

Urban Flood Risk, Interventions, and The Role Of City Planning.

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ABSTRACT

This paper is a reflection upon the issue of urban flooding, attempts to adapt to it and strategic risk reduction measures of those with responsibility for planning at the level of the city region. Following the introduction, flooding hazards are considered within the context of global environmental processes and rapid urbanisation, and the paper has a discussion of both theoretical and policy perspectives to urban flood risk and vulnerability. Consideration is then given to a broad range of potential interventions that could be available to stakeholders, before, during or after a flooding event, whether the measure would be undertaken by a government, member(s) of the community or the private sector. Finally, in the context of international policy guidance, consideration is given to the role that city planners could make in addressing the risk of flooding emergencies through more strategic, medium and long-term approaches. The paper concludes that collaborative forms of governance with the full engagement of the community are essential for disaster risk resilience.

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1. Introduction

At the time of writing, the regions of Yemen, South Sudan, Somalia and northeast Nigeria face what could be the biggest humanitarian crisis since 1945, with potentially 20 million people being affected with disease, hunger and starvation [1]. The scale of such forecasts can seem overwhelming, and to even start to try and unpick the complexities involved can seem a daunting prospect. However, if such disasters are to be averted, greater focus upon the sources of risk and potential methods of reducing their potential impact, clearly remain of vital importance. As such, this paper has the aim of gaining a simplified understanding of theoretical conceptualisations used within the study of disasters and applying them to responses to the threat of flooding.

Having once been considered the result of supernatural or natural forces, calamitous events such as famines or floods began, to be seen, within the modern era, more in terms of their sociological elements [2]. In the pioneering work on disasters of American sociologist Lowell Juillard Carr in 1932, attention was brought to the failures of cultural protections, i.e. the actions and omissions of human beings, and these human failings were beginning to be seen, within a fledgling sociology of disaster at least, as being the cause of the consequences of catastrophes [3]. Conflict

continues to play a role for many societies and new threats have become apparent such as mishaps in engineering and biogenetics, failures in computers and networks, AIDS, and large scale contaminations of food and drink (be they accidental or deliberate), and the looming dangers of climate change. Identification of issues and shortcomings helps, of course, in finding solutions to societal problems, however global society continues to face ever more complex risks and uncertainties [4][5].

Acknowledgement of both physical and social elements to hazardous events, and the range of potential scales and impacts, is embodied by The United Nations Office for Disaster Risk Reduction [6] within their definition of disaster as: 'A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts'. Indeed, even when not deadly, hazards, such as flooding, can be psychologically disturbing, lead to disease and injury, and cause major disruptions that can be economically costly. So, it is with such a holistic frame of reference, that incorporates socio-economic and political factors, as well as environmental ones, and that is relevant to a range of scales, that any reflection on flooding hazards,

urban flood risk, and potential interventions ought to be considered.

2. Material and Methods

2.1 Flooding Hazards Within Context

Great floods, whether historical events or part of mythological narratives, have made an impression on human consciousness for millennia. The impacts upon society can be catastrophic whether an actual flooding event has been a natural, geophysical occurrence and/or the result of the actions or inactions of people. As Table 1 shows, of the range of hazard types that contributed to death in the twentieth century, flooding led to the highest percentage of deaths amongst the rapid onset events.

Table 1. Hazard types and their contribution to deaths, 1900-1999

Hazard type in rank order	Percentage of deaths
Slow onset:	
Famines – drought	86.9
Rapid onset:	
Floods	9.2
Earthquakes and tsunami	2.2
Storms	1.5
Volcanic eruptions	0.1
Landslides	<0.1
Avalanches	Negligible
Wildfires	Negligible

The huge flooding in Central China of 1931, for example, when flooding extended over an area equivalent in size to England plus half of Scotland, led to casualties that have been estimated to have ranged from several hundred thousand people to several million deaths [8][9]. More recently, persistent downpours led to extensive flooding of the Indus river region within Pakistan in 2010, with at least 3.2 million hectares of land deluged leading to the death of 2,000 people, and as many as 20 million people affected [10]. As well as vast areas of cropland being swamped, with the loss of valuable crops such as rice and cotton, damage to infrastructure and difficulties with sewage and access to clean water led to widespread disease. More recently still, in 2017, there have been examples of exceptionally intense rainfall leading to deadly flooding, mudslides and landslides in Peru [11][12] and Colombia [13][14].

