Open Journal of Social Sciences, 2015, 3, 57-68
Published Online March 2015 in SciRes. http://www.scirp.org/journal/jss
http://dx.doi.org/10.4236/jss.2015.33012

Economic Impact of Climate Change in Port Harcourt, Nigeria

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Received 20 January 2015; accepted 2 March 2015; published 6 March 2015

Abstract

The study examines the economic impact of climate change. This is done through a field survey design which involves survey of marketers in Port Harcourt with the aid of archival data from Port Harcourt. Climate data were collected from the archives of Nigeria Meteorological Agency from 1950 to 2015 based on the availability of data. And data on prices and quantity of umbrella, cement, ice cream, cream, palm oil, rubber sander, cold sachet water sold, etc. were extracted from the traders' dairies from 2004 to 2014. The data collected were presented in tables and descriptive diagrams, and analyzed with the multiple regression analysis; this was done to determine the effect of rainfall and temperature on prices of goods in the city. The results revealed an evidence of climate change in Port Harcourt with an increase of 1581 mm and 3˚C for rainfall and temperature, and double rain maxima in the months of July and September. It also confirms the concept of eco-no-climate by establishing strong correlation between rainfall and temperature and price of goods demanded and supplied. The price and the quantity of goods demanded and supplied are significantly dependent on the amount of rainfall and temperature in the area, and as such the quantity of goods demanded and supplied negates the law of demand and supply which states that the higher the price, the higher the quantity supplied in the area. On this premise planners at the federal, state and local government levels are advised to incorporate climate mitigation and adaptation strategies in urban renewer and planning to avoid unforeseen climate disasters in our urban areas.

Keywords

Climate Change, Economic Impact, Goods, Urban Planning, Port Harcourt

1. Introduction

Climate change and variability affect countries' economies and households through a variety of channels [1].

How to cite this paper: Efe, S.I. and Weli, V.E. (2015) Economic Impact of Climate Change in Port Harcourt, Nigeria. *Open Journal of Social Sciences*, **3**, 57-68. http://dx.doi.org/10.4236/jss.2015.33012

Rising temperatures and changes in rainfall patterns affect agricultural yields of both rainfed and irrigated crops. The unchecked rise of sea levels leads to the loss of land, landscape, and infrastructure. A higher frequency of droughts will change hydropower production, and an increase in floods can significantly increase the need for public investment in physical infrastructure [2]-[4]. These sector-level impacts will in turn affect other sectors and thus economic growth and household incomes. Depending on countries' natural conditions and economic structure, climate change affects countries differently. For example, countries that depend on rainfed agriculture, such as many in sub-Saharan Africa, are more vulnerable to an increase in climate variability, with projected large losses in their national output [5]. Countries with large delta regions, such as Vietnam, are projected to be hardest hit by rising sea levels, with strong implications for food security and the rural poor [6]. Countries that are already experiencing water stress, especially those in the Middle East and North Africa, are likely to experience additional declines in agricultural yields, resulting in negative effects on rural incomes and food security [7]. Climate change may also exacerbate climate variability and reduce agricultural production and incomes in countries that depend on annual floods such as Bangladesh or in drought-prone countries such as many in the Middle East [7] [8].

Adding up these country level effects from climate change is likely to have impacts on the global economy through changes in global supply, trade flows and commodity prices. Depending on the net importing or exporting position of countries and the net producing and consuming status of households of specific commodities affected, countries and households are likely to be affected differently by climate change. [9] [10] projected that global food prices will increase as a consequence of continued high global population growth, changing food consumption patterns, and climate change. Furthermore, continued high economic growth rates in emerging economies are likely to increase future energy costs [11]. In addition to rising energy demand, climate change mitigation policies may significantly raise energy costs, with potentially strong economic implications for developing countries [12]. For example, the Energy Information Administration (EIA) projects that oil prices may rise to US$200 a barrel under its high-price scenario. Taking higher food and energy prices into consideration is therefore important for any climate change impact assessment at the country level. Yet, although the potentially significant impacts on world commodity price changes from climate change induced, existing country-level economic impact assessments have largely neglected this global dimension. To address this gap in the literature, this paper assesses the local economic impacts of climate change in the sub-humid tropical Niger delta city of Port Harcourt. Port Harcourt is an important case study given the city's location in a region that is consistently projected to be amongst the hardest hit by climate change.

2. Conceptual Issues and Methods of Data Collection

This study adopted the concept of econo-climate in explaining the economic impact of climate change. According to [13] [14] econo-climate is the economic or socioeconomic analysis of weather in an area. And this has been applied in managing the social and economic outcomes that are weather sensitive in most cities of the world [15]. Econo-climate can be use satisfactorily to resolve the following: Firstly the determination of weather attributes required by a given economic activity; their amount, frequency, and timing; Second is the assessment of the cost of economic variations arising from weather hazards in a given economic activity; and thirdly development of methods of measuring the impact of weather variation through the economic system [16]. This later aspect formed the focus of the study. The World Meteorological Organization (WMO) has stressed on the important to emphasize that information on impact of climate vagary on man's activities. Upon the above premise, the concept of econo-climate is vital to this study because it helps to understand the effect of the rainfall, temperature on the economy of Port Harcourt.

