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Effects of Weather Conditions on Satellite Television Cable Network Reception Quality in Warri Metropolis, Delta State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author OVN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ICG and OVN managed the analyses of the study. Author ICG managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The study examined the effects of weather conditions on satellite television cable network reception quality. The ex-post facto research design was used. The primary data were generated through personal observation/monitoring of Television sets that were connected to the three prominent networks (MYTV, DSTV, and HITV) in Warri. Rainfall stations were established in each of the sample areas and were used to collect rainfall amount between the months of May and August, being rainy season in the location. Additionally, wind speed, humidity, temperature and rainfall data were collected from the archives of the Nigerian Meteorological Agencies office in Warri for 20 years. A total of fifteen (15) TV sets and fifteen modems of MYTV, DSTV and HITV satellite-cable network were utilized for this study. Results showed that there is variation in the trends of climate

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parameters in Warri. There is variability in the rainfall, relative humidity as well as the wind speed trends in Warri from 1991-2011. The variations in these climate attributes have effects on the durability and functionalities of satellite cable network in the area. The reception quality for MYTV reduced from 69.8% on days without rainfall to 15.4% on rainy days during the study period, while DSTV signal quality reception was also reduced by rainfall and weather effect to 20.4% on rainy days from 85.6% mean on days without rainfall. HITV signal quality reception of 33.4% on days without rainfall was reduced to 7.2% by the effect of rainfall. Rainfall impairs signal quality. Further, the result revealed that there is a significant variation in cable network reception qualities of MYTV, DSTV and HITV. This is evident from the calculated F-value of 1028.136 which was greater than the critical table-value of 19.49 at 0.05 significant level. The r value shows a correlation of 0.989 between rainfall and MYTV reception quality. However, the R^2 value of 0.977 shows that 97.7% variation in the quality of signal reception from MYTV is explained by other weather parameters. The r value shows a correlation of 0.994 between wind speed and DSTV reception quality. However, the R^2 value of 0.988 shows that the quality of the signal reception from DSTV is explained by 98.8% dependency on weather parameters. Similarly, the r value shows a correlation of 0.970 rainfall and HITV reception quality. However, the R^2 value of 0.942 shows that the quality of the signal reception from MYTV is explained by 94.2% dependency on weather parameters. The policy implications of the findings of this study are that adequate and well-implemented weather monitoring with remote sensing/satellite-based platforms should be captured in the national laws of Nigeria.

Keywords: Weather conditions; MYTV; GOTV; DSTV; network reception; Warri.

1. INTRODUCTION

Weather and climate affect day-to-day activities and lifestyles from the clothes we wear to the buildings we design, the food and energy we produce and consume. Climate-environment relationship and impacts on human activities are predicted to change dramatically if global warming accelerates at the rates currently proposed. One of such impact is on satellite TV signal distortions as well as video quality and clarity [1].

Changes in the weather condition affect the quality of the satellite television signal reception though this occurs rarely, and lasts only a short period [2,3]. For the majority of users, it is heavy rains that can attenuate signal enough to result in noticeable degradation of image quality. In extreme cases, the reception can be effectively disrupted. The level of concern about the possibility of signal degradation/loss in a particular area depends on (1) regional yearly rainfall figure, (2) location in the satellite footprint and (3) height of the satellite above the horizon. Ezekoye and Obodo [4] noted that radio waves which are the ultimate wave used in telecommunication suffer lots of disturbances as a result of the irregular behaviour of the ionosphere which is caused by erratic solar radiation from the sun.

The Rainfall pattern experienced in a place has much effect on a satellite television system [5], yet the microwave attenuation due to rainfall in tropical regions has not been very widely studied [6]. According to Nweke [3], fading in television occur more at the pick of heavy dry and heavy rainy seasons in Nigeria. Siddique et al. [6], Harun et al. [7] and Kestwal et al. [5] reiterated that rainfall causes the severe degradation of the received signal level above 10 GHz, and generally this degradation is directly proportional to the frequency of radio waves. Each particular raindrop contributes to the attenuation of the wanted signal [8,9]. Several propagation mechanisms affect the earth-space and terrestrial communications performances, but attenuation due to rain is the most severe [10,11].

Rain-caused attenuation has for a long time been identified as a major inhibitor in radar and communication systems operating at millimetric and microwave frequencies [9] and [12]. The attenuation of microwave line-of-sight signals due to precipitation (rainfall, in particular) limits the propagation path length of line-of-sight communication systems. Satellite transmission is an example of line-of-sight communication. The actual amount of fading is dependent on the frequency of the signal and the size of the raindrop [13,14,15,16,17,18]. The two main causes of rain fading are scattering and absorption [19] and [6].

Warri and many other places in the Niger Delta area of Nigeria have a rainfall pattern that is

highly variable in drop size, duration and intensity. Thus, during the peak of the rainy season, as was reported in other places in the tropics [3], signal reception of a properly aimed and wired satellite home system are affected. The effects normally last for the period or time of the rainfall. In some cases, it lasts longer after the rainfall period especially when there is a heavy downpour and likely to occur more often in regions with significant annual rainfall. This puts Nigeria's the Southern States where Warri is located in a disadvantaged and unfavourable position. What causes signal attenuation is mainly waved absorption by the rain drops. There is also some signal scattering, due to refraction and diffraction of electromagnetic waves in and around rain drops [20]. Nelson [21] reported that rain affects the transmission of an electromagnetic signal via attenuation of the signal which leads to increase in system noise temperature resulting in changes in polarization.

Changes in signal reception from factors such as degrading antenna connections as a result of changing weather conditions may gradually reduce the quality of a Television signal. The nature of digital TV results in a perfectly decodable video initially, until the receiving equipment starts picking up interference that overpowers the desired signal or if the signal is too weak to decode. Some equipment will show a garbled picture with significant damage, while other devices may go directly from perfectly decodable video to no video at all or lock up. This phenomenon is known as the digital cliff effect [20].

In Warri metropolis, different users of satellite TV products such as HITV, MYTV and DSTV have observed poor image quality on TV screens, poor videos and ceasing audio quality copiously on the weather. Even the LNB of these satellite TV dishes could be blown by thunderous storms that characterize the onset of the rainy season in these areas. Despite this problem, the producers of these satellite Cable TV product seems to have adopted only little measures to abate this situation. As such the poor reception of digital satellite signals persist unabated in the area. With the aforementioned problems steering glaringly at the face of almost all satellite-based TV network subscribers, it is of necessity to probe into the effect of weather characteristics on satellite TV broadcasting service quality. Thus, this study is set out to examine and determine how weather conditions affect reception of different satellite cable networks, HITV, MYTV and DSTV in Warri metropolis in the Delta State of Nigeria. To achieve this aim, the following objectives have been outlined:

i. To examine the general nature of the Weather characteristics in Warri.
ii. To Identify the network signal quality on rainy days and days without rains and compare the reception quality of MYTV, DSTV and HITV in Warri
iii. To assess the effects of weather elements such as rainfall, temperature, relative humidity and wind speed on MYTV, DSTV and HITV satellite Television network in Warri by determining the extent of attenuation.
iv. To suggest solutions to identified problems of Satellite TV network (MYTV, DSTV and HITV) that are linked to climate.