These recent examples of floods in Pakistan and South America have been attributed to 'El Nino' and 'La Nina', phases within the fluctuations in temperature between the ocean and the atmosphere in central eastern part of the Pacific Ocean known as the El Niño-Southern Oscillation (ENSO) cycle. The effects from the ENSO are truly global in their reach as movement of monsoons and unusual jet stream patterns can lead to unusually persistent and intense rainfall. In addition to these natural, complex weather patterns, climate change is now being seen, within the scientific community at least, as one of the greatest of threats to global society

as a whole. Global temperature rises and changes to the natural cycles of climate, as a result of human activities such as industry and transportation, are seen as further exacerbating the prospect of flooding due to the melting of glaciers, sea level rise, and increased intensification and variability of rainfall [15][16][17][18][19][20][21]. Many cities of the world are near to the sea and, with 100 million people living less than 1 metre above mean sea level, the flooding of heavily populated delta regions looks set to lead to many millions of people being made homeless as the twenty-first century progresses [22].

There are many implications for the health and wellbeing of populations from flooding. As well as drowning, a flooding event can lead to a greater number of bites and stings from snakes, scorpions and insects, cuts from sharp objects, heat stress from exposure whilst homeless, problems in accessing fertile land and potable water, and the consequent, dehydration, nutritional stress, mental health issues and epidemic and endemic communicable disease [23][24]. Scarcity and price rises can also lead to food and water insecurity that could have wider political ramifications through civil unrest. Also, if an area is no longer feasible for occupation then people are forced to migrate and consequently experience all the risks and opportunities that that may entail [25][26].

2.2 Theoretical and Policy Perspectives on Urban Flood Risk

Although public perceptions of urban flood risk do vary considerably, risk does seem to have become a much more complex and dynamic prospect as the twenty first century progresses [17][27]. Given the unprecedented rise in the level of urbanisation in recent decades, over half of the growing world population is now considered to be urban and the increasing amount of people and assets in the world has huge implications for the risk of flooding. Most of the growth in the world population over the next two decades is expected to be within countries classified by the World Bank as being 'Low' or 'Middle Income' and, as such, many of the most vulnerable live in hazardous urban settings within those countries [24][28]. As such, without suitable planning and management of city regions, the natural growth in populations and rapid urbanisation combine to ensure more people are likely to live in hazardous locations and face the prospect of widespread urban flooding events with their huge accompanying social and economic consequences. This is the case whether the probability, magnitude and frequency of flood events is believed to be influenced by natural or manmade causes. The United Nations sought to highlight the hardships of the urban poor in its Millennium Development Goal (MDG) 7 for sustainable development. Within the Millennium Development

Goal Report of 2013, that focused on the progress in working towards the MDGs, it was reported that there had been significant improvement to the lives of 100 million slum dwellers several years ahead of the target date of 2020, and that the percentage of slum dwellers in developing regions had fallen from 39% in 2000 to 33% in 2012. However, given the context of a rising world population and the trends towards increased urbanisation in the developing world, the actual number of people living in slums was reported as having increased over the same period from 760 million people to 863 million [27]. Currently, the number of people estimated as living in slums has grown further to over 880 million [29].

Any particular flooding event can be considered, in general, as being primarily due to over-development within flood plains and/or the effects of climate change. More particularly, a closer look at any particular flooding event at a particular urban location, shows that the episode tends to have been due to tidal, fluvial and/or pluvial flooding, rises in ground water, the exceeding of the capacity of sewers, and/or the failure of manmade structures, such as reservoirs, water mains and pumping stations [30]. Any of these causes may be perceived as presenting a disaster risk to a particular urban area with the potential for impacts upon the health and wellbeing of the community, the local ecology, the built environment and/or the activities and services that form the local economy. To help in understanding disaster risk, a conventional 'pseudo-equation' is often used as follows:

$$\text{Disaster risk} = \text{Hazard} * \text{Vulnerability}$$

The equation shows that a hazard does not translate into a disaster without vulnerability of people and/or systems, i.e. their susceptibility to the damaging effects of the event in question. The term 'vulnerability' tends to be used differently within literature related to climate change and disaster risk literature [31], however, in general it can be considered as the flipside to risk. A simple definition of vulnerability would refer to the personal or group characteristics related to the capacity to anticipate, cope, resist or recover from the impact of a hazard. Vulnerability is affected by various factors working in combination to place the life and livelihood of someone at risk to an identifiable and discrete natural or societal event; the degree of vulnerability experienced having three aspects, i.e. the exposure to particular stress(es), the sensitivity, and the adaptive capacity or resilience to resist or recover [7][30][32].