The study employs the field survey design that involves survey of traders in Port Harcourt through the use of archival data from Port Harcourt. Climate data were collected from the archives of Nigeria Meteorological Agency from 1950-2015 based on the availability of data. And data on prices of some goods (umbrella, Cement, Ice cream, Cream and Palm oil, rubber sander, cold sachet water etc were extracted from the traders' dairies from 2004-2014. These goods were selected based on the marketer's view that they are the most weather sensitive goods in the area. And the choice of 2004-2014 years is based on availability of data in the marketers dairies, continuity and consistency of records. Therefore the quantity and price of Coca Cola, baby pears, umbrella, sachet water, cement, ice cream, cream and palm oil etc. were collected and used for the study. The metropolis was stratified into 5 zones (A Ikwerre road, Afam street, B Olu-Obasanjo road, Port Horcourt Aba Express road,

C Old Aba road, Choba/Elekahia road, D East West road, and E Trans Amadi) (see **Figure 1**). A trader in each of these zones with consistent documentation of sales records in dairy were selected and used for the study.

Data collected were summarized in tables and descriptive diagrams and multiple regression analysis was used to determine the effect of rainfall and temperature on prices of sachet water, baby pear umbrella, cement, ice bock, cream and palm oil etc.

3. Results and Discussion

The climate characteristics, quantity and price of goods sold in Port Harcourt are discussed in this section.

3.1. Climate Characteristics

Figure 2 showed mean annual pattern of rainfall and temperature in Port Harcourt from 1950-2015. Port Harcourt had an annual mean rainfall of 2375 mm that spans 1475 mm in 1951 to 3056 mm in 2012. This showed an increase of 1581 mm over the years. The polynomial trendline show an increase in rainfall over the years, with 0.61 R^2 value and shows an increase of 1581 mm from 1950-2015. Similarly Port Harcourt has experienced a rise of 3˚C in temperature (25˚C - 28˚C) from 1950 -2015, with 27.2˚C mean annual temperature distribution. The temperature polynomial trend line showed a rise in temperature with R^2 value of 0.15. The flow pattern of rainfall and temperature followed an inverse pattern, indicating that temperature decreases with an increase in rainfall in the area. This corroborated [17]-[19]. From **Figure 2**, the normal period of rainfall showed a u-shape, indicating a decrease in rainfall from 2693 mm (1950-1979) to 2316 mm (1980-2009), thereafter a rise to 2670 mm in 2010-2015, this showed that while 1950-1979 and 2010 till date are wetter epoch, 1980-2009 is the driest periods. This is an evidence of climate change in Port Harcourt with R value of 1, and the polynomial trend line revealed that increase in rainfall correlated perfectly with increase in years. On the other hand from **Figure 3**,

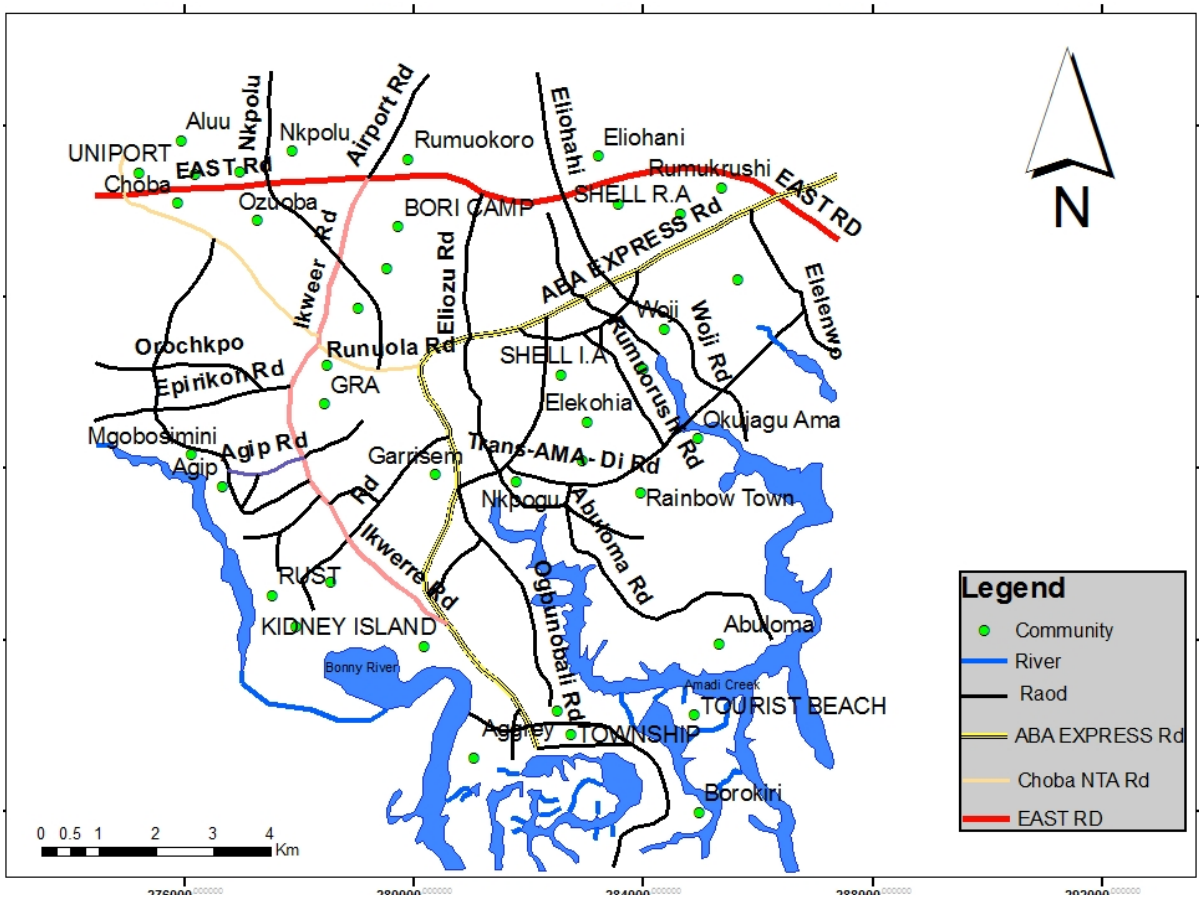


Figure 1. Port Harcourt region.

