



## MEASUREMENT OF ELECTRIC FIELD STRENGTH TO DETERMINE THE COVERAGE AREAS OF FM RADIO SIGNALS IN NIGER STATE, NIGERIA

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### ABSTRACT

At the VHF band (30 MHz – 300 MHz), radio propagation is usually by ground waves which consist of direct wave, ground reflected wave and surface wave. These radio signals are affected by the electrical parameters of the ground, curvature of the earth surface, height of the antenna above earth's surface and weather conditions in the troposphere. The electric field strength of radio signals decreases with increase in distance from the transmitting antenna. In this work, measurement of electric field strength of Frequency Modulated (FM) radio broadcast signals from two FM radio stations - Crystal FM on 91.2 MHz and Power FM on 100.5 MHz in Niger State were carried out in all the 25 Local Government Areas in Niger State, using a Digital Signal Level Meter, GE-5499, covering the signal range of 30 – 120 dB $\mu$ V. The longitude, latitude, altitude and also distance from the reference point (i.e location of the transmitting antenna) were measured at every location using a Global positioning System (GPS), GPS-72, personal navigator. These measurements were carried out at the onset of rain season (May). The parameters obtained were used to determine the coverage areas of FM radio signals in Niger State. The result obtained showed that; 16% of the Local Government Areas (LGAs) receive Grade A (signal level  $\geq$  60 dB $\mu$ V) quality of service from Power FM while 24% receive Grade A quality of service from Crystal FM, 48% of the LGAs receive Grade B (signal level  $>$  30 dB $\mu$ V and  $<$  60 dB $\mu$ V) quality of service from both Power FM and Crystal FM, 52% of the LGAs receive Grade C (signal level  $>$  0 dB $\mu$ V and  $\leq$  30 dB $\mu$ V) quality of service from both Power FM and Crystal FM, 12% of the 25 LGAs are completely out of the coverage areas of Crystal FM and Power FM. The configuration of FM radio transmitters in Niger State does not give optimum coverage in the State.



## Introduction

At the VHF band (30 MHz – 300 MHz), radio propagation is usually by ground waves which consist of direct wave, ground reflected wave and surface wave. These radio signals are affected by the electrical parameters of the ground, curvature of the earth surface, height of the antenna above earth's surface and weather conditions in the troposphere [Hall and Barclay, 1991]. The electric field strength of radio signals decreases with increase in distance from the transmitting antenna [Hall, 1979].

Coverage areas of broadcast stations can be classified into primary, secondary and fringe areas. The size of each of these coverage areas depends on the transmitter power, the directivity of the antenna, the height of antenna above the earth surface, the ground electrical conductivity and the frequency of propagation. The coverage areas decrease with increase in frequency and reduction in the ground conductivity [Ajayi and Owolabi, 1979].

The **Primary Coverage Area** is defined as a region about a transmitting station. In this region, the signal strength is adequate to override ordinary interference in the locality at all times. The region has signal level value of **Grade A**, with signal level value greater than or equal to 60 dB $\mu$ V.

The **Secondary Coverage Area** is a region where the field strength is often sufficient to be useful, but is insufficient to overcome interference completely at all times. This region has signal level value of **Grade B**, with signal level value greater than 30 dB $\mu$ V but less than 60 dB $\mu$ V.

The **Fringe Coverage Area** can be regarded as that in which the field strength can be useful for some periods, but its service can neither be guaranteed nor be protected against interference. This region has signal level value of **Grade C**, with signal level value greater than 0 dB $\mu$ V but less than or equal to 30 dB $\mu$ V.

Niger State has two FM Radio Stations presently in operation. These stations are:

- 1) **91.2 MHz FM Radio** in Minna (**Crystal FM**) which is state government owned. Its transmitter has a maximum transmitting power of 35 kW but it is operated at a transmitting power of 15 kW and the transmitting antenna is 450 m above the ground surface



- 2) **100.5 MHz FM Radio** in Bida (**Power FM**), Niger State which is Federal Government owned. Its transmitter has a maximum transmitting power of 20 kW but it is operated at a transmitting power of 9.3 kW. The transmitting antenna is 540 m above the ground surface.

### **Acquisition of Data**

Electric Field strength measurements of Crystal FM (91.2 MHz) and Power FM (100.5 MHz) radio signals were taken at towns and villages in the local government areas of Niger State as far as the road network permitted, using a Digital Signal Level Meter. Measurements were also taken at some neighbouring villages in the Federal Capital Territory, Abuja. The longitude and latitude, height above sea level (elevation) and also distance from the reference point (i.e location of the transmitting antenna) were also noted at every location with a Global Positioning System (GPS). These measurements were carried out in the month of May, at the onset of rain season.

