

Flooding: An Environmental Problem in Built-Up Areas of Oyo Township

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Keyword:

Assessment, Built-Up areas, Flood, Flooding activities, Oyo Township.

Abstract

The paper assessed the activities of flood in built-up areas of Oyo Township. The assessment was based on the likely causes of flood, its effects on the Study Area and what could be the steps to be taken to control flooding activities in Oyo Township. Survey design was adopted and the study was descriptive in nature. Both primary and secondary sources of data collection were adopted. Structured questionnaire and personal observations were used and copies of the questionnaire designed were administered to 200 residents that were selected through clustered random sampling in the study area to collect primary information while secondary information were gathered from textbooks, magazines, materials downloaded from websites. The data gathered on the field were analyzed using frequency counts and simple percentage methods. The results of the findings were presented in tables. The result however, revealed that flooding in built-up areas of Oyo Township increases due to: natural factors in some ways and largely by anthropogenic factors (human factors). The factors responsible for flooding to occur are: Excessive rainfall; erection of buildings and structures along drainage channels; dumping of refuse on the drainage paths; poor construction, inadequate urban planning and higher proportion of the surface being concreted and the structure (hard nature) of the soil surface due to population increase which could not allow easy infiltration and absorption of rain water just to mention a few. In view of the above, recommendations were made: Environmental education should be organized for people to exhibit good attitude towards their environment, town planning laws and environmental regulations should be enacted and followed for effective planning of towns, people should be equipped with

adequate information about the seasonal variation in the volume of a river among others

Introduction

The ever increasing rate of population and search for technological development which is now common in Nigeria urban and peri-urban centres and some developing countries of the world have caused serious environmental problems among which flooding is well pronounced. Literarily, flooding is a large amount of water covering an area that is usually land. It is a natural re-occurring event, often caused by unusually intense precipitation, storm surges, and dam collapse resulting into a deluge. Flood is one the natural hazards that has devastating effects on lives and property. It is a condition that occurs when land that is usually dry is covered with water. It is a common environmental occurrence that regularly claims more than 20,000 lives per year and it also affects about 75million people world-wide (Smith, 1996). It occurs when water in a river overspills the banks , that is, at the bankful stage most especially during heavy rain. It means the river channel would have become full to its brim (Dury, 1963). When flood occurs, the water erosive power and its capability for load- carrying is greatly increased (Areola et al, 1980). There are varied forms of floods: Riverine or drainage-line floods, Flash floods which occur when the surface run-off turns into torrents, sweeping loose gravel, sand particles and fine dust down the hill side. These (floods) cut deep gullies and ravines forming bad land topography (Areola et al, 1980); Storm surge floods whose effect could be felt with water heights in excess of 8meters (NOAA, 2012; 2013). In some types of natural disasters, such as drought, floods affect urban as well as rural livelihoods. Floods (in all their forms) are growing more frequent (Parker et al, 2007) and in some cases reaching unprecedented size and impact, such as the Thai floods of 2011 (Komori et al, 2012). Flooding is among most affecting natural cum induced disaster in the world, claiming more lives and other natural phenomena. This is as a result of change in landuse associated with urban development which could be seen in many ways .In Nigeria, though not leading in terms of claiming lives, flooding affects more people than any other disasters. It also causes more damages to properties, farmland et-cetera.

In Nigeria, flooding has been perilous to people, communities, and institutions. By definition, flooding is a situation which arises when land that usually dries is covered with water, a river overflowing its bank during heavy rainfall.

Flooding occurs naturally on the flood plains, which are prone to disaster. It occurs when water overflows its banks or some result from constructed dam. One of the problems facing human being in present time is environmental problem and spatial flooding in a built up area. The urban areas are mostly concerned and it is simply due to ever increasing population of the urban centres. This is coupled with technological improvement in cities. Increase in built up areas reduces percolation and this in turn increases the rate of run-off which eventually results in higher volume of water in rivers, stream, dams et-cetera, and when the capacity of river banks is exceeded, excess water would flow into the surrounding areas.