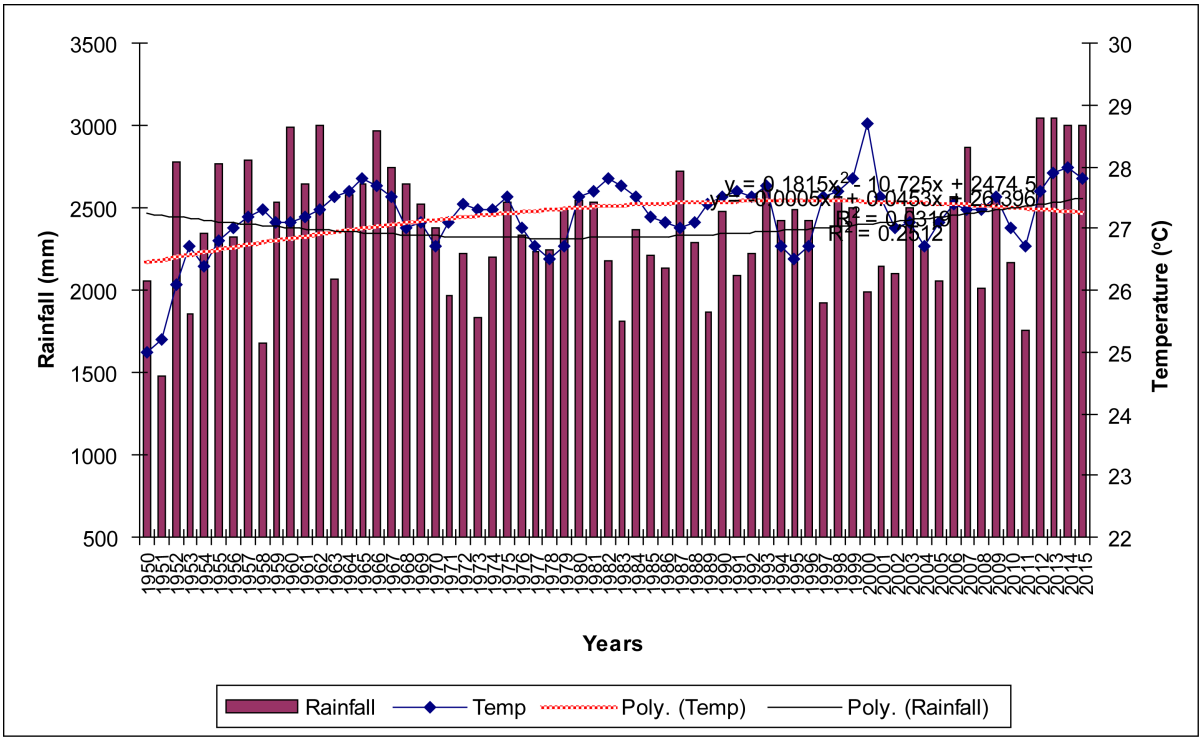


Figure 2. Annual pattern of rainfall and temperature in Port Harcourt 1950-2015.

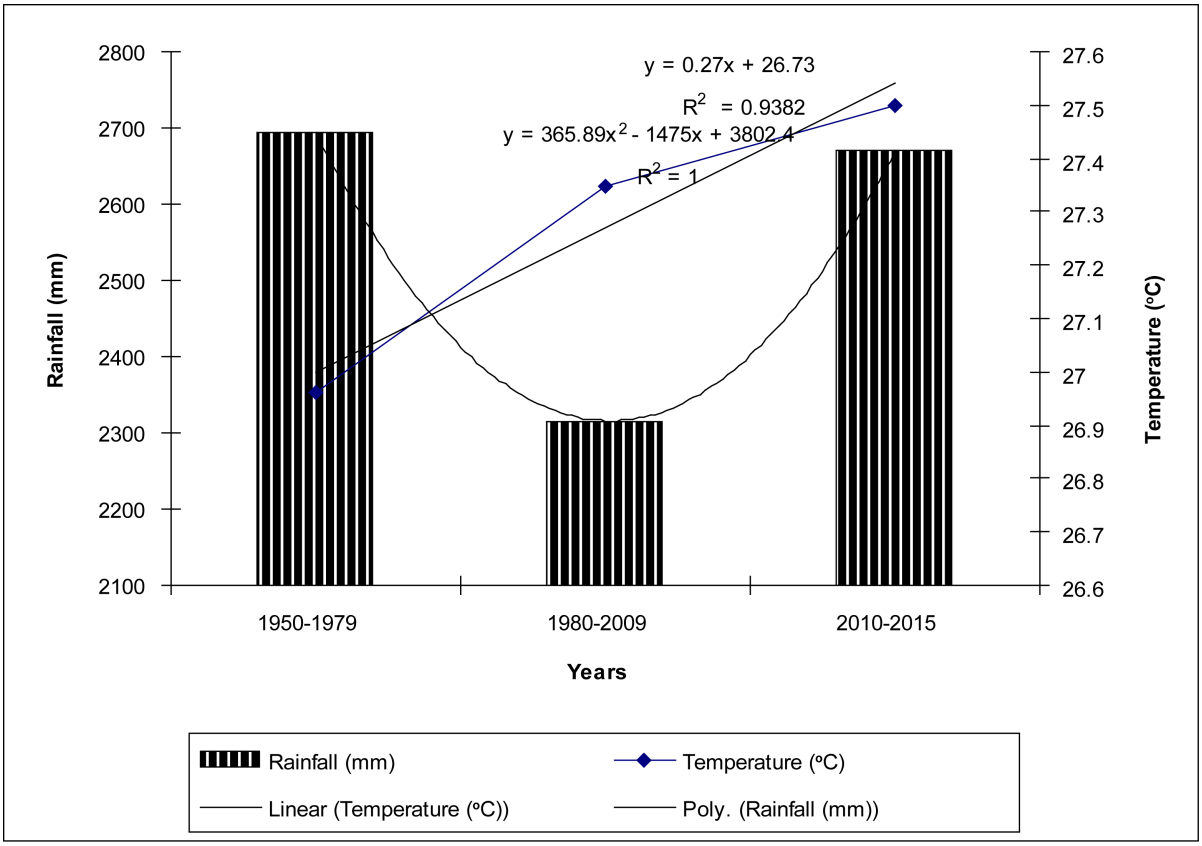


Figure 3. Rainfall normal (30 years intervals).