2. MATERIALS AND METHODS

2.1 Study Area

Warri metropolis lies between latitudes 5°30` and 5°35` N and Longitudes 5°29`E and 5°48`E. The study area is situated within the Niger Delta region of Nigeria. It is bounded on the North by Okpe and Sapele Local Government areas, on the South by Warri South West and Ughelli South L.G.A, on the East by Ughelli South and Ughelli North L.G.A and to the West by Warri South West Local Government Area (see Fig. 1.1). Warri Metropolis is made up of Warri South, Udu and Uwie Local Government areas. The areal expansion of Warri during the past two decades has been remarkable. From a small river settlement, Warri has grown to cover the surrounding towns of Effurun, Ekpan, Enerhen, Edjeba, Ogunu, Jakpa, Ovwian-Aladja, Udu Road, etc. with the results that Warri is now about 31,668km^2 [22].

2.2 Climate

Warri has a tropical climate. Rainfall is significant most months of the year, and the short dry season has little effect. The Köppen-Geiger climate classification is Am. The mean annual temperature is 32.8°C, and annual rainfall amount is 3000 mm [22] rainfall period is between January–December, with the minimum value of 8.2 mm in January and over 536.6 mm in September. The predominant wind system in Warri metropolis is the tropical Maritime Air Mass (mT) which is humid and moist and brings rainfall

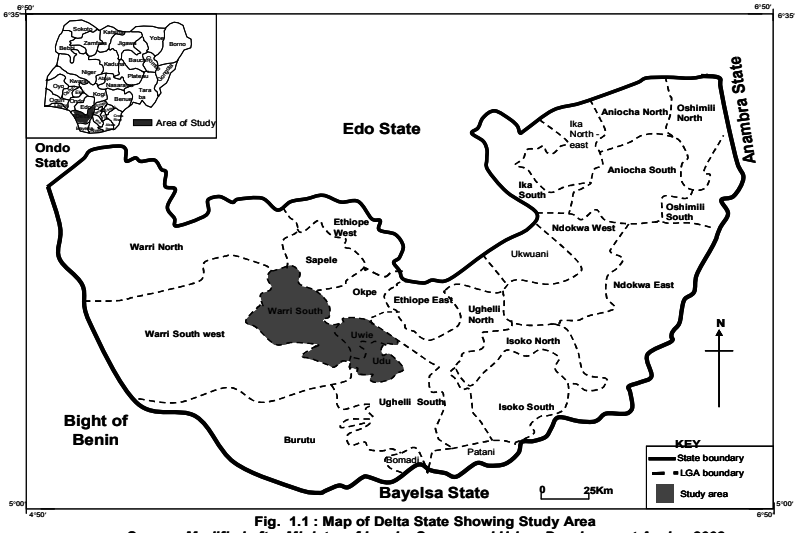

Fig. 1.1 : Map of Delta State Showing Study Area

Source: Modified after Ministry of Lands, Survey and Urban Development Asaba, 2008

into this environment. The influence of the Tropical Continent (CT) air mass is minimal; it brings in slight harmattan in the area between December and February.

There is no marked dry season in the area as rainfall in all the months is above 2.5 mm [22] There are high temperatures of 36°C and 37°C in the heavily built up and traffic congested areas of Enerhen junction, Enerhen road area, Estate, Okere road areas, Jakpa junction, Jakpa roads areas, Hausa quarters and Igbudu market areas respectively [22].

The rainfall patterns in Warri metropolis show that Warri has been experiencing the heavy amount of torrential rainfall that spans 12 months annually over the years. This is expected to have significant effects on television signals received in the area especially in the face of a changing climate. This climatic mix accounts for the general attenuation of satellite TV signals characteristic of the area. The annual mean rainfall, relative humidity, temperature and wind speed for twenty-one years (1991-2011) in Warri was 238.39 mm, 83.5%, 32.8°C and 3.35 m/s respectively.

There have been tremendous growths in population in the area from a rural to urban. Warri metropolis is one of the rapidly growing cities in Nigeria, with its population rising rapidly from 280,000 in 1980, 500,000 in 1991 to 638,250 in 2006 [23] and estimated at 730, 000 in 2010 [23]. It has a high population density that is concentrated in the core areas of the city. These areas include; Warri-Sapele road, Agbassa, Okere, Okumagba Avenue, Egbudu, Iyara, Jakpa, Airport road, P.T.I. Road, Udu and Ekpan. Thus, the increase in the population of the area has led to increasing in the demand of satellite TV products patronage. Presently, one does not even need to subscribe directly to major distributors/dealers like Poyen Nomovo, but with as little as ₦500.00 some smaller dealers can get every household in the proximity neighbourhood connected. As such satellite dish antennas are found on virtually every roof top in the metropolis as a result of both legal and illegal connections from youths who have perfected the act.

Socio-economic activities: Warri is an oil city with many multinational oil companies such as Shell Petroleum Development Company (SPDC), Chevron, and home-based oil and gas companies such as Warri Refinery and Petrochemical Company (WRPC), Nigeria National Petroleum Corporation (NNPC), exploiting oil and flaring of gas [24]. Service companies in Warri are varied and numerous among which are Banks such as Oceanic Bank Plc, Zenith Bank Plc, Intercontinental Bank Plc among others, which provide banking service and Insurance companies in the area. The Insurance companies include IGI Insurance, Equity life Assurance, Intercontinental-Wapic Insurance, Investment and Allied Assurance to mention but a few.

Warri metropolis boosts many Satellite TV connections to homes in the different parts of the metropolis. There are also ones provided by the Delta State Government for the public. In Warri metropolis, almost every big registered and

unregistered establishment are users of one or more of these satellite TV company products. All banks, Hotels, oil Companies found in Warri are connected to DSTV or HI TV or MY TV or all in most cases because of specific programs/channels provided by these stations. For football lovers, HI TV is the favourite; for home movies, it is MY TV, and for major international news channels, DSTV is most preferred though they all share some programs/channels in common. Monthly subscription for MYTV is N1900.00, and this makes available 20 channels to the subscriber. For HITV, it is N3500.00 for 31 channels while DSTV premium comes with 70 channels with a monthly subscription of N9800.00. About four audio services and 5-14 international radio channels are available to all subscribers.

2.3 Methods

This study adopted an Ex-post facto (Causal Comparative) design. In the process of carrying out the study "*A Study of Climate Effects on satellite television cable network Receptions," the research design was base*d on field survey which involves personal observation/monitoring of reception problems associated with MYTV, DSTV and HITV occasioned by rainfall, temperature, wind and relative humidity. Rainfall, temperature, Relative humidity and wind speed data were obtained from Nigerian Meteorological Agency, Warri for 20 years and complimented by field data generated through personal observation/monitoring of Television sets that were connected to the three networks (MYTV, DSTV, and HITV) and another set of rainfall data that was generated from rainfall stations established in each of the sample areas.

The stratified sampling technique was adopted for the collection of primary data which involves personal observation of screens of three television sets with the different networks. The stratified sampling method was used to divide the area into five zones based on major economic activities (land use) shown in Table 1. A total of fifteen (15) TV sets and fifteen modems of MYTV, DSTV and HITV satellite-cable network were utilized for this study, three for the representative sampling area in each of the five (5) zones. The data were collected from Independent Satellite Television service provider's offices located in the five zones. The choice of the independent satellite cable service providers was borne out of the fact that they already have MYTV, DSTV and HITV networks installed for about three (3) years and have been providing services to their clients (subscribers) in Warri. This was done to ensure that the three TV cable networks (MYTV, DSTV and HITV) have equivalent signal reception.

