Graeme Evans

Design for Hydrocitizens: Architectural Responses to the Defend-Retreat-Attack Scenario

Introduction

Over two thirds of the world's mega-cities are coastal and delta cities such as New York, Rotterdam and London are all faced with increasing flood risk due to a changing climate leading to more intense rainfall events, sea level rise, soil erosion and storm surge[2]. Of all worldwide disasters, 90% are water related and it is through water that most of the impact of climate change is felt. Northern hemisphere cities and populated coastal areas are now experiencing flooding as the global South continues to do, suggesting that there is scope for international knowledge exchange in this field, including Mediterranean southern European and northern coastal and estuary cities. North-South collaboration is now a feature of European coastal and flood risk projects such as SECOA (www.projectsecoa.eu) with partners in India, Israel, Italy, Vietnam, Portugal, Belgium, the UK and Sweden [2], whilst Dutch water and land use engineering leads the world in terms of flood adaptation and architectural design. It is no accident therefore that Dutch influence in the UK is evident in inspiring creative water architecture solutions by UK design firms, as outlined below. This is important, since tidal/estuary cities like London and southern coastal cities are also the subject of further urbanisation and population growth through high density development and intensification of land uses, with waterfront development now seen as a solution to housing demand, as well as an attractive investment proposition for commercial and leisure developments. Over 1.4 million people currently live in flood plain in London, and 200,000 new homes planned in the extended Thames Gateway region are in high flood risk zones. Urban design and architectural strategies to create flood-resilient urban waterfronts are therefore being promoted to incorporate flood mitigation measures in the design of outdoor areas and new buildings.

This article reviews a selection of these architectural responses to the 'Defend-Retreat-Attack' scenarios through land-water/human-nature inter-action. This research draws on the recently completed SECOA project for which the author led the UK team, and a new art and design-led research project: Hydrocitizenship (www.hydrocitizenship.com), based in the Lea Valley region - the river Lea is London's 'second river' traversing a 26 mile corridor of canals, rivers, and reservoirs. This brownfield area has been the prime regeneration zone planned to accommodate London's 10+% population growth, to extend the city and create new destinations in a major place-making masterplan originating in the 1980s London Docklands. This has been renewed through the London 2012 Olympics built alongside the Lea River and tributaries, including a new Olympic Park and several waterfront urban neighbourhoods [3].

Defend - Retreat - Attack

These three scenarios represent the key options available in the light of flooding/flood risk to existing urban settlements [4]. They also offer different (but not exclusive) design and engineering solutions to living with water.

Defend refers to massive investment in flood defences or 'holding the line' to keep the existing separation between developed land and water/intertidal areas. This includes many built areas that have been reclaimed (e.g. marshlands) from the sea over several centuries such as in New Orleans USA and Portsmouth, UK. In many areas of London and the South-East, this prospect is beyond the funding capacity of local government and private landholders, with cities such as Portsmouth (largely situated below sea level) requiring over £€350m just to defend its existing coastline from sea level rise and storm surge. Architecturally, this option requires design and construction able to withstand ground level flooding and eventually, 'amphibious' solutions. In Southern hemisphere cities, vernacular permeable construction and locations afforded this regular flooding event with residents retreating to higher floors during the flood season and using water transport. But with western styles of building and transport, and unsustainable development (e.g. roads, airports, high-rise) on softer soil (e.g. peat), the results in cities such as Bangkok have proved disastrous (fig01). The media representation that these flood events are new is also misleading, since they have been occurring for centuries. What has changed is the extent of urbanisation, and unsustainable land-use and building design and construction methods.

Fig. 1 - Floods in Bangkok [5]

Nonetheless, politically in countries such as the UK and USA (i.e. post-Hurricane Sandy in New York) 'Defend' is still the preferred option, but not a viable one in most cases. Where high commercial property values are threatened, the economics of localised sea defences can be presented as a viable option (fig.02), but in practice this just defers future investment and maintenance in flood defence, whilst not offering a solution to a wider area, or adapting building design (or behaviour) to the realities of climate change. This can also mean passing on the flood threats downstream to more vulnerable waterfronts and properties.