### **Results and Discussion**

The coordinates of the various locations with the signal level measurements were used to draw contour maps for Crystal FM (91.2 MHz) and Power FM (100.5 MHz) Radio Signals coverage in Niger State. These contour maps were overlaid on a digitized map of Niger State as shown in figures 1 and 2.

Figures 1 and 2 show that Borgu, Agwara, and Rijau Local Government Areas are completely out of the coverage areas of Niger State FM radio signals.

Some towns in Kontagora and Mashegu Local Government Area, as shown in figure 2, receive signal level of Grade B (Secondary Service Area) while their neighbouring towns receive signal level of Grade C (Fringe Service Area). This can be attributed to the ground elevation of these towns being higher than their neighbouring towns and also reception of reflected signals from hills in the region.

Neighbouring towns in states in the southeastern region of Niger State (Kogi State and FCT Abuja), receive FM radio signals of Grade C quality from Niger State and a bit of Grade B quality of service from Power FM (100.5 MHz). These are not strong enough to interfere with radio signals in these states.

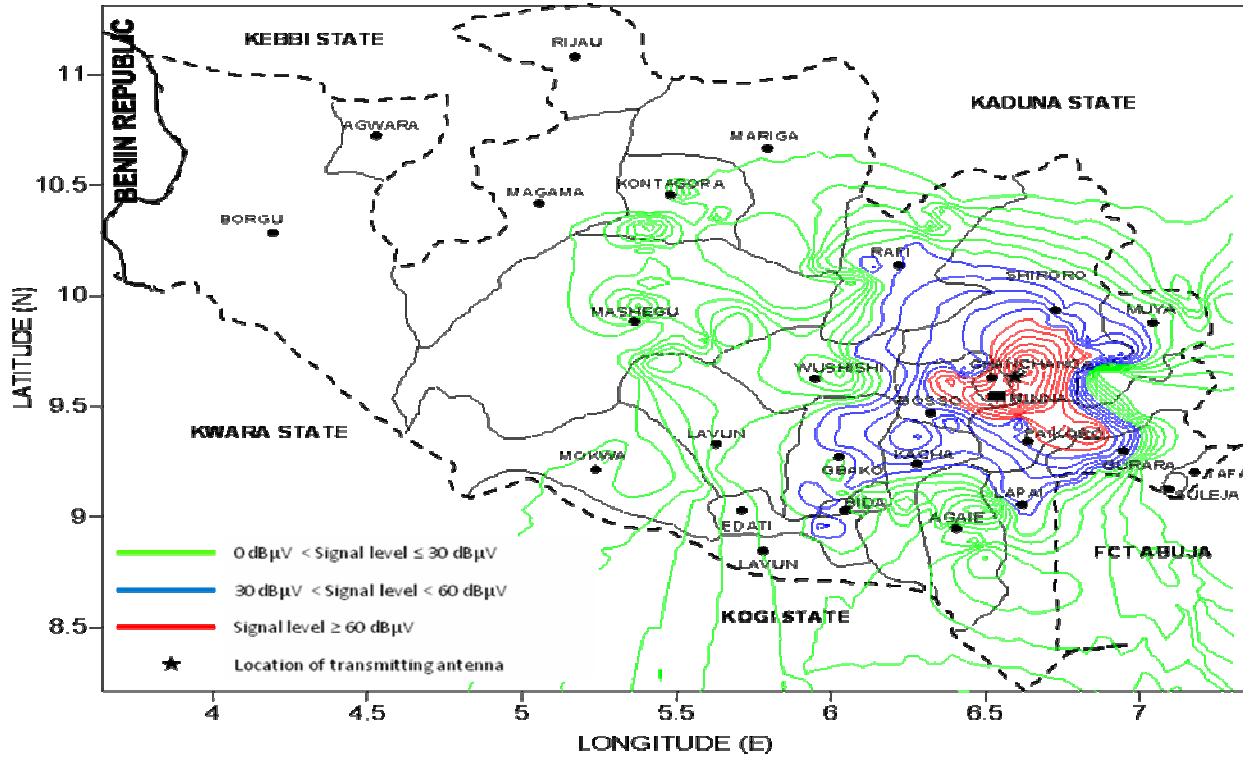


Figure 1 Contours of coverage area for Crystal FM (91.2 MHz) in Niger State at the onset of raining season

