THE INTERNATIONAL REVIEW OF LANDSCAPE ARCHITECTURE AND URBAN DESIGN

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Water

Resource and Threat

USA LOS ANGELES RIVER REVITALIZATION; SPONGE PARK IN BROOKLYN; STRATEGIES FOR NEW ORLEANS • **INDIA** SABARMATI RIVERFRONT IN AHMEDABAD • **MOROCCO** FEZ RIVER REHABILITATION • **CHINA** NEW WATER CULTURE FOR TIANJIN • **UK** SUSTAINABLE DEVELOPMENT AND FLOOD-RISK • **NETHERLANDS** ROOM FOR THE RIVER; RIJN-MAAS-SCHELDE DELTA PLAN • **BELGIUM** DE-POLDERING IN BEVEREN NORTH • **GERMANY** COASTAL ADAPTATIONS; DESIGNING TIDAL LANDSCAPES IN THE HAMBURG REGION

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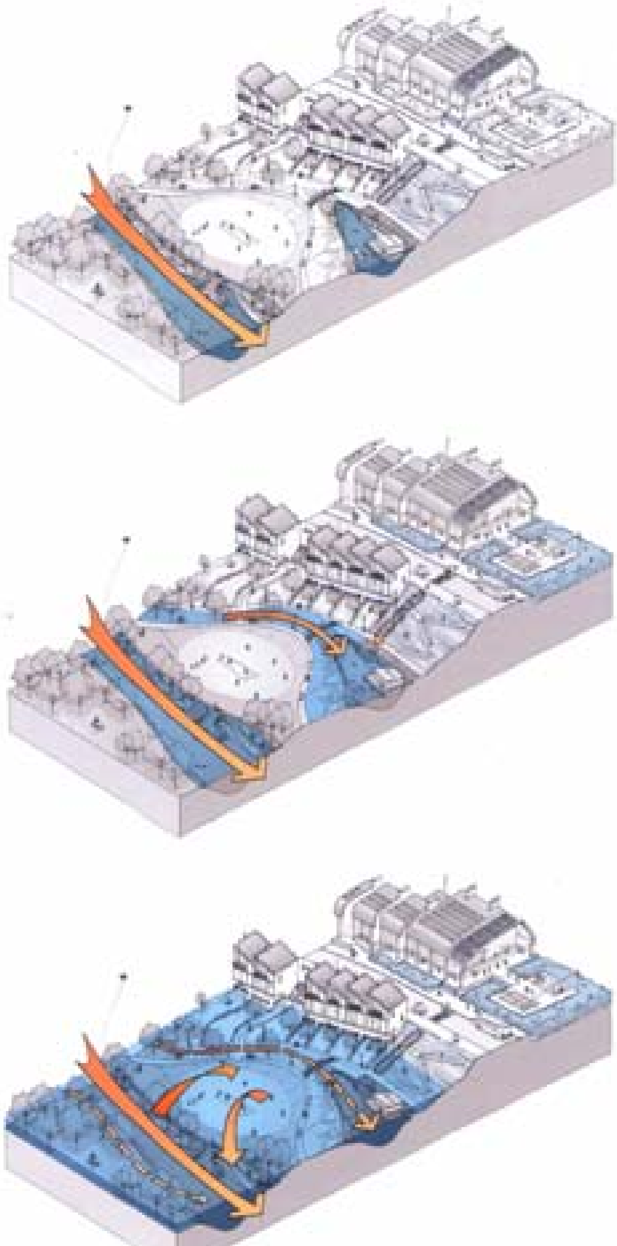
Sustainable Development in Flood-risk Environments

A United Kingdom study designs three conceptual developments that mitigate flood risk, generate their own energy, and provide high quality amenities.



Using non-defensive flood-risk management, open spaces are designed to accommodate rainwater in rain gardens and on green roofs. Floodwater is directed into planted channels, retention ponds or multi-use recreation areas. From top: everyday scenario, 1 in 20 year storm, 1 in 100 year storm.

With few obvious sites in the United Kingdom available for new development and existing towns hemmed in by protected Green Belt land, pressure to build new homes on floodplains is greater than ever. Floodplains, however, are expanding. Rising sea levels and stormier weather, both caused by climate change, are putting more land at risk of flooding. Compounding this problem, each new home built results in more greenhouse gases emitted, leading to further global warming.