The procedure adopted for collection of the signal quality and strength data was a full range of concurrent observations. The researcher and four (4) trained research assistants collected the primary data needed for this study. The four (4) research assistants including the researcher had three television sets each having the three digital cable TV networks (MYTV, DSTV and HITV) that the study is set to examine. A total of fifteen TV sets were deployed for this study and were positioned at 2m above the ground on a flat table at the offices of the satellite network providers used as a platform for this study. Observations took place between 6.00am and 9.00pm daily with observations recorded at intervals of every one hour for four months (May, June, July and August in 2012). Each of the observers was located in one of the five zones (A-E) in Warri where they monitored and collected data in that area.

For the purpose of clarity, the reception (signal) quality displayed on the "Information Central" screen of the cable TV networks was used to adjudge reception quality. viz:

0-30% - No Signal
30-60%- Poor reception
61-90%- Good reception
91% & above-Very good reception

Table 1. Sample areas

Zones	Areas	Sampling Sites
A	Effurun, PTI, NNPC, GRA	PTI
B	Osubi, Shell, NPA, Aladja	NPA
C	Edjeba, Ugborikoko, Estate	Edjeba
D	Enerhen, Udu, Ekete	Enerhen Road
E	Okere, Okumagba Avenue	Okere

Also, a total of five (5) rainfall stations were established, one for each sample area. These were manned by the researcher and four (4) research assistants who were trained in such act to collect daily records of rainfall amount and intensities for the period of four (4) months. Records were made once every day. The data were presented in statistical diagrams and analysed with the aid of multiple regressions and Analysis of variance. The result for the quality of reception and the effects of weather characteristics was tested using the multiple regression using the SPSS (version 17), while the results from the reception according to satellite TV system in use was tested using the analysis of variance (ANOVA statistics).

3. RESULTS AND DISCUSSION

3.1 Climate Characteristics in Warri

From Table 2 and Figs. 2 and 3, there is variation in the trends of instrumental climate parameters in Warri. There is variability in the rainfall, relative humidity as well as the wind speed trends in Warri from 1991-2011. The variations in these climate attributes have effects on the durability and functionalities of satellite cable network in the area.

From Fig. 2, the highest amount of rainfall was in the year 1995 and 2004 while there was a decline in 2009 and 2010 but gradually increased in 2011.

From Fig. 3, there was also a variation in the RH pattern between1991 to 2011. However, the decline in RH started from 2010 to 2011. The implication of that is that the amount of water vapour in the atmosphere of the study area is changing.

From Fig. 4, the wind pattern shows that the beginning of the 1990's had more wind and a 3-year decline was observed before the wind became steady for almost four years and there was an increase in 2011.

From Fig. 5, the trend in temperature shows it was rising from 33.2°C in 1991 and 31.5°C in 2007 to 34.2°C in 2011.

3.2 Prominent Climatic Elements Causing Network Distortions and Effects on MYTV, DSTV and HITV

From Table 3 and Fig. 6, the reception quality for MYTV reduced from 69.8% when there was no rainfall to 15.4% on rainy days during the

Table 2. Mean annual rainfall, relative humidity, wind speed and temperature trend in Warri from 1991 to 2011

Years	Rainfall (cm)	RH (%)	Wind Speed (m/s)	Temperature (°C)
1991	254.20	85.2	4.12	33.2
1992	266.74	82.5	4.18	33.1
1993	274.68	83.1	3.93	33.7
1994	233.13	81.5	3.97	32.8
1995	286.40	84.8	3.08	32.7
1996	226.39	85.2	2.88	32.4
1997	220.48	83.0	2.88	32.3
1998	207.73	81.3	3.34	33.5
1999	249.63	83.8	3.18	31.8
2000	224.07	83.8	3.61	33.3
2001	199.22	83.9	3.55	32.6
2002	246.95	83.8	3.52	33.4
2003	232.80	83.7	3.10	32.5
2004	293.51	84.0	3.13	33.3
2005	197.38	84.0	3.23	32.4
2006	201.89	85.1	3.20	32.2
2007	239.22	86.3	2.94	31.5
2008	269.93	85.4	2.98	33.2
2009	203.79	83.9	2.99	32.7
2010	223.13	84.3	2.99	33.4
2011	254.95	74.4	3.45	34.2
Mean	238.39	83.5	3.35	32.8

