COMPARISON OF PRECIPITATION CHARACTERISTICS IN WARRI AND PORT HARCOURT METROPOLITAN AREAS OF NIGERIA

By

Sunday Ighovie EFE, Ph.D
Department of Geography and Regional Planning
Delta State University Nigeria
efesundayighovie@gmail.com

Abstract

The study compares the precipitation amount in the Warri and Port Harcourt metropolitan areas of Nigeria. To do this, the study adopted a field survey of the two cities where precipitation data were obtained from the archive of the Nigerian Meteorological Agency from 1953-2014, and rain gauges were placed in the six existing land use types in these metropolitan areas for 2015. Precipitation data were obtained from the various landuses in these areas. The data were presented with statistical diagrams and analyzed with paired t test. The results of the study showed high and heavy precipitation amount with annual precipitation of 2360mm in Port Harcourt; and 3125mm in Warri, and these indicate that precipitation in Warri metropolis were generally higher than those of Port Harcourt metropolis. The study also revealed 33% and 20% urban influence on the precipitation of the built-up areas than those of the surrounding rural areas of Warri and Port Harcourt metropolitan areas of Nigeria. This is ascribed by the increased in the socio-economic activities (SEA) and anthropogenic activities of the residents of Warri over that of Port Harcourt. The increased precipitation in these cities has triggers adverse environmental and socio-economic effects on the residents and government of Nigeria, as such individual, private organizations and government should plan with the precipitation characteristics as they carried out their routine activities annually.

Keywords: Precipitation, Urban Areas, Nigeria

Introduction

Over the years it has been established that urban environment has impact on its precipitation (see Jauregui and Romales, 1996 in Mexico City; Dixon and Mote, 2003, Burian and Shepherd, 2005 in Houston; Seino and Aoyagi, 2009 in Tokyo, Efe and Eyefia, 2014 in Benin city; Efe, 2013 in Warri metropolis). These studies revealed increased precipitation in cities than their countryside with an increase of 5-10% in precipitation amount and stressed that urban induced precipitation studies are hindered by inadequate scientific data, limited archival data which are occasioned by insufficient data to establish urban induced precipitation, and large capital outlay required for instrument procurement. This has led to the dearth of data in most Africa cities, and they call for periodic studies to evaluate the urban influence on precipitation, and if possible comparison studies amongst cities should be encouraged (Burian and Shepherd, 2005 and Efe 2013).

On the other hand while there are volumes of similar studies in developed countries, only few studies could be identified in Africa urban environment, which according to Ayoade (2008) and Efe (2013) is attributed to the inadequate capital required for modern instruments. Based on the calls and problems, the only attempt made in Nigeria were those of Efe (2013) and Efe and Eyefia (2014) in the cities of Warri and Benin City respectively to the neglect of comparative study of urban induced precipitation in Nigeria. Therefore this study is aimed at a comparison of urban effects on precipitation in Port Harcourt and Warri

metropolitan areas of Nigeria.

Warri and Port Harcourt metropolitan areas are oil rich cities of the Niger Delta region of Nigeria, with low lying terrain, and in most cases the relief span 0-10m above sea level. This has encouraged the occurrence of tropical equatorial and rainforest climate, and these cities experiences rain throughout the year of above 2250mm that result in flood hazard, acid rain etc, and temperature that span 27-30^{0}C. There are lot of oil companies, iron and steel company, agro allied industry, glass factory, government establishments, and private organizations in these cities. Added to this, is the areal expansion of these cities occasioned by increased population and socio-economic activities. These activities are drivers of the urban climate characteristics experienced in these areas (urban warming and increased precipitation). However in Port Harcourt and Warri metropolitan areas of Nigeria, the residents are not only face to face with the urban warming, but also with torrential downpour which results in per annual flood hazard in these coastal cities between May to September. For examples, heavy precipitation usually manifested in flood hazards at Choba, Alakayia, Aba express way, Trans Amadi, Waterlines, Garrison, Rumokoro, East West road etc in Port Harcourt and Ugborikoko, Jakpa road, Okumagba layout, Enerhen road, Mabiaku road, GRA, Ekpan, , Enerhen etc in Warri. Whenever it occurs, it paralyse socio-economic activities, examples of this is the 2012 flood disaster in the areas (Aderogba, 2012 and Elenwo and Efe, 2014). Based on the above premise, this study compares the urban effects on the precipitation of Warri and Port Harcourt metropolitan areas of Nigeria and to outlines the environmental and socio-economic impact in these areas.

