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Trends of Weather Elements Induced Flights Cancellation in Nnamdi Azikiwe International Airport, Abuja, Nigeria

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Abstract The Study assess the trends of weather conditions in aviation transport in Nnamdi Azikiwe International Airport, Abuja. Records on visibility, rainfall, cloud cover; wind speed and two aspects of flight operations (flight delay and cancellation) for a period of 14 years (2000-2014) were collected from secondary source. Simple regression analysis or trend analysis was used to determine the trend of the weather parameters as influencing flight operations. Findings in this study show that. Trends reveal that flight cancellation and delay have reduced drastically at Nnamdi Azikiwe International Airport, Abuja as a result of installation of advanced navigational aids to take care of unforeseen weather obstructions. Individual weather elements (visibility, rainfall, cloud cover and wind speed) on their own do not have significant effects on flight operations between 2000 and 2014, however when they are combined, these weather elements affect aviation transportation tremendously. Hence there is need for the installation of reliable and well equipped weather station with precise prediction of weather elements not only in airports, but also in strategic locations across the country to enable the spatial analysis of weather records across air routes.

Keywords Flight operation, Weather elements and trend analysis

1. Introduction

The effect of weather variation brought about by global warming is a lot of concern to the aviation industry. Abass *et. al.,* (2012)) stated that several airlines have been rendered moribund, while some offer partial services as a result of extreme weather events. Weather is the state of the atmosphere at a given place and time with respect to variables such as temperature (heat or cold), moisture (wetness or dryness), wind velocity (calm or storm), visibility (clearness or cloudiness) and barometric pressure (high or low). Stringer (1989) is of the opinion that weather conditions can evolve at a rapid rate, over a wide spatial extent when compared with other factors that may affect the safe conduct of flight. This is apart from aircraft maintenance, runway status, airspace sector access and support services. Thus, the spectrum of weather information is an important component for the safe conduct of a flight and the efficient management of air traffic in future (Mirza *et. al.,* (2009). Weather continues to play a significant role in number of aviation accidents and incidents. While National Transportation Safety Board (NTSB) reports most commonly find human error to be the direct accidents caused, weather is a primary contributing factor in 23 percent of all aviation accidents (Kulesa, 2002). Extreme weather events present major challenges for transportation and are becoming more frequent and intense.

Ayoade (2004) revealed that Poor visibility is the single most important weather hazard to all forms of transportation especially air transportation. Poor visibility can be caused by thick fog, snow, rain, thunderstorm, harmattan dust, mist, volcanic ash or smoke, urban smoke, low ceilings and even smog. The Sosoliso plane crash in 2006 was partly caused by poor visibility because of thunderstorm and rain when trying to land in Port Harcourt airport. Investigation on aviation accidents shows that 80% of aviation accidents take place before, after or during landing or take off and is described as resulting from human error. For example the ADC air crash in 2006 was reported to occur between landing and takeoff due to wind shear. (Culled in (Accident Investigative Bureau (AIB) 2014).

Weather is the single largest contributor to delays in the efficiency of flight operation. It is becoming the dominant cause of delay in Nigeria. Flights can incur delays while airborne or on the ground, for example, a late arrival of one flight may cause a late departure of the next flight on the itinerary of the aircraft (Schaefer and Millner, 2001). Moreover, visibility and a minimum cloud ceiling, as well as certain crosswind maxima are required for a safe landing or

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take-off.

