Urban Storm Water and Residents' Liveability in Akure, Nigeria

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Abstract: The recent phenomenon of climate change and its associated quandary in the world, calls for urgent attention by respective government and the public. Several attempts to alleviate this challenge have not been really effective in developing nations and in particular Nigeria. The effect is worsened by improper use of land resources and other natural attributes like topography or terrain of land in the affected areas. This undoubtedly has continued to pose serious threats to environmental sustainability and human conveniences. Against this backdrop, the paper appraises impact of storm water on the liveability of residents in Akure Nigeria. It analyses topographical situation of land terrain, incidence of urban storm water and its associated impacts on residents, adequacy of storm sewers and allied facilities as well as perception of residents on government effort in solving the menace.

The study employed primary data from structured questionnaire. This was used to elicit relevant information on the subject of discourse. Using random systematic sampling techniques and interval of five buildings, questionnaires were administered to three hundred and eighty residents (380) in selected localities. The method of data analysis was both descriptive and inferential. Chi-square was used to compare the difference in storm water situation and adequacy of drainage facilities in the selected localities while correlation analysis was used to explain the relationship between incidence of storm water and liveability of residents.

The study reveals that a significant proportion (>70%) of respondents affirmed that the underlying factors responsible for storm water are heavy rainfall, inadequate drainage facilities, topography , unpaved surfaces , blocked drainage and indiscriminate disposal of waste to water channels. There is a strong relationship (correlation coefficient = 0.71) between incidence of storm water and inadequacy of drainage facilities. The Chi Square analysis shows a significant difference (P value= 0.00) among effects (i.e. loss of farm crops, loss of property, traffic problems, pollution physiological stress among others) suspected to result from urban storm water in different wards. There is also a significant difference (P=0.00) in the adequacy of drainages facilities among the wards. Government intervention towards the menace was also observed to be poor (P value of 0.00) for drainage construction, clearing of blocked drains, construction of bridge and tarring of road. Against this background, the paper recommends that government should be more pragmatic in provision of public utilities particularly construction of more drainages and repair of the damaged ones. Coupled with this, there should be proper environmental management through public participatory efforts and community monitoring, to discourage indiscriminate dumping of waste into drainages and water bodies especially during raining season. These would ultimately promote a sustainable environment.

Keywords: Liveability, Storm Water, Sustainability, Urban

Introduction and Background to the Study

Cities particularly in West Africa are growing at unprecedented dimension. This rapid urbanization is characterized by movement of people to cities, haphazard development on urban landscape and several attendant problems such as massive reclamation of swamps and destruction of natural ecosystems (Akajiaku and Chukwuocha, 2014). Until now this rapid conversion of urban and suburban land has continued to alter flows of water during and following storm events, putting higher volumes of water and more pollutants into the nation's rivers, lakes and estuaries (The National Academy of Sciences, 2008) This experience is different in the natural environment where the infiltration capacity of the soil is higher than the rainfall intensity and carrying capacity of the population as against urban environment where the infiltration capacity of the soil have reduced by the replacement of the natural environment with impervious urban concrete surfaces (Odemerho, 1998; Okoko, 2008) . Consequently, in the urban environment, the usual experience is surface overland flow or urban storm water.

Urban storm water runoff is described as water from precipitation and landscape irrigation that does not infiltrate into the soil or that flows over roadways and other hard surfaces in urban landscape (Fact Sheet by California State Water Resources Control Board, Retrieved 8th November, 2014). Storm water runoff from urbanized areas is generated from a number of sources including residential, commercial and industrial areas, roads, highways and bridges. Essentially, any surface which does not have the capability to pond and infiltrate water will produce runoff during storm events. Storm water has long been regarded as a major culprit in urban flooding (The National Academy of Sciences, 2008) Until now, the urban runoff has continue to be alarming throughout or in most cities in developing nations and most especially Nigeria where streets are characterized with bad surfaces and mostly without drainage channels to control storm water. Storm water rushes over impervious surfaces with escalating speed and volume, picking up an assortment of pollutants (Fact Sheet by California State Water Resources Control Board, Retrieved 8th November, 2014). The underlying factors responsible for urban runoff apart from unprecedented urbanization include the following among others: design and function of urban landscape which are mostly covered with impervious surfaces such as roofs, streets sidewalks and parking lots (USEPA, 2013).

