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Determination of the Coverage Areas of VHF Television Signal in Ilorin, Kwara State, Nigeria.

[1]*Adewuni O.T, [1] Moses A.S

Department of Physics, Federal University of Technology, Minna, Niger State, Nigeria

E-mail: [1*] adewuniosenitaiwo959@gmail.com

*Corresponding Author

Abstract:

This study investigates the coverage areas of Nigerian Television Authority (NTA), Ilorin in Kwara State by means of quantitative measurement of the television signal level. The signal levels of NTA Ilorin, Channel 9, were measured radially along several routes with the transmitting station at focus. Their corresponding distances from the transmitting station and locations were also measured. These measurements were taken using Digital Signal Level Meter, GE-5499 and GPS 72 – Navigator. Measurements were taken radially along several routes in Ilorin Local Government Area and environs until the signal faded away completely. From the data obtained, surfer 8 application software was used to draw the contour maps of the signal levels around the transmitting station to show the coverage areas around the state. The results obtained showed that the present configurations of the transmitter for the television station did not give an optimum coverage area. The television signal, covers only 7.66% of the entire land mass of Kwara State.

Keywords: Coverage area, radio propagation, signal level, transmitter, VHF

Introduction

Radio propagation is the behavior of radio waves when they are transmitted, or propagated from one point on the earth to another, or into various parts of the atmosphere (Westman, 1968). As a form of electromagnetic radiation, like light waves, radio waves are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering (Demetrius *et al*., 1969).

Radio propagation is also affected by the daily changes of water vapor in the troposphere and ionization in the upper atmosphere, due to the Sun. Understanding the effects of varying conditions on radio propagation has many practical applications, from choosing frequencies for international shortwave broadcasters, to designing reliable mobile telephone systems, to radio navigation and operation of radar systems.

Radio waves at different frequencies propagate in different ways. At extra low frequencies (ELF) and very low frequencies the wavelength is very much larger than the separation between the earth's surface and the D layer of the ionosphere, so electromagnetic waves may propagate in this region as a waveguide. Indeed, for frequencies below 20 kHz, the wave propagates as a single waveguide mode with a horizontal magnetic field and vertical electric field (Hall and Barclay, 1989).

The coverage areas of broadcast stations are usually classified into primary, secondary and fringe areas. The size of each of these areas depends on the transmitter power, the directivity of the aerial, the ground conductivity and the frequency of propagation. The coverage area decreases with increase in frequency and reduction in the ground conductivity (Ajayi and Owolabi, 1975).

The primary coverage area is defined as a region about a transmitting station in which the signal strength is adequate to override ordinary interference in the locality at all times. The primary coverage area corresponds to the area in which the electric field strength is greater than 60dBμV. The appropriate value of the electric field strength for this quality of service is dependent on the atmosphere and man-made noise in the locality. The relevant electric field strength also depends on whether the locality is rural, industrial or urban.

The secondary coverage area is a region where the electric field strength is often sufficient to be useful but is insufficient to overcome ordinary interference completely at all times. The service provided in this area may be adequate in rural areas where the noise level is low. The secondary coverage area corresponds to the area in which the electric field strength is at least 30 dBμV but less than 60 dBμV. The quality of service enjoyed in this area can be regarded as Grade B1.

The fringe service area can be regarded as that in which the electric field strength can be useful for some periods, but its service can neither be guaranteed nor be protected against interference. This is an area in which the electric field strength is greater than 0 dBμV but less than 30 dBμV. Such an area may be said to enjoy Grade B2 service (Moses *et al*., 2013).