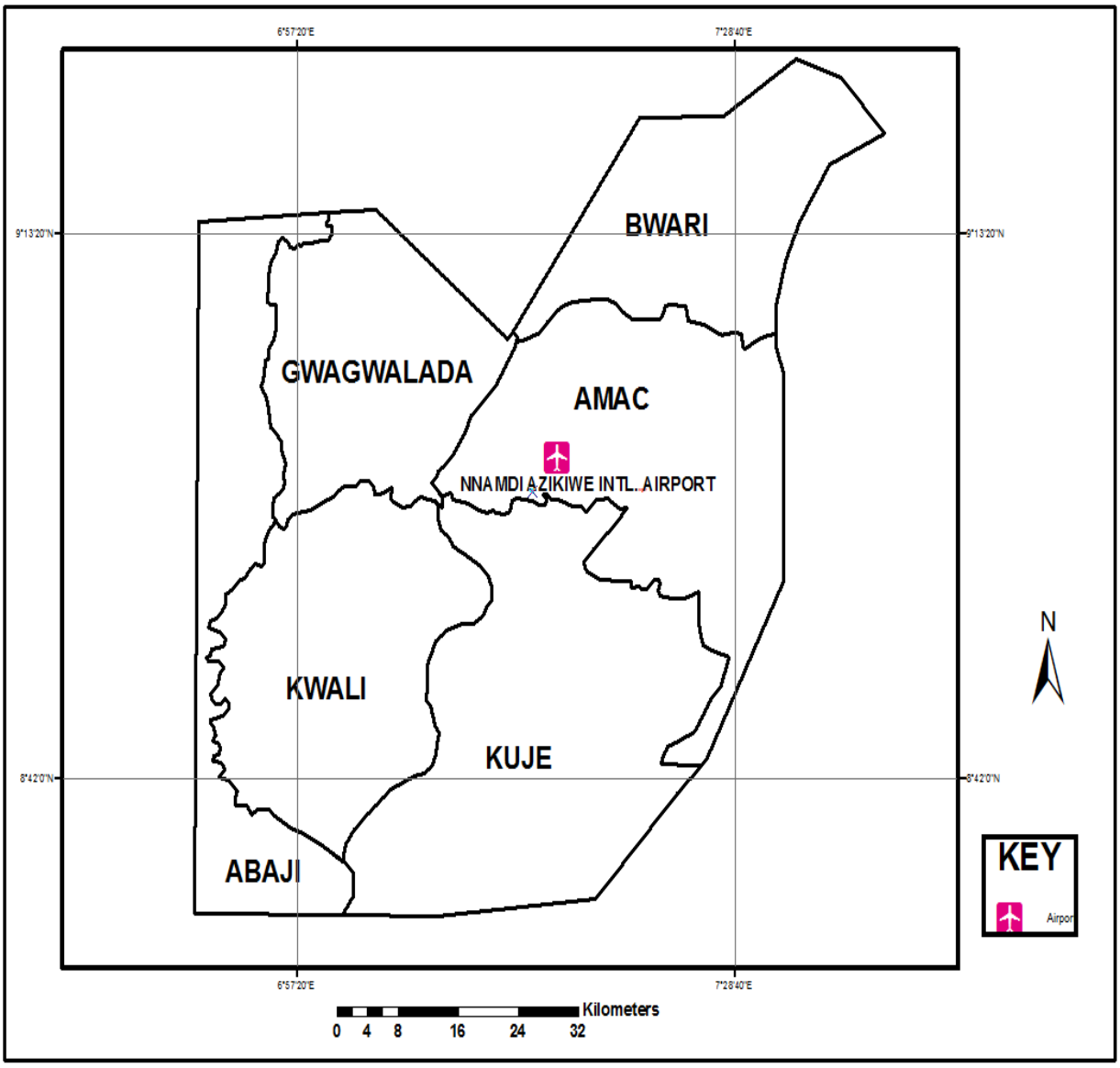
In rainy seasons, airports in Nigeria experiences frequent bouts of severe convective weather that blocks en-route or terminal airspace and results in very high delays. Critical weather phenomenon reduces the operational capacity of regions entire airspace through delays, diversion and flight cancellations. However, this concern for safety comes at a cost and it leads without doubt to traffic delays, diversions, and cancellations (Rodenhuis, 2004). As a consequence, Nnamdi Azikiwe International Airport Abuja has to be investigated separately with regard to its susceptibility to adverse weather.

Therefore, assessment of the impact of weather in the current environment as well as in future changing climate conditions is essential in order to enable the sector to adjust to it adequately.

Study Area

Nnamdi Azikiwe International Airport is located in the Federal Capital Territory (FCT), Abuja. It is about 45km south of the city. The airport has both international area which serve domestic and international flights, and the private area that is used for charter flights. The elevation of the airport is 1,123ft / 342m above mean sea level. It has two runway directions namely 04/22, and the runway length is 3600m/11,842 ft (Nigerian Aeronautical Information Publication [NAIP], 2013).

Abuja International Airport provides flight services both to domestic and International destinations. It is a public airport operated by the Federal Airports Authority of Nigeria.



Source: Federal Capital Development Authority (FCDA) 2017

Figure 1

Climate of the Study Area

The climate is generally tropical (Abomeh, 2013). The climate if FCT is largely governed by the Inter-Tropical Convergence Zone (ITCZ). This zone of convergence is normally defined by both the moisture-laden south-west winds and the north-east dry, continental winds. Rain normally occurs south of ITCZ when the ITCZ passes northwards through the FCT between the middle of March and June, it heralds the beginning of the rainy season. On its return southwards about the middle of October, it heralds the onset of the dry season. Consequently, there is a distinct rainy season that starts in April and ends in October, and a dry, cold season that begins in November and ends in March (Ujoh *et. al.*, 2010).

The mean annual rainfall total ranges from 1,145mm to 1,631.7mm (Ujoh *et. al.*, 2010). This reflects a situation that results from the FCT's location on the windward side of the Jos plateau. This gives rise to frequent rainfalls and a noticeable increase in the mean annual total from the south to the north (Balogun, 2001).

The FCT records its highest temperatures and greatest diurnal ranges during the dry season, when the maximum temperature ranges between 30.40℃ and 35.1℃. During the rainy season the maximum temperature ranges between 25.8℃ and 30.2℃. Also, the diurnal range is much reduced. Two main factors strongly influence temperature patterns in the FCT. These are cloud cover and elevation, these therefore, accounts for the relatively higher temperatures in some parts of the FCT (Ujoh *et. al.*, 2010).

Abuja is easily the best place to situate a business because of its strategic location and market structure. Abuja officially became Nigeria's capital in December 1991, following relocation from the former capital Lagos. It is one of Africa's few purpose built cities (Jibril, 2006; Adama, 2007). The City was designed to serve as a model to other Nigerian cities in the way utilities and services are managed. It has been reported that the population in some areas in Abuja is growing by as much as 20-30% per annum Jibril (2006).

