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Renaturing cities: Reducing flood risk through Nature Based Solutions

Abstract

Climate change is already reshaping the environments within which we live. From regional impacts such as increased frequency, severity and duration of extreme weather events in the forms of wildfires and hurricanes, to localised events in the forms of riverine flooding and coastal storm surges, different disciplinary professionals all recognise that adaptation to a warming planet needs urgent attention and action. Focusing on just one aspect of climate change adaptation, flood risk management, this article will examine how emerging scholarship around 'Renaturing cities' could support societal transformation in the face of uncertain futures. The first section of the paper will explore the concept of 'flood risk management' (FRM) from its emergence from, and beyond, flood prevention strategy principles, to examine the reasons why FRM's current approach only goes so far in supporting adaptation strategies. The second section of the article will explore the rationale behind 'Renaturing cities', particularly in light of global urbanisation, to interrogate how using Green Infrastructure (GI) and Nature Based Solutions (NBS) can enrich the current FRM discourse's 'toolbox' to help reduce flood risk – both for city dwellers and those living and working in surrounding peri-urban and hinterland environments. Using case study examples of different 'Renaturing cities' strategies from around the world which directly address flood risk, from arboreal avenues, pocket parks and Sustainable Urban Drainage Systems (SUDS) to reconstructed urban wetlands, the article will conclude with a short reflection on how feasible, equitable and sustainable this 'renaturing cities' approach might be for our current and future global citizens.

Introduction

Human dependency on the water cycle has meant that we have developed strategies to both live with nature and to control it. Myriad examples exist of human ingenuity in managing freshwater resources in challenging environments. From Meospotamium aquaducts and Roman underground storage cisterns, through to cloud nets to capture water moisture in the Atacama desert, human habitation is intimately linked with hydraulic engineering. This is true also of controlling water in its abundance: with earth bunds to control rivers in spate; sea wall defences against sea surges; dams, sluices and retention ponds to manipulate water flows.

Human development is therefore intimately linked with hydraulic management. Without access to regular, controlled, good quality water flows it is difficult to grow food, farm animals, support industry and to keep local human populations healthy. Through hydraulic practices we have been able over many centuries to manipulate how and where we live on planet Earth.

Yet our ability to control the water cycle is no longer certain. We now have evidence that climate change is reducing the efficacy of our water management methods; changing rainfall patterns in both duration, intensity and location impacts on our ability to plan and manage for our water needs[1]. After three years of drought Cape Town, South Africa, has been frantically trying to prevent 'Day Zero' – the day in which their potable water supply completely runs out. Sao Paolo in Brazil and most of southern California, USA, are not far behind, both areas being acutely water scarce. This uncertainty is true too for flooding events: with 353 global flood 'disasters' in 2015 costing 92 billion dollars in economic losses; and costs set to steeply rise[2].

With over 60% of the world's population living in urban areas[3], climate change impacts are likely to be felt most acutely in densely populated urban settings. The next section of the paper will explore urban water hydraulic management from the perspective of flood management narratives– to trace the development from flood prevention to flood risk and flood disaster management – and now contemporary engagements with using nature based solutions, or 'green infrastructure' to live with, rather than try to control, flooding.

From Flood prevention to Flood risk management.

In order to understand current green infrastructure perspectives we must first interrogate why 'hydraulic paradigm' [4]approaches seemed so intractable. It would be naïve to suggest that flood prevention has always been an integral part of human engagement with the water cycle. Archaeological, anthropological and physical geographical evidence demonstrates that past and present human civilisations often work in harmony with flood cycles. Long-standing indigenous farming techniques, used even today, work in rhythm with the episodic and cyclical occurrences of monsoon rains and El Nino and La Nina events.

Flood prevention is a then a very modern concept, aligned with rapid economic industrialisation from the 18th century and onwards. Industry and water resources become co-dependent; with water needed to make products and to ship products. Equally labour needs to live near industry. We then see a slow unravelling of this industry-water-labour nexus across the 'global North' and, now, to the 'global South'. Rather than living with the water cycle, the water cycle is manipulated to work with economic demands and timeframes; which means controlling the flow of water. Water reservoirs are needed for dry periods; flood banks, flood defences and fast flowing rivers for wetter periods.