Several negativities have been associated with urban storm water most especially on the various component of the environment. According to The National Academy of Sciences (2008), urban storm water has continue to degrade streams, rivers, lakes and other water bodies in urban and suburban areas. The report established further that water is estimated to be the primary source of impairment for 13 percent of assessed rivers, 18 percent of lakes and 32 percent of estuaries. It has also increased the risk of local flash floods. The severity of the effects of storm water run-off is usually proportional to the area of urban land use directly connected to the receiving water. It has been noted that it can be measured as the percentage of the catchments with impervious cover (%IC) and this has been shown to be a useful predictor of potential impacts of urbanization on stream health (ARC, 2004). Urban storm water runoff affects water quality and quantity, habitat and biological resources, public health, and the aesthetic appearance of urban waterways. As reported in the National Water Quality Inventory of 1996 (USEPA, 1998). Storm water is also regarded as the leading source of pollutants causing water quality impairment related to human activities in rivers lakes ocean shoreline waters and the second leading cause in estuaries across the nation. The percent of total impairment attributed to urban runoff is substantial, approximately 5,000 square miles of estuaries, 1.4 million acres of lakes, and 30,000 miles of rivers (USEPA, 1999). This occurrence is not different from what is experienced in developing country like Nigeria. According to Adedeji and Eziyi (2010) Nigeria cities are witnessing high rate of environmental deterioration and storm water is rated high among urban areas with the lowest liveability index in the world. Urban liveability is borne out of the realization that there is a connection between urban living conditions and health of residents (Okoko, 2008).

He reiterated further that, the increment in storm water has attendant and negative consequences on the environment and residents liveability in the city. Storm water picks tip and carries debris and trash and flushed it into any available drains, consequently, the drains become clogged and impassable by water. This has undoubtedly results to urban flood and consequently lead to destruction of basic facilities, lives and properties. Similarly, clogged drains usually slows down the movement of water, causing coagulation of pollutants such as sediments, grease, wastes from failing septic systems. These have consequential effect on the residents' health living in or around such drains. Hazardous wastes like pesticides, insecticides, paint solvents, used motor oil, auto fluids and other chemical materials are not only gathered into the stagnant water in drains, but they also find their way into rivers and streams with the aid of storm water. This is capable of destroying the aquatic life and those who consumes such polluted water. This have consequence for those who practise aquatic agricultures. People will incure unnecessary but high cost of treatment of water as a result of contamination caused by storm water. This trend is also capable of causing property value decline in the subject area. The area that is prone to gully erosion has poor imageability and therefore loses value in the property market. Residents would therefore be prepared to pay a lower rent for properties in the area relative to similar ones in the adjoining area.

Against this incessant occurrence of urban storm water and associated negativities the paper examines the extent which damage done by storm water has hamper the liveability of the city dwellers? What must be done or incorporated into urban design to facilitate the general environmental management; particularly in a typical rainforest city? This needs to be studied within the urban context especially in a typical state capital city: Akure, Ondo State Nigeria.

Research Methodology

The study area is Akure city, which comprises of two major local government areas i.e. Akure North and Akure South Local Government Areas. The estimated population for 2010 (1,102,422) was employed in the study. Thirty one localities from these Local Government Areas were selected and considered for the survey. The study employed mainly primary data from structured questionnaire. This was used to elicit relevant information on the subject of discourse. Using random systematic sampling techniques at interval of five buildings, questionnaires were administered to three hundred and eighty residents (380) in selected localities. Both descriptive and inferential statistics were used. Chi-square was used to compare the difference in storm water situation and adequacy of drainage facilities in the selected localities. Residents' response on effects of storm water and rating of factors responsible for urban storm water was examined with Likert scale rating.

Results and Discussions

Incidence of Storm Water

Chi square test of difference was computed to determine whether there is a significant difference in the incidence of storm water among the sampled localities. It is observed that all variables that point to a high incidence of storm water have different characteristics among the wards. The probability value of each of the chi-square analysis indicates that at 95% confidence limits, there is significant difference in the residents' response to the occurrence of storm water among the sample wards. In other words, storm water occurs highly in some places than others.

Table 1: Chi Square Result on Storm Water Occurrence 8

Level of Occurrence of	**X^2**	**Df**	**P. value**
Stagnant Water	148.734	70	.000
Marshy Ground	200.984	70	.000
Erosion	187.396	70	.000
Flooding	296.049	70	.000
Irrigation	142.935	70	.000

Source: Author's Computation, 2010.