Methods of Data Collection

The study adopted a field survey of Warri and Port Harcourt metropolitan areas, where precipitation data were extracted from the archive of the Nigerian Meteorological Agency from 1953-2014 based on consistencies, reliability and continuity of data. This period also corroborated those of Efe 2013 in these areas. Precipitation data were also collected from the six existing landuse types (Industrial areas, High density residential areas, Medium density residential areas, Low density residential areas, Commercial areas and Parks/Tourism areas) within the urban canopy and another in the surrounding rural areas, in Warri and Port Harcourt in 2015, as recommended by Huff and Changnon (1972) in St Lious; and Efe and Eyefia (2014) in their urban precipitation study of Benin city, Nigeria. This is done with the aid of rain gauges placed in these landuse types in line with Efe (2013) methods of precipitation observation in the areas. The data were presented in statistical diagrams and subjected to paired t-test analysis for the purpose of comparing the precipitation distribution in Warri and Port Harcourt metropolitan areas. The linear trend analysis was used for the annual precipitation trend lines, while the Polynomial trend analysis was adopted in establishing the monthly precipitation trend lines in the areas during this period in line with those of Efe (2013) and Efe and Weli (2015).

Results and Discussion

Precipitation in these metropolitan areas is generally high and heavy with mean annual precipitation of 2360mm for Port Harcourt; and 3125mm for Warri metropolis. This showed a difference of 765mm and thus indicates that precipitation in Warri were generally higher than those of Port Harcourt (see fig 1). From fig 1, there is a general fluctuating pattern in precipitation in Port Harcourt and Warri metropolitan areas. For instance the decadal precipitation distribution in Port Harcourt showed the wettest period 1963-1972 (2503mm) and the driest period 1983-1992 (2220mm). And in Warri, 2003-2014 with precipitation amount of 3456mm had the wettest years, and the driest period is 1963-1972 with precipitation amount of 2882mm (see fig 1). This result corroborated those of Cicek and Turkoglu (2005) in Ankara, Efe (2013), Efe and Weli (2014) in these cities. Precipitation in Warri were 25% higher than those of Port Harcourt metropolis as seen in fig 1, and confirmed by the t value of 11.93 (see table 2), which is higher than the critical table value of 2.00, indicating that significant difference exist in the precipitation distribution in Warri and Port Harcourt Metropolitan areas.

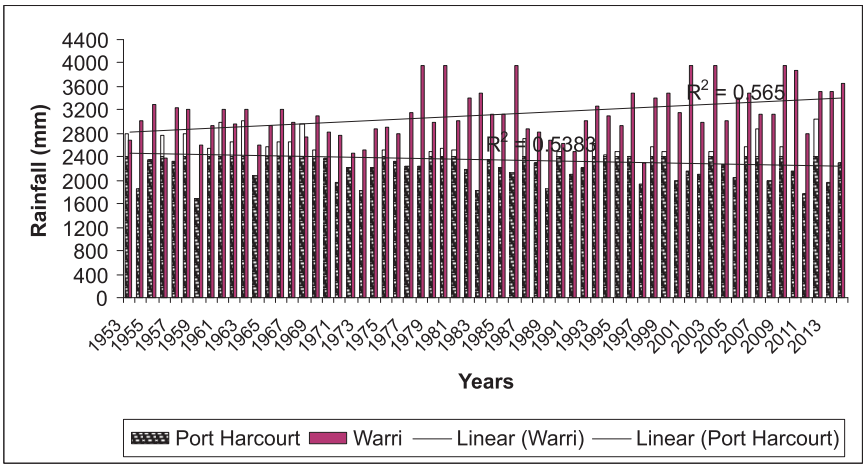

Fig. 1: Annual Precipitation Distribution

Table 1: Paired t-test

	Paired Differences					T	Df/Table value	Remark
	Mean	STD dev	Std Error	95% Confidence interval				
				Lower	Upper			
Port Harcourt and Warri	764.56	504.59	64.08	892.7	636.42	11.931	61 2	Sign Diff Exist