As we move into the late twentieth century and early twenty first, and as global industrialisation and urbanisation features within most regions of the planet, evidence builds that flood prevention becomes harder to secure. Countless examples exist of dreadful flooding events; Wuhan, China in 1931, the North Sea flood in the UK and the Netherlands in 1953 and New Orleans in 2014 killing

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[1] Gosling, S.N. and Arnell, N.W., 2016. A global assessment of the impact of climate change on water scarcity. *Climatic Change*, *134*(3), pp.371-385.

[2] Swiss Re (2016) 'Natural catastrophes and man-made disasters in 2015: Asia suffers substantial losses' Available at: ttp://www.swissre.com/library/012016_Natural_catastrophes_and_manmade_ disasters_in_2015_Asia_suffers_substantial_losses.html

[3] World Health Organisation http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/. Accessed on 21st March 2018.

[4] Linton, J., 2014. Modern water and its discontents: a history of hydrosocial renewal. *Wiley Interdisciplinary Reviews: Water*, *1*(1), pp.111-120.

almost 4 million people in the Wuhan event alone[5]. The causes of the flooding are multiple; faster flowing rivers and unplanned building development causing flooding 'bottlenecks' or pinch points; deforestation to create arable land leading to top soil erosion and compacted soil – leading to reduced percolation, higher temperatures altering rainfall patterns all attributing to flash flooding. See Jha et al (2012) [6]for a thorough discussion of urban flooding drivers.

To contend with this flooding certainty the hydraulic paradigm in the Global North has moved to an integrated, interdisciplinary approach deemed 'flood risk management' (FRM), using river basins as the unit of management and analysis. From this viewpoint hard engineering (flood walls, storm sewers, drainage channels) is coupled with soft engineering (developing online flood risk maps, planting trees higher up in the river's catchment, clearing and maintaining culverts and small watercourses). Local communities are also encouraged to become stakeholders in the development and implementation of flood risk management plans within their area. Combined local knowledge and capacity together with integrated interdisciplinary approaches are seen as the logical way to reduce risk and prevent flooding disasters.

Nature based solutions: renaturing cities

However progressive FRM perspectives are for many they are seen to provide only part of the solution. There has been a growing awareness that urban areas are not only impacted by flood events but that they also contribute to flooding. The buildings, roads, driveways, flood walls and all the other impermeable elements of urban fabric, deemed 'grey infrastructure,' add to the problem. When rain falls these structures simply retard water, rather than letting it infiltrate to the soil beneath. This run-off contributes to flood events within the area and further downstream. Additionally, grey infrastructure creates urban heat islands, shaping micro climates which impact on local rainfall variability[7].

Increasingly the answer is seen to lie within 'nature based solutions' (NBS); letting nature provide the remedy. NBS approaches argue that 'green' infrastructure can provide additional benefits over grey infrastructure with even small amounts of investment. Green infrastructure takes many forms. Urban wetlands to store and release floodwater can replace underground storm water drains. Reducing road traffic lanes and replacing them with tree lined green corridors promotes commuting via cycling and walking. Roadside depressions called 'rain gardens' capture rainfall, deflecting it off the road, to support both natural and manmade growing spaces. Other infrastructure includes 'pop up' community allotments built in portable skips and housed in unused urban areas such as building developments and abandoned housing lots. These endeavours enable local people to come together to grow food and socialise, greening brownfield sites and creating biodiversity havens. Green roofs and living walls filter rainfall and reduce run off through their own evapotranspiration; absorb CO2 and release oxygen, moderate the heat of temperature differentials in buildings and are proven to improve human health and wellbeing through creating green vistas. The expansion of city parks to form green-blue space constellations, creates biodiversity chains across urban fabric. These 'green

[5] https://www.statista.com/statistics/267746/number-of-deaths-globally-due-to-major-flooding/ Accessed on 21st March 2018.

[6] Jha, A.K., Bloch, R. and Lamond, J., 2012. *Cities and flooding: a guide to integrated urban flood risk management for the 21st century*. World Bank Publications.