Factors Responsible For Urban Storm Water

Certain factors are hypothesized to be responsible for high level occurrence of storm water. Some are natural while others have human inputs or otherwise are man-made or man -induced. Among such factors are: heavy rainfall, inadequate drainage facilities, incidence of paved or concreted floors and roads, the topographical nature of the area, blockage of drains, channels, rivers, canals, etc. This information is presented on table 2. Most respondents irrespective of their wards indicated that among all; heavy rainfall due to climate change, inadequate drainage facilities, high incidence of paved or concretized urban land surfaces and the topography of their area contributes highly to high occurrence of urban storm water in the study area.

Table 2: Factors Responsible for Urban Storm Water (%)

	Extent	Adegbola	Ajegunle	Ala	Alagbaka	Ayedun	Gbangbalogun	Igboyegun	Ijomu
Heavy Rainfall	1	100	80	95.	55	64	40	76	88
	2	0	20	7	45	28	55	24	04
	3	0	0	4.3	0	04	05	0	08
	4	0	0	0	0	0	0	0	0
Inadequate Drainage facility	1	85	20	95.	20	40	15	76	84
	2	15	40	7	50	32	65	20	12
	3	0	10	4.3	20	24	20	04	04
	4	0	30	0	10	04	0	0	0
Paved Floor/road	1	85	10	95.	0	24	20	76	84
	2	05	45	7	35	48	35	16	08
	3	0	25	4.3	15	16	45	08	04
	4	10	20	0	50	0	0	0	04
Topography	1	85	15	95.	05	36	20	76	80
	2	10	45	7	65	40	25	12	16
	3	05	25	4.3	20	12	50	12	04
	4	0	15	0	10	08	05	0	0
Unpaved Surfaces	1	05	10	8.7	10	24	05	08	04
	2	20	25	0	45	28	30	12	12
	3	15	15	0	20	32	50	08	16
	4	40	50	13	25	08	15	12	40
River Overflow	1	80	10	95.	0	68	10	76	84
	2	05	10	7	20	24	55	20	08
	3	0	05	4.3	0	04	05	04	08
	4	15	75	0	80	0	30	0	0
Soil Structure/texture	1	05	05	26.	05	44	05	24	04
	2	05	05	1	20	16	20	12	12
	3	35	05	4.3	15	24	40	12	36
	4	45	85	4.3	60	04	35	12	20
Deposition of waste into Drain & River	1	85	60	95.	15	68	35	76	88
	2	15	15	7	65	24	55	24	12
	3	0	15	4.3	0	0	10	0	0
	4	0	05	0	29	0	0	0	0
Levis/Construction	1	05	0	4.3	0	36	0	04	04
	2	15	05	0	05	24	20	08	16
	3	35	25	8.7	10	24	50	20	36
	4	30	10	13	85	12	05	04	28

Source: Author's Field Survey, 2010. Key: 1-Very Much Significant, 2-very significant, 3-Significant 4- Not Significant, 5-Not at all Significant. .

Table 2 Contd: Factors Responsible for Urban Storm Water (%)

	Isikan	Isolo	Odokoyi	Odopetu	Ojaaba	Osinle	Oyemekun
Heavy Rainfall	65.6	65	64	60	70	70	48
	31.3	35	32	37.5	20	15	48
	3.1	0	0	2.5	05	10	04
	0	0	04	0	0	05	0
Inadequate Drainage facility	50	15	28	52.5	30	30	12
	31.3	60	32	32.5	40	55	72
	12.5	15	16	15	25	10	16
	6.3	10	24	0	05	05	0
Paved Floor/road	31.3	0	24	47.5	20	40	20
	28.1	30	28	20	60	35	44
	12.5	10	32	30	05	15	36
	28.1	60	16	2.5	10	05	0
Topography	31.3	05	24	47.5	35	10	12
	43.8	70	28	15	45	45	32
	15.6	10	24	35	05	20	48
	9.4	15	25	2.5	10	20	08
Unpaved Surfaces	8.7	10	12	2.5	30	05	08
	43.5	50	28	20	40	15	24
	13	15	16	30	25	20	40
	34.8	25	40	47.5	05	25	20
River Overflow	37.5	0	24	47.5	70	70	20
	15	05	12	42.5	10	10	48
	0	0	08	2.5	15	15	04
	46.9	95	56	7.5	05	05	28
Soil Structure/ texture	11.1	05	08	0	55	05	04
	14.8	10	12	17.5	15	10	16
	14.8	10	16	27.5	15	25	36
	59.3	75	60	55	15	35	40
Deposition of waste into Drain & River	46.9	20	64	47.5	75	65	32
	37.5	60	16	50	20	15	48
	3.1	0	12	2.5	0	10	12
	12.5	20	08	0	0	05	0
Levis/ Construction	0	0	08	0	40	05	0
	9.5	0	08	28.6	25	10	20
	14.3	0	24	52.4	10	15	40
	76.2	100	20	19	25	45	16

Source: Author's Field Survey, 2010. Key: 1-Very Much Significant, 2-very significant, 3-Significant 4- Not Significant, 5-Not at all Significant. .