2. Methodology

Research Design

The study adopted the retrospective survey design which will involve the use of historical/archival data of weather parameters and records of flight operations from Nnamdi Azikiwe International Airport, Abuja. Weather and flight cancellation data for 15 years will be collected from Nigeria Meteorological Agency (NIMET) and Nigerian Air Space Management Agency (NAMA) at the Abuja International Airport respectively. The weather parameters collected from Nigerian Metrological Agency (NIMET) includes:

i. Rainfall data from 2000 -2014 (15 years) for Nnamdi Azikiwe International Airport
ii. Records of low horizontal visibility from 2000-2014 (15 years) for Nnamdi Azikiwe International Airport.
iii. Records of wind speed (WNSPD) on runway 04/22 for Nnamdi Azikiwe International Airport.
iv. Records of cloud cover from 2000-2014 (15 years) for Nnamdi Azikiwe International Airport.

While The Airport Operational Data which include **flight delays**, **cancellations** and **diversions** will be collected from for the same period.

Trend Analysis of Records

Trend analysis will be used to ascertain the trend of weather parameters (rainfall, visibility, wind speed and cloud cover) and Airport Operational Data (flight delays, cancellations and diversions). The model for trend analysis is given by:

$$y = mx + b$$

Where

y = Flight cancellation/flight delay
x = Weather Parameter(s)
m = rate of flight cancellation/flight delay
b = constant equal to the value of y when x = 0

3. Results

Annual Trend of Flight Cancellation in the Study Area

Figure 2 shows the annual trend and variation of flight cancellation records between the periods of study (2000-2014) in the study area.

The annual records of flight cancellation show a negative trend. The highest number of flight cancellations were recorded in the year 2003 (180) and the lowest in 2013 (18). The negative trend in flight cancellation is an indication that fewer flights schedules were cancelled as time progresses. This may be connected to the use of modern sophisticated weather monitoring equipment in the airport.

Monthly Trend of Flight Cancellation in the Study Area

The monthly trend and variation of flight cancellation is presented in figure 3.

The monthly trend of flight cancellation shows that the dry month of November to March have higher flights cancellations than the rainy months. February and December has the highest monthly flight cancelation (11) while June has the least (3). Monthly flight cancelations can be view as a seasonal effect with the rainy season having fewer cancellations while the dry season which is characterized by Poor visibility, dust haze and fog which can lead to flight cancellation.

Suleiman (2012) also noted that apart from seasonal effect of flight cancellations, other factors like absence of a coherent air transport policy, bad management, decaying facilities, loose security, closure of airports, and intermittent air crashes also result to flight cancelations.

Annual Trend of Flight Delay

Figure 4 shows the annual variation in the trend of flight delay. The strength of the trend line is indicated as R^2

(0.7161).

The trend analysis of annual flights delay at Nmadi Azikiwe Airport shows a negative trend line the year 2000 has the highest delay (165) while the least was recorded in 2011 (40). The result shows there is a decline in the delay in flight takeoff and landing at the airport. This may not be unconnected to vigorous government policies since the return of Democarcy to make Nigeria aviation industry viable and efficient.

Monthly Trend of Flight Delay

The monthly flight delay records also show disparities in variation, with an almost definite bow-like pattern (figure 5).

The graphical presentation of the monthly flight delay records shows absolute fluctuation in the records. However, a seasonal pattern can also be deduced, the drier months of October to March seems to have the highest delays, this will be much likely as a result of poor visibility connected to haze dust in the season. While the rainy months have fewer delays this also goes to show that visibility causes more delays than rainfall.

Annual Trend of Visibility

The annual and monthly trend of visibility shows the variability and fluctuation among the data sets with no definite pattern as shown in figure 6a and 6b respectfully.

Figure 6a and 6b represent the trend in visibility in the study area in an annual and monthly basis respectfully. They both have a positive trend which means that visibility on annual and monthly basis are increasing. Which is a positive sign to the aviation industry as less delays and flights cancellations will be recorded. However, in recent years the high rate and increase in visibility is in favor of air transportation.

Annual Trend of Rainfall

The records of annual and month rainfall trends and variability are presented in figure 7a and 7b respectfully.

Figure 7a and 7b shows the trends in annual rainfall and monthly rainfall respectively in the study area. The annual trend has a negative trend while the monthly shows a positive trend. The results agreed with findings that rainfall is decreasing in Nigeria on an annual basis.

Annual Trend of Cloud Cover

Figure 8a and 8b present the outcome of cloud cover recorded over the space of fifteen years (2000-2014), in Oktas unit.

The amount of cloud cover on an annual rate shows a decline. This means we are having fewer tendencies of thunderstorm. The highest cloud cover recorded was in 2004 and the lowest in 2010. The monthly trend as shown in figure 6b reveals that the cloud cover is increasing on the monthly basis. Cloud cover is an element that affects flight operations. It determines the extent of thunderstorm in an area. Thunderstorm is a wind with a strong upward current of air, forming well developed cumulonimbus clouds Enete, *et. al.*, (2015). This may paralyze aircraft operations by disrupting all radio communication between the pilot and control tower. Generally, within the study period cloud cover and rain fall have been depreciating.

Annual Trend of Wind Speed

The annual trends and variability of wind speed within the period of (2000-2014), in study area is presented in figure 9a and 9b respectfully.