Source: Nigeria Meteorological Station (NIMET) Lagos

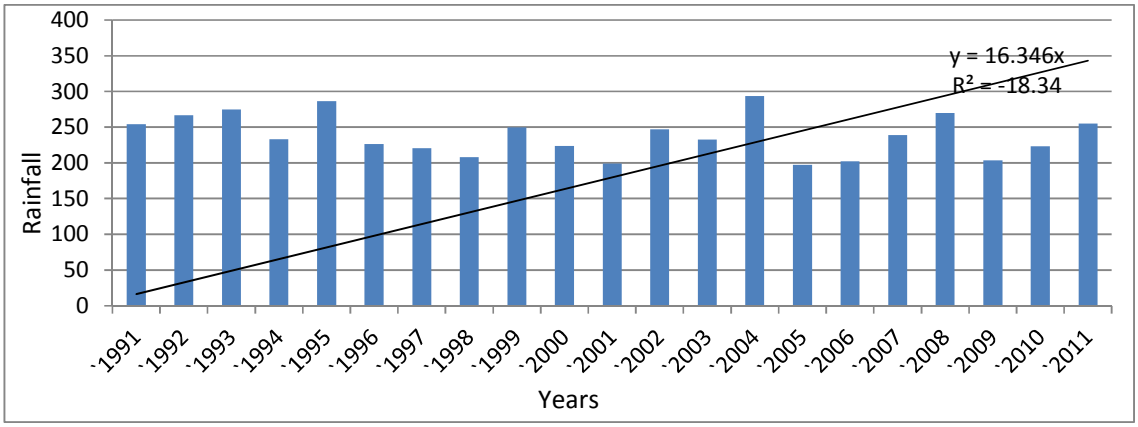

Fig. 2. Rainfall variation in Warri from 1991-2011

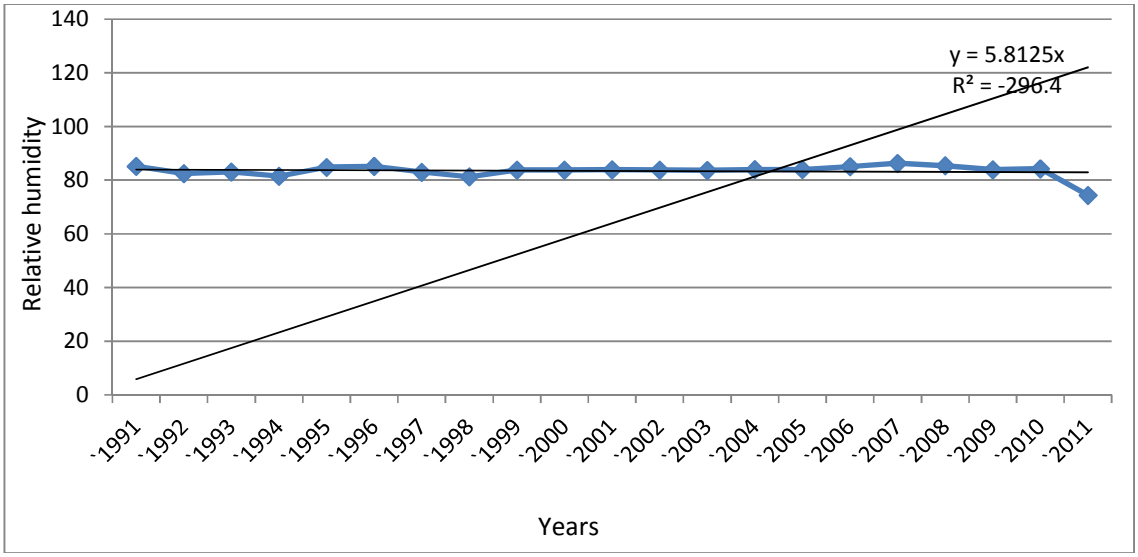

Fig. 3. Relative Humidity Trend in Warri from 1991-2011

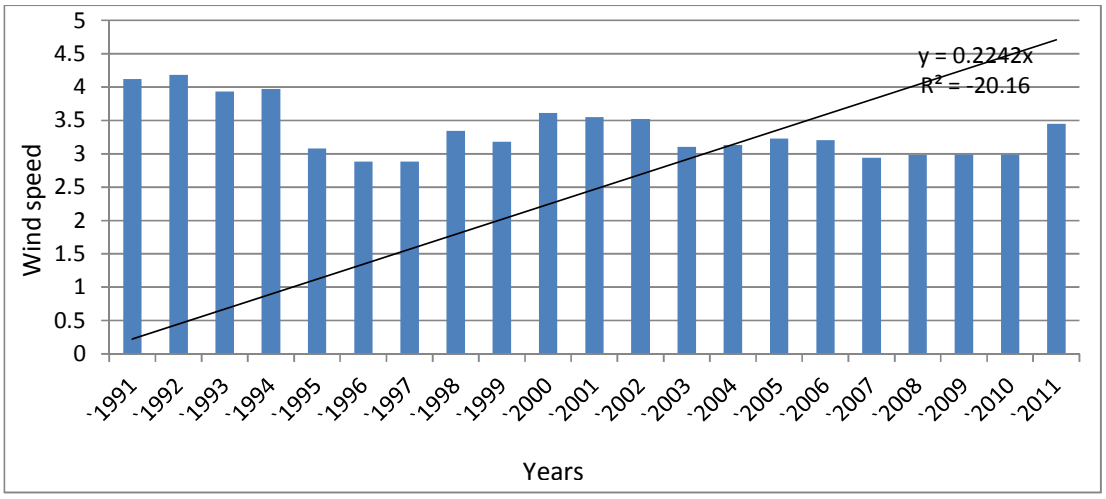

Fig. 4. Wind Speed Trend in Warri from 1991-2011

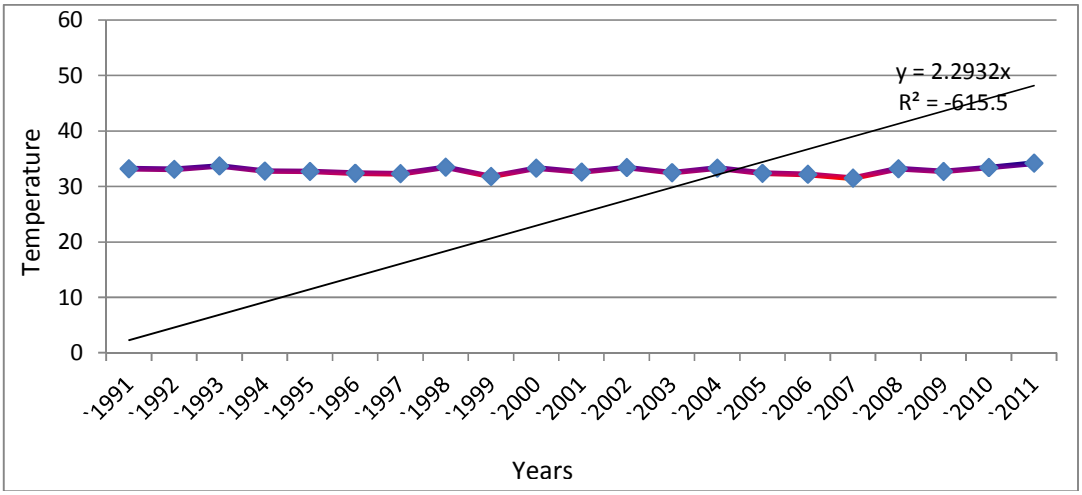

Fig. 5. Temperature Trend in Warri from 1991-2011

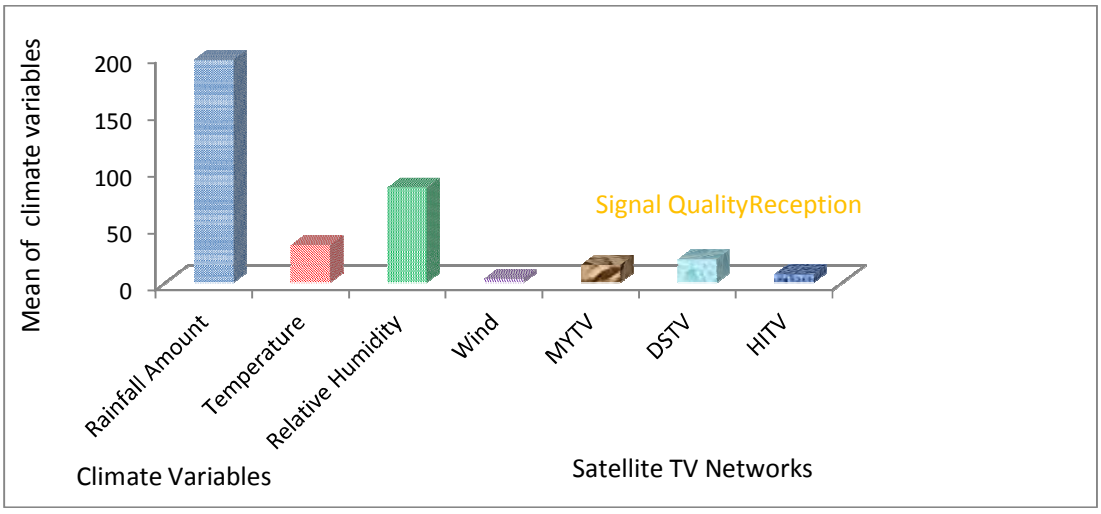

Fig. 6. Satellite TV network quality reception signal on Rainy Days (May-August, 2012)

study period. DSTV signal quality reception was also down to 20.4% on rainy days from 85.6% mean on days without rainfall. More so, HITV signal quality reception of 33.4% on days without rainfall was brought down to 7.2% by the effect of rainfall. This implies that climatic elements have attenuating effect on network quality in Warri and rainfall has been implicated for the signal quality reduction.

3.3 Comparison of MYTV, DSTV and HITV Reception Quality in Warri

From Table 4 and Fig. 7(a) and (b), network signal quality in the different areas of Warri exhibited different characteristics on normal days without rainfall and rainy days. In Fig. 7a, the signal quality of DSTV showed a very good reception in all the zones and within each of the time frames where the network quality monitoring was done during the four-month study period. The signal quality of MYTV, on the other hand, shows good reception quality but not as high as DSTV while that of HITV showed low signal reception quality. It is also observed from the Table 4 that the mean signal reception quality show that it was 69.8% for MYTV, 85.6% for DSTV and 33.4% for HITV on normal days without rainfall. In rainy days as presented in Fig Table 4 and 7(b), the mean network signal quality observed were very poor as compared to those of days without rainfall. The values of the observed network quality were 14.4% for MYTV, 19.7% for DSTV and 7.3% for HITV respectively.