According to Federal Environment Protection Agency (1991) Nigeria has undergone rapid socio-economic and physical development since year of independent (1960) but this rapid

development, as an achievement is coupled with some environmental problems out of which is flooding. Floods are large volume of water in places that are usually dry or usually contain less water. A flood is an overflow of an expanse of water that submerges land. Flooding is the most common of environmental hazards and it regularly claims over 20000 lives per and adversely affects around 75million people worldwide (Smith 1996) across the globe. Flood causes about one third of all death, one third of all injuries, and one third of all damages from natural disasters, (Askew, 1999). The change in landuse associated with urban development influence flooding in many ways. Removing vegetation (deforestation) and soil, grading land surface and constructing drainage networks increase run off to stream from rainfall and this automatically increases the water volume beyond the capacity of the river courses. Consequently, the peak discharge, volume and frequency of floods increase in nearby streams. Oyo town is also undergoing different types of development which other cities like Ibadan, Lagos, PortHarcourt et-cetera had undergone and which they are still undergoing. This development coupled with many environmental disasters out of which flooding is one have created a lot of environmental problems. As a result, the comparative observation of flooding in most big urban areas in Nigeria brings about the fact that Oyo Town is continually being affected with flooding activities . Most built- up areas being affected by flooding activities are not experiencing good health and peaceful living conditions, and since much has not been done to forestall the created problems by floods in Nigeria on the effective management and adaptation to the flood hazards and also on the preparation for potential future hazards according to Komolafe, et al 2015, it is on this ground that this environmental hazard is studied to examine the causes, the severity of its effects on socio-economic activities of people in the study areas and to suggest possible solutions to curb the problem of environmental degradation.

Aim and Objectives

This research aims at examining how susceptible are some built-up areas of Oyo Township to flooding. To achieve this aim, the following objectives are set:

- i. To identify causes of flooding in built-up areas of the study area.
- ii. To examine the identified causes of flooding
- iii. To identify the effects and danger posed by flooding on people and their activities in the study area.
- iv. To suggest the needed control measures against the devastating effects of the environmental hazard in question.

Research Questions

- i. What are the major causes of flooding in Oyo Township?
- ii. How has flood affected the economic activities of Oyo Township?
- iii. How has flooding problem in Oyo Township affected the level of communication and social interaction among people?
- iv. What are steps to take to curb the environmental problem?

Methodology

This paper assesses the rate of flooding in some areas in Oyo Township in terms of its causes and the effects of this on the environment. The respondents selected were people of the town. Some areas were sampled as clusters from which respondents were randomly picked for questioning. The areas selected are Akesan, Owode, Oroki, Akinmoorin and Oke–Eebo. Forty people were picked from each of the sampled areas resulting to two hundred respondents. Survey research design was adopted. Questionnaire and personal observation were used to collect primary data. Frequency counts and calculation of percentages were used to analyze the data collected which were presented in tables.

Oyo Town, a traditional town with phenomena activities in Oyo State, South Western Nigeria lies within Latitude $07^{\circ} 48' 00''\text{N}$ and $08^{\circ}22'00''\text{N}$ and Longitude $03^{\circ} 47' 00''\text{E}$ and $04^{\circ} 05' 00''\text{E}$. The region lies within 859834mn and 926523mn, and 590879m^E and 622152m^E on Universal Traverse Mercator projection. (Odedare and Adesayo 2014). It is found on undulating terrain of about 300 to 500m above sea level.

Potential Causes of Floods

In the results and analysis of Nwingwe and Emberga 2014 on the assessment of causes and effects of flood in Nigeria, many substantive causes of flood were mentioned such as: illegal structure on/ across drainage channels, inadequate drainage channel, poor physical planning, land reclamation/ encroachment blockage of canals/drains nature of terrain torrential rain storms, negligence, poor waste management, social/cultural activities, construction and reconstruction, illegal channelization of drainage channels among others. According to Ologunorisa and Tersoo 2006, a major cause of flood is attributed to extreme rainfall globally. This is seen in the studies done by Gobo (1988), McEwen (1989), Oriola (1994), Babatolu (1996), FMWRRD (1998), Odekunle (2001), Fowler and Kilsby (2003), and Ologunorisa (2004). Bariweni et al (2012) is of the belief that climate change could majorly influence the occurrence of flooding through heavy rain as even supported by Etuonovbe (2011) and Wright (2011) and rise in sea level. Welch et al., (1977) were of the opinion that flooding could become serious by increased amount of impervious surface or by other natural environmental problems like wildfires which lower the supply of vegetation which could lead to reduced water infiltration and absorption.

