REVIEWING THE ARGUMENT ON FLOODS IN URBAN AREAS: A LOOK AT THE CAUSES

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Abstract
The paper reviewed literature on the causes of floods in urban areas in order to establish direct links between the "causes" and "floods" using the city of Accra, Ghana as case study site. The systematic review process was used and involved 45 reports and peer reviewed literature 64% of which was based on work done in developing countries. The causes of floods were skewed towards finding solution to perennial floods in developing countries as against addressing secondary effects of floods in developed countries. There was lack of precision in describing the causes of floods. No common vocabulary was found in expressing the causes of floods, some of the phrases used were ambiguous, and the linkages to floods were either assumed or not clear. The review identified 24 causes of floods out of which 12 scored more than 10%. Heavy rainfall was the most frequently cited cause (62%) followed by urbanization 40%, inadequate drains 33%; poor waste management 31%, unplanned growth 24%, storm surge 24% and failure of infrastructure 22%. Other causes included poor engineering 16%, weak law enforcement 16%, development in flood plains 13% and poor maintenance of drains 11%. Climate change was cited by only 9% but its possible impact on urban development could be far reaching. The causes of floods were grouped into direct such as intense rainfall, increased imperviousness, and inadequate drainage. Indirect causes included poor waste management, sedimentation, construction in low laying areas, etc. Interventions to address flooding were suggested based on the three direct causes.
Keywords: floods, direct causes, indirect causes, urbanization, imperviousness, sedimentation, poor drainage

1. INTRODUCTION

Another year, season has begun with the never ending cycle of death and destruction from floods in urban and rural areas in the tropics. The latest record shows that there were victims from the rain event on the night of Sunday, 7 April, 2019 in the city of Accra Ghana, one of several tropical urban centers suffering from perennial floods. The numbers may not be significantly large; five lives were lost but similar earlier events in the year have already claimed lives too and the season is just about to begin when one could expect more torrential rains and more lives to be lost. Then political authority will again take notice and make fine speeches about what has been done and is being done to address the perennial menace, most of which unfortunately will remain lip service as they do not seem to posses the political will to take the necessary action(Twumasi, 2002), preferring rather to adopt adhoc measures to addressing the problem(Tengan, 2016). Frick and Bruns in an extensive review of policy documents on floods identified a major gap between what is stated in policy documents and what is actually

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implemented on the ground to address the problem of perennial floods(F. a. B. Frick-Trzebitzky, Antje, 2017). But so far what has been the contribution of research to finding a solution to the problem whilst the politicians and technocrats wait for the next season to begin. Several papers have been written about floods in urban areas both in the developed and in developing countries(N. and Lamond Bhattacharya-Mis, J., 2011; F. Frick-Trzebitzky, 2018; Jha, 2012; Karley, 2009b; NRC, 2009; Rain, 2011; UNEP/OCHA, 2011). But none seems to establish clear and strong links between the "causes" and "floods" in urban areas. This paper reviews some of the literature on urban floods from the perspective of the "causes" and attempts to establish a direct link with floods. The paper will argue that although the role of climate change in the increased incidence of floods is not very clear based on present records(Z. Kundzewicz et al., 2012a), there is a potential for climate change to worsen the problem. The paper takes the position that popular use of engineering approach alone to address flooding issues in urban areas in developing countries is not sustainable and is indeed worsening the problem and suggests interventions to address the challenge based on key identified causes.

2. METHODOLOGY

The research adopted the city of Accra in Ghana as a case study. Accra is one of the fastest urbanizing cosmopolitan areas in West Africa with a population density of 1,235.8 persons per sq km (GSS, 2014; Programme, 1991; Services, 2014) and is well suited as a case study because of its dense population, serving as an economic hub for the West African Sub-region. The city is part of a collection of urban centers called Greater Accra Metropolitan Area (GAMA) with similar characteristics and challenges as other developing urban centers in Africa and Asia.

The Systematic Review approach was used to review literature from both documented and undocumented sources - The systematic review process is an established system of Literature review used to synthesize published and grey evidence material to identify key factors and use the evidence to inform policy(Kamwamba-Mtethiwa, 2016, p. 310). To carry out a systematic review the following procedural options were considered.