Table 3. Mean Rainfall, Temperature, Relative Humidity, Wind and Network Signal Quality (May-August-2012)

Months	Rainfall mount (mm)	Temperature (°C)	RH (%)	Wind (Knots)	Reception Quality on Rainy Days			Reception Quality on Days Without Rainfall		
					MYTV	DSTV	HITV	MYTV	DSTV	HITV
May	135.5	33.4	82.2	3.1	17.8	22.3	9.3	69.6	84.3	32.4
June	219.4	34.2	84.5	3.4	14.2	19.8	6.8	66.9	87.2	33.8
July	259.4	32.6	84.8	3.4	13.4	19.5	5.3	68.9	85.9	32.9
August	170.8	31.4	82.5	3.3	16.2	20.4	7.4	73.8	85.0	34.5
Mean for the 4 Months	196.2	32.9	83.5	3.3	15.4	20.4	7.2	69.8	85.6	33.4

Table 4. Mean Network Signal Quality in Warri Metropolis on Days without Rainfall and Rainy Days

Months	Time	Zones Sample Area	Network Reception Quality on days without rainfall (%)			Network Reception Quality on rainy days (%)		
			MYTV	DSTV	HITV	MYTV	DSTV	HITV
May	6 am-12 noon	PTI	69	85	36	11	18	5
	0500-1100hrsGMT	NPA	67	90	30	32	41	8
		Edjeba	70	89	25	7	13	3
		Enerhen Rd	61	83	39	12	17	8
		Okere	67	87	35	8	18	6
	12 noon-6 pm	PTI	81	85	32	20	28	14
	1100-1700 hrsGMT	NPA	73	89	31	18	21	7
		Edjeba	72	61	39	24	36	12
		Enerhen Rd	74	86	41	17	19	15
		Okere	68	81	29	42	56	18
	6 pm-12 midnight	PTI	70	90	37	31	38	15
	1700-2300hrsGMT	NPA	56	67	29	19	22	12
		Edjeba	69	87	29	3	14	3
		Enerhen Rd	91	94	33	19	21	4
		Okere	69	74	31	8	13	9

Months	Time	Zones Sample Area	Network Reception Quality on days without rainfall (%)			Network Reception Quality on rainy days (%)		
			MYTV	DSTV	HITV	MYTV	DSTV	HITV
June	6 am-12 noon	PTI	67	96	38	11	18	5
	0500-1100 hrsGMT	NPA	70	85	30	32	41	8
		Edjeba	61	91	25	7	13	3
		Enerhen Rd	67	90	39	12	17	8
		Okere	71	89	35	8	18	6
		PTI	73	83	32	18	24	6
		NPA	79	90	33	5	13	2
		Edjeba	69	89	39	3	12	0
	12 noon-6 pm	Enerhen Rd	67	83	43	6	12	3
	1100-1700 hrsGMT	Okere	70	87	29	13	18	8
		PTI	61	85	37	16	19	6
		NPA	67	89	31	21	24	7
	6 pm-12 midnight	Edjeba	81	90	30	11	13	4
	1700-2300 hrsGMT	Enerhen Rd	73	89	25	24	29	11
		Okere	69	90	31	16	19	9
July	6 am-12 noon	PTI	70	89	30	36	41	19
	0500-100 hrsGMT	NPA	61	83	25	15	21	8
		Edjeba	67	85	39	21	26	13
		Enerhen Rd	71	85	35	13	17	7
		Okere	70	89	32	4	8	4
		PTI	61	90	31	32	39	11
		NPA	69	89	39	13	17	8
	12 noon-6 pm	Edjeba	67	83	41	22	25	13
	1100-1700 hrsGMT	Enerhen Rd	70	87	29	32	46	14
		Okere	61	85	37	7	9	3
	6 pm-12 midnight	PTI	70	90	31	12	14	5
	1700-2300 hrsGMT	NPA	61	89	30	17	21	8
		Edjeba	67	83	25	3	7	3
		Enerhen Rd	81	87	39	7	7	4
		Okere	69	85	35	12	16	7

Months	Time	Zones Sample Area	Network Reception Quality on days without rainfall (%)			Network Reception Quality on rainy days (%)		
			MYTV	DSTV	HITV	MYTV	DSTV	HITV
August	6 am-12 noon	PTI	83	89	32	21	27	9
	0500-1100 hrsGMT	NPA	73	90	31	3	8	7
		Edjeba	71	89	39	4	7	3
		Enerhen Rd	69	83	41	9	11	6
		Okere	72	87	29	28	34	17
	12 noon-6 pm	PTI	73	85	37	39	58	21
	1100-1700 hrsGMT	NPA	72	89	31	11	15	6
		Edjeba	73	90	32	9	12	3
		Enerhen Rd	69	81	31	8	9	3
		Okere	67	78	39	0	0	0
	6 pm-12 midnight	PTI	70	81	41	3	8	2
	1700-2300 hrsGMT	NPA	61	67	29	0	0	0
		Edjeba	61	81	37	7	11	5
		Enerhen Rd	80	90	31	3	3	3
		Okere	75	81	30	0	0	0
		Mean	69.8	85.6	33.4	15	20	7.2

Source: Field Work

(Note: calculated values are proportionate values from observation of the digital values from decoder signal qualities)

