International Journal of Environmental Monitoring and Analysis
2014; 2(2): 73-85
Published online March 20, 2014 (http://www.sciencepublishinggroup.com/j/ijema)
doi: 10.11648/j.ijema.20140202.13

Selective impacts of the 2012 water floods on the vegetation and wildlife of Wilberforce Island, Nigeria

Elijah Ige Ohimain*, Sylvester Chibueze Izah, Dimie Otobotekere

Biodiversity Conservation and Research Group, Biological Sciences Department, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

Email address:
eohimain@yahoo.com (E.I. Ohimain)

To cite this article:
Elijah Ige Ohimain, Sylvester Chibueze Izah, Dimie Otobotekere. Selective Impacts of the 2012 Water Floods on the Vegetation and Wildlife of Wilberforce Island, Nigeria. *International Journal of Environmental Monitoring and Analysis*. Vol. 2, No. 2, 2014, pp. 73-85. doi: 10.11648/j.ijema.20140202.13

Abstract: The study was designed to evaluate the impacts of the 2012 water floods on the wildlife and vegetation of Wilberforce Island. Ten transects of 1 km each were established cutting across the three levels of impacted vegetation namely, dead, dying and intact plants. The relative topography of the plots was assessed based on the measurement of receding water marks on plants. The effects of the floods on wildlife were assessed through interviews and field work. The study found that 23 mammals, 21 avian fauna and 37 plants were impacted. The plant species, which exhibited the greatest impacts, was *Musanga cecropoides*. The water level marks on *Musanga cecropoides* coincided with the physiological stress on the plant. The receding water level mark on *Musanga cecropoides* ranged from 59.33 to 164.67cm for the dead plants, 12.00 to 32.67cm for the dying plants, but the water was at ground level for intact vegetation. The study provided an assessment of the 2012 floods impacts on biodiversity, providing scientific evidence for planning responses to mitigate future flooding events and providing the basis for assessment of cumulative impacts of multiple flooding events on the Island since flooding was also predicted to occur in 2013.

Keywords: Climate Change, Flooding Impacts, Relative Topography, Receding Water Marks, Wetlands

1. Introduction

Over the years, environmental issues are gaining attention due to change in climatic condition, increase world temperature as well as emission of greenhouse gases. Anthropogenic and natural phenomenon has led to increase in natural disaster such as earthquake, flooding, erosion etc. The impacts of flooding are multifarious and fundamentally unused in policy making in most nations of the world [1]. Over the years, the focus on water management has changed from the need to dominate and control water resources to a more harmonious philosophy that seeks a balance between the structural flows needed to support and protect the ever growing population and its environment [2 – 4]. As a result, most countries in the World that have not witnessed floods as far back as the 19th century are now prone to it including Nigeria.

Depending on relative topography, land use pattern, population density and other factors, the primary effects and implications of floods in terms of the nature, severity and expected duration of damage varies. In mountainous areas, for instance, the phenomenon which is mostly in the form of flash floods has been intense and highly destructive. The flash flood has affected areas where the proportion of land cultivated are relatively low, and where reliance on irrigation is limited. Basically, flooding occurs in Nigeria in three key systems namely coastal flooding, river flooding, and urban flooding, Coastal flooding usually occur in low-lying belt of fresh water swamps and mangrove especially in Bayelsa State, Nigeria. River flooding take place in flood plain of big rivers, and urban flooding or short-lived flash floods are associated with inland water ways, especially in Niger Delta Nigeria. This typically occurs when there is change in rainfall pattern and it can be destructive within a short period of time. Urban flooding is caused by blockage of drainage system with municipal wastes including cassava processing wastes, wood wastes, scrap metals, plastic, etc. This type of flooding occurs in major cities of Nigeria including Lagos, Aba, Port Harcourt, Yenagoa, Warri, Benin and Ibadan almost on yearly basis. Therefore, nearly all Nigerian is vulnerable to natural disasters. Due to flooding, properties worth millions of Naira were lost in these major cities during the 2012 raining season.

The 2012 flood disaster in Nigeria that began in July in the northern part of Nigeria, and spread across many states of the country started in Wilberforce Island in Mid-September and ended in mid-November, 2012. Therefore, the five month flood that besieged over twenty six states out of the thirty six excluding federal capital territory [5] has been massive and unprecedented, killing wildlife and vegetation, affecting over 20 percent of the land area, rendering people homeless and causing billions of Naira (US $1 = ₦ 156) loss and damages to infrastructure, housing, agriculture (several hectares of land and crops) and livestock. Essential infrastructure impacted includes roads, bridges, schools, health centers, financial institutions and filling stations. These infrastructures were severely damaged and many relics remained even after the flood. The flood resulted in disruption of basic amenities such as potable water, electricity, transportation, education, telecommunication, markets and other important economic activities. The flood caused the inhabitants of the affected areas to be economically vulnerable to poverty, starvation and death. For instance, in north central area of the country about 104 lives were lost and over 50000 – 150000 persons were displaced by the ravaging flood [5]. In Kogi state about 12,000 inhabitants were displaced [6]. In Delta state, the flooding wreaked havoc in 12 local government areas and over 70,000 victims were camped in 18 government designated camps[7]. In Ughelli, within Delta state, it displaced over 53,000 people in eleven communities submerged [8]. A non-governmental organization Dickens Sanomi Foundation rescued 12,320 people trapped in the ravaging flood in six local government areas of Delta states under its project rescue 10,000 flood victims in Delta and Bayelsa state[9]. In Estako central, Estako East and Esan South East local government council of Edo state, properties worth over ₦1 billion were destroyed by the flood and over 20 communities were submerged [10]. In Cross Rivers, over 5,000 persons in Eja communities were displaced [11]. By the end of September 2012 over 134,371 people were displaced, 64,473 injured and 148 killed [12]. The major highways affected include East West road, Abuja-Lokoja express way, Asaba-Okwe road and many others[12]. The flood, which killed three persons, also destroyed some sections of the only road linking Wilberforce Island to Yenagoa (the capital city of Bayelsa state).

The consequence of the flood is mostly negative, but some could be positive depending on the location, duration, depth and speed, as well as the vulnerability and value of the affected natural and constructed environments. Floods impact individuals, vegetation and wildlife. Flooding in key agricultural production areas could lead to widespread diseases and plant and animal disruption. The 2012 flooding affected agricultural production and subsequently led to increase in food prices [13 - 15] as a result of farm destruction and disruption of food supply chains. On the other hand, flood events can result in long-term benefits to agricultural production by revitalizing water resource storages, particularly in drier, inland areas, and by invigorating soil fertility through silt deposition.