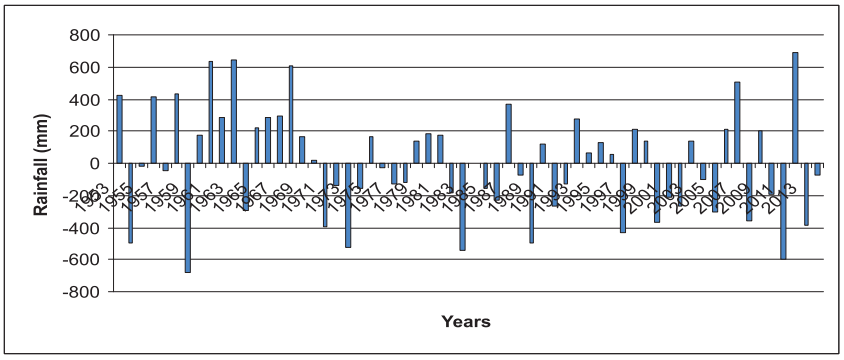

Fig 2: Precipitation Anomaly (1953-2014) in Port Harcourt

Fig 2 showed precipitation anomaly in Port Harcourt, with fluctuating pattern. However 1953-1970) had a general increase in precipitation above the mean 2360mm for the past sixty two years with few years (1954,1955,1957, 1959, 1964) of precipitation decrease below the 3360mm average. While 1971-1974 showed a general recession in precipitation, 1975-2014 revealed a fluctuating pattern. This corroborated those of Efe and Weli (2015), who ascribed these patterns to presence of gas flaring at the Eleme refinery and anthropogenic activities of the residents. The pattern in Port Harcourt is quite different from those that occurred in Warri with four distinct epochs (see fig 3)

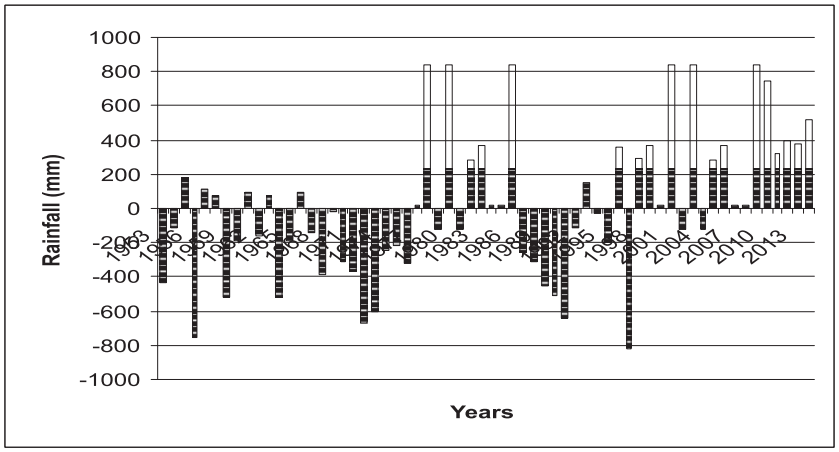

Fig 3: Precipitation Anomaly (1953-2014) in Warri

Fig. 3 showed four epochs. The first epoch (1953-1977) and the third epoch (1987-1997) had a general decrease in precipitation below the 3125mm mean precipitation recorded in Warri for the past sixty two years, but with few years (195-1958, 1961, 1966 etc) of precipitation values above the normal. The second epoch (1977-1986) had a general increase in precipitation above the sixty two years mean of 3125mm with few years of precipitation recession. However the fourth epoch (1998-2014) had a general precipitation increase. These corroborated Efe (2013) on the precipitation of Warri. The pattern are precipitated by the increased in anthropogenic activities and closeness to river Warri (Efe, 2011, 2013).