The concepts of 'resilience' and 'sustainability' have come to the fore within the field of international development, although the hazards, vulnerabilities and capacities within any particular region or for any particular community can be influenced by multi-

various factors that are socio-economic, cultural and political, as well as environmental and temporal. It is clear that the poor and marginal within any society are those that are most at risk of suffering the impacts of flooding, in both the short and the long term. Flooding can, of course, effect both rich and poor alike, however the vulnerable urban poor tend to be subject to economic pressure to live in hazardous, flood-prone locations. In addition, lack of financial resources may hamper the urban poor in their attempts to cope with, and recover from, flooding, and the impacts of climate change can further exacerbate the difficulties faced as they seek to secure sustainable livelihoods [22][34][35]. As many different socio-economic and political aspects can have a bearing on flood risk, vulnerability and the resilience of the community within any city region, numerous authors consider that comprehensive theorising on vulnerability ought to encompass a more integrated perspective on the dynamics that interrelate the environment(s), social structure and human agency; see, for example, McLaughlin and Dietz (2008)[32]. The risk of flooding can be a major problem for different social groups such as households with low incomes, households headed by a female, squatters, renters, the old, the infirm and the young, particularly in developing country contexts. Also, even when individual hazardous events are seemingly minor, a ratchet effect of vulnerability can occur when the coping capacities of people are undermined by the wearing down of the health and livelihood resources of people due to continuous exposure [24][36].

So, whilst flooding, as a geophysical event, may have direct implications for what is considered a 'natural disaster', the root causes for losses of life and injury and/or damage to assets may be a variety of economic, political and social determinants, including the actions or inaction of people. It is clear there is an urgent need to have a deeper and more holistic appreciation of the various factors that lie behind the adaptive capacity of the urban poor and their attempts to cope with flood risk to help inform more 'pro-poor' interventions for sustainable planning and management for disaster-resilient city regions [35][37][38][39][40].

3. Results and Discussions

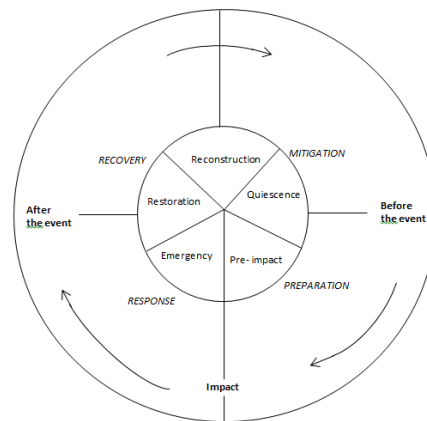
3.1 Interventions to Reduce Risk

Many authors consider that interventions to reduce risk and bolster the resilience of the poor ought to be a developmental priority (see, for example, [7][41]). There are many different perspectives, however, that can be brought to bear on the threat of flooding, both from professionals and from a plethora of academic disciplines, from geography, political science and anthropology to management studies and psychology, all of which can shed light on some of the issues

involved [30]. Clearly, in the case of an actual emergency, the modus operandi of those working for emergency services in response, such as medics, fire and ambulance crews, crisis managers, civic leaders, police, military, and engineers, are of vital importance. Furthermore, the scope and duration of the impacts of a hazardous event can, not only be affected by the magnitude of that hazard, but also by the expertise in forecasting and the amount of forewarning time that vulnerable communities are given.

On a more strategic level, the methods and decisions of planners and policymakers, prior to a hazardous event, can either help or hinder in reducing vulnerabilities and enhancing the resilience of communities through their ideas and plans. Moench (2009) [42] listed the essential, underlying elements related to resilience of livelihoods and adaptive capacity to flooding, which can be summarised as: the environmental systems; the knowledge systems; livelihood and economic systems; communication systems; transport systems; financial systems; organisational systems; and adapted infrastructure systems. The elements listed can be difficult to relate directly to measures to reduce risk, and human nature is such that once the perception of an immediate threat dissipates, so does a willingness to invest resources and time in risk reduction measures. However, as Moench (ibid) stressed, there is great importance of carefully identifying potential points at which interventions can be made to reduce risk at the system level.

As well as individual capacities to cope, and the readiness of emergency response systems, many other aspects play a part in mitigation and adaptation and the reduction of risk at the system level, and so there are many potential points at which successful interventions for the protection of the natural and built environment and people and their assets can be made. Interventions, may involve many different forms of action during the various stages of mitigation, preparedness, response and recovery of the cycle of disaster. Figure 1 is a representation of the cycle of disaster that is helpful for appreciating the context for any particular type of intervention when addressing the case of a major flooding event; all the various stages (before, during and after) at which a potential intervention can take place are shown.