[7] Norton, B.A., Coutts, A.M., Livesley, S.J., Harris, R.J., Hunter, A.M. and Williams, N.S., 2015. Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. *Landscape and Urban Planning*, *134*, pp.127-138.

wedges' act as both 'lungs' and 'kidneys' of city spaces, circulating oxygen and cleaning air and water. They act as floodwater storage areas and increase the permeable surface of the city. Together green infrastructure is a viable alternative to grey, with multiple environmental, social, economic and cultural benefits. NBS thus supports the 'natural capital' of an area or region. Turning old railway lines, such as the Highline in New York, into green walkways both improves the visual look of a space, improves civic safety and supports the local economy by attracting tourists. Different green interventions provide a wide range of differing NBS benefits.

Green infrastructure endeavours support human geography concerns too. Using green wedges to connect the city through foot and cycle paths links poorer and richer neighbourhoods to engender a localism based on a city wide rather than a 'barrio' mentality. Through generating social enterprise schemes and boosting local employment, NBS aims to support and improve social mobility. Green activists hope that reconnecting with nature and creating 'clean' green spaces will raise individual awareness around sustainability and climate change messaging. Renaturing cities advocates claim interventions to help reverse decline in life expectancy and quality of life for urban dwellers.

The rationale behind renaturing cities, NBS and GI is to live with nature rather than against it. Flood 'prevention' and 'risk management' is replaced by a sensibility concerned with 'flood accommodation'. Accepting that flooding will occur, and accepting that our consumption orientated lifestyles has contributed to a changing climate which has exacerbated flooding, returns us to a consideration to live respectfully alongside our water resources. Though we are a long way from accomplishing this, the renaturing cities perspective goes a long way in accepting that the Anthropocene is our new reality.

Flood ready cities of the future: Retrofitting; city visions, sponge cities

Governance is a key issue when we consider renaturing cities. In many cities the GI,NBS approach is piecemeal and accumulative – in other words only a proportion of buildings have green roofs or integrated sustainable urban drainage systems (SUDS). These are often lead by green minded activists or developers, sometimes making good use of economic downturns in central urban spaces. Examples include the cities of Detroit, Cleveland and Buffalo in the 'American rustbelt' of the USA, where residents have reappropriated abandoned parking lots and turned them into citizen managed allotments to grow food for personal use and for sale.

Some city councils have taken charge of leading renaturing strategies. Durban in South Africa have purchased hinterland to protect water resources and prevent soil erosion in a long term 'Durban Metropolitan Open Space System' strategy, which seeks to greenbelt the city and then link it to create radial spokes of green blue space within. Barcelona in Spain have a green 2050 vision which will overhaul the city with low cost public transport leading to roads closed and transformed into green 'superislands' for play, exercise and socialising. These will connect with arboreal channels of green walkways spanning the city. Singapore has used hybrid technologies to create living 'metal trees' – steel structures filled with plants and solar panels which at night light up the downtown area to make safe, well lit spaces to converge and socialise.

Some urban planners have gone further, seeking to either retro-design their cities to make them flood resilient; or redeveloping whole swathes of cityscape to make them 'sponge cities'. Sixteen

regions across China are developing ‘sponge’ megacities; with rain and flood water embraced as a metabolic part of the city structure. Roads will have porous tarmac and surface level drainage channels, green sky walkways will provide shelter and alternative routes at times of heavy rainfall. Flooding is seen as both inevitable and a potential asset for the city; mindsets, along with infrastructure, are changing.

Despite all the optimism and promise that renaturing cities heralds we must also take a moment to be reflective. The scale of climate change is unlikely to be countered by isolated examples of greening. Renaturing cities must work in tandem with other strategies such as carbon banking, an end to fossil fuel use and a move to clean technologies. It can be argued that only be moving away from consumerism and wasteful consumption of goods and services can we live within our planetary boundaries. We all need to consume less. This engenders a very profound concern around ‘rights to development’; and if not openly debated could lead to NBS and GI being accused of a form of ‘green neo-colonialism’ which excludes or demonises citizens and economies of the global South.

Concluding thoughts

Renaturing cities perspectives challenges us to consider new approaches to living with water in densely populated urban spaces. Alongside physical change is a need for a change in sensibilities; and a recognition that as humans are part of the causes of flooding in the Anthropocene, we can also be part of the remedy. However, GI and NBS need to be part of a wider debate concerning global social equity and climate change adaptation strategies. As geographers we need to ensure that the ills of industrialisation which have long benefitted the global North do not further penalise those citizens of the global South.