Study Area

Ilorin is located in Kwara State, North-central Nigeria and its geographical coordinates are latitude: 8.5° N and longitude: 4.55° E. Ilorin is a confluence of cultures but populated majorly by people of Yoruba extraction. Its combine population is between 500 thousand and 1 million. It is the state capital of Kwara state which is one of the 36 states in the federal republic of Nigeria. Kwara state has a geographical area of 36,825km^2. Kwara state shares common boundary with Niger and Sokoto state to the north, Oyo, Ondo and Edo state to the south, and Benue, Plateau and Federal capital territory to the east. It maintains an international boundary with the republic of Benin to the west. The mineral resources available in Kwara state are limestone, marble, feldspar, clay, kaolin, quartz and granite rocks. Recently Kwara state has witnessed an increase in telecommunication companies (stations) (http://en.wikipedia.org/wiki//Kwara,state, 2013).

Figure 1: Location of Ilorin in Kwara state, Nigeria (8.5° N, 4.55° E)

Data collection and analysis

This work was carried out using the VHF television signal transmitted by the Nigeria Television Authority (NTA), channel 9, Ilorin. NTA, Ilorin, channel 9 has one working transmitter operating at the transmitting station at Ganmo, Ilorin, during the period of this research work, the power of the transmitter being 5 kW and the transmitting power fluctuate between 2.2 – 3.2 kW. NTA Ilorin transmits at 203.25.4 MHz for video signal and the transmitting antenna is mounted on an antenna tower height of 150 m, located at a site of 418 m above sea level.

The signal levels of Nigeria Television Authority (NTA) Ilorin, channel 9 were taken radially along several routes with the transmitting station at focus. Their corresponding distance and locations were also measured. These measurements were taken using GPS 72- Personal Navigator type and Digital Signal Level Meter GE- 5499 ranges from 30 dBμV -12030 dBμV. The Measurement were taken in Ilorin Local Government Areas and environs in Kwara State until the signals faded away completely.

From the data obtained, Surfer 8 software application was used to draw the contour maps of the signal levels around the transmitting station to determine the coverage areas of the station.

Table 1: Data obtaining along one of the radial routes considered in Ilorin, Kwara State

Signal Levels(dBμV)	Latitude(°N)	Longitude(°E)	Elevation(m)	Distance(km)
94.5	8.43190	4.60826	418	0
90.6	8.42960	4.60565	406	0.385
76.7	8.42529	4.60007	381	1.16
39.5	8.49328	4.56963	280	8.05
38.8	8.50107	4.55351	304	9.78
56.4	8.52013	4.55492	287	11.44
56.0	8.53909	4.55331	309	13.88
46.9	8.57301	4.55784	292	16.66
36.7	8.58987	4.5968	298	18.38
43.9	8.60294	4.54869	282	20.14
54.4	8.61985	4.53522	319	22.41
43.1	8.63868	4.52385	273	24.82
30.6	8.65761	4.52304	328	26.82
43.5	8.67582	4.51970	336	28.85
41.2	8.69158	4.50711	368	30.97
35.2	8.69803	4.49124	335	32.30
40.6	8.70545	4.47398	343	33.85
37.4	8.71076	4.45760	340	35.19
Low	8.71321	4.44541	356	36.08

RESULTS

Figure 1 and 2 shows the contour map of the signal levels around the transmitting stations and coverage area in the state, while Figure 2 shows the elevation of the ground around the coverage area of the station under study. Tables 2 to 6 show the television signal coverage areas relative to the percentage of the total land mass and the local government areas. The results obtained show that:

(a) The contour maps need for repeater stations at appropriate intervals to provide reception of television signals for the entire state.

(b) The present configurations of the transmitter of the television stations do not give an optimum coverage of the state. Only 7.66% of the entire land mass of Kwara State has television signal coverage.