The trend line in figure 9a shows a positively increased in the annual recorded wind speed. The recorded wind speed is on a steady increase from the year 200. The highest wind speed was recorded in the year 2003 with about 130knots while the lowest is in the year 2006 with about 116knots. The difference is not much which shows the wind speed is on the increase and hence has a negative tendency towards successful flight operations. The monthly total on the other hand has shown a negative trend, which implies that on a whole; wind speed is not increasing on a monthly basis and hence has no potential threat to flight operations at Nnamdi Azikiwe International Airport.

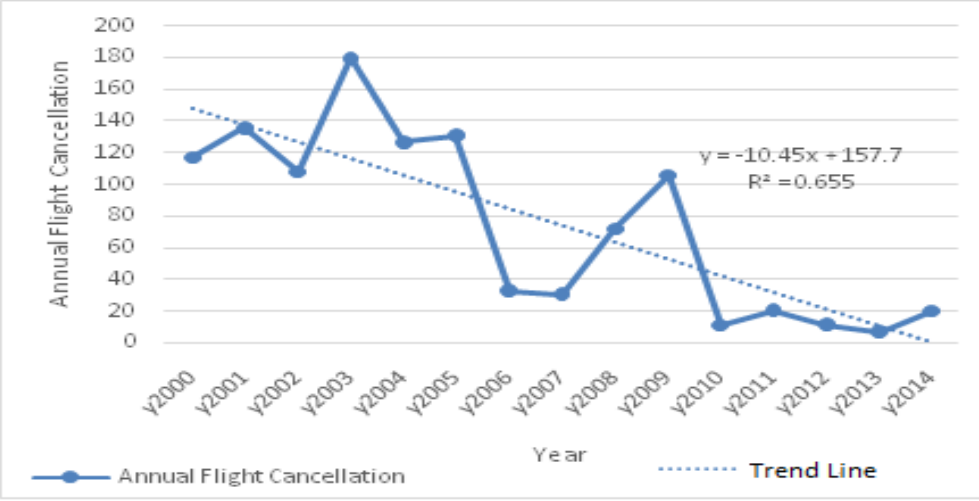


Figure 2. Annual Trend of Flight Cancellation

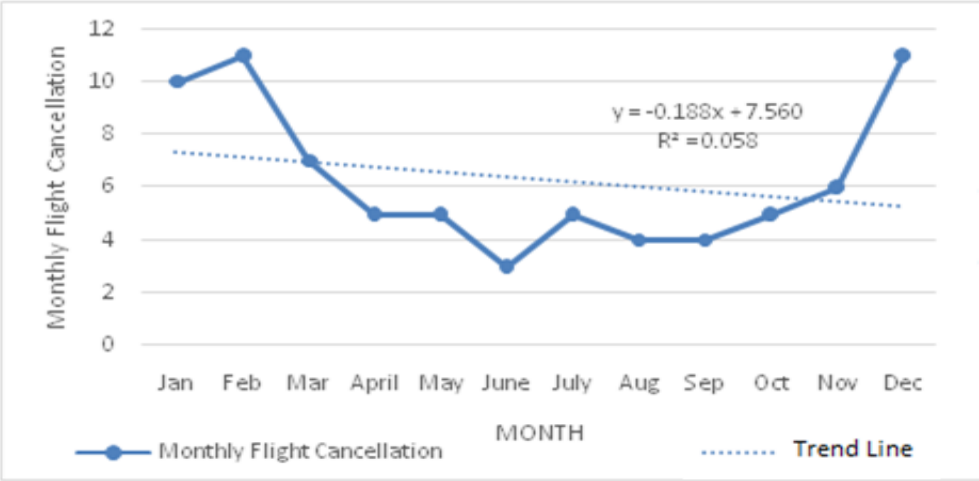


Figure 3. Monthly Trend of Flight Cancellation

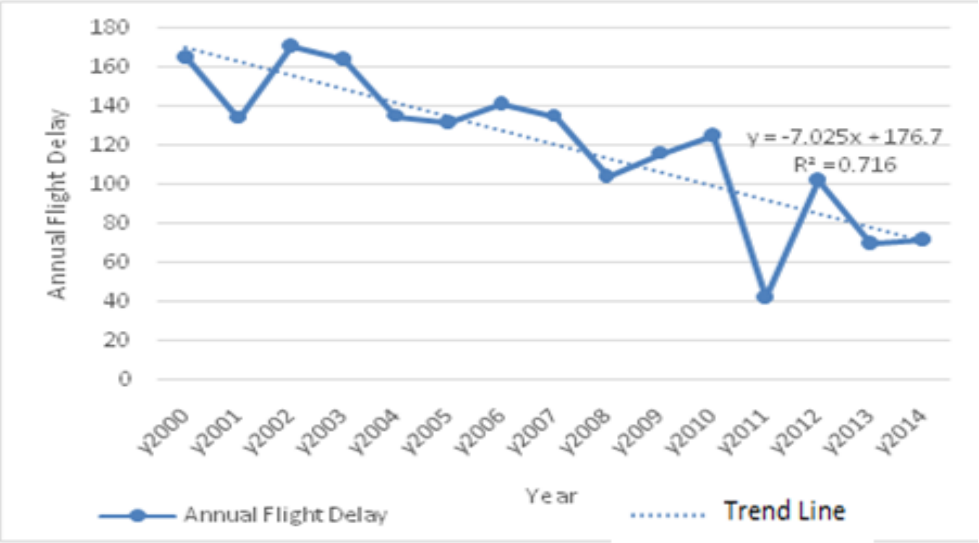


Figure 4. Annual Trend of Flight Delay

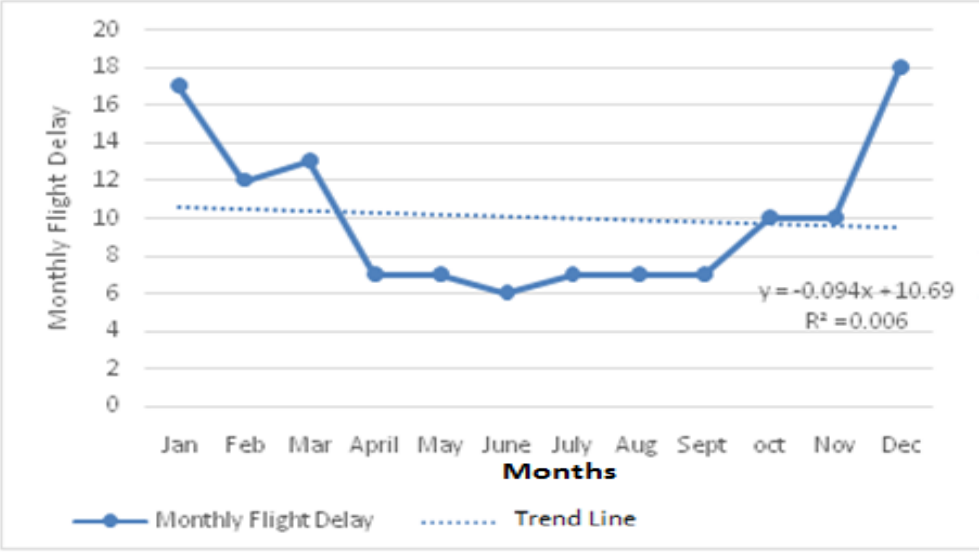


Figure 5. Monthly Trend of Flight Delay

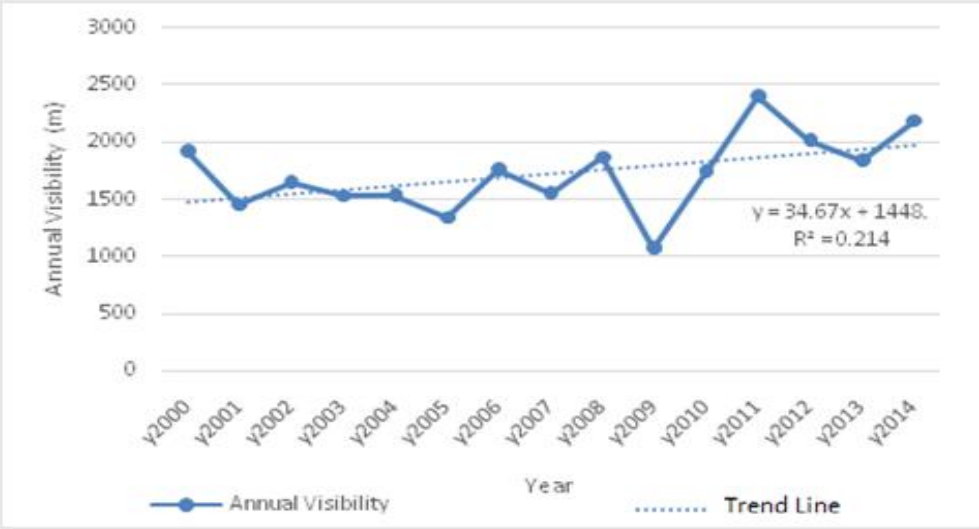


Figure 6a. Annual Visibility Trend

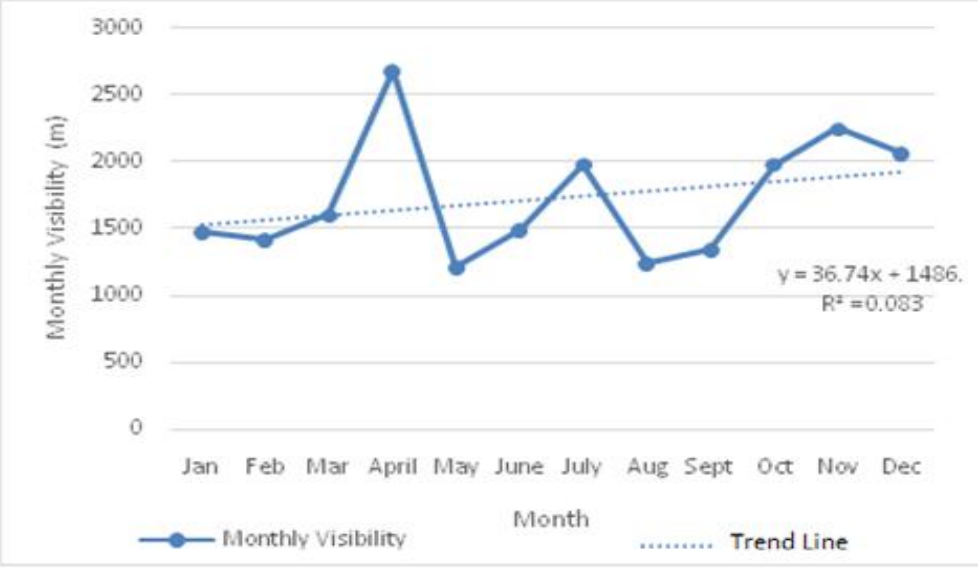


Figure 6b. Monthly Visibility Trend

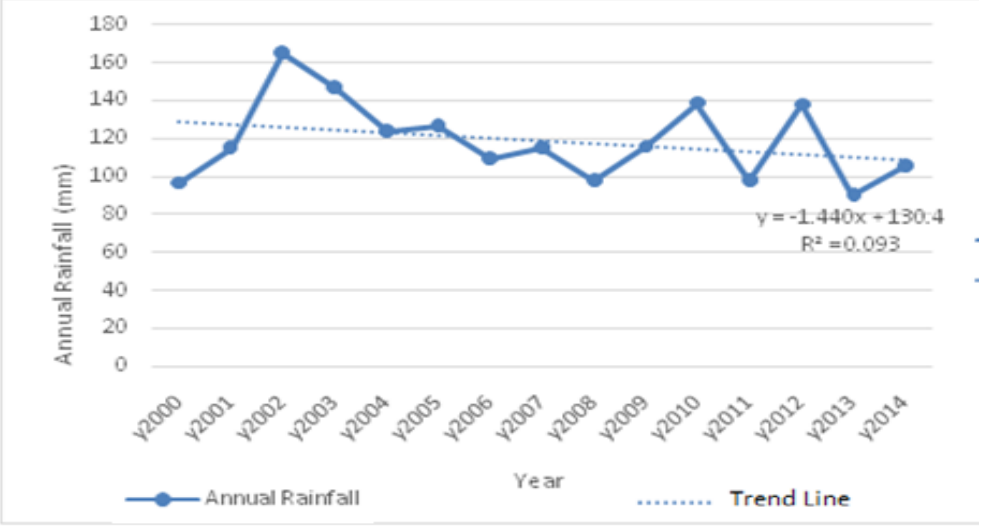


Figure 7a. Annual Trend of Rainfall

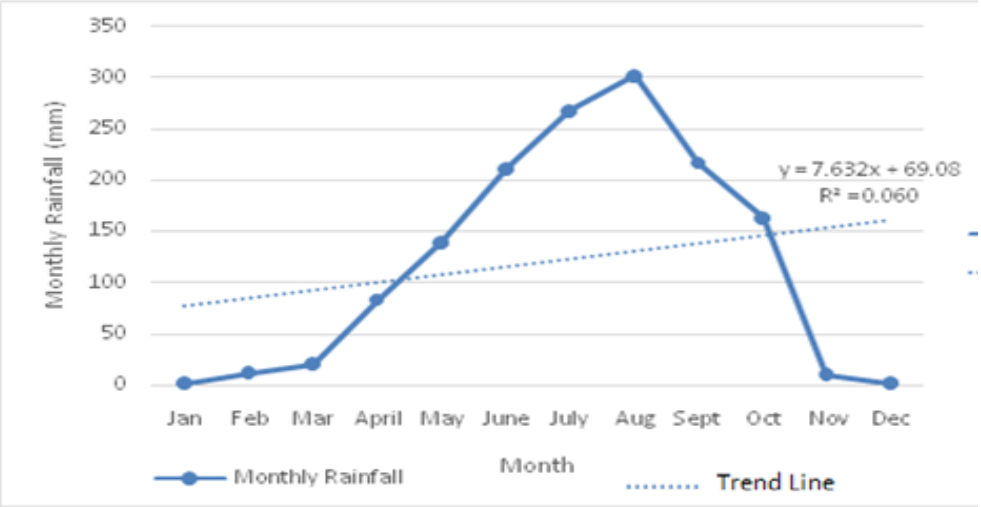


Figure 7b. Monthly Trend of Rainfall

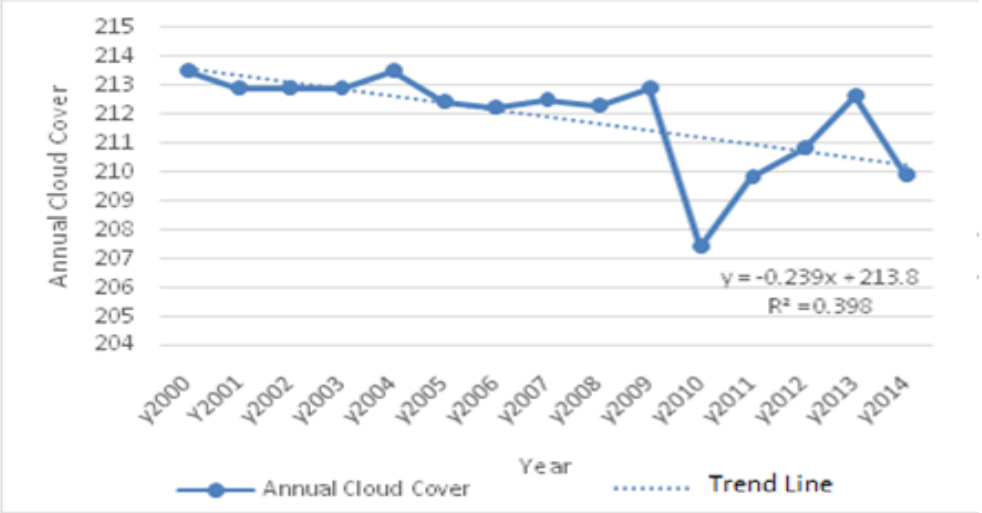


Figure 8a. Annual Cloud Cover Trend

