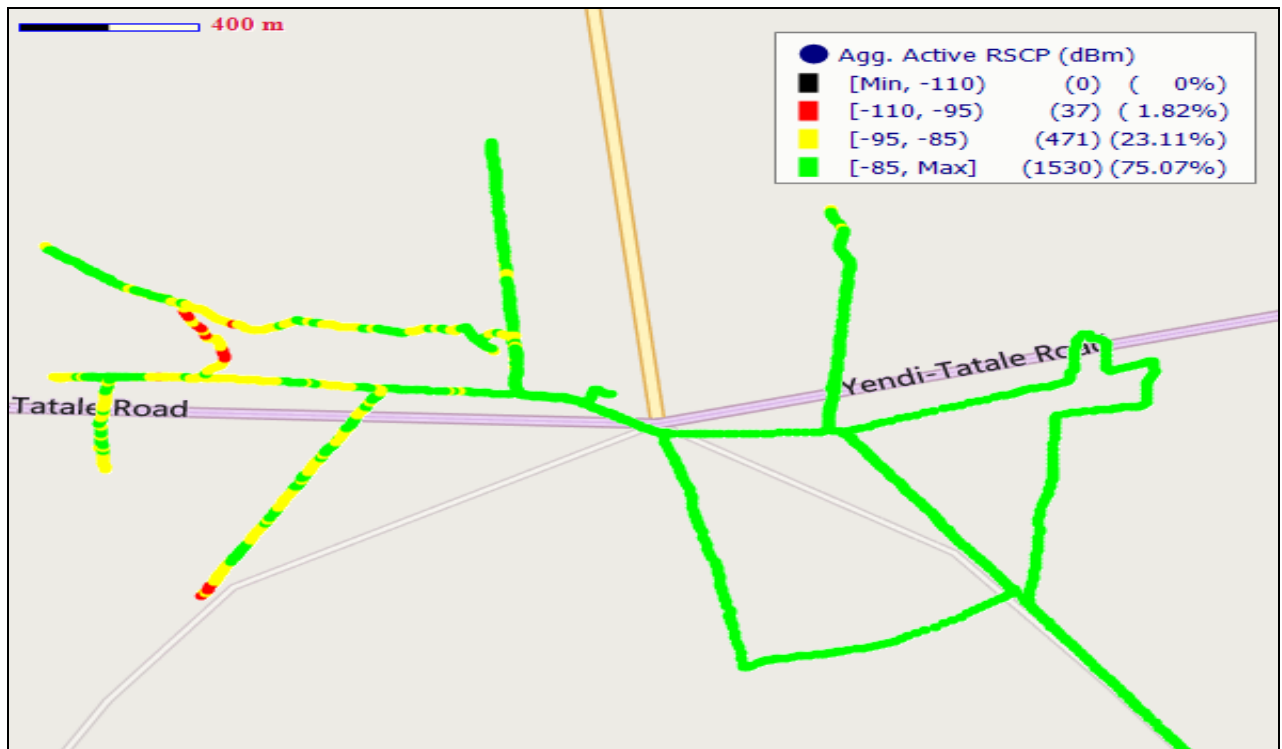
Fig 95. MTN Network Coverage Map Zabzugu– August 2016



Remarks: Fair network coverage in Zabzugu however improvement is needed at the DCE’s Bungalow, Nurses Quarters, Nangeli and Market.