Source: (Alexander, 2000, p.3)[30]
Figure 1: The Disaster Cycle

In considering urban flood risks, and the threats and opportunities that they present, it is helpful to estimate the magnitude of potential impact(s), the proximity of when they may materialise and to have an idea of how the impact(s) may change over time. If risks for a city region have been identified, it is helpful to provide a summary risk profile, as in Figure 2, in order to prioritise action. The ten hypothetical risks are ranked according to the probability of a hazard occurring in comparison to the degree of impact were the hazard to occur; this way, it can be clearly seen, in the context of limited resources, which risks can be tolerated and which need to be addressed as a priority.

Very high	2			1	3
High					4
Medium		8		6	
Low		10		7	
Very low	1		9		5
Prob. / Impact	Very low	Low	Medium	High	Very high

Figure 2: Summary Risk Profile

(N.B. The hypothetical risks above and to the right of dotted risk tolerance line represent those that will not be tolerated by decision-makers(s) except under special circumstances)

Once the risks and realities of urban flooding have been identified, there are, of course, a variety of potential responses from a variety of different stakeholders, i.e. individuals, households, communities, governments and businesses. Whilst everywhere in the world is unique in terms of the particular combination of socio-economic, demographic, environmental and political factors at play, there are clearly some measures

that could be applicable generally to areas at risk of flooding. For instance, disaster flood risk reduction can be effected through enhanced flood forecasting and warning systems, financial measures, such as insurance and tax inducements to encourage flood resilience, the establishment of evacuation and relocation procedures, changes to policy, flood control engineering, building codes, watershed management and enhanced urban and regional planning processes [31][43] has provided very useful tabulated examples of measures that could be taken in relation to flood risk and grouped them according to where they sit within the disaster cycle; as such, it is considered useful to appreciate measures in terms of their contribution to i) hazard reduction and avoidance, ii) vulnerability reduction, iii) preparedness for response, and/or iv) preparedness for recovery.

3.2 The Role of Planning

Amongst a plethora of potential interventions, the formulation of more responsive forms of urban and regional planning can help communities be more prepared for the risk of flooding [23][25][44][45][47]. The term ‘planning’ may not be a word that people perceive positively as it may reflect for them long-winded and inflexible approaches by authoritarian governments; however, some form of strategic planning is needed to face the aforementioned growing risks of urban flooding and to avert some of their potential impacts [17]. Planning decisions have a considerable impact on whether an urban environment is a healthy one; for example, a planned environment with green infrastructure may facilitate healthy lifestyles (salutogenic) or lead to communities encountering lots of traffic and pollution or, through poor layout and limited range of facilities, have limited opportunities for exercise and a lack of fresh food stores (obesogenic). The allocation of appropriate land for house building, hospitals and schools, and ensuring safe and adequate water supplies and sanitation are clear examples of where urban and regional planning can have a strong bearing on the health and wellbeing of the population in city regions. Given that the majority of growth of urban populations is in Middle and Low Income countries, there is an ever present need for their flood-prone city regions to be planned and managed in ways that are mindful of the health, wellbeing, and rights of all their current citizens and future generations. However, strategic decisions over the planning and management of city regions can be far from apolitical in favouring some communities far more than others and, if governments are to try to work towards equitable outcomes, the threat of flooding adds a further layer of complexity [37][48][49].

At the international policy level, a degree of momentum has been gathering for the disaster risk agenda with the publication of the United Nations Plan

of Action on Disaster Risk Reduction for Resilience. Also, the work in preparing for the World Conference on Disaster Risk in Japan in March, 2015 lead to the revision of the disaster risk management guidelines that had been enshrined in the Hyogo Framework for Action on Disaster Risk Management 2005-2015 (HFA); for the Post-2015 Framework (HFA2), the Sendai Framework for Disaster Risk Reduction 2015-2030 has now been launched. The Sendai Framework has four specific priorities for action, i.e. understanding disaster risk, strengthening disaster risk governance to manage disaster risk, investing in disaster risk reduction (DRR) for resilience, and enhancing disaster preparedness for effective response in recovery, rehabilitation and reconstruction, and to ‘build back better’ [6].

At the level of the city region, it is helpful to use a project management perspective, such as that of the UK government PRINCE2 methodology of the Office of Government Commerce, to help transfer risk awareness into action and prioritise responses [50][51]. Table 2 reflects the potential responses listed within PRINCE2, amended to focus on the risk of flooding and potential responses for the governance of a city region.