Looking at the various land use types, the industrial areas had the highest precipitation amount of 3324mm and 2875mm for Warri and Port Harcourt respectively, and natural parks recorded 2067mm and 2066mm at Warri and Port Harcourt respectively (see fig 4). Precipitation generally decreases from the built-up areas with the highest anthropogenic activities to the parks and the rural areas where the lowest precipitation amount 2049mm and 2026mm for Warri and Port Harcourt respectively were recorded. A decrease of 685mm and 405mm in precipitation amount in Warri and Port Harcourt were observed between the urban canopy and the countryside of Warri and Port Harcourt, an indication of 33% and 20% urban influence on precipitation amount in these cities.

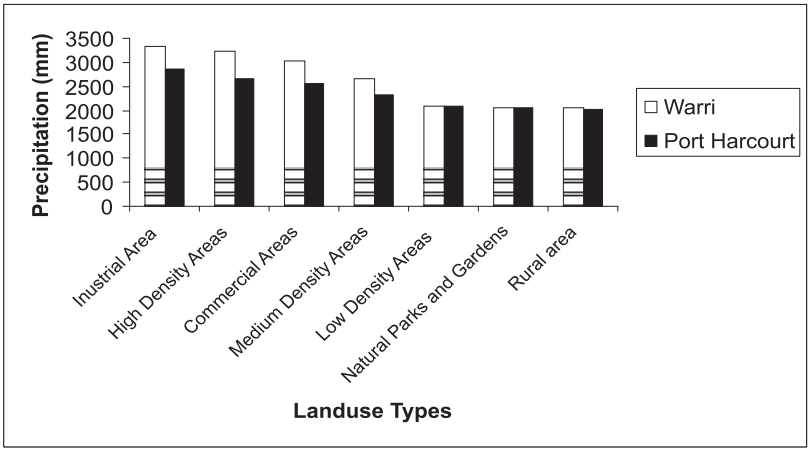

Fig. 4: Mean Annual Precipitation Distribution (mm) in the Various Landuses

Table 2: Seasonal variation of Precipitation

Cities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Warri	39	181	193	358	460	596	669	292	688	523	98	69
Port Harcourt	35	78	129	168	285	325	344	287	468	230	92	30
Differences	4	103	64	190	175	271	20	5	220	293	6	39

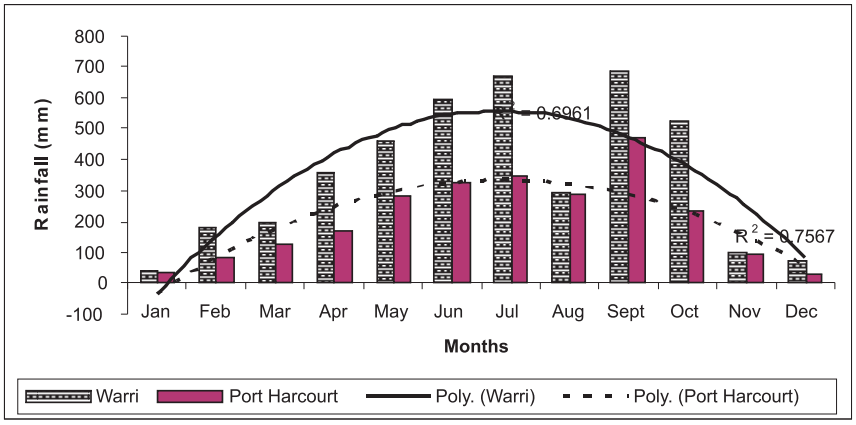

Fig. 5: Monthly Precipitation Distribution

From table 2 and fig. 5, there is the occurrence of precipitation from January to December throughout the period. Seasonal precipitation spans 39mm and 35mm in January to 688mm and 46mm in September in Warri and Port Harcourt metropolitan areas respectively, with September being the month with peak precipitation in both cities. Though precipitation in Warri were generally higher than those of Port Harcourt, but precipitation in the two cities showed double rain maxima which is a characteristics of tropical equatorial climate. The polynomial trend analysis showed correlation values of 0.76 for Port Harcourt and 0.70 for Warri, indicating that precipitation correlated strongly with the months. Thus precipitation in these cities, follow the normal distribution pattern of tropical equatorial climate of Koppen (Efe, 2006). The annual and seasonal pattern of precipitation distribution in Port Harcourt and Warri certainly had some implication on the environment and Socio Economic Activities (SEA) of the people, this is discussed below.