Nigeria has a rich variety of natural forest ranging from open vegetation and savanna forests of northern dry climate, to the tropical moist forest of the south with riparian forest along the major rivers (Niger and Benue) [16]. Nearly 11% of the total land area of the country is covered by forest, comprising 80% savanna and 20% high forest [17]. The Niger Delta is one of the largest wetlands covering about 20,000km^2[16] and Wilberforce Island forest make up a significant proportion of it. The forest holds a large number of species that are economically and scientifically valuable. The Niger Delta is ranked 12th among the 24 global biodiversity hotspots for endemic vertebrate wildlife [18]. Hamadina et al. [19] reported wildlife (Mammals, Aves and Reptiles) found in Wilberforce Island, which formed the baseline for the study i.e. presenting conditions of the Island prior to the flooding events of 2012.Flooding of this magnitude has never occurred in Nigeria before; hence information on flood is scares in literature. Besides, the Nigerian Meteorological Agency (NIMET) predicted more flooding in 2013. It is on this background that we investigate the impacts of the recent flooding on the wildlife and vegetation of Wilberforce Island, Bayelsa State, Nigeria. The study could provide scientific evidence for planning responses to mitigate future flooding events and also to provide the basis for cumulative assessment of multiple flooding events.

2. Methodology

2.1. Field Sampling

Wilberforce Island which is situated in Southern Ijaw local government area of Bayelsa State, is located in the gazetted Nun River forest reserve in Niger Delta, Nigeria. It has several adjoining communities including Egbedi, Ikibiri, Oweikorogha, Bumadi, Agudama-Ekpetiama, Ogobiri and Amassoma. The topography is typically flat with depressions. Hence, they are characterized as wetland flood plain with terrestrial habitat submerging most part of the year [20]. Assessment of flood impacts was carried out from 4 to 6th December, 2012. In the study, ten transects of approximately 1 km each were established on ten different plots of land within the island, with a width of 50m. Transects were established to cover the various scale of vegetation impacts noticed during the field work including dead (i.e. vegetation species that dried up completely), dying (i.e. vegetation species that are showing signs of drying up) and healthy vegetation with no visible impacts. Being the most impacted tree, the relative height of the receding water marks were measured on *Musanga cecropoides*. Direct sampling techniques was used to measure in triplicates the heights of the receding water marks in five *Musanga cecropoides* plants found in each of the three different impact categories.

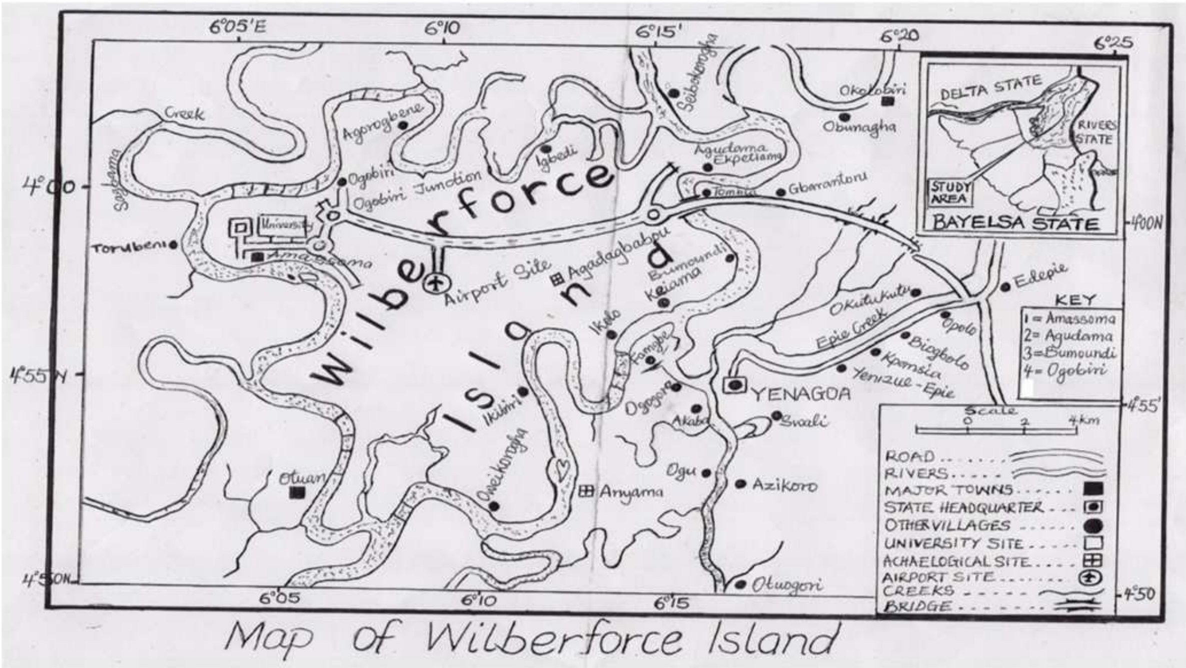
The wildlife mostly mammals and aves were studied indirectly through interviews and questionnaire administered to the inhabitants and hunters at the plots visited and directly during the field study. The findings were compared to results reported by Hamadina et al. [19] before the flooding events. The plants were identified using the scheme of Nyananyo [21], Okezie and Agyakwa [22] and Adiribe and Illoh [23]. The mammals were also identified using the guide provided by Dorst and Dendelot [24] and Jonathan [25]. The birds were identified using the identification guide provided by Borrow and Demcy [26]. The description of impacts was according to the criteria presented in Table 1.

***Table 1** Description of impacts on wildlife and vegetation with respect to flooding*

Categories	Effects	Impact description
Nature of impact	Positive	Beneficial impacts such as deposition of silt and organic matter that increased soil fertility or prevention of access for monkey attacks
	Negative	Detrimental impacts such as death of wildlife and vegetation
Impact type	Directly impacted	These are impacts resulting primarily/directly (direct cause and effect relationship) from flooding such as the death resulting from the drowning of wildlife. It also includes the direct destruction of vegetation such as tree felling by water floods and erosion.
	Indirectly impacts	These are secondary impacts such as destruction in the habitats and food sources of the wildlife making them vulnerable to hunter attacks. It also includes vegetation stress resulting from drowning and suffocation.
	Un-impacted	Health wildlife and vegetation not impacted directly or indirectly.
Duration of impact	Short term	Impacts that can recover (with or without human intervention) within a period of about 1 year or less
	Medium term	Impacts that remain for period of about 1 - 5 years
	Long term	Adverse impacts that remain (with or without human intervention) for period of about 5years or more
Reversibility of impacts	Reversible	These are impacts whose effects can be addressed on application of adequate mitigation measures to revert the environmental features back to their pre-impact conditions
	Irreversible	Impacts whose effects cannot be returned to its original state even after adequate mitigation measures are applied
Other impact categories	Residual Impacts	These are impacts that would still remain after mitigation/ intervention measures have been applied.
	Simple impacts	The impacts attributed to flooding alone
	Cumulative Impacts	These are impacts resulting from interaction between the flooding effects with other activities, taking place simultaneously such as wood logging, hunting and bush fires. It could also include the cumulative impacts of multiple flooding events
IUCN classification (IUCN 2012)	Extinct (EX)	No known individuals remaining.
	Extinct in the Wild (EW)	Known only to survive in captivity, or as a naturalized population outside its historic range.
	Critically Endangered (CR)	Extremely high risk of extinction in the wild.
	Endangered (EN)	High risk of extinction in the wild.
	Vulnerable (VU)	High risk of endangerment in the wild.
	Near Threatened (NT)	Likely to become endangered in the near future.
	Least Concern (LC)	Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
	Data Deficient (DD)	Not enough data to make an assessment of its risk of extinction.
	Not Evaluated (NE)	Has not yet been evaluated against the criteria.