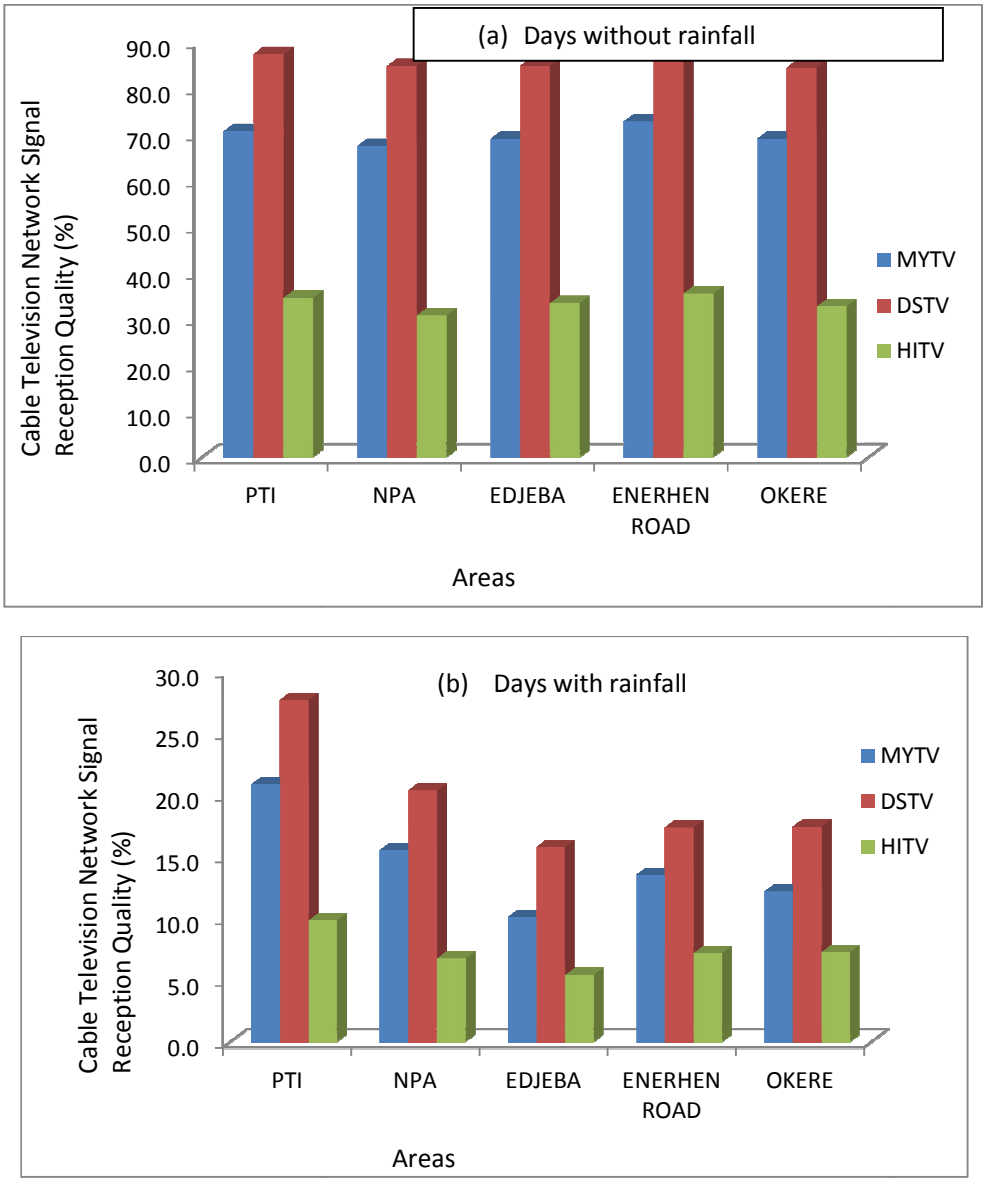

Fig. 7(a & b). Satellite TV network quality reception for days with and without rainfall event

3.4 Effects of Rainfall, Temperature, Relative Humidity, and Wind on MYTV, DSTV and HITV Signal Reception

3.4.1 Hypothesis I

H0: There is no significant variation in the reception quality output of MYTV, DSTV and HITV in Warri.

From Tables 5 and 6, the calculated F-value is 1028.136 with 177 denominators under two numerator degree of freedom is greater than the critical table-value of 19.49 at 0.05 significant level. Thus the posited null hypothesis that there is no significant variation in the reception quality of MYTV, DSTV and HITV in Warri is rejected, and it can now be inferred that there is significant variation in the reception quality output of MYTV, DSTV and HITV in Warri. This can be seen from the multiple comparisons in Table 6 that there was significant variation in means of MYTV and that of DSTV and HITV. This result corroborates Ezekoye and Obodo [4].

Table 5. Multiple comparisons

Multiple Comparisons
Reception Quality
Tukey HSD

(I) Satellite TV reception quality Signal	(J) Satellite TV reception quality Signal	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
MYTV	DSTV	32.500*	1.545	.000	28.85	36.15
	HITV	70.000*	1.545	.000	66.35	73.65
DSTV	MYTV	-32.500*	1.545	.000	-36.15	-28.85
	HITV	37.500*	1.545	.000	33.85	41.15
HITV	MYTV	-70.000*	1.545	.000	-73.65	-66.35
	DSTV	-37.500*	1.545	.000	-41.15	-33.85

**. The mean difference is significant at the 0.05 level.*

Table 6. Anova statistics – Explaining the variation in Reception quality

	Sum of Squares	Df	Mean Square	F	Table value	Sig.	Remark
Between Groups	147250.000	2	73625.000	1028.136	19.49	.000	Significant variation exists
Within Groups	12675.000	177	71.610				
Total	159925.000	179					

3.4.2 Hypothesis II

H0: MYTV, DSTV and HITV reception Quality are not significantly dependent on weather characteristics in Warri metropolis.

This hypothesis was tested using the stepwise method of multiple regression analysis (Table 7).

From Table 7, the R-value shows a correlation of 0.989 between weather elements (rainfall as predicted by stepwise regression) and MYTV reception quality. However, the R^2 value of 0.977 shows that the quality of the signal reception from MYTV is explained by 97.7% dependency on weather characteristics (especially rainfall). The contributions of wind, relative humidity and temperature were excluded. The Durbin-Watson value of 3.36, implies a negative first-order autocorrelation. Negative first-order autocorrelation occurs when consecutive residuals differ widely. This result corroborated earlier study by [25].

In Table 8, the calculated value, F, is 86.408 which is greater than the table value of 5.23 at P>0.05. This means the null hypothesis is rejected and the alternate hypothesis that MYTV reception quality is significantly dependent on weather characteristics (rainfall) in Warri.

From Table 9, the standardized beta value of 0.989 shows that MYTV signal reception quality correlated strongly with rainfall. The other weather parameters, temperature, RH and wind which were excluded by stepwise regression are presented in Table 10.

The beta values of wind, RH and temperature in Table 10 shows a weak correlation of these weather parameters with MYTV reception quality in Warri.

From Table 11, the R-value shows a correlation of 0.994 between weather elements (wind as predicted by stepwise regression) and DSTV reception quality. However, the R^2 value of 0.988 shows that the quality of the signal reception from DSTV is explained by 98.8% dependency on weather characteristics (especially wind). The contributions of rainfall, relative humidity and temperature were excluded. The Durbin-Watson value of 1.933, imply a positive first-order autocorrelation. Positive autocorrelation occurs when consecutive residuals tend to be similar.

In Table 12, the calculated value, F, is 160.514 which is greater than the table value of 14.66 at P>0.05. This means the null hypothesis is rejected and the alternate hypothesis that DSTV reception quality is significantly dependent on weather characteristics (wind) in Warri.

Table 7. Model summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.989[a]	.977	.966	.36596	.977	86.408	1	2	.011	3.363

a. Predictors: (Constant), RAINFALL
b. Dependent Variable: MYTV RECEPTION

Table 8. ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Table Value	Sig.
1	Regression	11.572	1	11.572	86.408	5.23	.011[a]
	Residual	.268	2	.134			
	Total	11.840	3				

a. Predictors: (Constant), RAINFALL
b. Dependent Variable: MYTV RECEPTION

Table 9. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	22.493	.785		28.666	.001			
	RAINFALL	-.036	.004	-.989	-9.296	.011	-.989	-.989	-.989

a. Dependent Variable: MYTV RECEPTION

Table 10. Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	WIND	-.310[a]	-1.989	.297	-.893	.188
	RH	-.230[a]	-.473	.719	-.428	.078
	TEMPERATURE	-.039[a]	-.267	.834	-.258	.991

a. Predictors in the Model: (Constant), RAINFALL
b. Dependent Variable: MYTV RECEPTION

Table 11. DSTV model summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.994[a]	.988	.982	.17078	.988	160.514	1	2	.006	1.933

a. Predictors: (Constant), WIND
b. Dependent Variable: DSTV reception

Table 12. ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Table value	Sig.
1	Regression	4.682	1	4.682	160.514	14.66	.006[a]
	Residual	.058	2	.029			
	Total	4.740	3				

a. Predictors: (Constant), WIND
b. Dependent Variable: DSTV reception

Table 13. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	49.650	2.302		21.564	.002			
	WIND	-8.833	.697	-.994	-12.669	.006	-.994	-.994	-.994

a. Dependent Variable: DSTV reception

Table 14. Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	RH	.068[a]	.328	.798	.312	.256
	RAINFALL	-.068[a]	-.274	.830	-.264	.188
	TEMPERATURE	.098[a]	1.858	.314	.881	1.000

a. Predictors in the Model: (Constant), WIND
b. Dependent Variable: DSTV reception