Environmental and Sea Effects of Precipitation

According to Efe (2013), Elenwo and Efe (2014) and Efe and Weli (2015) Over the years, precipitation has affected the ecology and economy of Port Harcourt and Warri in the following ways:

First, ecologically the heavy rain amount and it seasonal distribution has resulted in flooding of Port Harcourt and Warri metropolitan areas and their countryside's (See Efe, 2007 and Efe and Weli, 2015). Also river Warri and Bonny that drain Warri and Port Harcourt respectively often overflow their banks in the months of July and September yearly, as such resulting in wide spread inundation of these cities. (see Aderogba, 2012, Elenwo and Efe,

2014). For instance soon after every precipitation in the months of June -September most of the urban-rural areas (streets and roads) of Port Harcourt and Warri are often heavily inundated with flood pondages in untarred streets, and as such result in huge economic loss, and also cause serious traffic jam and amongst others. This came to climax in 2007, 2012 with colossal economic loss in these areas.(see Efe, 2011, Elenwo and Efe, 2014). Second, it has resulted in acid precipitation in the areas and its destruction of farmlands, reduction in fish caught and quality of water sources, despoliation of sculpture and building etc (Efe and Mogborukor, 2012.). Third road side erosion and soil erosion are also evident in the metropolitan areas (Efe, 2013).

In terms of the SEA of the people, it has encouraged the growth of tree crops (rubber, Palm tree, Orange, Coconut, Pea, and Plantain etc). Also since there is rain all year around, it has encouraged all season farming. For instance in these areas, there is all year planting of Casava, Okro are planted in August. Also fish farming is being heavily practiced by the residents of the riverside communities.

Precipitation has also has resulted in lateness and occasional absenteeism from schools and work. Others are damage to crop and market wares, by force harvest as result of flooding leading to food insecurity, reduced participation in recreation and tourism in the months of July and September when the rains are heaviest (Efe and Weli, 2015). During this month, there is frequent road failure resulting in pot holes; and thus causes road traffic accident. This is evident along Warri-Port Harcourt dual carriage road, Aba road, East West road, Trans Amadi, Garrison, Alakayia areas etc in Port Harcourt. And Nigeria Port Authority road, Effurun round about, Avenue/Okumagba layout, Jakpa, Aiport and Enerhen junctions, Upper and Lower Eredjuwa etc in Warri.

Precipitation also causes delay in river transportation because of the open speed boat that is used in river transport in these areas. Also it has resulted in the hike in price of rain boot, rain coat, rubber shoes, umbrella etc, and a fall in the price of vegetables, yam, and sweet potatoes because of by force harvest during the peak period of precipitation (Efe and Weli, 2015). On the above premise, it is therefore recommended that urban planning with the incorporation of the urban precipitation characteristics should be encouraged in these cities. Periodic impact assessment of urban dwellers effects on the climate should be carried by the government and private establishments in these areas.

Conclusion

The study revealed urban effects on precipitation amount with 33% and 20% increase in precipitation between the built-up areas and the countryside of Warri and Port Harcourt metropolitan areas of Nigeria. However, this study also revealed that precipitation is generally high and heavy with mean annual precipitation of 2360mm for Port Harcourt; and 3125mm for Warri, and this showed a difference of 765mm in precipitation amount in Warri and Port Harcourt, and thus indicates that precipitation in Warri were generally higher than those of Port Harcourt. This is ascribed to the

increased in the SEA of the people and anthropogenic activities of Warri over that of Port Harcourt. The increased precipitation has precipitated negative environmental and socio-economic impact on the residents and government of these cities. Hence incorporation of precipitation characteristics into the urban planning processes in these areas is recommended.

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