2.2. Statistical Analysis

SPSS software version 17 (SPSS Inc, Chicago) was used to carry out the statistical analysis. A one-way analysis of variance was carried out at $\alpha = 0.05$, and Duncan's multiple range test was used to discern the source of the observed differences.



3. Results and Discussion

Table 2 presents the impact type and conservation status of mammals found in Wilberforce Island. The mammalian species is characterized into order; primates (with Lorisidae,Galagonidae and Cercopithecidae as families), Holiodonta (with Manidae as family), Carnivore (with Carnidae, Herpestidae, Mustelidae and Viverridae as families), Rodentia (with Sciuridae, Thryonomidae, Soricidae, Hystricidae, Muridae, muscardindae and Cricetidae as families), Sirenia (with Procaviidae, Anomaluridae and Tragulidae as families) and Artiondactyla (with Bovidae, Suidae and Trichechidae as families). The mammalian species were evaluated using IUCN classification. The mammalian species directly impacted include *Atilaxpaludinosus, Herpestes ichneumon, Crossarchus obscurus, Civet tictiscivetta, Thryonomys swinderianus, Atherurus africanus, Ratus ratus, Musmus culus, Lemniscomys striatus, Mastomys natalensis, Cricetomys emini, Hyemoschus aquaticus, Tragelaphus scriptus, Cephalophus maxwelli, Tragelaphus spekei* and *Potamochoerus porcus.* The indirectly impacted species are *Perodicticus potto, Arctocebus calabarensis, Phalaginus tricuspis, Uromonistetradactyle, Crocidura nigeriae, Nandini binotata* and *Dendrohyrax dorsalis.* Studies by Lameed [16] show that the mammalian wildlife species of Kwale forest is similar to what we found in Wilberforce Island.

In Wilberforce Island, wildlife are regularly killed and displayed for sale along the road (Fig. 1). However, the number of bush meat sold along the road reduced to zero since after the flood (December 2012), which indicated a decline in the wildlife stock of the area. The duration of impact can be short, medium and/or long term. The impacted mammals such as *Arctocebus calabarensis, Phalaginus tricuspis* and *Uromonis tetradactyle* may recover in the medium term. *Perodicticus potto* and *Nandini abinotata* may recover in a long term while *Crocidura nigeriae* and *Dendrohyrax dorsalis* could recover in short term. The impacts on most of the species are irreversible because the flood resulted to their death. Whereas, indirect impacts on species are reversible because such species have either their food or habitat or both destroyed. So, they stand a high tendency of natural recovery. *Nandini binotata, Cephalophus maxwelli* and *Potamochoerus porcus* were majorly indirectly impacted due to the activities of hunters during the flooding.

Mammals that feed on the plants that were affected by the flood were indirectly impacted including *Nandini abinotata* and *Hypsignthus monstrosus*,which feed on *Musanga cecropoides* fruits. *Musanga cecropoides* is one of the dominant plant species that was heavily impacted by the flooding (direct impacts). As a result, wildlife that depends on them for food sources may have starved to death. Again, the non-availability of *Musanga cecropoides* exposed them to hunter while searching for alternative food (indirect impacts). Land or ground dwellers are the predominant wildlife species directly impacted by the flood, because virtually all their life activities such as source of food, habitat, breeding mode are on ground. These groups of animals include *Atherurus africanus*, *Cricetomys emini*, *Cephalophus maxwelli*, *Thryonomys swinderianus*, *Potamochoerus porcus* among others. These animals may have drowned in the flood because they could not withstand the current of the water and the few that did after prolong swimming for survival may have died (direct impacts). While the species that escaped to non-flooded areas where killed by hunters, who were ever ready waiting for these animals with cutlass, club, etc (indirect impacts).Though, all climbers were not directly impacted unlike the ground dwellers. Hence, the flood has favored climbing wildlife which includes the different species of monkeys such as *Cercopithecus erythrogaster*, *Cercopithecus mona*, *Cercocebust orquatus*, *Procolobus verus*, *Cercopithecus nictitans*. Basically, the monkey's species were at advantages because hunter could not have access to where they reside because of the flood activities (positive impacts). The study revealed that monkeys were not displayed for sale in villages and/or road sides of Wilberforce Island as the usual practice before the flood.

Among the wildlife studied, avian species were also found to be impacted. The directly impacted species include *Guttera pucherani, Franicolinus squamatus, Pycnonotus barbatus* and *Sarothrura pulchra.* These avianfauna were adversely impacted because nearly almost all their life forms (feeding, breeding, etc) are on ground and they cannot fly over long distances, while the indirectly impacted species are *Lonchuracucullata, Estrilda melpoda, Lonchura bicolor, Centropus senegalensis, Streptopelia senegalensis, Streptopeliase mitorquata, Turtur afer, Turturtympa nistria, Tringa hypoleucos, Tockus fasciatus, Kaupifalco monogrammicus, Neophron monachus, Passer griseus, Ploceus cucullatus, Ploceus melanocephala, Ploceus nigerrimus* and *Vidua macroura*.

Majority of the birds were un-impacted because nearly all their life formsare not on ground. The impacts on avian fauna are generally reversible except for *Guttera pucherani* that could not fly forlong distances, and have nearly all its life forms on land. Consequently, the duration of impact is medium term except for *Kaupifalco monogrammicus* that could recover in a short term and *Tringa hypoleucos* and *Tockus fasciatus* that can recover in a long term.

Table 2: *Mammalian fauna of Wilberforce Island presented according to impact category*