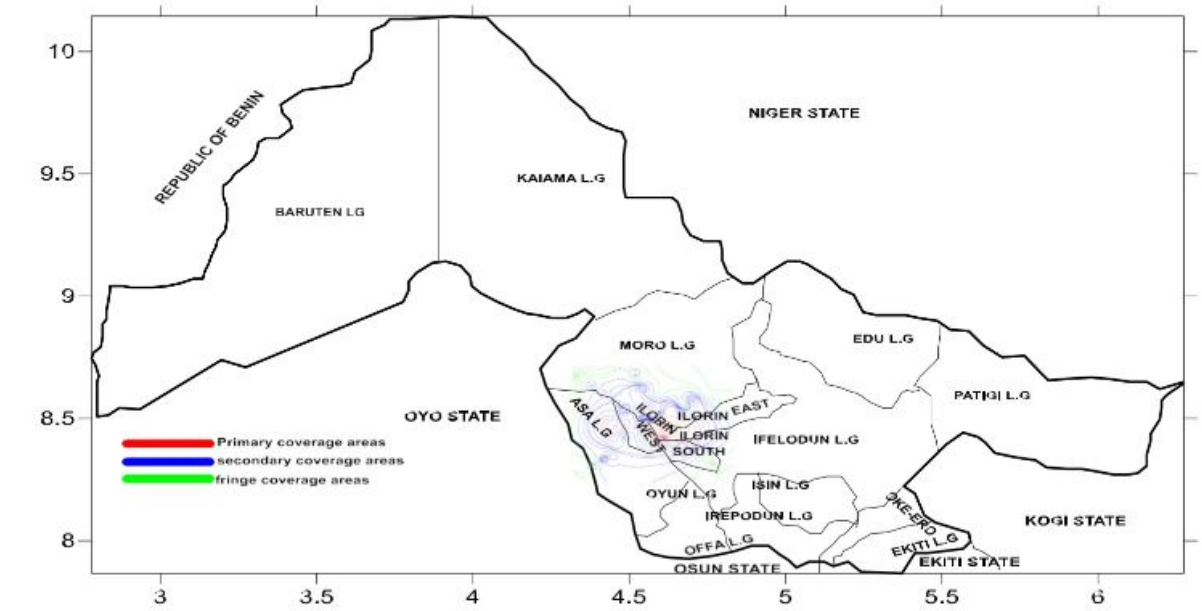

Figure 1. Coverage area of NTA, Ilorin channel 9 transmitting station in Kwara State

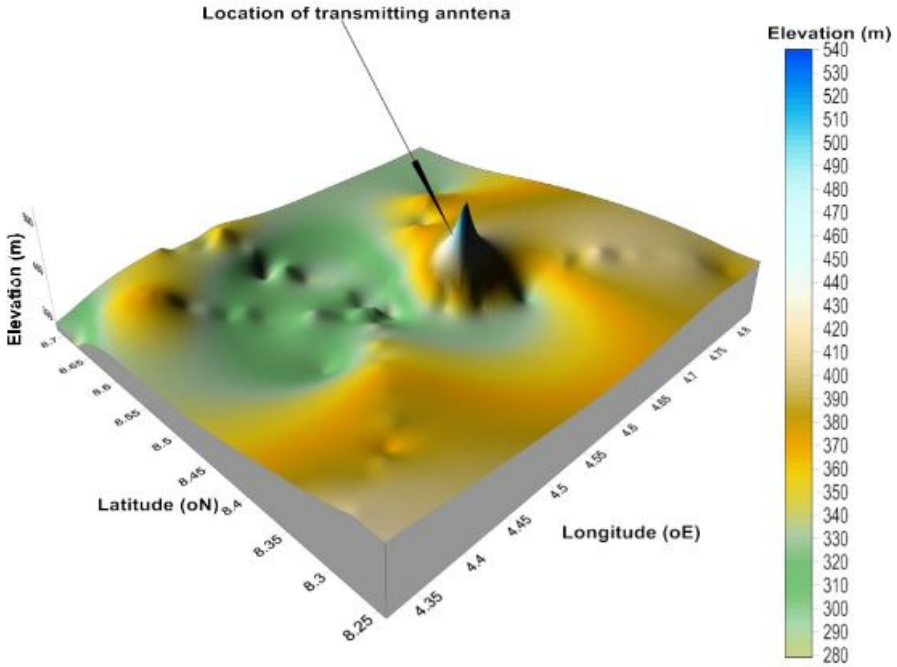

Figure 2. Surface Map showing the elevation of the ground above the Sea level around the Coverage Area of the Television transmitting station in Kwara State