Fig. 2 - New York post-Hurricane Sandy BIG scheme [6]

Another design challenge with traditional design-against-flooding is the poor aesthetic and impact on place-making, accessibility and legibility. An important urban design goal is to promote permeability and linkage through and across schemes. Whilst the function of a flood defence is to separate the source of the risk from the potential receptors, it is often desirable from a place-making point of view to link the inhabitants and visitors of a new neighbourhood with the river or coastline that poses the risk. The link should ideally be both visual and physical, providing access if possible.

However the received wisdom in new developments is to locate car parking and garages at ground level with residential accommodation at first floor and above, but this can often result in buildings with poor quality unanimated elevations at street level and leave both the public and private realm dead and lifeless (fig03). It can also be a challenge to provide equal access to accommodation raised above ground level. The assumption that more vulnerable groups, e.g. elderly, infirm, mobility-impaired, should be housed above ground level to minimise risk in the event of ground water flooding, also ignores other accessibility, social and vitality considerations where ground floor levels are made effectively sterile and inactive [7].

Fig. 3 - Flood defences and ground floor parking challenge place-making [8]

Retreat occurs where the line can no longer be held due to over-capping, sea level rise, storm surge and where costs of flood defence are too high - and/or the value of land/assets are too low to justify this investment. In practice *Retreat* means coastal squeeze and managed realignment, with land uses pushed back and the water line moved further inland [9]. This can also extend intertidal habitats e.g. salt water marshes, which can benefit wildlife and ecosystems. This issue of loss of land also arises, which is problematic particularly where property insurers are not willing to cover 'at risk' buildings, and government has no legal responsibility to compensate for private/ community losses (as is the norm in the UK).
In terms of planning and design for flood risk, the issue of scale is critically important. Whilst flood risk data and modelling is now available via GIS visualisation techniques, adapting this in urban design and architecture requires higher levels of accuracy and detail than flood mapping provides. Information at the level of decimetres not just metres; slight changes in ground levels; local flood walls; drainage systems; and flood entry thresholds of existing buildings - are all required in practice. On the other hand, building design and retrofitting tends to occur at the single building/block scale (due to private ownership), limiting integrated urban design as is practiced in the case of Integrated Coastal Zone Management [10].

Adaptation Tipping Points
The concept of Adaptation Tipping Points (ATPs) bridges this scalar gap between large-scale flood mapping and local planning and design [11]. ATPs describe the boundary conditions under which a system has to adapt or move to other strategies or policies in order to remain functioning. ATPs can be translated into area-specific threshold values, for example a maximum flood level or flood return period which offers clear criteria for design, e.g. the susceptibility of individual buildings, urban infrastructure and assets to a flood.
This has been applied in the case of the Feijenoord area in Rotterdam, a low-lying residential, high flood risk area, with 90% social

Fig. 4 - Adaptation measures for Feijenoord [11]

Fig. 5 - Paalwoningen 'stilt houses', Haarlemmermeer, Waterstudio (houses in a water-retention area in N.Holland, which have been raised above the floodplain, exploiting a site which would otherwise be uninhabitable).