there is a gradual rise in temperature from 1950-2015; this is evident with temperature values of 26.9˚C, 27.4˚C and 27.5˚C for three epochs (1950-1979, 1980-2009 and 2010-2015). And the linear trend line showed that a rise temperature correlated strongly with increase in years with R value of 0.94. This trend pattern of rainfall and temperature is an evidence of climate change in Port Harcourt. This is confirmed with a decrease of 377 mm in rainfall from the first epoch (1950-1979), and an increase of 354 mm from the second epoch (1980-2009) to the last epoch (2010-2015). This has triggered flood hazards in the area. Temperature on the other hand had a rise of 0.5˚C from the first epoch (1950-1979) to the second epoch (1980-2009), and a rise of 0.1˚C from the second epoch to the third epoch (2010-2015).

Table 1 the decadal rainfall pattern, which revealed that the period 1950-1959 and 1960-1969 had an increase in rainfall with 209.4 mm and 421.3 mm respectively, thereafter there is a decrease of 438.3 mm from 1970-1979. Nevertheless, 1980-1989 and 1990-1999 also recorded wetter periods of 19.6 mm to 112.9 mm rainfall, and a decrease of 70.3 m was recorded from 2000-2009. And the period 2010-2015 had an increase of 363.7 mm which often exacerbate ecological hazards in the area. The polynomial trend line of rainfall anomalies showed a clearer trend pattern of gradual decrease from 1950-1985, thereafter there a gradual increase in rainfall till date (see **Figure 4**), indicating a change in the rainfall sequence of Port Harcourt for the period 1950 till date, and this is a prove of climate change.

From **Table 1** and **Figure 5** the temperature pattern showed 2 epochs of 27.4˚C, and 27.5˚C for 1950-1969, 1980-1989, 2000-2009 and 2010 till date. This period had a temperature rise of 0.9˚C, 0.4˚C, 0.05˚C and 0.14˚C respectively, indicating a change in temperature. From **Figure 4**, the linear trend line of temperature anomalies showed a gradual rise in temperature from 1955 till date which showed that Port Harcourt is warmer in the last two decades than the previous years. However the first decade is cooler than other decades.

Table 2 revealed the monthly distribution of rainfall and temperature in Port Harcourt. Rainfall had 196 mm mean monthly distribution that spans 28 mm in January to 368 mm in September, indicating a monthly increase of 340 mm. July and September had double rain maxima in Port Harcourt (359 and 368 respectively) which confirmed the climate characteristics of tropical equatorial climate of Koppen [20] (see **Figure 5**). Temperature on the other hand, had 27.1˚C monthly mean temperature distribution, and span 26˚C to 28.6˚C, indicating an increase of 1.5˚C in temperature.

Table 1. Decadal distribution of rainfall and temperature.

Climate Elements	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2015
Rainfall (mm)	2261.52	2682.83	2244.57	2264.12	2377	2306.67	2670.4
Departure (mm)	209.42	421.31	–438.26	19.55	112.88	–70.33	363.73
Temperature (˚C)	26.48	27.38	27.02	27.39	27.31	27.36	27.5
Departure(˚C)	1.48	0.9	–0.36	0.37	–0.08	0.05	0.14

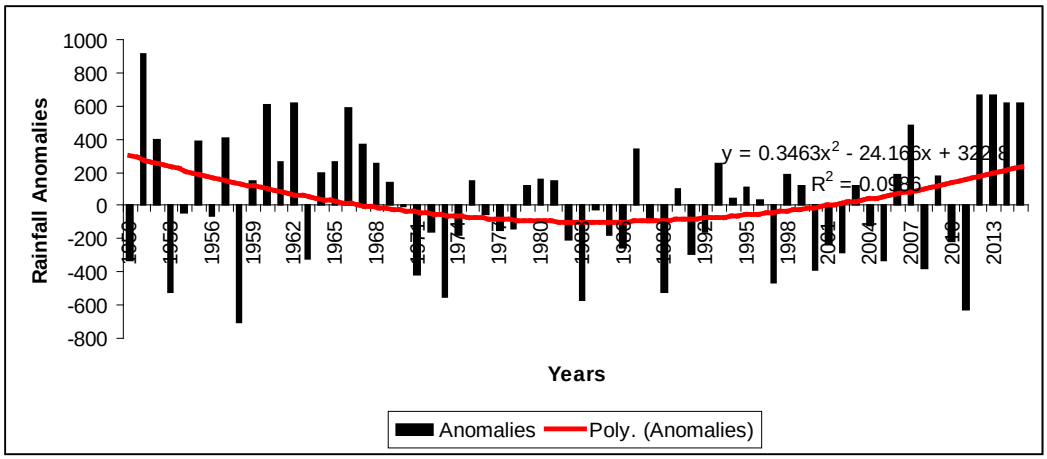


Figure 4. Rainfall anomalies 1950-2015.