Availability of Sewerage Facilities

Storm water should be natural. It occurs everywhere. This is because rain must fall and water that could not sink into the ground must find its way into a river through all the available courses. However, storm water becomes a problem when it is not prepared or planned for. To this end, it becomes important to appraise the availability as well as the adequacy of sewerage facilities that are supposed to curb or prohibit problems that may arise from urban storm water. Some of the variable considered here are the availability of: different type of drains, canal, pipes or sewers, channels, conduits, and reservoirs meant to alleviate storm water problems in any urban area. Open drain is the commonest type of drainage in the study area. It is present in more than 90% of the sampled areas. The chi-square test performed shows that, at 95% confidence level, there is no significant difference in the level of availability of open drain among the sampled wards (Chi square value is .044, see table 3). This indicates that all the sampled wards are similar in terms of availability of open drain availability. The other types of sewerage facilities, such as canals, pipe, channel etc are either smaller in proportion or not available.

Table 3: Availability of Drainage Facilities

Availabilty	Open drain	Cover drain	canal	pipe	Drainage channel	Conduit pipe	reservoir	Underground storage	others
Adegbola	95	0	10	20	10	0	10	05	15
Ajegunle	85	0	0	0	0	0	0	0	0
Ala	95.7	4.3	8.7	403	4.3	0	4.3	0	0
Alagbaka	95	10	10	10	15	20	15	05	05
Ayedun	88	12	16	24	24	04	28	12	12
Gbangbalogun	70	30	25	50	30	30	50	05	05
Igboyegun	88	16	20	20	16	12	20	0	0
Ijomu	96	4	08	20	16	12	20	16	12
Isikan	93.8	19	19	23.8	23.8	28.6	28.6	14.3	4.8
Isolo	95	0	0	05	0	05	0	0	0
OdoIkoyi	88	0	08	20	12	08	0	0	0
Odopetu	85	47.6	42.9	57.1	57.1	57.1	76.2	57.1	14.3
Oja Oba	100	10	10	10	25	0	15	25	10
Osinle	100	5	20	45	25	15	10	0	0
Oyemekun	76	24	24	48	28	24	48	40	04
X^2	0.044	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors' Field Survey 2010.

Most of the open drains available are blocked with debris of different categories of waste. Further analysis on adequacy of sewage facilities reveals that there is significant difference in the adequacy of drainage facilities among wards (see Table 4). This implies that level of adequacy of drainage facilities among sampled wards is not the same. In other words, there are areas where the facilities are adequate and there are areas where they are not. This suggests that different approaches need to be used in order to curb storm water problems depending on the areas involved.

Table 4: Chi-Square Test of Difference in Adequacy of Sewage Facility among Wards

Variable	**X^2**	**Df**	**P. Value**
Adequacy of open drain	193.722	70	. 000 *
Adequacy of closed drain	175.243	70	. 000 *
Adequacy of canal	166.297	70	. 000 *
Adequacy of pipe	281.803	70	. 000 *
Adequacy of channel	188.435	70	. 000 *
Adequacy of conduit	179.952	70	. 000 *
Adequacy of reservoir	238.725	70	. 000 *
Adequacy of underground storage	284.552	70	.000 *

Source: Author's Computation, 2010

****Difference is significant at 95% confidence level.***

Consequences of Urban Storm Water

There can be a host of intrinsic and extrinsic consequences of uncontrolled urban storm water. However the easily speculated ones are hypothesized for the study with rooms given for the residents to supply information on any one that may be omitted. Among the consequences observed in the research are: loss of farmland and crops; loss of properties including landed properties and other domestic materials; loss of lives as there have been cases of city residents drowned in storm water, loss of domestic animals, loss of environmental aesthetics or obscenity, traffic problems, pollution and psychological stress among others. The first step taken here is to know if the speculated consequences of urban storm water ever occurred in the areas. The result of this is presented on table 5. Among the consequences that have occurred highly are: property loss, loss of domestic animals e.g domestic birds like fowls etc. Obscenity pollution psychological stress and facility loss are interwoven and so are all having a high incidence in the area.