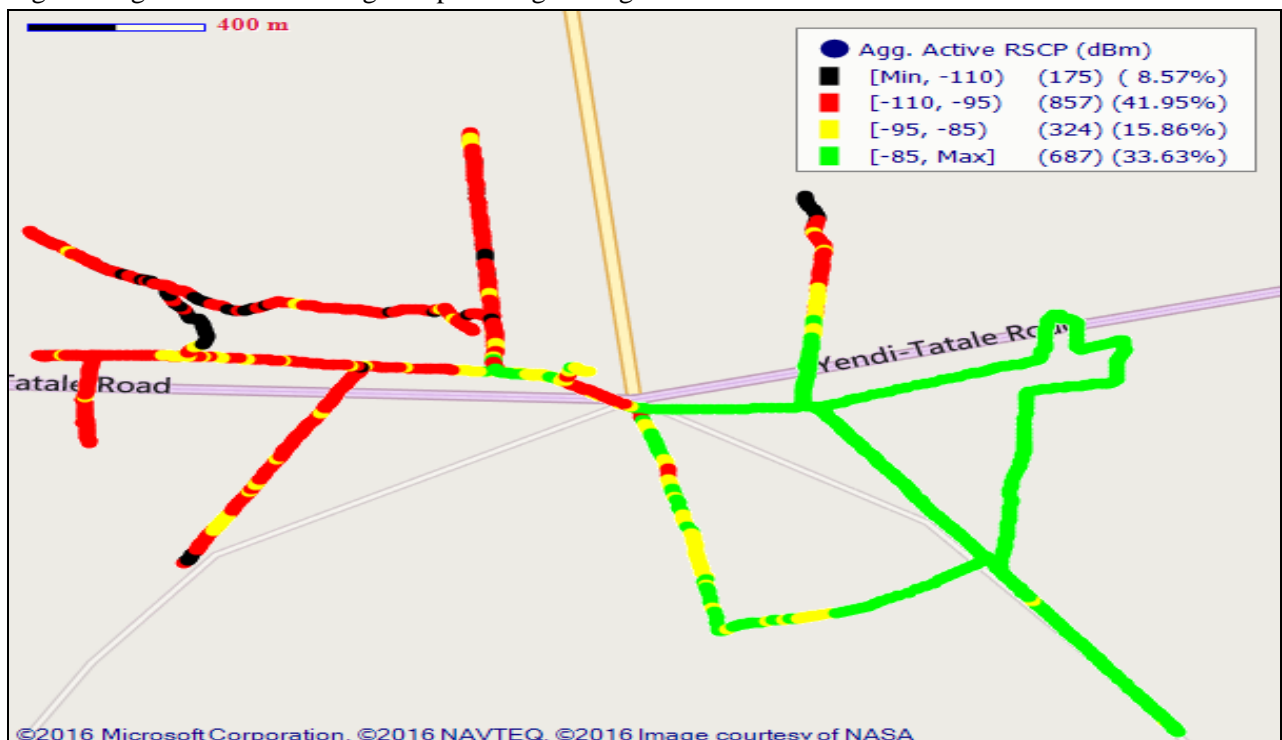
QUALITY OF SERVICE (QoS) MONITORING OF CELLULAR MOBILE VOICE SERVICES IN NORTHERN REGION, AUGUST 2016

Fig 96. Vodafone Network Coverage Map Zabzugu– August 2016



Remarks: Good network coverage in Zabzugu however improvement is needed at Nangeli, Market and Solayayili.