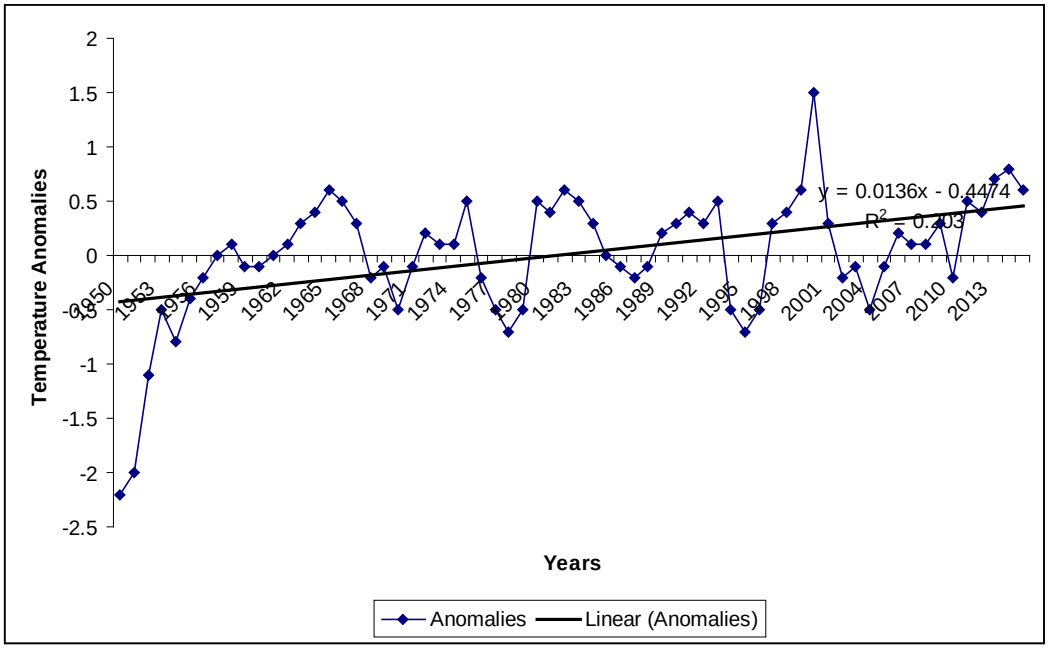


Figure 5. Temperature anomalies 1950-2015.

Table 2. Seasonal distribution of climate characteristics 1950-2012.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rainfall (mm)	28	64	130	174	255	273	359	306	368	268	100	30
Temp ˚C	27	27.4	28.6	28.3	27.6	26.8	26.1	26.2	26	26.7	27.1	27.2

There is double recession or fall in temperature in July (26.1˚C) and September (26˚C) (see **Figure 6**). This showed that monthly temperature decreases with increasing rainfall. However the linear trend line revealed a gradual rise in temperature from 1950 till date (see **Figure 6**).

3.2. Quantity and Price of Good Sold

The quantity of goods sold in Port Harcourt from 2004-214 is presented in **Table 3**. Generally the quantities of goods sold increase with increase in years. This could be ascribed to increase in the population of Port Harcourt being an oil city.

These quantities are: sachet water span 4181 - 5687 bags (2004) with a mean of 4675 bags, Palm oil recorded 1001 to 1670/per 20 litres (2004-2014) and a 1194/20litres mean value, Okra 718 baskets mean and it range from 550 - 980 baskets, cement had a 4754 bags mean value that ranges from 3480 - 6698 bags. Others are Coca Cola span 470 - 1098 with mean value of 738 bags; Umbrella had a mean of 722 that span 586 - 932; Rubber shoes recorded 276 mean and ranges from 201 - 420; Ice cream had a mean of 649/pe dozen and range 460 - 920/dozen; mentholator had 2106 mean value and varies from 1535 - 2610; and Baby Pears lotion/oil span 367 - 854 with a mean value of 519 (see **Table 3**).

Generally fro **Table 4**, the quantity of goods sold followed the climate of the area. For instance, generally the goods increased in months with lower rainfall with September being the month with lowest sales (110 bags) and January had the highest sales (630 bags), and there is double decrease in quantity of sachet water sold in July and Septembers over the years. Palm oil, cement and Coka Cola followed same pattern with sachet water of reduction in sales in the months of July and September. This showed that as rainfall increases/weather become cooler, the demand for sachet water, palm oil, cement, Coka Cola, ice cream, baby pears reduces. However the quantity of okra, umbrella, rubber shoes and rob/mentholator sold increased with increase in rainfall and low temperature, with double sales maxima July and September just like those of rainfall (see **Table 4** and **Figure 5**).