The systematic review based on (Kamwamba-Mtethiwa, 2016) involved the definition of the research question, drafting a protocol to define methodology and screening of the literature. In defining a research question, the research was set up to answer the "how and why" stormwater management to control floods have failed by reviewing the causes of floods in urban areas. Screening of the literature was done by first considering the titles and then the abstracts for keywords and phrases like 'flood', 'causes of floods', 'floods in urban areas' etc. Major sources used included published and unpublished literature from internet sources such as Google search engine, Google Scholar, Research-gate and

relevant peer reviewed literature sources like Water, Sustainability (Multidisciplinary Digital Publishing Institute MDPI), Natural Hazards and Earth System Sciences, Journal of Environmental and Earth Sciences, Conference Proceedings, etc,. There were about 2760 hits from the peer reviewed journals and over 13 million hits from the internet. Out of these only 45 cases were found to contain relevant material. The phrases and words identified as causes of floods were coded and their frequency of occurrence in each reviewed literature source calculated in percentage.

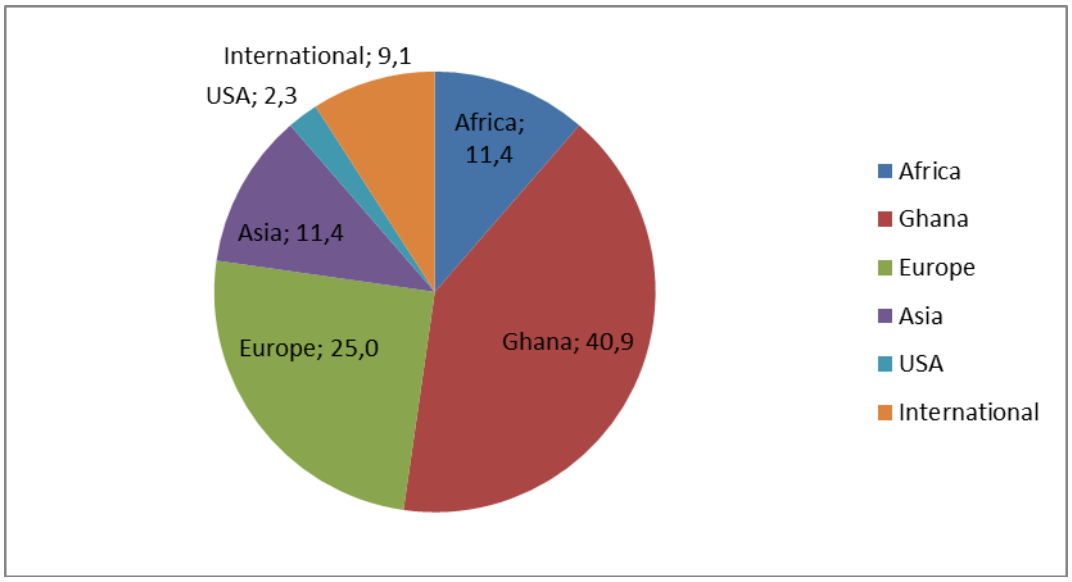

FIGURE 1 - GEOGRAPHICAL DISTRIBUTION OF CASES IDENTIFIED IN THE LITERATURE REVIEW

3. RESULTS

Sources - About 64% of the materials reviewed were based on work done in developing countries in Africa and Asia. The rest were mainly from Europe with only a small proportion from USA (Fig.1).

Causes of Floods - The 45 literature sources reviewed identified 24 factors which causes floods, out of which 12 scored more than 10%. The frequency of occurrence of these causes in the 45 literature sources is summarized in Figure 2.Among the causes of floods, heavy rains were the most frequently cited, representing 62%. Increased imperviousness caused by urbanization came next with 40% followed by inadequate or poor drains 33%, poor waste management which led to blockage of drains 31%, unplanned and haphazard development 24%. Luck of drainage facilities was the least cited as a cause of floods (2%). Climate change was considered by only 9% of the literature sources as a direct cause of floods.