Effects of Storm Water among Wards

A test of difference was performed to know whether all the areas in the study experience the same effects or not. This result is presented on table 5. The chi-square results for each of the variables of storm water effects are presented on table 6. The probability values for all suggest that there is significant difference in the incidence of the effects of storm water between the sampled wards. This implies that the situation is better at some places than other and vice versa.

Table 5: Effects of Storm Water Among Wards

Occurrence of:	Farm Crop Loss	Propert y Loss	Loss of Life	Loss of Domest ic Animal	Obscenity	Traffi c Proble ms	Pollution	Civil Activity Disturbanc e	Psychological Stress	Relocation	Facility Loss
Adegbola	5	95	0	100	100	85	100	85	90	85	90
Ajegunle	15	50	5	85	95	35	70	35	45	10	15
Ala	0	100	0	21.7	100	100	100	100	100	100	100
Alagbaka	15	95	20	80	80	70	90	45	50	50	80
Ayedun	8	52	24	24	20	56	84	56	68	56	52
Gbangbalo gun	20	80	10	80	50	20	75	35	65	70	60
Igboyegun	0	92	0	20	84	84	100	88	96	96	92
Ijomu	20	100	16	84	92	96	100	96	100	92	100
Isikan	9.4	93.8	21. 9	62.5	87.5	78.1	96.9	52.4	75	75	87.5
Isolo	10	90	5	85	85	55	90	30	45	35	75
Odokoyi	24	48	8	84	84	48	64	52	52	24	40
Odopetu	10	92.3	20. 5	43.6	67.5	72.5	92.5	57.1	85	90	77.5
Ojaaba	5	35	25	25	15	45	80	45	55	30	40
Osinle	60	90	30	55	75	80	85	85	90	80	95
Oyemekun	32	80	12	72	56	36	80	44	68	68	64

Source: Author's Field Survey, 2010

Table 6: Chi-Square Test of Difference in Effects of Storm Water.

Variable	X^2	df	P.value
Incidence of Crop Loss	182.361	70	.000*
Incidence of Property Loss	296.680	70	.000*
Incidence of Loss of Life	146.118	70	.000*
Incidence of Domestic Animal Loss	216.610	70	.000*
Incidence of Aesthetic Loss	297.916	70	.000*
Incidence of Traffic Problems	233.338	70	.000*
Incidence of Pollution	208.369	70	.000*
Hindrance to Civil Activities	282.064	70	.000*
Incidence of Psychological Stress	272.083	70	.000*
Incidence of need to Relocate	343.438	70	.000*
Incidence of Facility Loss	258.371	70	.000*

Source: Author's Computation, 2010. *Difference is Significant.

Table 7: Chi-Square Test of Difference In Health Problems Associated With Storm Water Among Wards.

Variables	X^2	df	P.value
Incidence of Typhoid	214.943	56	.000*
Incidence of Malaria	180.726	70	.000*
Incidence of Dysentery	287.720	56	.000*
Incidence of Cholera	290.873	70	.000*
Incidence of dracunaehasis	330.005	70	.000*
Incidence of irritation	348.611	70	.000*
Incidence of Diarrhoea	347.807	70	.000*

Source: Author's Computation, (2010).

In the same vein, a chi-square test was performed to examine if the difference in the incidences of the diseases is great enough to be statistically significant. The result of this is presented on table 7. Again there is significant difference in the incidence of the diseases among the wards. This means that in some areas resident suffer more from these diseases than residents of other wards.

Conclusion and Recommendations

This paper has shown that there is problem of urban storm water in Akure City though the level of impacts differs from one locality to the other. The underlying factors for this occurrence include climatic situation of the area being a tropic rain forest region with high level of rainfall coupled with poor and inadequate drainage facility in virtually all the area surveyed. The paper therefore recommends that government should be more pragmatic in provision of public utilities particularly construction of more drainages and repair of the damaged ones. Also, government through appropriate planning agencies should enlighten the residents on the need to allow permeable surface within their residences so as to allow infiltration of urban storm water easily into the earth surface particularly during heavy downpour. Similarly, proper landscaping by planting flowers around building premises will reduce the capacity of storm water within residential quarters and city at large.

More importantly, sustainable approach to managing storm water begins with environmental stewardship through which individual assume responsibility of managing and making sure adequate attention is given to environmental management. This can be achieved through public participatory efforts and community monitoring to discourage indiscriminate dumping of waste into drainages and water bodies especially during the raining season. These would ultimately promote a sustainable environment.

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