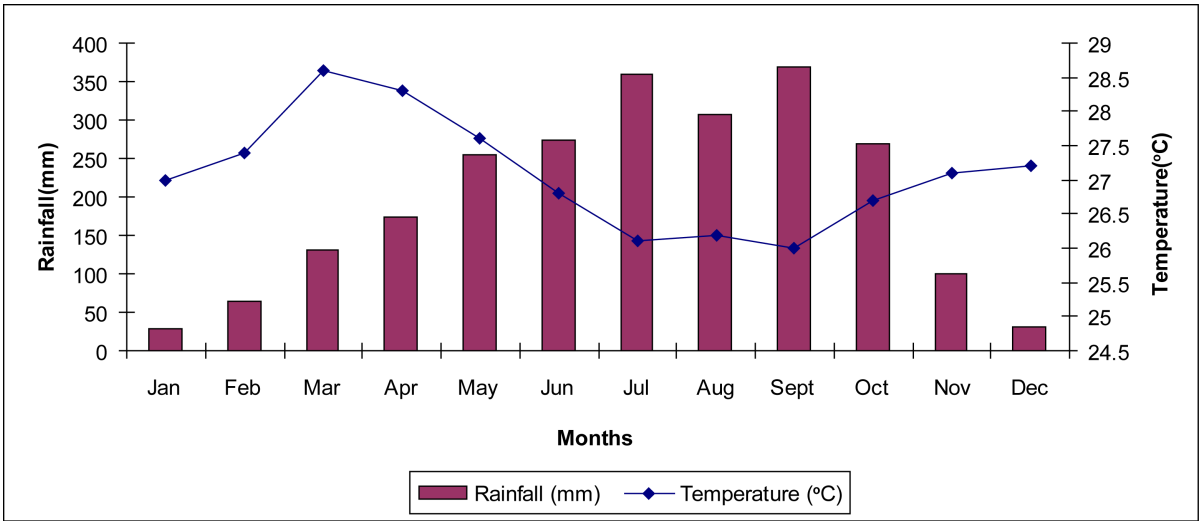


Figure 6. Mean monthly pattern of rainfall and temperature 1950-2012.

Table 3. Mean annual quantity of item sold per trader.

Months	Sarchet water/bag	Palm oil/ 20 litres	Okra/basket	Cement	Coca Cola/ creates	Umbrella	Rubber shoe	Ice cream/ pack of 12	Rob/ mentholator	Pears lotion
2004	4182	1001	550	3480	479	586	201	460	1535	367
2005	4198	1067	590	3500	502	590	205	495	1780	386
2006	4210	1088	603	3500	530	610	205	503	1956	403
2007	4256	1100	610	3689	560	638	203	540	2000	432
2008	4300	1100	630	3860	640	683	231	506	2002	450
2009	4367	1158	678	4021	692	705	275	584	2000	472
2010	4389	1164	705	4785	768	735	300	650	2140	498
2011	5056	1200	780	5758	852	766	310	720	2200	520
2012	5382	1270	850	6488	979	889	331	869	2356	579
2013	5400	1287	920	6510	1020	810	356	896	2589	751
2014	5687	1670	980	6698	1098	932	420	920	2610	854
Mean	4675	1191	718	4754	738	722	276	649	2106	519

Source: sales dairies of major dealers 2004-2014.

Table 4. Mean seasonal quantity of item sold per trader.

Months	Searchet water/bag	Palm oil/ 20 litres	Okra/ basket	Cement	Coca Cola/ creates	Umbrella	Rubber Shoe	Ice cream/ pack of 12	Rob/ mentholator	Pears lotion
Jan	660	120	32	750	93	12	15	84	220	67
Feb	630	120	58	620	86	15	17	90	165	65
March	630	116	68	730	82	18	20	87	165	50
April	560	109	74	674	79	20	27	88	156	47
May	535	93	74	600	71	58	30	75	168	40
June	320	88	78	262	60	63	35	73	180	33
July	156	87	100	85	55	130	50	32	260	32
Aug	386	90	95	120	67	106	42	58	245	39
Sept	110	82	100	67	50	185	56	30	265	29
Oct	367	110	54	682	85	65	16	76	167	37
Nov	420	125	33	830	98	45	13	87	175	66
Dec	608	130	34	858	152	15	10	89	200	69
Mean	5382	1270	800	6278	978	732	331	869	2366	574

Source: sales dairies of major dealers.

However, rob and mentholator sales is high in December and January because of harmatan season experienced. The increase in quantity of sachet water, rob/mentholator, palm oil and cement sold all through the year and season according to the inhabitants and the traders is due to the fact that these products used throughout the seasons of the year, be cold and warm season. This corroborated [16].

Table 5 showed the price of goods sold in Port Harcourt. Generally prices of all the goods increases over the years. The price of these goods increases as the quantity of these goods increases (see **Table 4** and **Table 5**). However the price changes with the season of the years (see **Table 6**). For instance the price of umbrella, rubber sander, pears oil and rob/mentholator increases with increase in rainfall, and falls with increase in temperature (see **Table 6** and **Figure 6**). On the other hand, the prices of cement, ice cream, cold sachet water, Okra and Coca Cola decreases with increase in rainfall, and rises with increase in temperature (see **Table 6** and **Figure 6**). These results corroborated those of [16] in the city of Warri.

Table 5. Prices of some goods in Port Harcourt.

Years	Oil palm	Okro	Corn	Cement	Umbrella	Sharp sand	Zinc	Nails	Coca-Cola drink
2004	2500	13,000	2700	1400	200	1500	7600	680	850
2005	2500	14,000	2500	1500	250	2000	7600	700	850
2006	3000	15,500	2800	1600	300	2000	7600	700	980
2007	3500	17,000	2800	1650	300	2000	7900	750	980
2008	4000	18,000	3000	1550	350	3500	8050	790	950
2009	6000	19,000	2800	1700	350	3500	8050	790	950
2010	7500	19,500	3000	1650	400	3000	8200	790	1000
2011	6000	20,000	3200	1750	400	3000	8300	900	1000
2012	6500	20,000	3500	1800	450	3000	8350	990	1000
2013	6500	20,000	7000	1850	500	3000	8300	835	1000
2014	6700	20,300	9000	1900	600	3200	8500	850	1050
2015	7200	21,000	10,000	2000	650	3700	8620	900	1050
Mean	5158	18,108	4358	1696	396	2783	8261	806	972

Table 6. Mean seasonal price of goods sold per trader (N).