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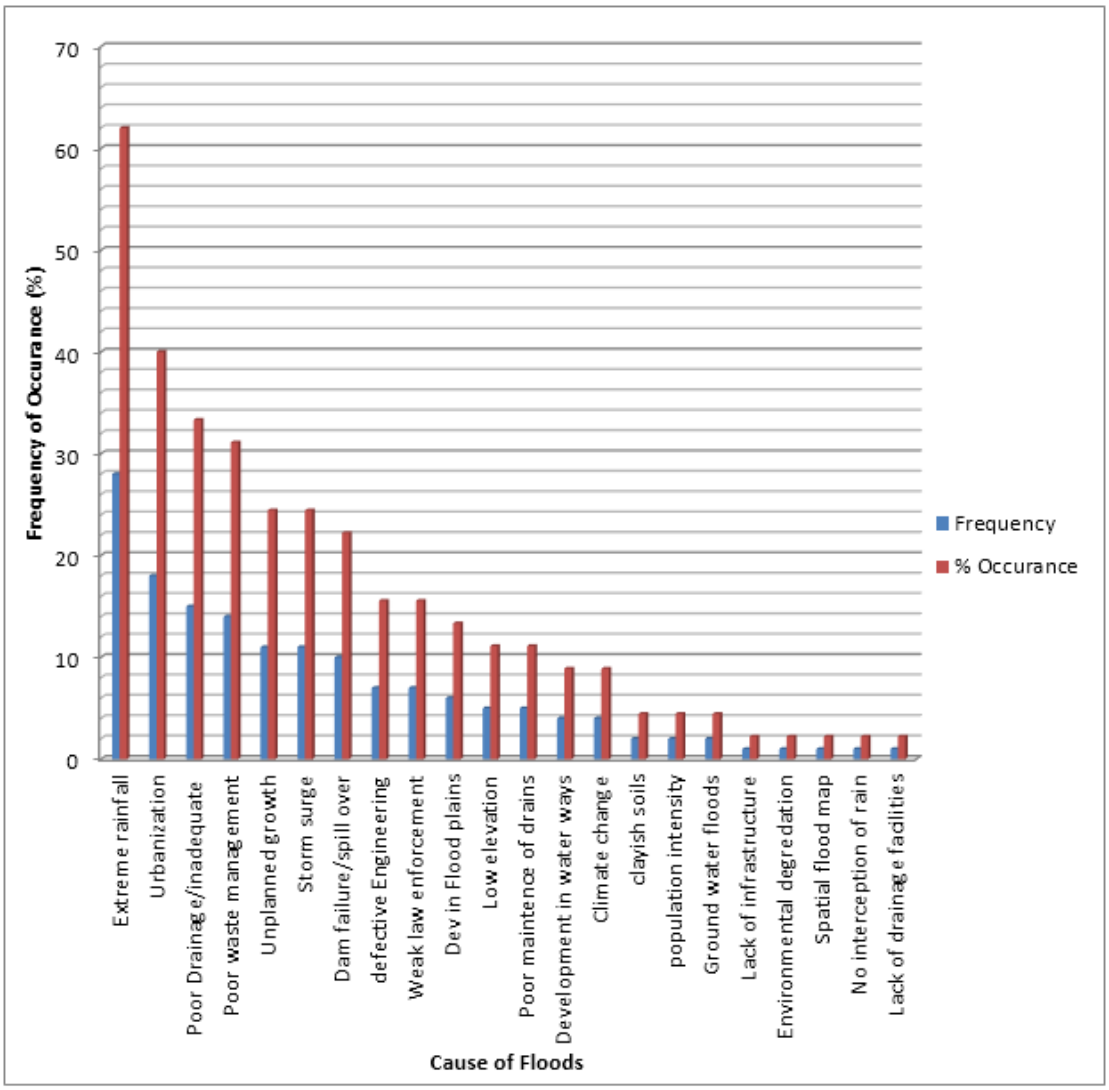

FIGURE 2 - SUMMARY OF THE MAIN CAUSES OF FLOODS

Other causes of floods included failure of infrastructure 22%, defective engineering 15.6%, development in flood plains 13%, low elevation of urban areas 11%, poor maintenance of drains 11%.

4. DISCUSSIONS

A large percentage of the literature reviewed (about 64%) were from developing countries in Africa and Asia where a wave of urbanization has resulted in fast land cover change and attendant challenges(Rain, 2011; UN-Habitat, 2012). The link to floods is made by a number of authors who have suggested that a lack of systematic approach to the challenge of rapid urbanization due perhaps to a poorly educated population is worsening the problem of floods in urban areas in developing countries(ActionAid, 2006; N. and Lamond Bhattacharya-Mis, J., 2011). This has seen floods transformed into the number one natural disaster in Africa, especially in urbanized areas(N and Lamond