Etuonovbe (2011) also identified apart from heavy rain other causes of flooding such as ocean storm and tidal waves, silting, population pressure, deforestation, unplanned urbanization, neglect of warnings. It is even mentioned by Owen Akenzua (2018) in his work titled “Ravaging Flood across Delta State” in Tell Magazine that deforestation and/or urbanization could trigger runoff to become severe and hence the occurrence of flood, population growth and climate change are regarded as potential causes of flood. Komolafe, et al., (2015) are of the opinion that floods can be caused by both natural causes and through human activities, that is, man is the major culprit behind flooding in the process of his interaction with the environment. The aforementioned causes and others such as inadequate environmental infrastructure, poor waste management, unregulated urban expansion, lax implementation of

planning laws, acceptance of bribes and overlooking of issues by town planning officials which is attributed to corruption have been emphasized by Adaku in her work in 2021.

Major Effects of Flood

Bariweni, et al., (2012) and IFRC (2005) examine the typical effects of flood under three major subheadings; these are the primary, secondary and tertiary effects. The primary is in form of physical damage (bridges, cars building, roadways et- cetera) or casualties (people and livestock due to drowning). The secondary effects take the form of contamination of water, occurrence of diseases due to unhygienic conditions. These according to Watson et al, 2007; Huang et al, 2011, floods are considered as disasters that may damage water and sanitation systems or may prevent access to safe water sources. Interruptions to water and sanitation systems are a risk factor for increased levels of communicable diseases. Floods may themselves distribute sewage (Few et al, 2004). Overflowing sewage is a particular hazard in urban settings (Sanderson et al, 2012). Tertiary or long term effects which are seen in terms of economic hardship, rebuilding costs, food shortages and the attendant price increase among others. The danger of inundation to the surrounding plains during time of flood becomes progressively greater once the flood waters breach the embankments spreading widely over lower lying lands (Monkhouse, 1965). Floods are usually destructive especially during torrential downpours which may cause great damage and loss of life in a few hours. This was experienced in Lisbon in 1967. Floods may lead to impacts on the natural environment such as erosion and landslides. Kolawole, et al., (2011); Omeriobeole, (2015) pointed out the major negative results of flooding to include loss of human lives, submerging of residences and streets, municipal pollution, damage to properties, health hazards, cleanup cost, disruption of services, aesthetic discolouring, traffic obstruction, economic loss and infrastructural damage among others. Nigeria is said to have faced many environmental challenges among which is flooding which is considered to be the most serious with wide-reaching impacts (Adaku, 2020). It is even corroborated by Hart and Victor (2020) that many environmental problems are said to have been caused by inadequate and improper flow of water in urban areas such as pollution by heavy metals, organic materials, suspended materials and nutrients.

Needed Measures to Control Flooding

Control measures are methods that could be used to reduce or to curb the effects of floods. People have been practicing some methods in the past such as planting vegetation to absorb excess water, establishment of flood forecasting systems, drainage and dams' construction, adequate town planning measures et-cetera. Jeb and Aggarwal (2008) are of the opinion that reduction of flood risk will depend largely on the amount of information on floods that is available and knowledge of the areas that are likely to be affected during a flooding event. Study of climate and human interactions with the environment towards foretelling the occurrences of floods should be done by some agencies known as Early Warning. The use of modern methods is suggested by Aderoju, et al., (2012) such as remote sensing geographical information system (GIS) to investigate and map areas that are less or more vulnerable to flooding. Checking of dams, levees, flood walls and provision of adequate drainage systems

are also put up as measures that could control floods (Agbonkhese, et al., 2014). It is pointed out in the work of Hart and Victor, 2020 in which they used Terrestrial Surveying Techniques, Bathymetric Mapping and Hydrological Models to study storm water that the traditional way of handling storm water runoff from cities has always been to drain it as fast as possible by means of drainages.

Table 1: Showing the causes of flooding in the built – up areas of Oyo Township

CAUSES	FREQUENCY	PERCENTAGE
Excessive rainfall/Increased runoff	50	18.05
Indiscriminate refuse dumping on drainage channels	32	11.55
Erection of buildings on water shed, roads and culverts sides	58	20.94
Inadequate urban planning	30	10.83
Establishment of settlement along river channels	40	14.44
Presence of steep slope in the area	26	09.39
Inadequate environmental education	20	03.61
Poverty and Ignorance	11	03.97
Spreading over of sewage to distance locations	10	07.22
Total	277	100%

Source: Author's Fieldwork, June, 2021.