Table 15. HIV model summary

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.970[a]	.942	.912	.48966	.942	32.283	1	2	.030	.772

a. Predictors: (Constant), RAINFALL
b. Dependent Variable: HITV reception

Table 16. ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Table value	Sig.
1	Regression	7.740	1	7.740	32.283	2.79	.030[a]
	Residual	.480	2	.240			
	Total	8.220	3				

a. Predictors: (Constant), RAINFALL
b. Dependent Variable: HITV reception

Table 17. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	13.001	1.050		12.383	.006			
	RAINFALL	-.030	.005	-.970	-5.682	.030	-.970	-.970	-.970

a. Dependent Variable: HITV reception

Table 18. Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	WIND	-.272[a]	-.559	.676	-.488	.188
	RH	.765[a]	1.894	.309	.884	.078
	TEMPERATURE	.231[a]	3.177	.194	.954	.991

a. Predictors in the Model: (Constant), RAINFALL
b. Dependent Variable: HITV reception

From Table 13, the standardized beta value of 0.994 shows that DSTV signal reception quality correlated strongly with the wind. The other weather parameters, temperature, RH and rainfall which were excluded by stepwise regression are presented in Table 14.

The beta values of rainfall, RH and temperature in Table 14 showed a weak correlation of these weather parameters with DSTV reception quality in Warri.

From Table 15, the R-value shows a correlation of 0.970 between weather elements (rainfall as predicted by stepwise regression) and HITV reception quality. However, the R^2 value of 0.942 shows that the quality of the signal reception from MYTV is explained by 94.2% dependency on weather characteristics (especially rainfall). The contributions of wind, relative humidity and temperature were excluded. The Durbin-Watson value of 0.772, imply a positive first-order autocorrelation. This result corroborated earlier study by the Commonwealth of Australia [25].

In Table 16, the calculated value, F, is 32.283 which is greater than the table value of 2.79 at P>0.05. This means the null hypothesis is rejected and the alternate hypothesis that HITV reception quality is significantly dependent on weather characteristics (rainfall) in Warri.

From Table 17, the standardized beta value of 0.970 shows that HITV signal reception quality correlated strongly with rainfall. The other weather parameters, temperature, RH and wind which were excluded by stepwise regression are presented in Table 18.

The beta values of wind, RH and temperature in Table 18 showed a weak correlation of these weather parameters with HITV reception quality in Warri.

The implication of the result of this study is that rainfall significantly affects the signal reception of MYTV and HITV more than DSTV which is more affected by wind. Also, the effects exerted by temperature, relative humidity on MYTV, DSTV and HITV had negative correlation indicating that as rainfall amount and intensity increases, the reception signals of MYTV and HITV decreases while it combines these effects with the wind in the case of DSTV.

3.5 Level of Signal Strength at which total loss of Signal is experienced in MYTV, DSTV and HITV Networks

Table 19 shows that at these levels of signal quality (37%-41%), most of the channels go off air on MYTV completely but few channels still retains signal such as Emmanuel TV, Press TV, Muvi TV (African Unit) while on DSTV, most of

Table 19. Signal Levels at which total Loss of signal is experienced in certain Channels

MYTV Channel name	Signal Strength	DSTV Channel name	Signal Strength	HITV Channel name	Signal Strength
BBC World	38	Africa Magic	50*	Sky News	25
BET	38	Africa Movies	50*	BBC World	28
MYTV More	39	CCTV	52	HI Sport	21
Trace	37	Action	50	HI Soccer	24
1 Music	38	CCTV 9	53	HI Nolly	26
MYTV Series	40	CCTV N	55	Trace	22
MYTV Africa	36	Channel O	50	Kidsco	25
MYTV Promo	38	MTV Base	50	Ajazeerra	32
Dove Vision	40	B4U	53	Zee Cinema	29
Nollywood	37	Universal Ch	55	TVC	24
Nollywood Plus	38	Silver Bird	51	E!	26
Channel 44	39	AIT	58	HI Mix	22
MYTV Yoruba	38	NTA	52	History	29
Elshaddai	37	ESPN	55	National Geo	28
Soul Life	39	TV 3	55	Hits	26
Inspiration	38	TV 5	57	HI Sport2	26
CTL	37	Food Channel	54	God	24
Praise TV	39	LTV	53	HI Life	29
KBC World	40	Channels TV	53	Fox news	31
ATV	39	Eurosport News	56	Sony Enter TV	29

MYTV Channel name	Signal Strength	DSTV Channel name	Signal Strength	HITV Channel name	Signal Strength
MFM TV	41	Blitz	52	HI Movies	28
Cpice TV	38	CNN	50*	HI Kids	25
Evangel TV	37	Cartoon Network	50*	Amuludum Y	29
EWTN	39	BBC World	54	Discovery W	31
W.R.S	38	Travel Channels	51	Eurosport	28
Muvi TV Africa Unit		Magic World	56	HI mix2	29
IQRAA	35*	Animal Planets	55	Channels	30
Love World	37	Nat Geographic	52	NTA5	29
True Movies 1	37	Trace TV	55	HITV 9ja	29
Muvi TV	39	E!	53	Bollywood	28
Dunamis	38	ETVA	50		
Setanta Africa	39	MNET	55		
FX	37	Super Sports 10	53		
ITVN	37	NaGeo Wide	51		
Chosen TV	39	Super Sports 1	53		
Eurosport News	37	Super Sports 2	50*		
Omega	38	Super Sports 3	53		
K.L.N	36	Super Sports 4	50*		
Hossanna	37	Super Sports 5	52		
Messiah	37	SuperSports 5N	52		
Press TV	39	Super Sports 6	50*		
R.T.M	35*	Super Sports 7	53		
Novo Tempo	38	SuperSports 3N	51		
Overcomer TV	37	Super Sports 9	56		
Miracle TV	39	SuperSport HD	55		
Spirit World	41	Zee Cinema	53		
Prophetic Ch	38	BET	54		
CTV	39	Kidsco	53		
AIT	37	FLN	51		
NTA Plus	38	FX	51		
Emmanuel TV	35	Ajazerra	55		
Olive TV	35*	Mnet Series	53		
ACBN	39	BBC L	53		
Jim Jam	38	BBC Prime	53		
F.L.N	39	SuperSp Select	55		
KICC	42	ESPNC	52		
ABN	38	Swahi	55		
Fox	38	B4U Music	53		
E!	37	Sky News Int	53		
Kidsco	37	ETWN	55		
Zee Cinema	39	DISH	52		
E.T.V	39	CCTV 4	54		
Ahlulbayt TV	38	Learn	51		
Ben TV	39	Africa Movie II	53		
	38	LC2	55		
		Islamic Chann	52		
		Metro	55		
		Africa Magic H	50*		
		Africa Magic Y	50*		
		Mira	54		
		Sun City	52		
		MMI	58		
		GTV	53		
		LC1	55		

** these channels will still be on at this level of signal (Author monitored, 2012)*

the stations also goes off air at 51%-58% with the exception of Channels like Super Sports 4, Super Sports 5N, Super Sport 7, Africa Magic Hausa, Africa Magic (Yoruba), Mira, Cartoon network, BBC World, Africa Magic and Africa Movies which goes off at 50% signal strength level.