Order	Families	Common Names	Scientific Names	IT	Q	O	P	CS	PT
	Lorisidae	Potto	*Perodicticus potto*	I	R		L	LC	S
		Calabar Angwantibo	*Arctocebus calabarensis*	I	R		M	LC	U
	Galagonidae	Dwarf Galago	*Galagoides demidovii*	U				LC	S
		Allen's Galago	*Galago alleni*	U				LC	U
Primates	Cercopithecidea	Nigerian white-throat monkey	*Cercopithecus erythrogaster*	U				V	D
		Red-capped mangabey	*Cercocebus torquatus*	U				V	D
		Olive colobus	*Procolobus verus*	U				NT	U
		Putty nosed monkey	*Cercopithecus nictitans*	U				LC	D
		Mona monkey	*Cercopithecus mona*	U				LC	U
Holidonta	Manidae	Tree pangolin	*Phalaginus tricuspis*	I	R		M	**	
		Black bellied pangolin	*Uromonis tetradactyle*	I	R		M	LC	D
	Canidae	African clawless otter	*Anoyx capensis*	U				**	
		Spot necked otter	*Lutra maculicollis*	U				LC	D
	Herpestidae	Marsh mongoose	*Atilax paludinosus*	D	IR	A,B		LC	D
		Long nose mangoose	*Herpestes naso*	U				LC	D
		Egyptian mongoose	*Herpestes ichneumon*	D	IR	A,B		LC	S
Carnivore		Cusimanse mongoos	*Crossarchus obscurus*	D	IR	A,B		LC	U
	Viverridae	African civet	*Civettictis civetta*	D	IR	A,B		LC	U
		Two-spot palm civet	*Nandinia binotata*	I	R	A,C	L	LC	U
		Large-spotted Genet	*Genetta tigrina*	U				LC	U
	Mustelidae	Cape clawless otter	*Aonyx capensis*	U				LC	S
		Spotted-neck otter	*Lutra maculicollis*	U				LC	D
	Sciuridae	Giant forest squirrel	*Protexerus strangeri*	U				**	
		Fire-footed rope squirrel	*Funisciurus pyrrhopus*	U				**	
		Red-less tree-squirrel	*Funisciurus anerythrus*	U				LC	U
		Red-legged sun squirrel	*Heliosciums rufobrachium*	U				**	
	Thryonomidae	Cane rat	*Thryonomys swinderianus*	D	IR	A,B		LC	U
	Soricidae	Nigerian musk shrew	*Crocidura nigeriae*	I	R	A	ST	LC	U
Rodentia	Hystricidae	Brush-tailed porcupine	*Atherurus africanus*	D	IR	A,B		LC	U
	Muridae	Black House rat	*Ratus ratus*	D	IR	A,B		**	
		House mouse	*Mus musculus*	D	IR	A,B		LC	S
		Spotted-grass mouse	*Lemniscomys striatus*	D	IR	A,B		LC	I
		Multimammate mouse	*Mastomys natalensis*	D	IR	A,B		LC	S
	Cricetidae	Emin's Giant rat	*Cricetomys emini*	D	IR	A,B		LC	S
	Muscardinidae	Common African dormouse	*Graphiurus nagtglasii*	U				LC	U
	Procaviidae	Tree hyrax	*Dendrohyrax dorsalis*	I	R	A	ST	LC	U
Sirenia	Anomaluridae	Beecroft's flying squirrel	*Anomalurus beecrofti*	U				LC	U
		Derby's Anomalure	*Anomalurus derbianus*	U				LC	U

Order	Families	Common Names	Scientific Names	IT	Q	O	P	CS	PT
Artiondactyla	Tragulidae	Water Chevrotain	*Hyemoschus aquaticus*	D	IR	A,C		LC	D
	Bovidae	Bush buck	*Tragelaphus scriptus*	D	IR	A,B		LC	S
		Maxwell's duiker	*Cephalophus maxwelli*	D	IR	A,C		LC	D
		Sitatunga	*Tragelaphus spekei*	D	IR	B		**	
		Yellow-backed duiker	*Cephaloplus sylvicultor*	U				**	
	Suidae	Red River hog	*Potamochoerus porcus*	D	IR	A,C		LC	D
	Trichechidae	African Manatee	*Trichechus senegalensis*	U				V	U

IT= Impacts type; D = Directly impacted; I = Indirectly impacted; U = Un-impacted; R = Reversible impact; L = Long term impact; ST= Short term impact; M= Medium term impact; IR = Irreversible impact; C= Cumulative impact; = A= Simple impact; B=Residual impact; O= Other impact category; P=Duration of impact; Q=Reversibility of impact; CS = Conservation status; NT = Near threatened; V = Vulnerable; S = Stable; LC = Least concern; D = Decreasing; PT = Population trend; U = Unknown; I = Increasing; ** = Not yet been accessed but name is not in the catalog list of life; *** = Not yet been accessed but name is in the catalog list of life. The conservation status and population trend were based on IUCN, 2012.

Fig. 1: *Monkeys displayed for sale along the Wilberforce Island roadbefore the flood*

The ecosystem of Niger Delta is dominated by evergreen plants (trees), shrubs and herbs which belong to several families that share common habitat preference, physiognomy, function and structural adaptation [16]. The ecosystem of this wetland is frequently affected by several activities emanating from decisions that place alternative land use as a priority. The recent flood destroyed the natural rainforest ecosystem resulting to the loss of wildlife and vegetation. The major families of Wilberforce Island vegetation include Annonaceae, Potaliaceae, Lamiaceae, Moraceae, Portulacaceae, Soloanaceae, Costaceae, Asteracae, Myrtaceae, Araceae, Malvaceae, Marantaceae, Poaceae, Curcurbiataceae, Fabaceae,Rutaceae, Anarcadiaceae, Clusiaceae, Vapacaceae, Apocynaceae, Irvingiaceae, Arecaceae (Palmae), Potaliaceae, Mimosaceae, Melastomataceae, Oleandracceae, Amaranthaaceae, Tiliaceae, Verbenaceae, Dioscoreaceae, Euphorbiaceae, Caricaceae, Convolvulaceae, Musaceae, Lauraceae, Rubiaceae, Burseraceae, Asteraceae and Urticaceae (Moraceae). Wilberforce Island is characterized by five distinct vegetation/land use types which include forest reserve, home gardens, riparian forest, bush fallow and farm plots. The forest has stratified layers of shrubs and herbs comprising an upper and lower storey. The riparian forest was characterized by plants that have morphological and physiological adaptations to wetland conditions[27]. The entire Wilberforce Island could be broadly classified as freshwater wetlands. The bush fallow was characterized by light loving, fast growing species such as *Chromoneana odorata*. The common crops cultivated in farm plots and home garden include *Elaeis guineensis, Manihot esculenta, Dioscorea* species,*Colocasia esculenta, Citrus sinensis, Musa* species, *Psidium guajava*. The plants in Wilberforce Island are classified into Nanopharophytes (height below 2m), mesopharophytes (height between 8 – 30m) and Phanerophytes (tall trees) exceeding 30m in height. Most often mesopharophytes and phanerophytes are often regarded as trees. Nanophanerophytes are made up of herbs and shrubs including *Panicum maximum, Ageratum conyzoides, Colocasia esculenta, Aspilia africana, Pennisetum purpureum, Thaumatococcus danielii*, *Vernonia amygdalina* etc, while theshrubs includes *Chromolaena odorata*, *Capsicum annuum, Abelmoschus esculenta* etc. The Phanerophytes and mesopharophytes which are found at the fringes of most farm plots occupied the upper stratum and these trees include*Musanga cecropioides*, *Irvingia gabonensis, Mangifera indica, Psidium guajava, Elaeis guineensis,Cocos nucifera,* *Artocarpus heterophylla,* and *Citrus sinensis*. In the flora of Wilberforce Island, thirty one and six species were directly and indirectly impacted. The presence of *Harungana madagascariensis* in a site indicates that the flooding did not establish in that particular area perhaps due to the relative higher topography. This claim by the indigenous people is subject to further research.