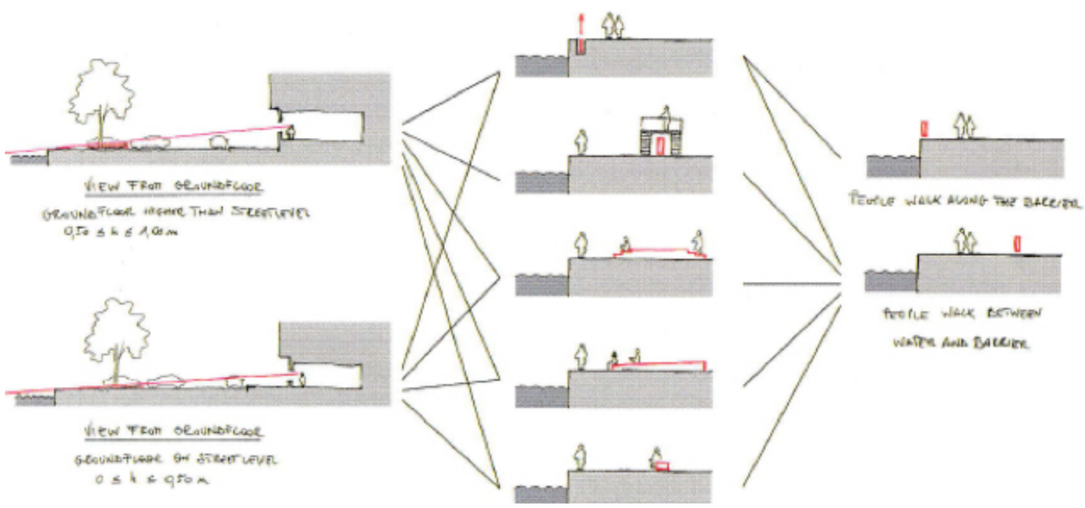

Fig. 6 - Sketch designs examining flood barrier options [11].

Fig. 7 - Turnaround house design [12]

housing, high unemployment, poor housing, and lack of public realm maintenance. In flood-prone Feijenoord a planned new development along the quay had the potential to create a local embankment with a strip of elevated ground offering sufficient safety (fig04).
A variety of adaptation measures are available to create resilient urban environments. Buildings can be wet-proofed, dry-proofed, built on stilts (fig05), situated in elevated ground or temporarily protected by movable flood barriers. To discover when tipping points (ATPs) are reached, detailed analysis of thresholds (flood entry points) of buildings and other urban facilities is required. In this Dutch case, historically 19th century housing blocks showed a sensitivity to flooding because many have their ground floors on or below street level, whereas generally housing of this stock, e.g. in the UK, all had a minimum 5cm step-up to the house/front door. Using sketch designs, different measures were tested on buildings and public spaces (fig06), followed by a consultative 'co-design' workshop with local residents, developers and

housing providers. As well as doorsteps, the vertical position of plinths and window sills appeared to be important technical and visual boundaries for retrofitting dry-proofing measure such as closing-off windows.
Another example is the award-winning Turnaround House by Nissen Adams, an adaptable house that responds to a flood, without compromising living during the rest of the year (fig07). It is also a house that meets the occupants' needs at all times and a dwelling that acts as a physical link to the community and its support networks. For most of the year, the flood-house functions as a typical house and only in a flood does it transform to allow an alternative 'turned around' living arrangement to be adopted. When a flood warning is issued, occupants relocate to the first floor while the flood waters are partly allowed to penetrate the ground floor. A robust concrete dado extending from the foundations allows for easy cleaning after the flood subsides. Drinking water is concealed in a deep first flood void and storage walls can be turned around to access emergency supplies or relocated to act as privacy screens. The timber shutter at the first floor door folds down like a drawbridge to become the new front entrance, to link with neighbouring balconies and create a raised access path joining the house to the flooded community.