This is the reason behind the level of differences experienced by subscribers to these networks. Most of the channels that continue to receive reception at these low level of signal quality in either MYTV or HITV are DSTV-fed channels in which additional satellite Dish and LNB are deployed to tap into DSTV channels by positioning the dish to face DSTV signal reception axis in the EMS. Thus, DSTV, therefore, has more resistance ability to the vagaries of climate. However, this study has been able to show that climate parameters especially rainfall has a great role to play when it comes to signal reception strength and quality. The result presented is in agreement with the study of Nweke and Ukwu [26] and Nweke [3] in Enugu. Though the study has proved that there are some other stations that can withstand rainfall effect to a certain level as a result of its high signal strength and can be watched at the presence of this weather anomaly, except when the rainfall becomes more intense. It has also been observed that the higher the signal strength, the lower the effects of rainfall on the above satellite cable modems (MYTV, DSTV and HITV).

4. CONCLUSION

This research was undertaken to examine the effects of weather conditions on satellite cable television cable network (MYTV, DSTV and HITV) reception quality in Warri metropolis to examine the general nature of weather characteristics, its effects on cable networks as well as signal quality patterns on rainy and non-rainy days.

We conclude from the study that climate elements especially rainfall significantly influenced reception quality of MYTV, DSTV and HITV in Warri metropolis due to its attenuation, thus a serious concern for rainfall monitoring through state-of-the-art technology platforms is indispensable.

Suggested Solutions to the problems of Satellite TV Networks Linked to Climatic Elements.

In the light of the above findings, the following recommendations were made concerning climate effects on satellite cable television network reception (MYTV, DSTV and HITV) in Warri.

1 Rainfall monitoring through satellite and ground stations should be intensified with a view of daily prediction and communication to users of cable satellite television products to know what signal quality to expect at the event of an anomaly in climate elements especially in the face of a changing climate.
2 The subscription to any of the cable network should be borne on a clear understanding of the polarity and band of operations in the electromagnetic spectrum whether KU on the high or low band.
3 There should be constant monitoring of modems sold to new subscribers to rid the market of fake products.
4 There should be more research on the part of the manufacturers of these cable satellite television products to actually incorporate better technology that can stand the test of time in the face of a changing climate.
5 Finally, most of the product users should communicate to the providers on the possibility of making modems that are less electricity consuming as this could contribute to signal quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ikuomola AJ. Wireless communication II; Course work developed for the National Open University of Nigeria, Lagos. 2011; 6-140.
2. Wole O. Digital TV talk: Why your TV signals are affected by rain. Eagle Online Newspaper, accessed 17th April 2018 @ The Eagle Online; 2015.
3. Nweke FU. The effect of weather and fading rate in television transmission and reception. Middle-East Journal of Scientific Research. 2017;25(10):1872-1875.

4. Ezekoye BA, Obodo RM. The effects of solar radiations on telecommunications. The Pacific Journal of Science and Technology. 2007;8(1):109-117. Spring.
5. Kestwal MC, Joshi S, Garia LS. Prediction of rain attenuation and impact of rain in wave propagation at microwave frequency for tropical region (Uttarakhand, India). International Journal of Microwave Science and Technology; 2014. Article ID 958498, 1-6.
6. Siddique U, Ahmad L, Raja G. Microwave attenuation and prediction of rain outage for wireless networks in Pakistan's Tropical Region. International Journal of Microwave Science and Technology. 2011;1-6.
   DOI: 10.1155/2011/714927
7. Harun H, Agil H, Rashid RA. Improvements of signal gain for measat-2 and measat-3 using orbital diversity under rain attenuation: A simulation approach. International Journal of Scientific & Engineering Research. 2013;4(7):367-372.
8. Ivanovs G, Serdega D. Rain intensity influence on to microwave line payback terms. Electronics and Electrical Engineering. 2006;6(70):60-64. Nr.
   ISSN: 1392-1215.
9. Adetan O. Modelling of raindrop size distribution and critical diameters for rainfall attenuation over microwave links in southern Africa. Submitted in fulfilment of the academic requirements for the degree of Doctor of Philosophy in Electronic Engineering, University of KwaZulu-Natal, South Africa. 2014;178.
10. Crane RK. Electromagnetic wave propagation through rain. Wiley Interscience Publication John Wiley & Sons Inc; 1996.
11. Roddy D. Satellite communications, 3rd Edition. Copyright 2001 The McGraw-Hill Companies; 2001.
12. Orji HE, Udeh IJ, Offia IS. Comparison of attenuation effect of rainfall on television signal with/without (Atpc) automatic transmit power control. IOSR Journal of Engineering. 2016;06(03): 01-05.
13. Siddique U, Sabbir I, Raja G. Rain outage prediction for GSM networks in Pakistan. IEEE ISWCS. 2008;85-88.
14. Hassan D, Md. Rafiqul I, Khalid A, Ismail AF, Sheroz Khan. Fade slope modelling at high elevation angle on space-earth path link. Computer and Communication Engineering (ICCCE) 2012 International Conference. 2012;686-689.
15. Ajewole MO, Kolawole LB. Theoretical study of the effect of different types of tropical rainfall on the microwave and millimetre-wave propagation. Radio Science. 1999;34(5):1103-1124.
16. Kanellopoulos JD, Livieratos SN, Vazouras CN. Analysis of the interference due to differential rain attenuation induced by an adjacent pathona double-site diversity system using frequency reuse. Radio Science. 1999;34(4):967-981.
17. Townsend AJ. A Study of the raindrop size distribution and its effect on microwave attenuation. A thesis submitted for the degree of Doctor of Philosophy, Department of Electronic and Electrical Engineering, University of Bath. 2011;200.
18. Sanyaolu ME. Rainfade analysis at C, Ku and Ka Bands in Nigeria. A Dissertation Submitted in the Department of Physical Sciences to the School of Postgraduate Studies, Redeemer's University Ede, Osun State, Nigeria in Partial Fulfilment of the Requirements for The Award of the Degree of Masters of Science (M.Sc) in Communication Physics. 2016;103.
19. Nelson RA. Rain: How it affects the communications Link. Via Satellite. 2000; 1-4.
20. Peebles PZ Jr. Radar principles. John Wiley and Sons, Inc. 1998;20.
21. Efe SI. An aspect of Indoor microclimates characteristics in Nigeria Cities: The Warri experience. Environmental Analar. 2002; 8(906):9-6.
22. National Population Commission, NPC. Nigeria 2006 population census figures, Delta State; 2006.
23. Ojeh VN. Thermal comfort characteristics in Warri, Delta State, Nigeria. LAP Lambert Academic Publishing, Saarbrucken, Deutschland, Germany. 2014;1-137.
24. Tamuno TT. Climate change and human wellbeing. IAIA 09, Conference Proceeding of International Association for impact Assessment, May 16-22. 2009;1.
25. The Commonwealth of Australia. Better television and radio reception, Identifying your analog TV and radio interference

problem. Australian Communications and Media Authority. 2010;1-21.

26. Nweke FU, Ukwu CN. Weather variation and its effect on transmission of communication signal. International Journal of Scientific & Engineering Research. 2015;6(6):643-645.

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