Vegetation plays several diverse roles during extreme events. Phanerophytes impacted were selective. For instance, *Citrus sinensis* were seen flourishing after the flood whereas *Mangifera indica* dried up under the same water level, soil, environmental factors, and time (Fig. 2). *Musanga cecropoides* despite having buttress root system (Fig. 3), which make them to adapt to wetland conditions, could not survive the flood as all was observed dead (Fig. 4) in Wilberforce Island. Vegetation usually mollifies damage by dissipating energy of the flow, and by stabilizing banks and steep slopes against the erosive forces of overland flow [28]. The symptoms of vegetation under excessive water stress include yellowing of leaves, leaf curling, wilting, reduction of new leaf size, early fall, discoloration, defoliation. Some plants affected have the potential to recover from flooding injury in as little as one growing season while others might not recover at all. However, these stressed trees are more susceptible to microbial attacks such as cankers fungi and wood boring insects. During flooding, extreme moisture leads to reduction in oxygen levels thereby obstructing root respiration. This could increase carbon dioxide and other gases level around such plant root, consequently, leading to suffocation and death of the plant. This is so because photosynthesis is subdued.

Table 3 presents the height of the receding water marks on *Musanga cecropoides*, being the tree species exhibiting the hardest impacts. The water level that resulted to death of *Musanga cecropoides* ranged from 59.33 – 163.33 cm being significantly different in the sampling plots ($P< 0.05$). The water level of dying *Musanga cecropoides* ranged from 12.00 – 32.67 cm being significantly different among the plots($P< 0.05$). However, the water heights did not exceed the ground level in areas where the vegetation was relatively intact (i.e. un-impacted plants). The relative topography of the Wilberforce Island is depressed with some slight elevations in few sections, which may have resulted to the variation of water level among the plots studied. The relative differences in the heights of the water exhibited different impacts on *Musanga cecropoides*. Species of the plant occupying the greatest depressions suffered the worst impacts, being already dead at the time of the study in December 2012, whereas species occupying relatively higher position where un-impacted, but the species occupying moderate depressions i.e. locations between these two extremes are gradually dying (exhibiting visible signs of stress with the leaves drying up).Ohimain and Akinnibosun [29] classified *Musanga cecropoides* as facultative wetland plant with an ecological index value of 3 (index value of 1 being obligate wetland plant, while value of 5 represent upland plant). Musanga exhibits features of hydrophytic vegetation such as root stooling and buttress roots. It is therefore surprising why the flooding could adversely affect this plant. It can therefore be concluded that though the plant possess adaptation to survive under wetland conditions, they could become vulnerable to extended flooding events.

Table 3: *Heights of receding water marks on Musanga cecropoides in Wilberforce Island*

Plot #	Plant	Dead	Dying
	A	141.00±0.58y	22.00±0.58j
	B	147.33±0.88□	25.67±0.67lm
1	C	132.00±0.58xw	21.33±0.33ij
	D	136.33±0.33x	26.67±0.67mn
	E	143.33±0.33z	28.33±0.33op
	A	62.00±0.58b	17.33±0.33cde
	B	71.33±0.33de	15.67±0.67bc
2	C	73.33±0.33efg	19.67±0.33gh
	D	60.67±0.33ab	16.67±0.33cd
	E	65.33±0.33c	15.67±0.67bc
	A	164.67±0.33□	29.67±0.33pqr
	B	157.33±0.33□	27.33±0.33no
3	C	160.67±0.33□	31.67±0.33stu
	D	159.33±0.33□	30.33±0.33qrs
	E	163.33±0.33□	32.00±0.58tu
	A	90.33±0.33l	16.67±0.33cd
	B	87.33±1.20k	21.67±0.67j
4	C	88.00±0.58k	19.33±0.33fg
	D	98.00±0.58m	20.00±1.00ghi
	E	99.33±0.88m	21.67±0.67j
	A	124.33±0.33t	16.33±0.33c
	B	127.33±0.33u	18.67±0.33efg
5	C	131.67±0.88vw	19.67±0.33gh
	D	126.33±0.33tu	18.00±0.58def
	E	130.00±0.58vw	21.00±0.58hij
	A	76.33±0.33ij	14.67±0.67b
	B	71.67±0.33def	15.67±0.33bc
6	C	76.67±0.33j	18.67±0.33efg
	D	74.33±0.33ghi	16.00±0.58bc
	E	75.67±0.33hij	18.00±0.58def
	A	59.33±0.33a	12.00±0.58a
	B	65.67±0.67c	14.67±0.33b
7	C	70.33±0.33d	17.33±0.33cde
	D	62.67±0.33b	14.67±0.33b
	E	73.67±0.33fgh	18.67±0.33efg
	A	102.33±0.33n	26.00±0.58lmn
	B	105.67±0.33o	26.67±0.88mn
8	C	109.33±0.33p	29.33±0.33pq
	D	112.00±0.58q	29.67±0.67pqr
	E	110.67±3.67pq	25.00±0.58kl
	A	148.33±0.33□	21.00±0.58hij
	B	152.33±0.33□	23.67±0.33k
9	C	145.33±0.33□	24.67±0.33kl
	D	149.33±0.33□	27.33±0.33no
	E	156.67±0.33□	26.00±0.58lmn
	A	117.67±0.33r	29.00±0.58pq
	B	121.67±0.67s	28.33±0.33op
10	C	127.33±0.33u	31.00±0.58rst
	D	129.67±0.33v	32.67±0.33u
	E	125.67±0.33tu	27.00±0.58mno

Each value is expressed as mean ± standard error (n = 3). Different letters in each column indicate significant differences at $P< 0.05$ according to the Duncan Statistics.

High soil water heights greater than 3 inches might have impeded oxygen transport from the atmosphere to the roots of trees and shrubs that cannot withstand excessive water flooding despite being found in wetland areas. The nanophanerophytes, mesophanerophytes and phanerophytes seen drying after the flood have receded may be due to excess sediment which was accumulated at the base of the plant during the flood. On the other hand, the flooding exposed the roots of some trees due to soil erosion resulting to drying out and death of the plants. This was commonly noticed in *Musanga cecropoides*. Respiration is the plant physiological process most sensitive to flooding [30]. During flooding, extreme moisture leads to reduction in oxygen levels between soil and atmosphere thereby hindering respiration in the roots of the plants through reduction in root volume, water and nutrients transport from the roots to the shoot [30]. This might have enhanced the production of carbon dioxide, methane, hydrogen and nitrogen gas and production of butyric acid by microorganisms [31].Flooding can also cause the blockage of xylem and phloem vessels. The photosynthetic activities of such plants are subdued, which could lead to the death of the whole plant. During this process, leaf elongation stops whereas nitrogen, phosphorous and potassium concentration in leaves decline, while nitrogen, phosphorous and potassium concentrations in the roots increased [32]. This could be the possible cause of root injuries in the impacted plant species. The symptoms of the impacted flora include yellowing of leaves, leaf curling, wilting, reduction of new leaf size, early fall, discoloration, defoliation confirms impacts on the plants depending on species.