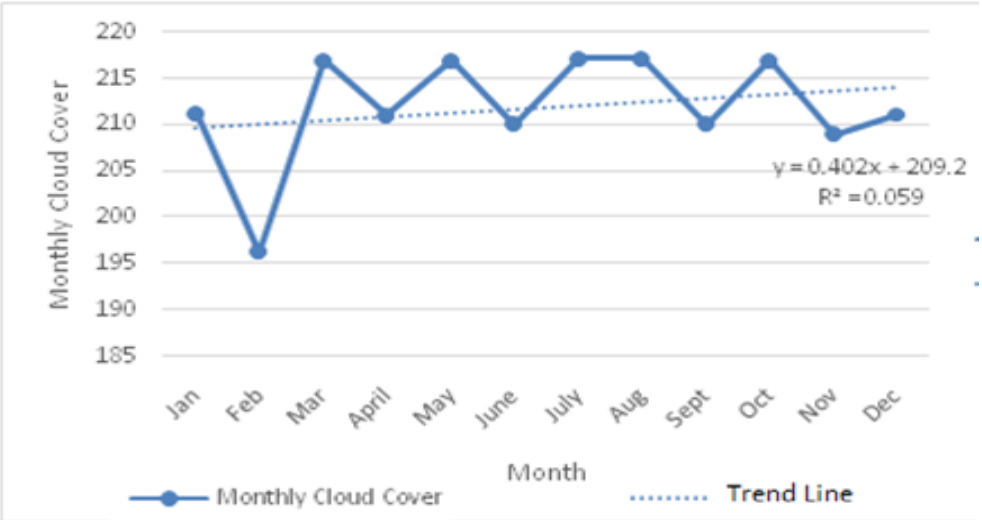


Figure 8b. Monthly Trend of Cloud Cover

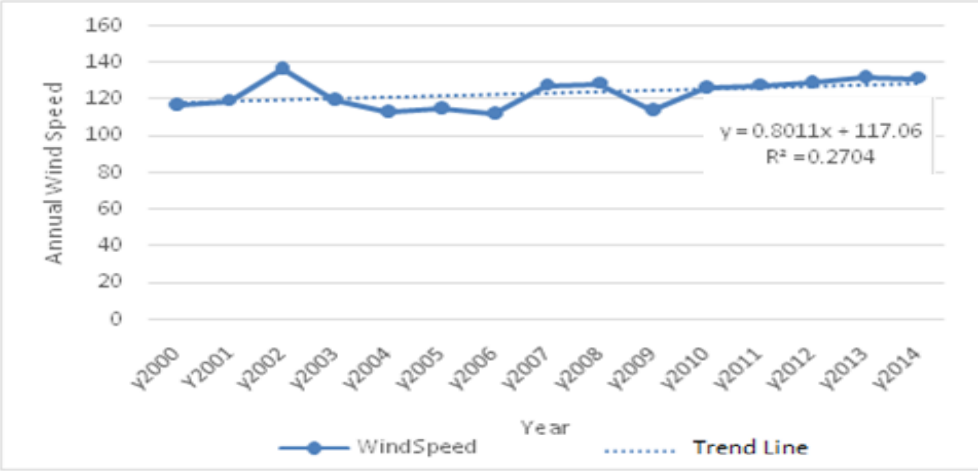


Figure 9a. Annual Trend of Wind Speed

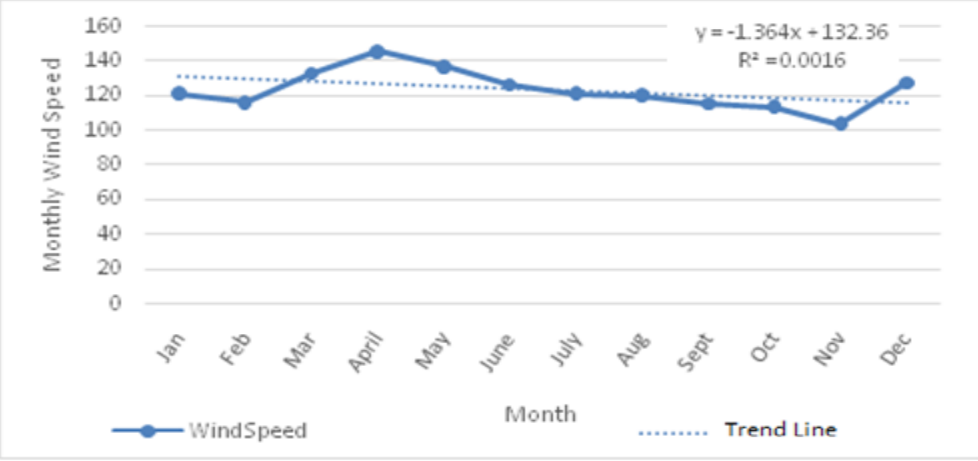


Figure 9b. Monthly Trend of Wind Speed

4. Conclusions

Trends in this study shows that the annual flight cancellation and delay have reduced drastically as a result of the installation advanced navigational aids to take care of unforeseen weather obstruction. In monthly flight cancellation and flight delay, the extent in which these weather elements influences flight operations vary with seasons. In summer periods there was high increase in flight delay and cancellation as a result of poor visibility. The trend line for monthly delay shows a downward trend of flight delay with a negative trend line of Y= -0.094x + 10.69. the seasonal peak of flight cancellation in the annual trend was in 2003 with a total of 108 cancelled flights, while that of the monthly trend was in the month of December with a total of 11 terminated flights. The seasonal peak for delayed flights was in 2002 with 171 flights, while Decembers has the highest peak period in delays with a record of 18 flights.

The annual trend of visibility shows a high rate of fluctuation, which is in favour of air transportation.