Bhattacharya-Mis, J., 2011). From the results of the review, the literature from developing countries dominates and seems to focus more on the causes of floods because those were seen as the most foundational analysis to a possible solution to the perennial floods challenge. This contrast with developed countries where the literature on floods looks more at the secondary effects of floods like contamination of the environment and spread of infectious diseases (Z. Kundzewicz et al., 2012b). There was no uniform vocabulary for describing the causes of floods across the literature creating a number of ambiguities and in some cases the link between the cause and incidence of floods were not clear. Also most literature sources only listed the causes of floods but did not follow it up with any extensive discussions to show actual link to floods. Some of the causes were conflicting and did not seem to have any direct bearing on floods, others though were clear. For instance inadequate spatial information on flood prone areas was cited by(Tengan, 2016) as a cause of floods but no further explanations were given. Frick and Cirella et al only listed population dynamics as one of the causes of floods(Cirella, 2019; F. Frick-Trzebitzky, 2018) but its link to floods was made by (Ahadzie, 2011, p. 228) in a different paper, where it is explained that rapid population growth especially in urban areas has generated haphazard development which destroys the integrity of the landscape to accommodate large volumes of runoff to avert floods.

5. EXTREME RAINFALL

Extreme rainfall was the most cited cause of floods making up 62% of the literature reviewed and different expressions were used to express this such as short extreme rainfall, extreme rainfall, heavy rainfall, heavy and intense rainfall, heavy storms (Amoako, 2015; Asumadu-Sarkodie, 2015; Atuguba, 2006; N and Lamond Bhattacharya-Mis, J., 2011; Gyekye, 2011; Hilly, 2018; Jha, 2012; Tiepolo, 2014; Twumasi, 2002), heavy down pour, torrential rains(Ahadzie, 2011). Some like Tapia et. al. (2017) cited in (Kaendler, 2018) and (OPW, 2009) linked intense rainfall to floods through surcharge of urban drainage systems, or high antecedent moisture conditions(de Bruijn, 2019). These phrases were used in the literature to express rainfall and duration in a qualitative form with no quantitative evaluation. The only exception is (Itsukushima, 2018) who reported an intense rainfall exceeding 100mm in 1h as the cause of floods. However other writers (Amoako, 2015, p. 8; Andjelkovic, 2001b, p. 2; Douglas, 2008, p. 188) explain that under current urban conditions, especially in Africa the duration of a rain event does not matter, as it could be short and intense or above an hour and moderate, yet produce enough runoff from impervious surfaces and drains to trigger floods. This is actually characteristic of the rainstorms common in Africa and other tropical climates where short intense rain events results in flash floods that generate fast moving runoff which carry debris and with increased volume is usually violent, causing

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destruction to life and property as it careens through the urban center(Douglas, 2008; Twumasi, 2002). Douglas et al further explain that unlike other forms of climatic events, flash floods which results from localized storms are caused by events which are hard to detect and predict using technology. This is because it is usually influenced by "urban heat island effect"(Douglas, 2008) which is directly related to increased imperviousness from urbanization.

6. URBANIZATION

Urbanization was the second most cited cause of floods. Kaendler et al considers urbanization as the cause of floods and links it to intense rainfall (Kaendler, 2018). Bhattacharya and Lamond discussed massive urbanization and its impact on flooding in urban areas(N and Lamond Bhattacharya-Mis, J., 2011), Itsukushima implicates urbanization by referencing 20% increase in urbanized surfaces in an urban area within a 20year period and how this has affected infiltration leading to floods (Itsukushima, 2018). Similarly, Oguntala links urbanization to lower infiltration resulting in floods(Oguntala, 1982b). Other researchers like Hilly et al links urbanization to high discharge of stormwater runoff resulting in floods(Hilly, 2018), expansion of urbanized surfaces which reduces permeability (OPW, 2009), urbanization as a cause of floods(Z. Kundzewicz et al., 2012b). Urbanization is defined as "the percentage of a basin which has been developed and improved with channelization and or a stormwater collection network"(ISWM, 2010, pp. HO-35) or the land area occupied by man-made structures such as roads, roofs, towns etc., (Scholz, 2004, p. 197), rock-outcrops and compacted soil (Rain, 2011). The aspect of compacted soil is interesting as compared with developed countries, there is less imperviousness per unit area in developing countries(Parkinson, 2005, p. 6), yet the problem of floods continue to worsen. A number of writers (Bhattacharya, 2010; Douglas, 2008; Oguntala, 1982b) have written about the role of compacted soils in runoff generation in developing countries. They explain that bare soils become compacted due to urban activities, affecting the structure of the top 150-200 mm of the soil. This goes on to affect the infiltration capacity of soils, altering the flow path of surface runoff towards receiving natural storage structures, leading to higher runoff generation. Where urbanization has been rapid, the impervious surfaces limits infiltration and storage of stormwater generated runoff in the landscape(Douglas, 2008; Oguntala, 1982a). Liu et al continued that urbanization results in the replacement of pervious surfaces with impervious surfaces such as roofs of buildings, roads, paved walks and drives, parking lots, sidewalks, as a result of which rainfall generated runoff which will normally be stored to infiltrate or intercepted is not able to but run over the surface of the soil as runoff. Where urbanization has resulted in extensive impervious surfaces, more runoff is generated in terms of volume, taking a very short time to accumulate ("peak flow") and to move from one end of a