Months	Searchet water/bag	Palm oil/ 20 litres	Okra/ basket	Cement	Coca Cola/ creates	Umbrella	Rubber sanderr	Ice cream/ pack of 12	Rob/ mentholator	Pears lotion/oil
Jan	120	4500	21,000	1850	1000	200	150	240	125	250
Feb	110	4500	21,100	1850	980	210	150	240	125	250
March	120	4800	14,500	1600	980	300	150	240	130	250
April	120	5500	15,500	1650	980	300	155	240	140	250
May	110	5700	17,000	1550	950	310	155	240	140	250
June	100	5700	17,500	1700	950	360	155	220	145	250
July	100	6650	190,00	1650	850	610	220	200	160	255
Aug	100	6500	19,500	1750	850	400	220	200	160	255
Sept	100	7400	14,500	1500	850	670	250	200	167	300
Oct	100	4550	20,000	1850	950	455	150	240	160	250
Nov	110	4600	21,800	1950	1000	269	160	240	150	250
Dec	120	4700	21,950	2000	1050	250	150	240	150	250
Mean	109.17	5425	18612.5	1741.67	949.17	361.17	172.08	228.33	146	255

Source: sales dairies of major dealers.

Tables 7-10 showed the results of the regression analyses performed to establish the effects of rainfall and temperature on goods in Port Harcourt. **Table 7** revealed 0.996 correlation value that rainfall had on the prices of Cement, Ice cream, cold sachet water, okra, Coca Cola, umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator. This showed that rainfall contribute 99% to the market price of these goods in Port Harcourt. Their individual standardized beta coefficients in **Table 8**, indicate correlation coefficient values of 0.77, 0.72, 0.51, 0.66 and 0.67 respectively for umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator which showed that the prices of these goods increases with increase in rainfall. This confirmed the concept of econo-climate by establishing the above strong positive correlation between rainfall and temperature and price of goods demanded and supplied. The prices of cement, ice cream, cold sachet water, okra, and Coca Cola drinks had an inverse relationship (–0.51, –0.55, –0.63, –0.61 and –0.66 respectively for these items), which showed that as rainfall increases, there is a correspondence fall in prices of these items. However the t value 9.614 is significantly at $P < 0.05$ significant level (see **Table 8**). Based on this, the study revealed that the prices of cement, ice cream, cold sachet water, okra, Coca Cola, umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator were significantly dependent on rainfall amount experienced over the season and year.

From **Table 9**, correlation value that temperature had on the prices of cement, ice cream, cold sachet water, okra, Coca Cola, umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator is 0.99. And this indicates that temperature contributed 98% to the market price of goods in Port Harcourt. However, the

Table 7. Regression model summary of the relationship between rainfall and price of goods.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.996[a]	0992.000	0.896	7.42587

[a]Predictors: (constant), pears, sachet, okra, rob, palm oil, umbrella, Coca Cola, cement, ice cream, rubber sander.

Table 8. Standardize beta coefficients[a] explaining the effects of rainfall on price of goods.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	1485.951	154.565		9.614	0.066
	Sachet	–2.096	0.975	–0.652	–2.150	0.277
	Palm oil	0.046	0.014	0.664	3.209	0.192
	Okra	0.000	0.003	–0.609	0.145	0.909
	Cement	–0.164	0.093	–0.511	–1.776	0.326
	Coca Cola	–1.241	0.362	–0.659	–3.428	0.181
	Umbrella	0.140	0.057	0.769	2.442	0.247
	Rubber sander	–2.503	0.660	0.723	–3.791	0.164
	Ice cream	0.387	0.838	–0.554	0.462	0.725
	Rob	3.163	0.466	0.666	6.792	0.093
	Pears	–0.079	0.562	0.509	–0.140	0.911

[a]Dependent variable: rainfall.

Table 9. Regression model summary the relationship between temperature and price of goods.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.990[a]	0.980	0.777	0.38030

[a]Predictors: (constant), pears, sachet, okra, rob, palm oil, umbrella, Coca Cola, cement, ice cream, rubber sander.

Table 10. Standardize beta coefficients[(a)] explaining the effects of temperature on price of goods.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	24.902	7.916		3.146	0.196
	Sachet	0.001	0.050	0.510	0.017	0.989
	Palm oil	0.000	0.001	–0.499	–0.312	0.808
	Okra	0.000	0.000	0.686	–1.231	0.434
	Cement	–0.001	0.005	0.555	–0.165	0.896
	Coca cola	–3.60E–005	0.019	0.603	–0.002	0.999
	Umbrella	0.000	0.003	–0.584	0.154	0.903
	Rubber sander	0.010	0.034	0.464	0.308	0.810
	Ice cream	0.051	0.043	1.094	1.187	0.446
	Rob	0.006	0.024	–0.414	0.267	0.834
	Pears	–0.025	0.029	–0.444	–0.867	0.545

[(a)]Dependent variable: temp.

standardized beta coefficients in **Table 10**, revealed a correlation coefficient values of –0.58, –0.46, 0.44, –0.50, –0.41, respectively for umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator. This is an inverse relationship which showed that the prices of these goods reduce with increase in temperature. The prices of cement, ice cream, cold sachet water, okra, and Coca Cola drinks had an inverse relationship (0.55, 1.09, 0.50, 0.69 and 0.60 respectively for these items), which showed that as rainfall increases, there is a correspondence increase in prices of these items. However the t value 3.15 is significantly at $P < 0.05$ significant level (see **Table 10**). Based on this, the study revealed that the prices of cement, ice cream, cold sachet water, okra, Coca Cola, umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator were significantly dependent on temperature experienced over the season and year.