The result of rainfall trend, shows a negative trend line equation of Y= 1.440x + 130.4 which could be as a result of the location of the study area where rainfall is not usually heavy for a long time of the day. In contrast, the monthly trend shows a positive trend line equation of Y= 7.64320x + 69.08.

Cloud cover had the highest impact on flight operations in the study. There was an increase in the annual trend of cloud cover and the monthly trend shows high impact of cloud cover on flight operations in March, May, July, August and October. The trend line shows a slight positive rise in trend equation with equation Y= 0.402x + 209.2.

Despite the fact that monthly wind speed did not affect flight operation, the trend shows a gradual rise from 2010 to 2014 and this has the potential for affecting fight operations in the study area.

5. Recommendations

Reliable and well equipped weather station with precise prediction of weather elements should be established not only in airports, but also in strategic location across the country to enable the spatial analysis of weather records across air routes.

More accurate ways of weather information should be emphasized through the training and retraining of aviation personnel.

REFERENCES

[1] Abass. I.I., Ojo, K.J. and Igbru P.A. (2012). The impacts of extreme weather climate and events on aviation. *Environment, Ecology and Management 1*(1), 12.

[2] Accident Investigation Bureau. (2014). *Reports of aviation accidents in Nigeria.* Retrieved October 10, 2015 from http://www.aib.org.

[3] Mirza, A.K., Page, C., and Geinde, S. (2009). An approach to flight safety using GML/XML objects to define hazardous volumes of aviation space. *13th American Metrological Society Conference on Aviation Range and Aerospace.*

[4] Kulesa, G. (2002). Weather and aviation: How does weather affect the safety and operations of airports and aviation and how does FAA work to manage weather related effects? The potential impacts of climate change on transportation: *Workshop summary and proceedings. US Department of Transportation, Centre for climate change and environmental forecasting.* Retrieved from http:climate.dot.gov/do...ts/workshop1002/kulesa.pdf.

[5] Ayoade, J.O. (2004a). *Climate change: A synopsis of its nature, causes, effects and management.* Ibadan: Vantage Publishers.

[6] Accident Investigation Bureau. (2011). *Reports of aviation accidents in Nigeria.* Retrieved June 8, 2013 from http://www.aib.org.

[7] Schaefer, L. and Millner, D. (2001). Flight delay propagation analysis with the detailed policy assessment tool. *In systems, man and cybernetics. Institute of Electrical and Electronics Engineers, 2,* 1229-1303.

[8] Rodenhuis, D. (2004). Adverse weather and air traffic delays.*11th Conference on Aviation Range and aerospace.* Retrieved November 3, 2012 from http://ams.confex.com/amspdfpapers/81939.pdf.