watershed to the other ("time to peak"). A classic example is found in the city of Accra where it is common for developers to "fill" and pave entire compounds in a bid to 'improve' the environment, adding to the expanse of concrete surfaces(Abeka, 2014, p. 109). Urbanization also results in channelization of drainage systems where previously natural drainage systems are made drainage efficient by concrete lining, forward "slopes made more uniform", curves and other obstructions removed to ensure a smooth and quick discharge of stormwater generated runoff (Liu, 2015; Raghunath, 2006). "These changes" results in large volumes of stormwater runoff being generated(Raghunath, 2006), which the urban landscape is not able to contain, resulting in floods. The situation is made worse when a fast growing urban population is forced to seek shelter, creating unregulated, unstructured, and uncontrolled development in areas prone to flooding. Such development has the added effect of reducing infiltration of stormwater generated runoff leading to runoffs six time higher than that which occurred prior to the invasion(ActionAid, 2006; N. and Lamond Bhattacharya-Mis, J., 2011). The results is an urban area which generate such large volumes of runoff from impervious surfaces that the existing poor drainage facility is overwhelmed, resulting in floods (Fig. 3).

FIGURE 3 - IMPACT OF LARGE VOLUME FAST MOVING STORMWATER RUNOFF ON A STORM DRAIN IN ACCRA.
Source: Author

Inadequate Drainages

Lack of drainage facilities, the least cited cause of floods (2%) and inadequate or poor drainage, the third most cited (33%) are ambiguous expressions which seem to express the same idea. In some of the literature, inadequate drainage system was mixed up with poor maintenance and sedimentation from massive soil erosion causing blockage (Karley, 2009b), or under sized drains which causes floods when it is silted-up or blocked with solid waste (Twumasi, 2002). Inadequate drains as a cause of floods is also listed by (UNCT-Ghana, 2015) but its exact meaning is not given. Amoako uses the expression “insufficient drainage next-work” and implies that this becomes a cause of floods when it is “clogged” by solid waste(Amoako, 2015). (Frimpong, 2014) used inadequate drainage system to refer to absence or

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insufficient number of conduits and channels. ILGS, Bhattacharya and Lamond lists "inadequate drains" as a cause of floods but relates it to drains not being sufficient in extent and carrying capacity (N and Lamond Bhattacharya-Mis, J., 2011; ILGS/IWMI, 2012). Abraham et. al. associate drainage systems as a cause of floods with "missing or obstructed" drains, "insufficiency of stormwater drains" or "under capacity drains" (Abraham, 2006) while WAVIN associates drainage and floods with insufficient capacity to carry stormwater runoff (WAVIN, 2017). Poor or inadequate drains is also listed as a cause of floods by several other authors (Z. Kundzewicz et al., 2012b; Miller, 2017; Okyere, 2013; Tengan, 2016; Xeflide, 2007) but no explanation is given on its actual link to floods.

Poor Waste management and Siltation of drains

Poor waste management was identified by 31.1% of the literature reviewed as the cause of floods. The argument is that urban areas generate a lot of waste, especially solid waste most of which is not properly disposed of (Fig. 4), resulting in blockage of drains(F. Frick-Trzebitzky, 2018) and eventually floods. A similar view is shared by (Oguntala, 1982a) that solid waste combine with silt wash into drains to reduce the capacity of drains, resulting in floods.