Following the first research question that demanded for the causes of flooding in Oyo, many responses were given such as excessive rainfall which accounted for 18.05% of the total respondents. This is in line with Nwingwe and Emberga, 2014; Bariweni et al, 2012; Areola et al; Parker et al, 2007 which they said caused the disastrous flood of Lisbon in 1967. It also gives credence to the works of Dury 1963; Monkhouse 1965. Eleven point fifty five percent of the respondents mentioned indiscriminate refuse dump in drainage channels which corroborates the work of Adaku 2021; Hart and Victor 2020. Ten point eighty three percent of the respondents mentioned inadequate urban planning which tallies with the opinion of Adaku 2021; Etuonovbe 2011 and Kolawole et al, 2011. Some respondents, that is, 14.44% said the establishment of buildings and other structures along river channels could cause flood in Oyo Township. Respondents also mentioned presence of steep slope in the area as a cause and this covered 09.39 percent while poverty and ignorance covered 03.97%. Inadequate environmental education was said to have accounted for 03.61 percent. Erection of buildings on watersheds, roads and culvert sides accounted for 20.94 percent, poverty and ignorance covered 03.97 while 07.22 percent of the respondents mentioned spreading over of sewage in the area as a cause.

Table 2: Showing the effects of flooding in the built – up areas of Oyo Township

EFFECTS	FREQUENCY	PERCENTAGE
Destruction of socio- economic activities.	30	15
Destruction of lives and properties.	32	16

Destruction of aesthetic postures of town through deposits of silt and garbage.	28	14
Surface deformation by erosion	30	15
Lack or reduction in the exchange of carbon-dioxide and oxygen in the soil thus affecting the effective growth of plants due to waterlogging.	30	15
Displacement or relocation of people	20	10
Outbreak of diseases	20	10
Spreading over of sewage to distant locations	10	05
Total	200	100

Source: Author's Fieldwork, June, 2021.

Research question number two examined the extent of the effects of floods in the study area. Fifteen percent of the respondents talked on the destruction of socio-economic activities in the study area. Another 16 percent said that flooding activities damaged lives and property. This tallies with the reports of the National Emergency Management Agency (NEMA) in which about 104 people were lost, 3800 homes, and 150,000 hectares of farmland were washed away according to Tell 2012; Parker et al, 2007. It is also in line with Areola et al, and with the findings of Akenzua, 2018. It also gives credence to the work of Emeriobeole, 2015. Fourteen percent of the respondents talked about the surface deformation by erosion and destruction of aesthetic postures of town through deposit of silt and garbage. Some said floods could cause the relocation of people or total displacement and this accounted for 10percent of the respondents. This corroborates the reports of the State Emergency Managements Agency (SEMA) in TELL 2012 that 69,186 people including pregnant women and children were displaced by flood which affected six Local Government Areas in Taraba State. Ten percent said that floods could trigger the spread of diseases and this is in line with the work of Bariweni et al, 2012 and IFRC 2005. It also conforms with the works of Huang et al 2011; Watson et al 2007.

Table 3: Showing steps to control floods.

S/N	RESPONSES	FREQUENCY	PERCENTAGE
	Adequate weather reports to be said out on radio and/or television	26	13
	Adequate warning to be adopted	20	10
	Good and strong retaining drainage walls to be constructed for effective movement of water	40	20
	People to be equipped with adequate information	30	15
	Afforestation to be encouraged	10	05

Environmental education to be organized	60	30
Laws to be enacted regarding planning of towns	14	07

Source: Author's Fieldwork, July, 2021.

Solution to control floods

Question was even asked on the steps to take to reduce the effects of floods in the study area. Multiple responses were given by the respondents. The responses were: having adequate weather reports which was embraced by 13 percent of the respondents which was mentioned to be said out on radio and/or television; 10 percent of the people interviewed said adequate warning and weather forecast should be adopted; good and strong retaining drainage walls were said to be constructed for effective movement of water which covered 20 percent of the total respondents. This is in support of Hart and Victor 2020; IFRC 2005. Fifteen percent of the respondents said people should be equipped with adequate information about the seasonal variation in the volume of a river. This corroborates the opinion of Areola et al, 1980. Afforestation was said to be encouraged by 5 percent of the respondents on steep slopes to reduce water transportation and erosion as opined by Monkhouse 1965. Thirty percent of the respondents said environmental education should be organized for people to exhibit good attitude towards their environment. By and large, town planning laws and regulations were said to be enacted and followed for efficient planning and control of towns by 7 percent of the respondents. All these are in line with the works of Jeb and Aggarwal 2008; Agbonkhese 2014 and Aderoju et al, 2012.