4. Conclusion

The 2012 flood event that occurred in Nigeria affected many states in the country with adverse impacts on infrastructure and basic amenities and the wildlife and vegetation of Wilberforce Island. The flood has contributed to loss of flora and fauna in Wilberforce Island. Most of the mammalian species had their habitat, breeding grounds and food source destroyed. Only the resilient avian fauna that could not fly for long distances were directly impacted by the flood. The flora impacted is mostly shrub and herbs which are food/ economic plants. Some of the trees impacted are important timber source used for building construction, canoe caving etc.

Majority of the impacted fauna are source of protein to humans, while the flora is a source of food and timber. Majority of the fauna impacted are of least concern [33]. The water level was quite high, submerging most shrubs and herbs. However, the study found out that despite some trees such as *Musanga cecropoides* having adaptation to wetland conditions, was the hardest hit by the flood. Also, the impact on plant were selective because *Mangifera indica* were also observed drying up whereas, *Citrus sinensis* that were found in the same area where flourishing after the floods.

Fig. 2: *Selective impacts of the water flooding on vegetation (notice dead mango on the left side, whereas orange on the right is healthy side; also observe the height of the receding water marks on the wall of the building at the background)*

Fig. 3: *Buttress roots of Musanga, a wetland adaptation feature*

Fig. 4: *Notice dead Musanga species while other vegetation in the fore ground and background are healthy*

Supplementary material Table 1: *Avian fauna of Wilberforce Island presented according to impact category*

Families	Common Names	Scientific Names	IT	Q	O	P	CS	PT
Numididae	Crested Guinea fowl	*Guttera pucherani*	D	IR	A,B		**	
Phasianidea	Scaly Francolin	*Franicolinus squamatus*	D	R	A	M	**	
Ralidae	White-spotted Flufftail	*Saarothrura pulchra*	D	R	A	M	**	
Nectarariniidae	Mouse-brown sun-bird	*Antherptes gabonicus*	U				**	
	Olive sun bird	*Nectarinia olivacea*	U				LC	S
	Yellow-bellied sun-bird	*Nectarinia venusta*	U				LC	S
	Olive-bellied sun-bird	*Nectarinia chloropygia*	U				LC	S
	Carmelite sunbird	*Chalcomitra fuliginosa*	U				**	
	Superb Sunbird	*Cinnyris superbus*	U				**	
	Copper Sunbird	*Cinnyris cupreus*	U				**	
Musophygidae	Green-crested turaco	*Tauraco persa*	U				LC	S
	Blue plantain eater	*Corythaeola cristata*	U				LC	S
Motacillidae	Yellow wagtail	*Motacilla flava*	U				LC	D
Meropidae	Swallow-tailed bee-eater	*Merops hirundineus*	U				LC	S
	Red-throated bee-eater	*Merops bulocki*	U				LC	S
	White-throated bee-eater	*Merops albicollis*	U				LC	S
Jacanidae	Lilly-trotter	*Actophilornis Africana*	U				**	
Hirundinidae	European swallow	*Hirundo rustica*	U				LC	D
	Fanti rough-winged swallow	*Psalidoprocne obscura*	U				LC	S
	Wire-tailed swallow	*Hirundo smithii*	U				LC	I
Glareolidae	Crocodile bird or Egyptian plover	*Pluvianus aegytius*	U				**	
Estrididae	Bronze manikin	*Lonchura cucullata*	I	R	A	M	LC	S
	Orange-checked waxbill	*Estrilda melpoda*	I	R	A	M	LC	S
	Anambra waxbill	*Estrilda poliopareia*	U				V	S
	Black and White manikin	*Lonchura bicolor*	I	R	A	M	LC	S
	Grey-crowed Negro-finch	*Nigrita canicapilla*	U				**	
Cuculidae	Klaass cuckoo	*Chrysococcyx klaas*	U				LC	S
	Black-throated coucal	*Centropus leucogaster*	U				LC	S
	Senegal coucal	*Centropus senegalensis*	I	R	A	M	LC	S
Corvidae	Pied crow	*Corvus albus*	U				LC	S
Columbidae	Laughing dove	*Streptopelia senegalensis*	I	R	A	M	**	
	Red-eyed dove	*Streptopelia semitorquata*	I	R	A	M	LC	I
	Blue-spotted wood dove	*Turtur afer*	I	R	A	M	LC	S
	Tambourine dove	*Turtur tympanistria*	I	R	A	M	LC	S
	Yellow-bellied fruit pigeon	*Treron waalia*	U				LC	D
	Green fruit pigeon	*Treron acalva*	U				LC	D
Charadriidae	Common sand piper	*Tringa hypoleucos*	I	R	A	L	**	
	White-headed plover	*Venellus albiceps*	U				**	
Bucerotidae	Black-casqued hornbill	*Ceratogymna atrata*	U				LC	D
	White-crested hornbill	*Tropicranus albocristatus*	U				LC	S
	Black-and-white tail hornbill	*Tockus fasciatus*	I	R	A	L	LC	U
	Pipping hornbill	*Bycanis fistulator*	U				**	
Ardeidae	Green-backed heron	*Butarides striatus*	U				**	
	Squacco heron	*Ardeola ralloides*	U				LC	D
	Grey heron	*Ardae cinerea*	U				**	
	Little eagle	*Egretta garzetta*	U				LC	I
	Great white eagle	*Egretta alba*	U				***	
Anatidae	White-faced tree duck	*Dendracygna viduata*	U				**	
Alcedinidae	White-bellied kingfisher	*Alcedo leucogaster*	U				**	
	Pigmy kingfisher	*Ceryx pictus*	U				**	
	Pied kingfisher	*Cerylx rudis*	U				**	
	Senegal kingfisher	*Halcyon senegalensis*	U				LC	S
	Blue-breasted King fisher	*Halcyon malimbica*	U				LC	D
Accipitridae	Lizard buzzard	*Kaupifalco monogrammicus*	I	R	A	ST	LC	S
	Black kite	*Milvus migrans*	U				**	
	Crown hawk eagle	*Stephanoaetus coronatus*	U				NT	D
	West African river eagle	*Haliaetus vocifer*	U				**	

Families	Common Names	Scientific Names	IT	Q	O	P	CS	PT
	Harrier hawk	*Polyboroides radiates*	U				**	
	Hooded vulture	*Neophron monachus*	I	R	A	M	***	
	Palm-nut vulture	*Cypohierax angolensis*	U				**	
Oriolidae	African golden oriole	*Oriolus auratus*	U				LC	S
	Black-headed oriole	*Oriolus brachyrhynchus*	U				LC	D
Picidae	Fire bellied woodpecker	*Mesopicus pyrrhogaster*	U				**	
Ploceidae	Orange weaver	*Ploceus aurantius*	U				LC	S
	Pin-tailed whydah	*Vidua macroura*	U				LC	S
	Grey-headed sparrow	*Passer griseus*	I	R	A	M	LC	S
	Village weaver	*Ploceus cucullatus*	I	R	A	M	LC	S
	Black-headed weaver	*Ploceus melanocephala*	I	R	A	M	**	
	Vieillots black weaver	*Ploceus nigerrimus*	I	R	A	M	LC	S
	Vitelline masked weaver	*Ploceus velatus*	U				LC	S
	Red bishop	*Euplectes orix*	U				LC	S
	Red-vented malimbe	*Malimbus scutatus*	U				LC	S
Psittacidae	Grey parrot	*Psittacus erithacus*	U				V	D
Pycnonotidae	Common garden bulbul	*Pycnonotus barbatus*	D	R	A,B	M	LC	I
	Little Green bulbul	*Andropadus virens*	U				LC	S
	Leaf love	*Pyrrhuru scandens*	U				**	
Turdidae	Fufous scrub robin	*Cercotrichas galactotes*	U				**	
Viduidae	Pin-tailed whydah	*Vidua macroura*	I	R	A	M	LC	S