Following the findings of the "Foresight – future flooding report in 2004", commissioned by the UK Government's Chief Scientist (Office of Science and Technology), the UK Government's Department for Environment, Food and Rural Affairs (Defra) established the Making Space for Water (MSW) programme. The vision of MSW is to manage the adverse consequences for people and the economy that can result from flooding and coastal erosion, while also achieving environmental and social benefits in line with wider government objectives.

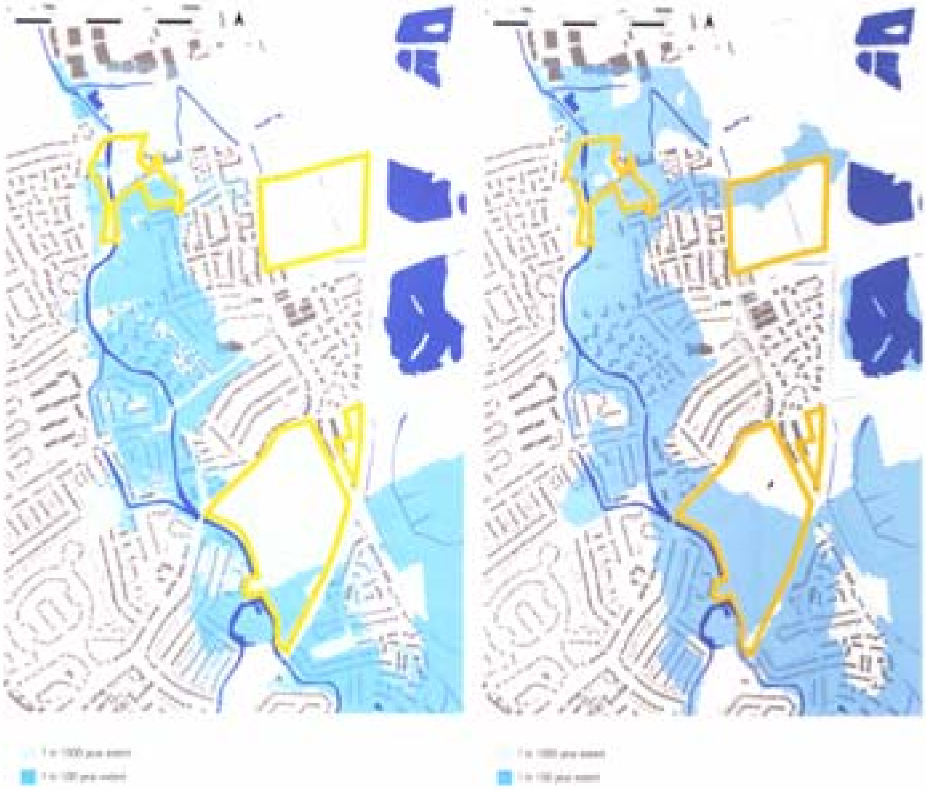
MSW plans to accomplish this "by employing an integrated portfolio of approaches which reflect both national and local priorities." When combined with other objectives for creating sustainable communities, this poses questions of our built environment, such as: What is an integrated approach? What needs to be integrated and why? What will it look like? And how much will it cost?

The LifE project, funded through the Department for Environment, Food and Rural Affairs' Innovation Fund, seeks to answer these questions and encourage genuinely sustainable development through intelligent planning and an understanding of technical issues and the options available. LifE stands for Long-term Initiatives for Flood-risk Environments. This means integrating sustainable (non-defensive) flood-risk management with sustainable (zero carbon) development and choosing the most effective (multi-use) tools to achieve this.

Development has contributed to climate change through energy use, and to the rise in flood-risk through locating people and property in areas of risk. Therefore, the benefit of tackling the cause of climate change (carbon emissions) at the same time as the effects (increased flood-risk, in particular) would seem obvious. The LifE project combines three approaches:

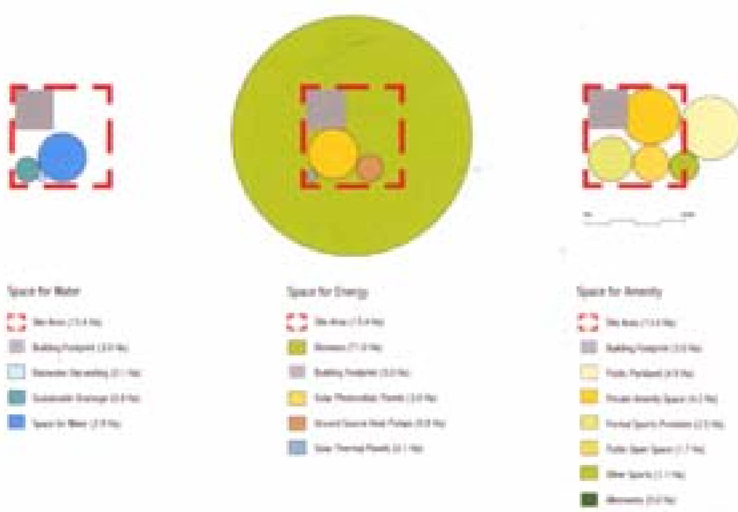
- Living with Water: Adapting to increased flood frequency and severity, which is likely to happen with climate change
- Making Space for Water: Working with natural processes to provide room for rivers and the sea to expand in times of flood and reducing reliance on defences, where possible.
- Zero Carbon: Providing all energy needs from renewable resources on-site, such as wind, tidal and solar power. In the UK zero carbon requires that the energy is provided locally (on-site) and does not use regional or national sources such as off-shore wind turbines.

Left: The LifE project addresses the need for new homes, increased risk of flooding and heightened environmental standards simultaneously by integrating three approaches.
Page 53: In Littlehampton mixed use development is elevated above "rain courtyards" that alleviate flooding.



Climate change could extend the area at risk from a 1 in 100 year event (dark blue) to the current 1 in 1000 year area (light blue) demonstrated on study sites in Hackbridge.

The diagrams below show the spatial requirements for a zero carbon sustainable development that also provides space for water on the Felnex site in Hackbridge.



The use of non-defensive flood risk management measures advocated by MSW requires a shift in thinking. Instead of keeping water out of sites, space for water is provided within developments and water is permitted onto sites in a controlled and predetermined manner. This may not be appropriate if the floodwater is deep or fast flowing, but, where possible, this approach may create other benefits, such as play areas, space for renewable energy generation, environmental remediation, and even roads and parking. Integrating the means of managing flood risk within the development plan also improves preparedness for flooding, helping to maintain continuity of daily life before and after flooding. This type of multiple asset creation can help to achieve the higher density development that is being advocated, without losing quality or amenities. It may also help to overcome the economic and social objections to implementing zero carbon and non-defensive flood risk management measures.

To test the LifE approach, three desktop masterplans were developed as case studies. The sites chosen, from those submitted by local governments, varied in character, flood-risk and renewable energy potential, but were all of a sufficient scale to consider a range of design and engineering

At the Felnex site in Hackbridge, buildings are arranged around rain garden courtyards. Swales provide buffers to entrances, which double as space for water. Naturalised riverbanks provide room for the river to expand.

options. On each site, conceptual proposals for between 1,000 and 2,000 new homes were developed. Each site included areas at risk of flooding: Hackbridge, within the upper catchment of the River Wandle; Peterborough, within the middle catchment of the River Nene; and Littlehampton, within the lower catchment of the River Arun.

Flood-risk management

Using emerging modelling data it was possible to map the areas where flooding from the river would occur on each site in an extreme flood now (a 100- or 200-year event), and an extreme event after 100 years of climate change. Using Lidar data it was also possible to assess the likely depth the floodwater would reach. These maps were based on the probability of a flood occurring, represented either as a percentage or return period, taking into accourt topography, land-use and flow rates.

Having assessed the areas most likely to be flooded or most susceptible to change it was possible to avoid building on existing floodplain, protect land that should be maintained as future floodplain and identify surrounding land that could be set aside for reducing flood levels in the future. Land was planned hierarchically to locate the most critical uses (hospitals, emergency services, power) in the least susceptible areas and the less vulnerable uses in more susceptible areas.

At a higher resolution, development was organised so that landscape would be affected by flooding first, followed by secondary paths and roads, then parking, then less vulnerable buildings, then primary roads, then more vulnerable buildings, all before emergency escape routes and people would be affected. This enabled non-defensive flood-risk management to be incorporated at a capital cost of between one percent and nine percent of the total development cost.

Renewable energy

Providing sufficient renewable energy on-site to achieve zero carbon development is very challenging using current technologies. Even after designing buildings to a very high level of thermal performance, the energy demanc is still about 50 percent that of occupants of traditional buildings. However, the electricity demand remains much the same and that is, therefore, the real challenge. On most sites there are only two renewable technologies suitable to produce electricity: Biomass Combined Heat and Power (CHP) and Solar Photovoltaics (PV).