Conclusion

In conclusion, there is urgent need for a collaborative effort on both government and people to support town planners and other professional agencies to combat flooding in the built-up area of Oyo Township to avoid its long range consequences. As for individual dwellers of Oyo Town and other flooding prone areas, people need to develop the habit of creating drainage channels that are wide enough to meet the future requirements also, people should discourage dumping of municipal waste along the drainage channels. The media should also assist in educating the public on the consequence relating to flooding action.

More so, people should have it at the back of their mind even without being chased by town planners that it is not encouraging to erect buildings very close to river channels. Remember that "The environment remains our most valuable possession and legacy which we must all try to protect, let us all join hand in protecting our common interest".

Recommendations

- i. Government should organize mass/public enlightenment programmes to equip people with adequate information needed on how to interact with their environment.
- ii. The city municipal waste should be thoroughly monitored by environmental management agencies so that wastes are dumped in the appropriate place.

- iii. There should be creation of water channels in areas needed and they must be maintained to avoid blockage.
- iv. Agencies awarding contracts for construction of dams and other infrastructural facilities should insist on high quality work in the construction of those structures.
- v. Government should employ more competent personnel especially those with adequate knowledge of urban planning.
- vi. Government should also intervene by legislating against indiscriminate land use in river flood plains.

REFERENCES

- Adaku, J. E. (2021). Nigeria has a Flooding Challenge: Here's Why and What Can Be Done. The Conversation. <https://doi.org/10.1080/20964129.2020.1791735>.
- Adaku, J. E. (2020). The Impact of Flooding on Nigeria's Sustainable Development Goals. <https://doi.org/10.1080/20964129.2020.1791735>.
- Aderoju, O. M., Jantiku, J., Fagbemiro, O. A., Aliyu, I; Nwadike, B. K., Ajonye, S. E; and Salman, K. S. (2012). "Geospatial Assessment of 2012 Food Disaster in Kogi State, Nigeria" *Journal of Environmental Science, Toxicology and Food Technology*, Volume 8, Issue 2 Ver. IV, PP 74-84.
- Agbonkhese, O; Agbonkhese, E. G; Aka, E. O; Joe-Abaya, Oholi, J. M, and Adekunle, A. (2014). Nigeria: A preliminary Report" K.N Momim, Plymouth Road, Michigan pp 38-42.
- Areola, O. and F. O. Akintola (1980). Managing the Urban Environment in Developing Cities, Nigeria. *Environment International* 3.3: 237-241.
- Askew, A. J. (1999). Water in the International Decade for Natural Disaster Reduction: In Leavesley et al (Eds), *Destructive Water: Water-Caused Natural Disaster, their Abatement and Control*. IAHS Publication. No. 239.
- Babatolu, J. S. (1996). Recent Changes in Rainfall Patterns and its Implication for Flood Occurrence in Ondo, Nigeria. *Ondo Journal of Arts and Social Sciences* 1 (1):125-136.
- Bariwani, P., Tawari, C., & Abowei, J. (2012). "Some Environmental Effects of Flooding in the Niger Delta Region of Nigeria" *International Journal of Fisheries and Aquatic Sciences*. 1 (1): 35-46
- Bariwani, P. A., Tawari, C. C. and Abowei, J. F. N. (2012). Some Environmental Effects of Flooding In the Niger Delta Region of Nigeria. *International Journal hydrological cycle and weather patterns as well as giving appropriate advice to the government*.
- Dury G. H. (1963). Rivers in Geographical Teaching. Geography, pp 18-30 vol. XLVIII In: Harry Robinson (1979) *Morphology and Landscape*. University Tutorial Press LTD.
- Emeribeole, A. C. (2015). Managing Flood Disasters in Nigerian Cities: Issues and Strategies towards Meeting the Challenges in the Modern World, a Case Study of Owerri Metropolis Imo State Nigeria. FIG Working Week, Bulgaria, 17-21.
- Etuonovbe, A. K. (2011). The Devastating Effect of Flooding in Nigeria. *Hydrography and the Environment Innocent Chirisa, Zimbabwe Inclusive instrument in Epworth, Zimbabwe FIG Working week. Bridging the Gap between Cultures Marrakech, Morocco*, 18-22 May 2011.
- FEPA (1991). Guidelines and Standards for Environmental Pollution Control in Nigeria. Federal Environmental Protection Agency, Lagos.
- FMWRRD (1998). Managing Flood Problems in Nigeria. *Federal Ministry of Water Resources and Rural Development (FMWRRD)* October, 1998.
- Fowler, H. J; Kilsby, C. G. (2003). Implications of Changes in Seasonal and Annual Extreme Rainfall. *Geophysical Research Letters* 30(13):17-20.
- Gwary, D. (2008). Climate Change, Food Security and Nigeria Agriculture. *Paper presented at the workshop on the challenges of climate change for Nigeria*. NISER 19th -20th May, 2008.
- Gobo, A. E. (1988). Relationship Between Rainfall Trends and Flooding in the Niger-Benue River Basin. *The Journal of Meteorology* 13(132). 318-324.
- Hart, L and Victor, G. U. (2020). Modelling of Basic Environmental and Spatial Parameters: An Imperative for an Optimal Design of an Urban Storm Water Canal in Greater PortHarCourt Development Area. *Journal of Geosciences and Geomatics*. Vol.8 No.2, 76-82.
- IFRC (2005). Nigeria: Floods, IFERC Information Bulletin No 1 August 29, 2005, Relief web Map Center, United Nations