[9] Nigerian Aeronautical Information Publication (NAIP). (2013). *Part 3 aerodromes (AD). AD2-dnaa-1*. Nigerian Airspace Management Agency.

[10] Abomeh, O.S. (2013). Assessment of leadership styles among hospitality business in Abuja. Arabian Journal of business and management, *2*(6), 43-57.

[11] Ujoh, F., Kwabe, I.D., and Ifatimehin, O.O. (2010). Understanding urban sprawl in the Federal Capital City, Abuja: Towards sustainable urbanization in Nigeria. *Journal of Geography and Regional Planning*, *3*(5), 106-113.

[12] Balogun, O. (2001). *The federal capital territory of Nigeria: A geography of its development.* University press Ibadan.

[13] Jibril, U. (2006). Resettlement issues, squatter settlements and problems of land administration in Nigeria's federal capital, Abuja. *In the proceedings of the 5th FIG Regional Conference, Accra, Ghana.*

[14] Adama, O. (2007). Governing from above: Solid waste management in Nigerians new capital city of Abuja. Ph.D. thesis, Stockholm University, Sweden.

[15] Suleiman, L.I. (2012). An analysis of air transportation in Nigeria. Journal of research in National development, 10(2), 5.

[16] Enete, I.C., Ajator, U. and Nwoko K.C. (2015). Impacts of thunderstorm on flight operation in Port Harcourt international airport Omagwa Rivers State. *International journal of weather, climate change and conservation research, 1(1)*. 1-10.