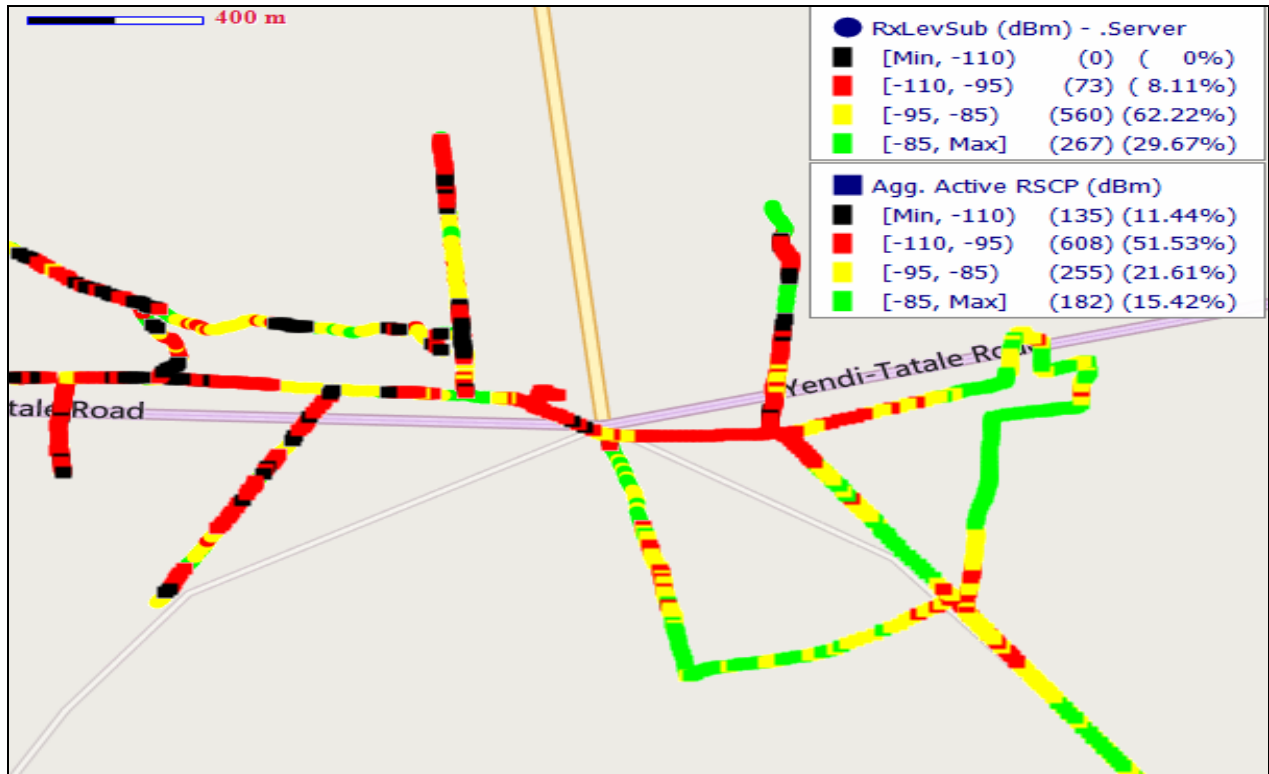
Fig 97. Tigo Network Coverage Map Zabzugu– August 2016



Remarks: Poor network coverage in Zabzugu. Major improvement is needed at Nangeli, Lorry Station, Zabzugu Senior High School and Solayayili.

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Fig 98. Airtel Network Coverage Map Zabzugu– August 2016



Remarks: Poor network coverage across Zabzugu requires major improvement at Zabzugu Senior High School, Rajia School, Sonayayili, Nangeli and the market.