- Jeb, D. N. and Aggarwal , S. P. (2008). “Flood Inundation Hazard Modeling of the River Kaduna Using Remote Sensing and the Geographic Information Systems”, *Journal of Applied Sciences Research*, 4 (12), pages 1822-1833
- Komolafe, A. A; Adegboyega, S. A. and Akinluyi, F. O. (2015). “A Review of Flood Risk Analysis in Nigeria” *American Journal of Environmental Sciences*, 11 (3): 157-166 Analysis and Adaptation Options –Ilorin as a Case Study” Scholars Research Library, Vol. 3, No. 1, 2011, pp. 17-24.
- McEwen, L. J. (1989). Extreme Rainfall and Its Implication for Flood Frequency: A Case Study of the Middle River Tweed Basin, Scotland. *Transactions of the Institute of British Geographers* 14 (3):287-298.
- Monkhouse F. J. (1965). Principles of Physical Geography. Great Bntain. University of London Press LTD.
- NOAA (2013). Types of flood. National flood Safety Awareness Week, March 18-22,2013. *US National Oceanic and Atmospheric Administration (NOAA)*.
- Nwingwe, C. and Emberga, T. (2014). An Assessment of Causes and Effects of Flood in Nigeria. *Scientific Research and Essay*. Vol. 2(7), 307 -315.
- Odedare, K. O., and Adesayo, T. O. (2014). Location of Oyo region Pp 9-13.
- Odekunle, T. O. (2001). The Magnitude and Frequency Characteristics of Rainfall in Ondo, Sourth-Western Nigeria. *Ife Research Publication in Geography* 8:36-41.
- Ologunirisa, E. T. (2004). Rainfall Flood Prediction in the Niger Delta, Nigeria (*Abstract*),
- Ologunorisa, T. E. and Tersoo, T. (2006). The changing Rainfall Pattern and Its Implication for Flood Frequency in Makuridi, Northern Nigeria. *Journal Appl. Sci. Environ. Mgt.* 10(3):97-102.
- Oriola, E. O. (1994). Strategies for Combating Nation: A Case Study of Ondo, Nigeria. *The Environmentalist* 14:57-62.
- Owen Akenzna (2018). Ravaging Flood across Delta State. In: Tell Magazine, July 9, 2018.
- Smith, K. (1996). Environmental Hazards; Assessing Risk and Reducing Disaster. 2nd edition. London; Routledge.
- Welch, H. E., P. E. K. Symons and D. W. Narver. (1977). Some Effects of Potato Farming and Forest Clear Cutting on New Brunswick Streams, Fisheries and Marine Service Environ. *Canadian Technical Report No. 745*. St. Andrew’s New Brunswick.
- Woodworth, H. G. (2014). Tsunami! Tidal Waves and other Extreme Waves.
- Wright, T. (2011). “Waterlogged: Pakistani Children Push a Motorbike through Flooded Streets after Rain in Lahorerin” *The Wall Street Journal London*.