IT= Impacts type; D = Directly impacted; I = Indirectly impacted; U = Un-impacted; R = Reversible impact; L = Long term impact; ST= Short term impact; M= Medium term impact; IR = Irreversible impact; C= Cumulative impact; = A= Simple impact; B=Residual impact; O= Other impact category; P=Duration of impact; Q=Reversibility of impact; CS = Conservation status; NT = Near threatened; V = Vulnerable; S = Stable; LC = Least concern; D = Decreasing; PT = Population trend; U = Unknown; I = Increasing; ** = Not yet been accessed but name is not in the catalog list of life; *** = Not yet been accessed but name is in the catalog list of life. The conservation status and population trend were based on IUCN, 2012.

Supplementary material Table 2: *Plants of Wilberforce Island presented according to impact category*

Families	Common Names	Local names	Scientific Names	IT	Q	O	P	Economic importance	Life forms
Urticaceae (Moraceae)	Umbrellatree	Afafa	*Musanga cecropoides*	D	IR	A,B	L	Food for monkeys/medicine	Tree
Asteraceae			*Tithonia diversifolia*	D	R	A	ST		
	Siam weed	Inegikuwogha	*Chromolaena odorata*	D	IR	A,B		Medicine	Herb
	Haemorrhage plant	Apalipo-itugo	*Aspilia Africana*	D	IR	A,B		Medicine	Herb
	Bitter leaf	Kiriologbo	*Vernonia amygdalina*	D	R	A	ST	Food, medicine	Shrub
Burseraceae	Butter fruit	Ube	*Dacryodes edulis*	D	R	A	L	Food	Tree
Rubiaceae	Ixora		*Ixora coccinea*	D	IR	A,B		Beautification	
Lauraceae	Avogadros pear	Beke-ube	*Persea Americana*	D	IR	A,B		Food	Tree
Musaceae	Plantain	Oyubo	*Musa paradisiacal*	D	R	A	ST	Food	Tree
	Banana	Beriba	*Musa paradisiacal var sapientum*	D	R	A	ST	Food	Tree
Convolvulaceae			*Ipomoea aquatic*	D	IR	A,B		Food	Vine
Caricaceae	Pawpaw	Pawpaw	*Carica papaya*	D	IR	A,B		Food, medicine	Tree
Euphorbiaceae	Cassava	Ababuru	*Manihot esculenta*	D	IR	A,B		Food	Herb
		Igbaragbara	*Macaranga barteri*	D	R	A	M	Food	
			Phylla anthusamarus	D	R	A	M	Medicine	Herb
	Rubber tree		*Hevea brasiliensis*	I	R	A	ST	Industrial	Tree
	Christmas bush	Ipain	*Alchornia cordifolia*	U				Medicine	Shrub
Dioscoreaceae	Yam	Buru	*Dioscorea* alata	D	IR	A,B		Food	Vine
		Kalakumu	*Hekistocarpa minutiflora*	D	IR	A,B		Medicine	Vine
Verbenaceae			*Lantana camara*	D	R	A	M		Shrub
Tiliaceae		kerere	*Corchorus olitorus*	D	IR	A,B		Food	
Amaranthaaceae	Green amaranth	Ikerere	*Amaranthus spinosus*	D	IR	A,B		Food	Herb
Marantaceae		Ute	*Marantochloa congensis*	I	R	A	M	Industrial	Tree

Families	Common Names	Local names	Scientific Names	IT	Q	O	P	Economic importance	Life forms
		Ute	*Marantochloa purpurea*	I	R	A	M	Industrial	Tree
	Miraculous fruit		*Thaumatococcus danieli*	D	R	A	ST	Industrial	Shrub
Oleandracceae			*Nephrolpis biserrata*	I	IR	A,B			Vine
Melastomataceae			*Melastomastrum capitalum*	U					
Mimosaceae	Sensitive plant	Igbenegbene	*Mimosa pudica*	U				Medicine	Vine
Potaliaceae	Cabbage	Osuwo	*Anthocleista vogelii*	U				Medicine	Tree
	Oil palm	Lii	*Elaeis guineensis*	U				Food	Tree
Arecaceae (Palmae)	Raffia palm		*Raphia hookeri*	U				Food	Tree
	coconut		*Cocos nucifera*	U				Food	Tree
Irvingiaceae	Ogbono	Bou-ogbointin	*Irvingia gabonegnsis*	U				Food	Tree
Apocynaceae	Stool wood	Kigbo	*Alstonia boonei*	U				Industrial/medicine	Tree
Vapacaceae		Ile	*Vapaca heudelotii*	U				Industrial / food	Tree
Clusiaceae		Ibisimo tin	*Pentadesma butryacea*	U				Food	Tree
		Bou-pulou	*Harungana madagascariensis*	U				Herb	Tree
Anarcadiaceae	Mango	Beke-ogboin	*Mangifera indica*	I	IR	A,B		Food	Tree
		Iginai	*Spondias mombin*	U					
Rutaceae	Orange	Alalanda	*Citrus sinensis*	U				Food	Tree
Fabaceae		Igbengi	Pterocarpus sp	U				medicina	Herb
Curcurbiataceae	Fluted pumpkin		*Telfaira occidentalis*	D	IR	A,B		Food	Vine
Malvaceae	Okra		*Abelmoschus esculenta*	D	IR	A,B		Food	Shrub
Araceae	Cocoyam		*Colocasia esculenta*	D	IR	A,B		Food	Herb
Myrtaceae	Guava		*Psidium guajava*	U				Food	Tree
Asteracae	Goat weed		*Ageratum conyzoides*	D	IR	A,B		Medicine	Herb
	Torpedo grass		*Panicum maximum*	D	R	A	ST	Food for livestock	Herb
Poaceae	Elephant grass		*Pennisetum purpureum*	D	R	A	ST	Food for livestock	Herb
	Sugar cane		*Saccharum officinarum*	I	R	A	ST	Food	Shrub
Costaceae	Bush cane		*Costus lucausianus*	D	IR	A,B			Herb
Soloanaceae	pepper		*Capsicum annuum*	D	IR	A,B		Food	Shrub
Portulacaceae	Water leaf		*Talinum trianglare*	D	IR	A,B		food	Herb
Moraceae	Bread fruit		*Artocarpus heterophylla*	U				Food	Tree
Lamiaceae	Scent leaf		*Ocimum basilicum*	D	IR	A,B		Food/medicine	Shrub
Potaliaceae	Cabage tree		*Anthocleista vogelii*	U					Tree
Annonaceae	Sour sop		*Annona muricata*	U				Food	Tree