***Glo had no service in Zabzugu at the time of the test**

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APPENDIX II

SPEECH QUALITY FOR OPERATORS

Fig 99. MTN Speech Quality report in Northern Region

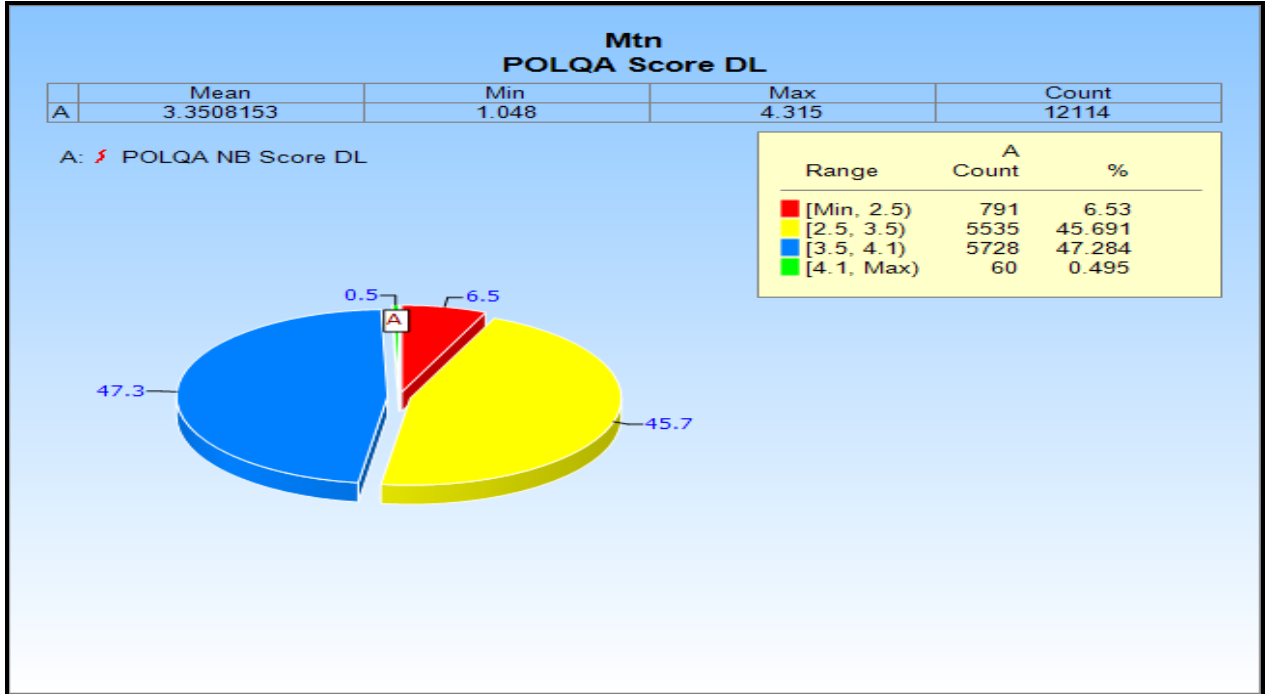
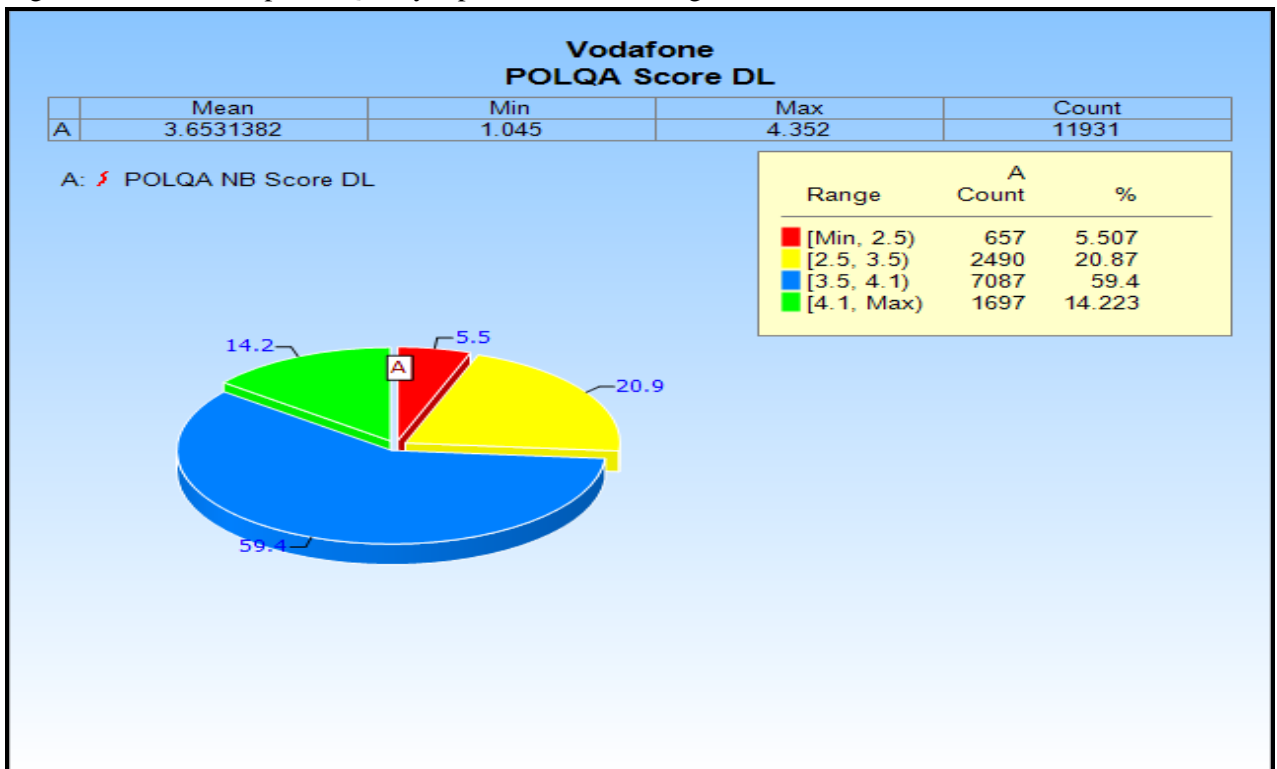