In some situations wind, hydro or tidal power may be viable, but local objections to wind, low output from hydro and the lack of working examples of tidal are obstacles to their use. CHP and Combined Cooling

Heating and Power (CCHP) can provide a complete energy solution for hot water, heating, electricity and cooling but achieving a balanced production of exactly the right amounts of each at the right time is much more difficult to achieve. This necessitates the use of several sources of renewable power to avoid wasting fuel and heat dumping.

Therefore, solar PVs become essential. The area of PV required on the study sites in Hackbridge and in Peterborough when no wind power was included was found to be approximately 35 percent of the Gross Internal Floor Area of the entire development. In other words, if every roof was designed to predominantly face south then any development above three stories would run out of roof for the minimum area of PV required. This immediately challenges the concept of high-density sustainable developments – unless they are located in areas that have other resources to draw upon, such as windy, tidal coasts and aquifer-rich floodplains. The study sites at Peterborough and Littlehampton showed that wind, aquifers and

The Felnex site in Hackbridge has a generous multi-use space at its heart. This village blue/green provides space for water, recreation, play and energy production.

In Peterborough raised home zones are arranged around so called "rain and stream corridors", linear gardens that attenuate rainwater, create drainage and store floodwater.

tides could be used to generate and/or save energy. Large, efficient wind turbines, however, may not normally be located within 500 metres of development (creating a 1,000 metre exclusion zone) and tidal energy generation through inland lagoons requires vast areas of land to be flooded (imagine the impoundment behind a hydro-electric dam).

Development and amenity

The final component was to integrate the quality of life factors that help to make development sustainable, successful, thriving and beneficial to the health and happiness of occupants. The "Six Acre Standard" was established in 1925 in part for this purpose. It sets forth minimum standards for outdoor playing space (revised in 1992 to include children's playing space). Broadly speaking, this equates to 36 square metres of open space per person. Based on a density of approximately 60 units per hectare this meant that approximately 50 percent of the developable area of each study site would be required for outdoor play and recreation – unrealistic for mid-rise developments. By providing public access to land set aside for floodwater attenuation, and by designing that land so that it could be safely used, the ideal provision for areas of open play could be better met. Gardens and play areas designed with minimal variations in elevation to allow access for everyday use could be compatible with water attenuation during storms. Prioritising pedestrian and cycle paths

The findings of the research have been published in "The LifE project", a technical document and "The LifE handbook" a concise guide to flood risk and development by IHS BRE press.

also helped to reduce the walking distances to public transport and therefore the quantity of parking required. This helped to reduce capital cost by as much as eight percent of the total development cost.

Integrated planning with improved standards

In each of the sites, use of the floodplain was the only feasible solution to meeting the open play standards. By considering the spatial needs for water, energy and open play from the beginning, these functions could be integrated into the design and layout of the site, to create more attractive and successful development plans. It also allowed for more efficient planning, helping to reduce capital costs.

In Hackbridge an area of land at the heart of the development was ascribed multiple functions. The "village/blue green" would provide a flexible informal recreation area that would provide current and future flood storage potential and space for an array of boreholes for ground source heat pumps. This area creates a focus for the development, increases the sales value of properties and improves access to the river for the wider neighbourhood. In Peterborough "rain and stream corridors" were introduced between buildings to create areas for rainwater attenuation and to create drainage and flood paths away from homes. The corridor widths were designed to allow generous daylight into taller buildings and provide separation from small wind turbines located at the centre. Integrating soft landscaping throughout the masterplan would create a high quality environment and reduce air temperature in and around buildings, mitigating the urban heat island effect. In Littlehampton a large area of land to the rear of the development site was designed for controlled flooding, to reduce water levels in the river and reduce the strain on existing defences. This inland lagoon would provide water recreation adjacent to the development and habitat for wildlife in intertidal regions (mudflats and salt marsh) beyond. Twelve tidal turbines would generate energy for five hours during each successive ebb tide. The lagoons would be an attractive backdrop to the development and unique regional attraction.

With pressure to deliver more homes to higher environmental standards, on less land, the need to create more integrated planning to maintain or improve standards becomes important. When combined with the need to adapt to the effects of climate change, the need for multi-functional land and buildings becomes essential. Making space for water, energy and play will become a central theme for new development and redevelopment throughout the 21st century. By considering the criteria required for sustainable (zero carbon) development and space for water at the beginning of the design process, multi-benefit masterplanning can be achieved more cost effectively and with wider local and regional benefits.

The "slice of LifE" illustrates a section through a life development, in which space for water is provided adjacent to the river and within the town. Construction type is chosen to reflect the degree of hazard if a flood occurs.