Attack - the third scenario represents direct engagement with water through 'building out' or on the water itself. This includes floating buildings, piers and adapting barges and platforms such as disused oil rigs for accommodation. In practice a combination of all three is evident in design solutions to the flood risk scenario. Examples of this design response include the floating house concept. The compact floating house responds to the under-use of tidal waters such as the River Thames and Lea with a part-house, part-boat hybrid concept. This also offers a temporary solution for victims of flooding as planning permission is not required to moor at designated sites. The design encompasses a base tray or 'barge', the house unit (rubber-coated, super-insulated timber box) and 2-side panels creating an outer skin and winter garden, supporting PV-Ts for electricity and water heating. A crow's nest containing a snug with panoramic views hovers over the house box with a rainwater harvesting tank above (fig08). The total gross area is 125m^2 on a 140m^2 plot. Where arranged in groups, floating gardens can be scattered between some of the houses with connecting walkways to create shared spaces. Different materials, colours and sizes can create a variable aesthetic. When sited on water, steel piles anchor the building while allowing it to float with the tide or rising water levels. On land subject to flooding a 'cut and cover' approach can be used to produce shallow depressions where the hull sits, and creating raised gardens and walkways around using the spoil. Alternatively the house can be built on dry land using compacted hardcore foundation and pads. In all scenarios the structure can be prefabricated and easily transported, e.g. via lorry or barge.
Floating or amphibious homes have been constructed in The Netherlands, for example in Maasbommel, where the houses are built on concrete floating bodies. At low water level the houses rest on a concrete foundation. The houses have a wood-frame construction in order to keep them as light as possible and are anchored to flexible mooring posts that cushion the swell of the water. It is expected that once every five years the water will rise to such a level (more than 70 centimetres) that the houses will lift off the ground. The houses can accommodate a difference in water level of up to 5.5 metres.
Plans to build Britain's first 'floating village' at London's Royal Docks came a step closer to realisation following a competition held by the Mayor. Carillion Igloo Genesis have been selected to transform the 15 acres of water at the Royal Victoria Dock site, transforming it into a thriving community with floating homes, restaurants, cafes and bars. Although a first for the UK, floating developments are already a popular idea with successful schemes at ljburg near Amsterdam and HafenCity in Hamburg (site for the 2024 Olympic bid), as well as many other examples of floating homes throughout Scandinavia. The architects for the floating village are dRMM, led by Alex de Rijke who recently presented his studies on floating villages to the Venice architecture biennale. The scheme includes a custom-build approach for each of the 50 residential homes, enabling prospective occupiers to be part of the design-process, and a blue water square, framed by a market square and a floating corniche (fig09). There will also be a large multi-purpose events space and a mix of non-residential uses including restaurants, cafes, shops and leisure and office space. Plans for additional facilities, such as a floating Lido and an ice rink, were also proposed as part of the bid.

Conclusion
This brief review of options and design responses to living with water in the context of flood risk and urbanisation of waterfront areas, reveals both technological and creative opportunities to the *Defend-Retreat-Attack* conundrum. How far these are universal design solutions to the Mediterranean climate and context, and the northern European situation, is worthy of consideration. Certainly the more adventurous and 'floating' schemes are novel, but will not meet the majority of housing and infrastructure imperatives, whilst attention to detail is important for new and adapted buildings to perform and be resilient over time.
An integrated approach across scales – building, block, street, neighbourhood and flood zone – and between design, resilience and sustainability, is also required in order to prevent an overly engineered solution being prioritised over an integrated design approach. Conflicts between areas that are the subject of intense land reclamation and development on desirable waterside locations, and existing communities upstream and downstream of these new water zones, can also lead to displacement of inundation and pollution. Designing and planning at catchment area level is therefore neeed, irrespective of administrative or land use boundaries, since this is the scale where we can adapt to and mitigate these risks through a comprehensive approach and by connecting planning, design and politics.
Finally, the input of residents - current and prospective - is also important, as some architects have discovered through design charrettes and greater use of co-design, not least since occupiers and users of these spaces have local knowledge on

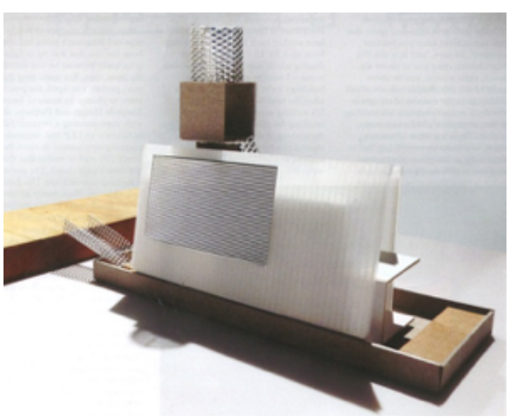

Fig. 8 - Model and plan & section of floating house [12]

Fig. 9 - Floating Village, Royal Docks, London

what works, is acceptable, and the impact of design interventions and water inundation – and the extent to which trade-offs and risks can be accepted. This leads to the key issue of resilience and adaptability of communities to climate change and flooding, and how far more sustainable behaviour can be influenced by design and vice versa. This relationship between water and people is being tested in the Hydrocitizenship project in the Lea Valley river region (www.leevalley.org), including working with our architecture/interior design students on waterfront sites, looking at themes such as 'Boundaries: The Edge Condition' [], and developing cultural ecosystems mapping with users to capture their perspective and use of the liminal spaces between the built and water environment they inhabit.