Fig 100. Vodafone Speech Quality report in Northern Region



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Fig 101. Tigo Speech Quality report in Northern Region

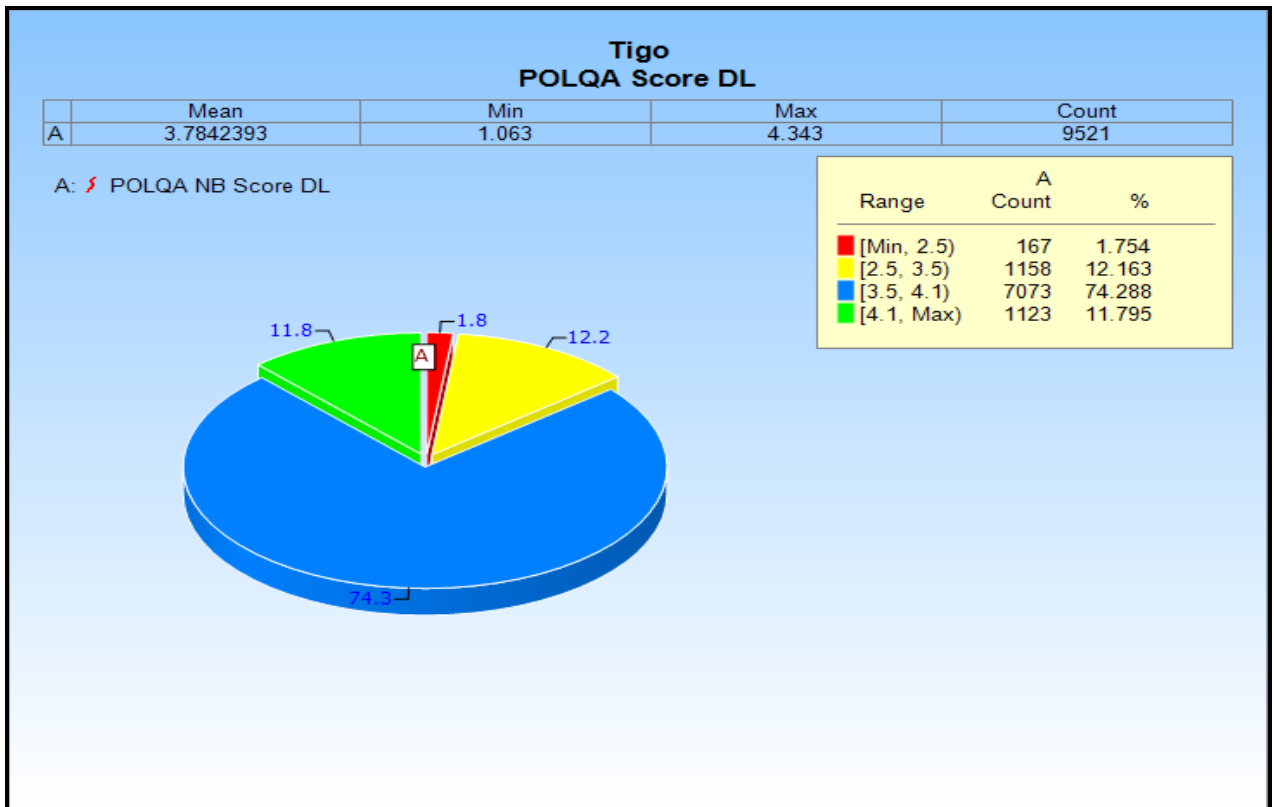