FIGURE 4 - SOLID WASTE DUMPED ALONG THE SHOULDERS OF A WATER COURSE IN THE CITY OF ACCRA.
Source: Author

This suggests that the waste generated at homes, market places, industrial areas, along the streets and those haphazardly dumped at waste dump sites is what is causing the floods. Afeku and Rain (Afeku, 2005; Rain, 2011) asked a rhetorical question, "how do waste management practices contribute to flooding?" A number of scholars and reports (Afeku, 2005; Nartey, 2012; UNEP/OCHA, 2011) have explained that only 60 to 75% of the solid waste generated within the urban area of Accra for instance is properly disposed-off, the rest is left along streets, illegally dumped into drains, along water ways, left in community dump sites or dumped on vacant lots. These are washed into the drainage system during

heavy rains resulting in blockage and floods. It is also interesting to note that flood waters usually enter homes and carry away belongings which also go to compound the problem of blocked drains. The real impact of these sources of 'solid waste' is appreciated when at the end of each flood event city authorities have to mobilize labour and equipment to clear urban centers of after-flood-waste(UNEP/OCHA, 2011). So far no research has tried to quantify the actual contribution of these sources of waste to the incidence of floods but (Cirella, 2019) consider blockage of drains from waste the second "highest cause" of floods, adding that this actually "worsen" the problem of floods.

The linkage of waste to floods is compounded by siltation or sedimentation which is recognized by 11.1% of the literature as one of the causes of floods. Although they did not directly associate it with floods, Nartey et al explain that sedimentation of water courses occur when vegetation along these water courses are cleared for farming, the exposed banks littered with illegally dumped solid waste are washed into the water course during rainfall accompanied by sediments, these accumulate and eventually block the water course, resulting in floods(Nartey, 2012). Again the role of sedimentation in floods is seen where sediment ladenned runoff from rain events which is slow to disperse settles in stormwater drains, leaving large quantities of fine sand (Fig. 5).

FIGURE 5 - SEDIMENTATION IN A SECTION OF A STORMWATER DRAIN IN ACCRA, GHANA.
Source: Author

Subsequent rain events adds to this, drastically reducing the carrying capacity of the drains and because the city authorities are already overwhelmed with other challenges of urbanization (Nartey, 2012), regular desilting of drains is not made a priority, the drains become incapacitated, resulting in floods from the least amount of rainfall.

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Storm Surge, Low Elevation and Clayey soils

Storm surge was attributed as a cause of floods by 24.4% of the literature. Storm surge occurs when heavy rain events causes a sea level rise, resulting in the sea flowing back unto land to cause floods inland (Amoako, 2015; OPW, 2009; WAVIN, 2017). Low laying nature of the land was identified by 11.1% of the literature as the cause of floods. A number of writers have suggested that floods results where urban dwellers are allowed to build in low lying areas which incidentally are usually flood prone(Abeka, 2014; Amoako, 2015) with clayey soils which limit infiltration(Twumasi, 2002). The situation is worse for communities with surface water bodies which bring in large volumes of stormwater runoff during rain events. The soil characteristics of low-lying areas, was also considered as a cause of floods but by 4.4% of the literature. Soils in low lying areas with high clay content have reduced infiltration (Bhattacharya, 2010), and this combined with the low elevation creates a natural drainage system for stormwater runoff from impervious surfaces within the catchment to quickly accumulate to flood communities. Thus these three factors combine to cause floods but each cannot be considered in isolation as a cause of floods. Development in low lying areas can be tied in with development in flood plains which was also cited as a cause of floods by 13.3% of the literature. Development in flood plains creates a situation where it is not possible for city authorities to provide surface drainage systems, because development within such areas is considered illegal (Amoako, 2015). There are also serious engineering challenges due to the low elevation of such areas some of which are known to be below sea level. In similar situations, areas which lie within flood plains but have been recognized by city authorities may also lack surface drains creating flooding situations. In these entire scenarios, the primary cause of floods is due to creation of impervious surfaces within flood plains and heavy down pour.

Unplanned growth and Failure of Infrastructure

Unplanned growth was cited by 24.4% of the literature as the cause of floods. Unplanned growth or development was linked to the cause of floods through various expressions such as unplanned development in flood plains (Jha, 2012), construction along water courses (Tengan, 2016), inappropriate urbanization of flood plains and unwise land use policies(Andjelkovic, 2001a), or unplanned development combined with inadequate drainage and poor waste management (F. Frick-Trzebitzky, 2018), uncontrolled physical development (Ahadzie, 2011), poor physical planning(ILGS/IWMI, 2012), poor planning and land use(Cirella, 2019). Others argue that unplanned development does not cause floods but worsens it (Okyere, 2013), or both cause and worsens the

incidence of floods (Abeka, 2014). However none of the literature gave any further detail on the processes by which poor planning cause's floods.