Table 2: Possible responses to urban flood risk for the governance of a city region prone to flooding

Avoid (threat)	Typically, a change to some aspect of city management so that threat can no longer happen or can no longer have an impact, e.g. change location of a new hospital project so that a flooding impact wouldn't be encountered.
Reduce (threat)	Proactive actions to either reduce probability of an event occurring or reducing the impact should it occur, e.g. flood defence engineering.
Fallback (threat)	Establish a plan for reaction should a flooding event occur, e.g. consultation for evacuation procedures in the event of major flooding.
Transfer (threat)	A third party takes on responsibility for financial impact of flooding event, e.g. the buying of a policy with an insurance company to cover for flooding.
Accept (threat)	Make a conscious and deliberate decision to accept the threat of flooding (whilst continuing to monitor the situation), e.g. decision to build a government office in a flood-prone area for economic reasons.
Share (threat or opportunity)	Agreement to share the costs/benefits that would accrue from a potential flooding event, e.g. contracts between neighbouring local authorities to share the potential 'pain or gain' from the impacts of a major flooding event.
Exploit (Opportunity)	Seizing an opportunity to ensure that opportunity will arise from the threat of a flooding event and that its impacts will be realised, e.g. using a flood warning to enforce building codes for better design of a hospital.
Enhance Reject (Opportunity)	Make a conscious and deliberate decision not to exploit or enhance an opportunity, having discerned that it is more economical not to attempt an opportunity response (though continuing to monitor the situation), e.g. continue with an urban agriculture project as originally planned, despite a revised flood warning. (Based on Office of Government Commerce, 2009)

3.3 Towards Collaborative Governance for DRR

Increasingly, policymakers at the international and local level consider it essential for disaster risk management (DRM) to take a more central role in the policies and plans related to sustainable development, with societies, governments and working together with the aim of helping cities to become more resilient. In linking disaster risk reduction to the Millennium

Development Goals, the United Nations stressed the importance of appropriate forms of 'pro-poor' urban and regional planning with its publication of an advocacy kit for parliamentarians. However, as Giddens (2009) [17] noted, sustainable development cannot just be left to governmental politicians and planners. Indeed, in introducing the United Nations Plan of Action on Disaster Risk Reduction for Resilience in 2013, UN Secretary-General Ban Ki-moon signposted a shift in policy emphasis. He stressed that 'To reduce risks from disasters, we must mobilize a broad coalition of partners, from village chiefs to government ministers, from family-run shops to international corporations, from school principals to hospital directors' [53]. The UN Sustainable Development Goals (SDGs) have built on and replaced the MDGs, and the Sendai Framework is intended to work in league with the SDGs to help make cities more inclusive, safe, resilient and sustainable; in this regard, SDG 11 is particularly relevant [1].

4. Conclusions

So, as well as the need for more 'pro-poor' approaches to DRM, policymakers at the international level are recognising the need for more collaborative and inclusive approaches to urban and regional planning, as the call for greater public participation becomes mainstream. Promising examples of partnership working in respect to DRR have already been emerging such as the government led resilience forums (LRFs) in the UK that Cabinet Office, and the philanthropic endeavours of the Rockefeller Foundation with its 100 Resilient Cities network programme [54][55]. However, whilst the promotion of the inclusion of civil society can be a key aspect for urban and regional planning in city regions prone to flooding, it is clear that further insights are needed into how various levels of governance are addressing and living with environmental change in disaster-prone areas [24][31][39][56]. There are various ways in which people may be engaged in civic matters within a city, with varying degrees of formality [57][58]. A deeper understanding of urban and regional planning processes, and various adaptation measures taken, to address flooding needs to be acquired through gaining a more comprehensive awareness of the perceptions of politicians, planners and the community themselves, with a genuine appreciation of both the formal and informal aspects of disaster risk reduction [35]. Initial stakeholder analyses may help bring attention to the power relations and relative impacts of potential adaptation measures. However, deeper explorations into the perceptions, experiences and actions related to flooding amongst urban poor flood victims themselves can help glean insights into their social milieu that could help enhance the resilience of the poor and inform the

making of more genuinely 'pro-poor' sustainable urban policy and regional planning for flood-prone city regions [59][60][61][62]. As such, with imagination and cultural sensitivity, holistic and collaborative approaches to more responsive forms of planning, that seek to address poverty reduction and public health and disaster risk and sustainable development, together, can be a 'win-win' for all [63][64][65].

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