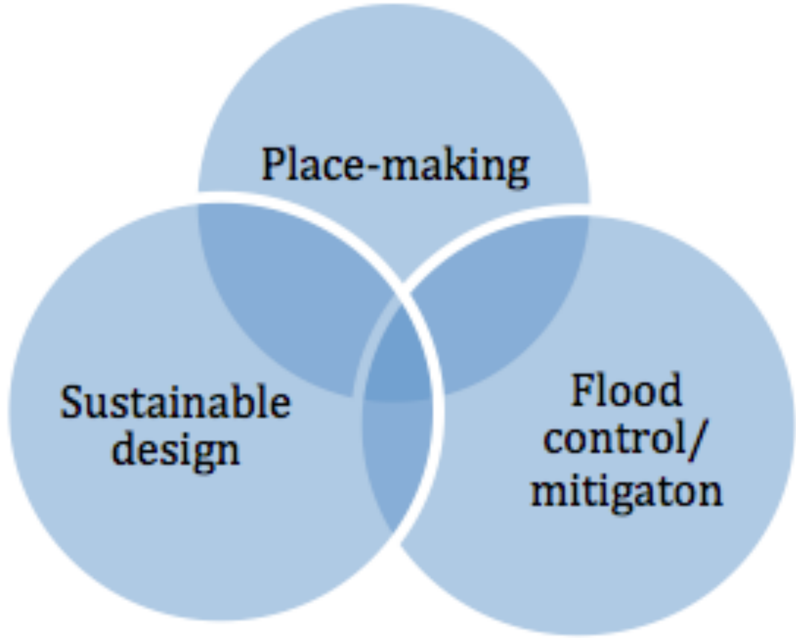

Fig. 9 - Integration of sustainable design, place-making and flood mitigation [8]

REFERENCES

[1] CDC, *Connecting Delta Cities. Resilient Cities and Climate Adaptation Strategies*. Rotterdam, 2013.
[2] Evans, G.L., Solutions for Environmental Contrasts in Coastal Areas: Coastal Cities and Climate Change, *Regions*, 2011, 282: pp.8-10
[3] Evans, G.L., Designing legacy and the legacy of design: London 2012 and the Regeneration Games, *Architectural Research Quarterly*, 18(4): 2015a, pp. 353-366.
[4] RIBA Futures/ICE, *Facing Up to Rising Sea Levels*. Building Futures. London: Royal Institute for British Architects, 2010.
[5] Schmidt-Thomé, P., The 2011 Floods in Bangkok - Causes and Consequences. *Regions*, 288(4): 2010, pp. 20-22
[6] www.rebuildbydesign.org/project/big-team-final-proposal.
[7] Evans, G.L., Ageing and Climate Change: A Society-Technology-Design discourse*, Design Journal*, 16(20), 20-13, pp.239-258
[8] RIBA, *Climate Change Toolkit 07: Designing for Flood Risk*. London: RIBA, 2009.
[9] Esteves, L., Climate Change Adaptation in England: is Managed Realignment a Sustainable Strategy?, *Regions*, 288(4), 2013, pp. 16-18.
[10] EU, *Integrated Coastal Zone Management: A Strategy for Europe* (COM/00/547), Brussels, 2000.
[11] van Veelen, P. and Kronberger-Nabvielek, Flood risk data and Urban Design, *Urban Design*, 2004, pp.132-134.
[12] CTA, Floating House. Carl Turner Architects, *New London Architecture*, 18; 2013, pp.30-31. www.designboom.com/architecture/carl-turner-architects-floating-house-paperhouses-01-16-2015
[13] Evans, G.L., *Exploring the Lee Valley: Boundaries – The Edge Condition*, BA Interior Architecture & Design Yearbook: 2013, pp.16-18.