Defective engineering

Defective engineering has been cited as a course of the floods in most developing countries and the literature produced 15.4% in support of this view. Atuguba et al cites poor engineering or construction of drains as the cause of floods(Atuguba, 2006), in terms of narrow bridges which is not able to accommodate stormwater runoff during excessive rainfall(Oguntala, 1982b), or poorly designed and maintained drainage systems(F. Frick-Trzebitzky, 2018), under sized drains(Abeka, 2014), poor engineering works where secondary drains are designed to connect primary drains at right angles resulting in quick build-up and overflow (Karley, 2009a).

Climate change

Only 8.9% of the literature reviewed considers climate change as a cause of floods in urban areas. Vogel et al explained that urbanized areas can experience dramatic increases in the frequency of extreme weather events, such as floods, where a 100 year event could become 2-3 times more frequent (Vogel, 2011). They further argue that although climate models may predict increases in some future flood events, it is possible that this could be due to increased urbanization. A similar view is expressed by (Douglas, 2008) who noted that recent extreme variability in rainfall could be due to the impact of rapid urbanization and not necessarily as a result of climate change. There has been a lot of debate on the effect of climate change on floods. Generally, the trend is that there are not enough grounds to support the assertion that there is climate change based on past record of climate data (IPCC, 2012; Z. Kundzewicz et al., 2012a; Z. W. Kundzewicz et al., 2007), however there is also a growing volume of research which takes the position that climate change could lead to variation in rainfall. Where the variation results in intense rainfall, the incidence of floods will increase both in frequency and extent, and with devastating effect (Jha, 2012; Z. Kundzewicz et al., 2012b). The implication is increased frequency of extreme rainfall events, where for instance 100year events could become 2-3 times more frequent (Z. Kundzewicz et al., 2012b). This means that extreme rainfall which may result in extreme incidence of floods may be more frequent under a future climate change scenario. Various writers however maintain that climate change has already begun citing instances like increased variability in rainfall and increase in global temperatures (Afeku, 2005, p. 3; Karley, 2009b, pp. 28,38; Rain, 2011, pp. 1-14; Zahran, 2008, p. 10).

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Direct and Indirect Causes

From the foregoing discussions the cause of floods in urban areas can be traced to three primary or direct causes; excessive rainfall, increased imperviousness, and absence of drainage systems. The other factors are secondary or indirect causes and which admittedly are difficult to separate from the causes. This include poor waste management, poor engineering of drains, development in flood plains or along waterways, the possible effect of climate change, lack of enforcement, haphazard or unplanned development, low lying nature of land, etc. In the opinion of this writer, the indirect causes actually reinforce in one way or the other the direct causes to exacerbate the flooding problem while direct causes actually cause floods. In this review a flood is defined as the temporal covering of land by water(OPW, 2009). Floods are natural phenomena but becomes a risk especially in urban areas because of its extent and damaging impact on life and property (Douglas, 2008; OPW, 2009). Intense rainfall is considered a direct cause of floods, and especially where it combines with impervious surfaces from urbanized areas, the runoff generated creates a situation where the natural landscape hardly has time to accommodate the heavy runoff generation. Thus floods results because the intensity of the rainfall is such as to exceed the infiltration, detention, retention and storage capacity of the natural landscape resulting in large volumes of runoff which existing highly urbanized drainage facilities do not have the capacity to accommodate(Jha, 2012).

Poor or inadequate drains explained in terms of undersized drains, absence of drains or blocked drains, conduits, channels, bridges (Abraham, 2006, p. 4; ActionAid, 2006; Amoako, 2015) is considered a direct cause of floods where large volumes of stormwater generated runoff easily overwhelms existing drainage systems to flood surrounding communities. This is an important factor since according to (Ouikotan, 2017) drains for stormwater management are designed and built in most developing countries without any empirical basis. The situation is usually compounded by the presence of refuse and sediment laden runoff which is swept into the drains, leading to blockage. This way urbanization is not a direct cause of floods but creates the environment for floods to occur, acting more like a floods driver (Okyere, 2013, p. 46) whilst the presence of impervious surfaces and concrete channelized drains actually cause the floods(Raghunath, 2006). Amoako and Boamah did an extensive work by categorizing different types of factors causing floods in the city of Accra (Amoako, 2015). Their categorization affirms that extensive imperviousness is the primary cause of floods in the urban area. This conforms with Frick, who argue that "urbanization" does not directly cause floods (F. Frick-Trzebitzky, 2018) but rather affect the intensity and location of flood events.