From **Figure 2**, the period 2010-2015 had an increase of 363.7 m which often exacerbate ecological hazards (flood, acid rain, soil erosion etc.) in the area [21] [22]. And one of such impact is the 2012 flood episode. From **Table 11**, before the inundation began, bag of garri is sold for N9000, and 128 bags of garri were demanded and supplied. But as rainfall increases, inundation level rise to cover most cassava farmlands in the rural area of Port Harcourt, as such quantity demanded increases with decrease in supply of garri to Port Harcourt. Thus demand outweigh supply, this is evident from only 70% and 28% bags of garri demanded that was supplied at the second and third months respectively. This confirmed the law of demand in economics. But the quantity supplied reduces as prices increases, and thus negate supply law in economics. But as prices of garri increases as a result of the flood, the quantity demanded also increases in defilement of the law of demand and supply. Thus prices are directionary proportionate to quantity demanded because the flood hazards has forced many inhabitants of the neighboring areas to relocate to join their relative and settlement camps in Port Harcourt. The price became expensive that most middle class residents can no longer afford it. This has exacerbated hunger and food insecurity in the area because it is only 45% of their demand that were met.

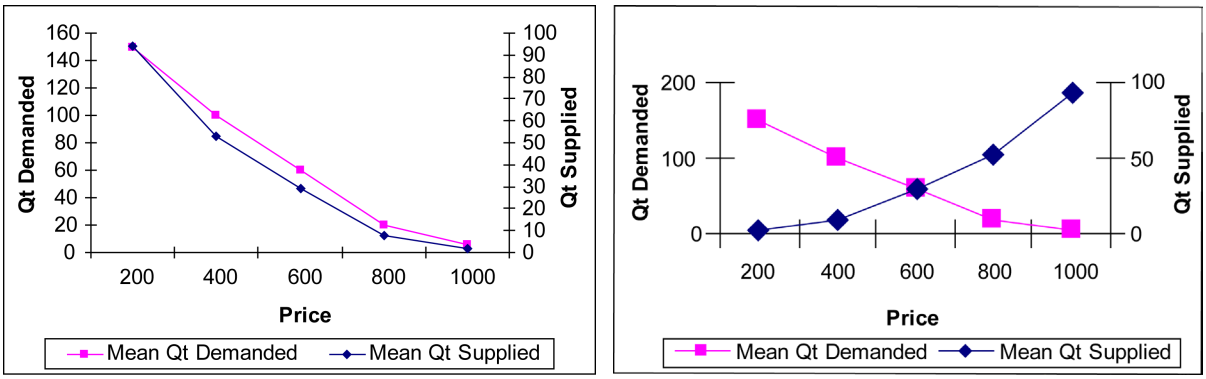
Table 12 revealed that the quantity demanded and supplied decreases with increase in price of fishes. For instance at N200, 150 and 63 fishes were demanded and supplied. And at N1000, 6 and 2 fishes were supplied. While the quantity of fishes demanded comply with the demand law in economics which states that the higher the price the lower the quantity demanded (see **Figure 7(a)** and **Figure 7(b)**), the quantity supplied is a negation from the law of demand and supply in economics, that states that the higher the price the higher the quantity supplied (see **Figure 7(a)** and **Figure 7(b)**). The abnormal supply curve is precipitated by increase in rainfall that occasioned high inundation level. This rose to overflow the rivers and fish ponds in Port Harcourt and environs, and causes most the fishes to escape along with the flood water. The quantity demanded also outweigh quantity supplied, during this period, it is only 55% of the quantity demanded that were supplied, and the percentage supplied decreases from 63% at N200 to 40% at N1000 (see **Table 12** and **Figure 7(a)**).

Table 11. Price and quantity (Qt) of garri during 2012 flood.

Months	Price	Mean Qt Demanded	Mean Qt Supplied	% Supplied
Before flood	9000	128	128	100
1st month	15,000	129	90	70
2nd month	18,000	360	102	28
		517	320	45

Table 12. Price and quantity (Qt) of fishes during 2012 flood per trader.

Price (N)	Mean Qt Demanded	Mean Qt Supplied	% Supplied
200	150	94	63
400	100	53	53
600	60	29	48
800	20	8	40
1000	6	2	33
Total	336	186	55.4



(a) (b)

Figure 7. (a) Demand and supply of fish occasioned by inundation; (b) Normal demand and supply of fish.

Figure 7(a) showed that the quantity of fishes demanded and supplied followed same pattern that reduces with increase in price. This is a negation from the normal demand and supply of fishes before the flood (see **Figure 7(b)**). Another factor that account for the abysmal supplied is the occurrence of acid rain in the region. The occurrence of acid rain has resulted in the lost of fish species and reduced quantity of fish caught by farmers [23].

4. Conclusion

The study has demonstrated that the economy of Port Harcourt is dependent on climate change. It revealed that Port Harcourt experiences rainfall of 2375 mm and temperature of 27.2˚C with an increase of 1581 mm and 3˚C for rainfall and temperature respectively from 1950 to 2015. This increase in rainfall and temperature indicates an evidence of climate change which precipitated other ecological hazards like urban heat island, the 2012 flood, and acid rain in the area and thus impacted negatively on the economy of Port Harcourt. It is showed that the prices of umbrella, rubber sander, baby pears oil cream, palm oil, and rob/mentholator increase with increasing rainfall; cement, ice cream, cold sachet water, okro and Coca Cola prices on the other hand reduce with increase in rainfall. The prices of these good are also significantly dependent on the temperature experienced over the season and year, and thus it is also revealed that the quantities of garri and fishes demanded and supplied de-

crease with increase in price which negates the law of supply, which states that the higher the price, the higher the quantity supplied. Hence the prices is directly proportionate to quantity demanded, because the increased rainfall leads to flood hazards which force many inhabitants of the neighboring areas to relocate to join their relatives and settlement camps in Port Harcourt. It is therefore recommended that economic, environmental and urban planners should incorporate climate adaptation option in their planning in order to protect their goods against climate disasters, as well as implement the urban developmental laws in the area.

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