IT= Impacts type; D = Directly impacted; I = Indirectly impacted; U = Un-impacted; R = Reversible impact; L = Long term impact; ST= Short term impact; M= Medium term impact; IR = Irreversible impact; C= Cumulative impact; = A= Simple impact; B=Residual impact; O= Other impact category; P=Duration of impact; Q=Reversibility of impact; CS = Conservation status; NT = Near threatened; V = Vulnerable; S = Stable; LC = Least concern; D = Decreasing; PT = Population trend; U = Unknown; I = Increasing; ** = Not yet been accessed but name is not in the catalog list of life; *** = Not yet been accessed but name is in the catalog list of life. The conservation status and population trend were based on IUCN, 2012.

Acknowledgement

The authors wish to thank Rohi Biotechnologies Ltd, and Sustainable Development Initiative, Port Harcourt, Nigeria for supporting this study.

References

[1] Hickey J T,Salas J D, 1995. Environmental effects of extreme floods. U.S.- Italy Research Workshop on the Hydrometeorology, Impacts, and Management of Extreme Floods Perugia (Italy), November 1995.

[2] Gardiner J 1995. Developing flood defence as a sustainable hazard alleviation measure. In: J. Gardiner, O. Starosolszky, and V. Yevjevich (eds.), Defence from floods and floodplain management, Kluwer Academic Publishers, Dordrecht, Boston and London, pp. 13-40.

[3] NachtnebelHP, 1995. Environmentally and socially sound utilization of floodplains; some Austrian experiences. In: J. Gardiner, O. Starosolszky, and V. Yevjevich (eds.), Defence from floods and floodplain management, Kluwer Academic Publishers, Dordrecht, Boston and London, pp. 539-554.

[4] Leentvaar J Stortelder PBM, 1995. The methods and mechanisms of establishing consensus on water management policy in the Netherlands.In: J. Gardiner, O. Starosolszky, and V. Yevjevich (eds.), Defence from floods and floodplain management, Kluwer Academic Publishers, Dordrecht, Boston and London, pp. 555-564.

[5] Obateru T,2012. 104 lives lost to flood in north central zone. Vanguard September 28, 2012. Pp 9.

[6] Obahopo B, 2012. Kogi moves to stop epidemics. Vanguard September 28, 2012. Pp 9.

[7] Ahon F, 2012. Flood victims find solace in Ughelli relief camp. Vanguard October 24, 2012. Pp 45.

[8] Ahon F, 2012. Food: 53,000 displaces, 11 communities submerged in Delta. Vanguard October 8, 2012. Pp 11.

[9] Ahon F, 2012. NGO rescues 12,300 trapped flood victims. Vanguard October 20, 2012. Pp 9.

[10] Ebegbulem S, 2012. Rag of River Niger: Edo communities cry out against ravaging flood. Vanguard September 28, 2012. Pp 20.

[11] Agbakwuru J, 2012. Rep weeps over displacement of 5,000 in C-River. Vanguard October 8, 2012. Pp 11.

[12] Osamor F U, 2012. Orubebe not cause of the flooding. Vanguard October 29, 2012. Pp 46.

[13] Edukugho E,2012. Devastating floods: Food scarcity loams. Vanguard October 20, 2012. Pp 10.

[14] Dangida A, 2012. Flood: Food prices soar in Jigawa. Vanguard October 26, 2012. Pp 8.

[15] Adingupu C, 2012. Up□ Up□□ goes price of staple food items. Vanguard October 20, 2012. Pp 13.

[16] Lameed G A, 2010. Potential impact on biodiversity in Kwale's forest reserve by power plant establishments. *African Journal of Food, Agriculture, Nutrition and Development*. 9(9): 1878 – 1900.

[17] Happold DC D, 1987. The Mammal of Nigeria. 1st Edition. Clarendon Press. Oxford. Pp. 8-17.

[18] Myers N, Mittermeier R A, Mittermeier CG, da Fonseca G AB, Kent J, 2000. Biodiversity hotspots for conservation priorities. Nature 403(6772): 853 - 858

[19] Hamadina MK, Otobotekere D, Anyanwu D I, 2007. Impact assessment and biodiversity considerations in Nigeria: a case study of Niger Delta University campus project on wildlife in Nun River forest reserve. *Management of Environmental Quality: An International Journal*. 18(2): 179 – 197.

[20] Jackman A, Bell S, 1979. Quantitative measurement of food selection. Oecologia 14, As in the Conservation Handbook; Research Management and Policy, by William Sutherland.: 413-417.

[21] Nyananyo BL, 2006. Plants from the Niger Delta. Published by Onyoma Research Publication.

[22] Okezie A I, Agyakwa C W, 1998. A Handbook of West African Weeds. Printed at INTEC Printers, Ibadan.

[23] Adiribe C C, Illoh H C, 2007. Plant Album. A Pictorial Collection of Plants in Nigeria. By S.O.S. Publications.

[24] Dorst J,Dendelot P, 1993. Larger Mammals of Africa. 2nd Ed. Collins, London.

[25] Jonathan K, 1997. The Kingdom Filed Guide to African Mammals. Academic Press Limited, London.

[26] Borrow N, Demcy R D, 2001. Birds of Western Africa. Helm Identification Guide. Christopher Helm London.

[27] Steentoft M, 1986. Vegetation in West Africa. In: Lawson, G.W. (ed.). Plant Ecology in West Africa. Systems and Processes. John Wiley, Chichester.

[28] Shroba R R, Schmidt P W, Crosby E J, Hansen W R, 1979. Geologic and geomorphic effects in the Big Thompson Canyon area, Larimer county: Part B in the Storm and flood of July 31-August 1, 1976, in the Big Thompson River and Cache La Poudre River Basins, Larimer and Weld counties, Colorado. U.S. Geological Survey (G.S. Professional Paper 1115), Washington, D.C.

[29] Ohimain E I, Akinnibosun H A, 2010. Hydrophytic vegetation indicators for wetland delineation in coastal swamp, southwestern Nigeria. *African Journal of Pure and Applied Science* 3 (1): 73 - 81

[30] Lauer J,2008. Flooding Impacts on Corn Growth and Yield. Agronomy advice, Field Crops 28.49-56. 2pp.

[31] Wesseling J,1974. Crop growth and wet soils. Van Schilfgaarde, J. (ed.). Drainage for agriculture. p. 7-37. American Society of Agronomy, Madison, WI.

[32] Ashraf, M,Rehman, H. 1999. Mineral nutrient status of corn in relation to nitrate and long-term waterlogging. Journal of Plant Nutrition 22:1253-1268.

[33] IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org. Downloaded on 25 February 2013.