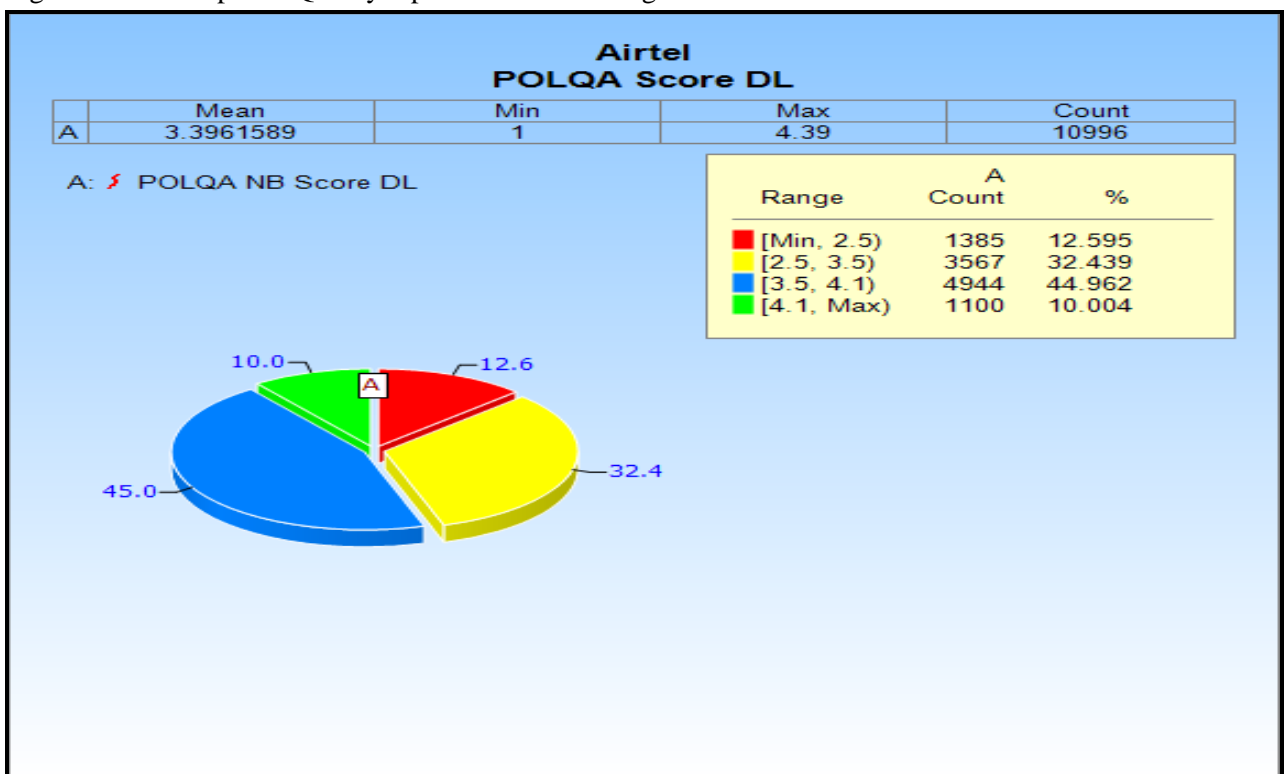


Fig 102. Airtel Speech Quality report in Northern Region



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Fig 103. Glo Speech Quality report in Northern Region