Coverage Areas of NTA Ilorin, Channel 9

Table 2: Some of the towns and villages in NTA, Ilorin, primary Coverage Area

L .G. A	Lat(^{0}N)	Long(^{0}E)	Elevation (m)	Average Distance (km)	Towns/Villages
Moro	8.61	4.53	319	11.44	Kwasu, Shobi
Asa	8.45	4.51	331	10.86	Eyenkorin
Ilorin South	8.43	4.60	418	1.55	Ganma, Offa Road
Ilorin East	8.53	4.61	325	10.94	Oke-Oyi, Kwara Poly,
Ilorin West	8.50	4.52	306	12.65	Adabata, Oloje

Table 3: Some of the towns and villages in NTA Ilorin secondary coverage Area

L .G.A	Lat(^{0}N)	Long(^{0}E)	Elevation(m)	Average Distance (km)	Towns/Villages
Moro	8.60	4.54	282	17.60	Shao, Oke-Oyi
Asa	8.51	4.50	318	19.41	Ote, Madala, Ogidi,
Ilorin South	8.50	4.55	287	11.44	Molete

Ilorin East	8.46	4.52	335	19.13	Moraba, Sango, Ose
Ilorin West	8.50	4.53	323	11.09	Alimi

Table 4: Some of the towns and villages in NTA, Ilorin, Fringe Coverage Area.

L. G.A	Lat(^{0}N)	Long(^{0}N)	Elevation (m)	Average Distance (km)	Towns/Villages
Moro	8.60	4.75	324	25.72	Old-Jebba,
Asa	8.30	4.36	385	21.15	Iresa-adu, Gbede
Ilorin South	8.24	4.81	385	30.45	Ajase
Ilorin East	8.55	4.68	370	14.55	Oke-oyi
Ilorin West	8.32	4.40	366	25.94	Aduegba
Ifelodun	8.25	4.80	380	28.88	Ajasepo, Igbomina

Table 5: The percentage of the Local Government Areas covered by the NTA Ilorin, Channel 9, Transmitting Station in Kwara State.

L.G.A	Average Distance(km)	% of L.G.A. with Primary Coverage.	% of L.G.A. with Secondary Coverage.	% of L.G.A. with Fringe Coverage.	Total % of L.G.A. Coverage Area.
Ilorin West	19.25	20%	80%	0%	100%
Ilorin South	10.97	16.6%	66.7%	16.67%	100%
Ilorin East	13.44	33.3%	16.6%	8.3%	58.2%
Asa	25.88	6.06%	33.3%	12.1%	51.4%
Moro	31.45	4.16%	15.2%	16.6%	35.9%
Ifelodun	31.65	1.13%	3.40%	4.54%	9.07%

Table 6: The Percentage of the Coverage Area of the Television Transmitting Station relative to the total land mass of Kwara State.

Station	% of Primary Coverage	% of Secondary Coverage	% of Fringe Coverage	Total % of Coverage Area
N.T.A. Ilorin Channel 9	1.14%	4.0%	2.52%	7.66%

Summary and Conclusion

This study presents the contour map of signal level around the transmitting station to show the coverage area of VHF television signal of Nigeria Television Authority (NTA), Ilorin, Kwara state, by means of quantitative measurement of the television signal level. The percentage of the coverage area of the television transmitting station relative to the total land mass is 7.66%. The percentages of the Local Government Areas covered by the NTA Ilorin television station are: 35.96% for Moro Local Government Area, 51.46% for Asa Local Government Area, 100% for Ilorin West Local

Government Area, 58.2% for Ilorin East Local Government Area, 100% for Ilorin South Local Government Area and 9.07% for Ifelodun Local Government Area. The signal from the television station is not a potential interference to any of the local television station in the neighboring states. In summary, only 7.66% of the entire land mass of Kwara State has television signals coverage. More than 92.34% of Kwara State does not received television signals in the state. Thus, the present configurations of the transmitter of the station do not give optimal coverage of the total land mass of Kwara State.

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