Suggested Interventions

Frick has done a comprehensive review of the literature on flood risk management on Ghana and makes the discovery that there is disconnect between the policy developed by government to address the problem of flooding and what is being implemented on the ground. This could be because of the miss-identification of the root causes of the flooding problem. This paper contributes to address this gap by suggesting that interventions to control floods in urban areas and also in other parts of the country should focus on three key areas identified as direct causes of floods.

Imperviousness - the contribution of imperviousness to increased runoff generation and eventually floods cannot be overstated. An intervention which therefore targets impervious surfaces, specifically at the plot level such as roofwater harvesting can be effective in controlling the situation. Roof water has been identified as contributing to stormwater runoff that accumulates to cause floods in communities (Armitage, 2013, p. 25; Jha, 2012, p. 241; Sharma, 2016, p. 446). Strategies should thus be developed to target roofwater management at the plot level; this way the volume of stormwater runoff from roofs that will join the street water will be reduced, making it far easier to manage (A working paper is underway to quantify the contribution of roofs to total runoff generation in urban areas).

Poor and Inadequate drainage - this is another direct cause of floods and has been explained in terms of absence, insufficient extent of concrete lined drains, undersized, poorly maintained, blocked drains. However the current system which relies on drainage efficient systems to manage stormwater is not sustainable as noted by several writers (Barbosa, 2012; Burns, 2010; Ouikotan, 2017; Scholz, 2004). Such a system of stormwater management is not environmentally friendly and is developed at the expense of biodiversity. Its use is based on construction of physical structures, whose size cannot be varied when the runoff they receive exceeds their design capacity, which means they may have to be removed and reconstructed to increase capacity. Another fact is that the continued use of this system leads to the orphaning of surface water bodies as it ensures that surface water generated from storm water runoff is quickly carried away from built up areas. This way rainwater which could have stored to infiltrate the soil, detained to recharge ground water reserves or utilized by surface vegetation is lost as it is emptied into the sea. This will have far reaching implications on a climate change scenario where increased variability could affect even distribution and availability of fresh water all year round. The negative effect of variability is appreciated where salt water intrusion due to over reliance on groundwater for fresh water supply and climate variability have already rendered bore-hole water salty and useless in some parts of the world(Z. W. Kundzewicz et al., 2007). A better option will be to adopt

strategies which reduce reliance on these strait-jacket surface drainage systems to nature based interventions which are considered to be more environmentally friendly and sustainable.

Intensive rainfall - overwhelmingly intense rainfall is recognized as the number one cause of floods but this can be turned into a resource in developing countries where the rate of urbanization has outstrip the capacity of city authorities to provide basic facilities like portable water. Rainwater harvesting for reuse either for irrigation or for none-portable household chores like washing, flashing of toilette could be a more sustainable alternative.

7. CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This paper reviewed 45 literature sources and reports, which may not have exhaustively covered every detail on the causes of floods in urban area. But an attempt has been made to identify and group the causes of floods into direct and indirect causes. Direct causes of floods included intense rainfall, increased imperviousness and poor or inadequate drainage systems. Indirect causes included siltation, blockage by waste, poorly constructed drains, and construction in low laying areas, among others. These do not directly cause floods but add to the problem. About 64% of the literature reviewed was based on cases in developing countries where research is building up to find solutions to the increasing challenge of perennials floods from fast urbanizing communities. This contrast with the literature on floods from developed countries which were more focused on interventions to control secondary effects of floods. Although climate change may not be a direct cause of floods, there are indications that our climate is changing, which may have very direct serious implications on urban development. The paper suggests interventions which target the direct cause of floods as the first step in addressing the problem of perennial floods in urban areas. The paper through the literature review attempted to explain the relationship between flooding and the various factors in the urban environment and to point out ambiguities. The paper also identified some gaps such as absence of common expressions to describe the cause of floods and how these expressions clearly link the causes to floods. It is suggested that to further deepen understanding on flood issues, and shift it from the current impact-based-knowledge, it may be necessary to quantify the contribution to floods by factors such as drainage and impervious surfaces in developing countries.

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