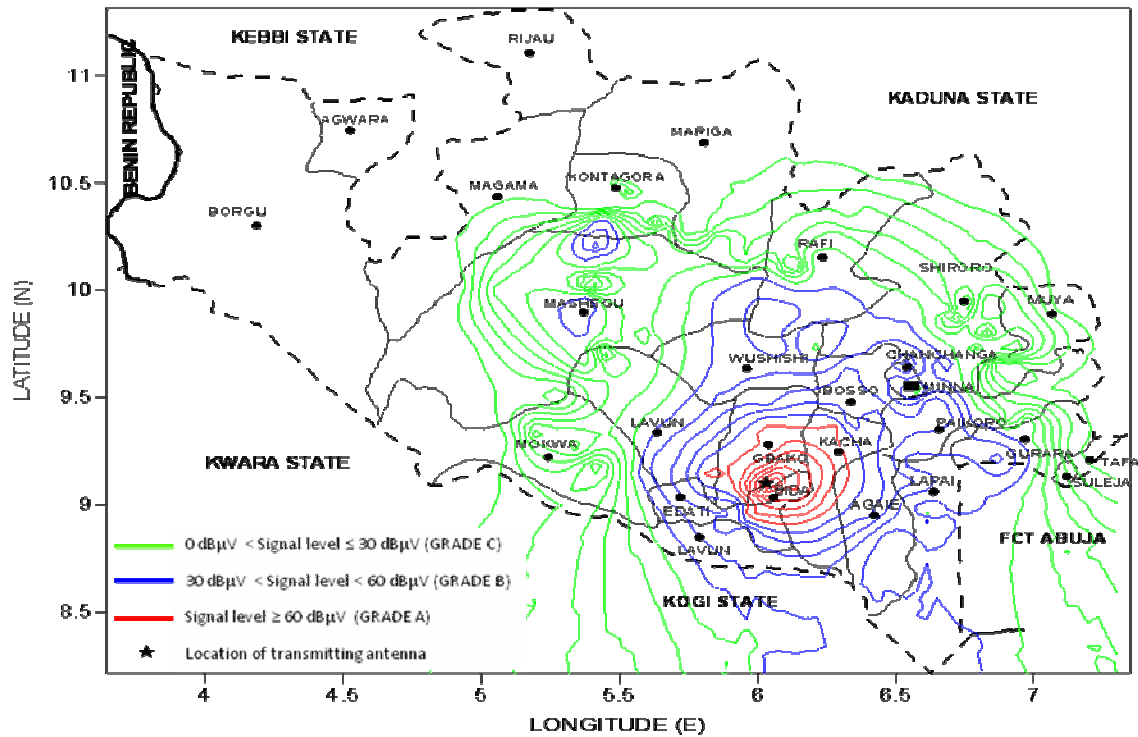


Figure 2. Contours of coverage areas for Power FM (100.5 MHz) in Niger State at the onset of raining season



## **Conclusion**

The configuration of FM radio transmitters in Niger State does not give optimum coverage in the State. For Power FM; 16% of the Local Government Areas receive Grade A quality of service, 52% receive Grade B quality of service while 64% receive Grade C quality of service. For Crystal FM; 24% of the Local Government Areas receive Grade A quality of service, 68% receive Grade B quality of service while 72% receive Grade C quality of service. 12% of the Local Government Areas (i.e. Borgu, Rijau and Agwara) are completely out of the coverage areas of Niger State FM radio signals. 48% of the Local Government Areas receive Grade B quality of service from both Power FM and Crystal FM. 52% of the Local Government Areas receive Grade C quality of service from both Power FM and Crystal FM.

For optimum coverage, there is need for relay stations for Crystal FM (91.2 MHz) and Power FM (100.5 MHz) in Kontagora and Borgu Local Government Areas of Niger State.

FM Radio Stations in Niger State are not source of interference to FM Radio Stations in neighbouring states. Hence, they are in compliance with Nigeria Broadcasting Commissions (NBC) regulations.

## **REFERENCES**

- Ajayi G. O. & Owolabi I. E. (1978): Coverage Area of The 10 kw, 702 kHz Medium Wave Transmitter at Minna and Feasibility Studies for Full Radio Coverage of Niger State, Electrical Communication Consultancy Unit (ECCU), Department of Electrical and Electronics Engineering, University of Ife, Nigeria, Pp. 1-8.
- Hall M. P. M. (1979): Effects of the Troposphere on Radio Communication. Peter Peregrinus Ltd, London, United Kingdom, Pp. 160-161.
- Hall M. P. M. & Barclay L. W. (1991): Radio Wave Propagation, Peter Peregrinus Ltd, London, United Kingdom, Pp. 1-20.