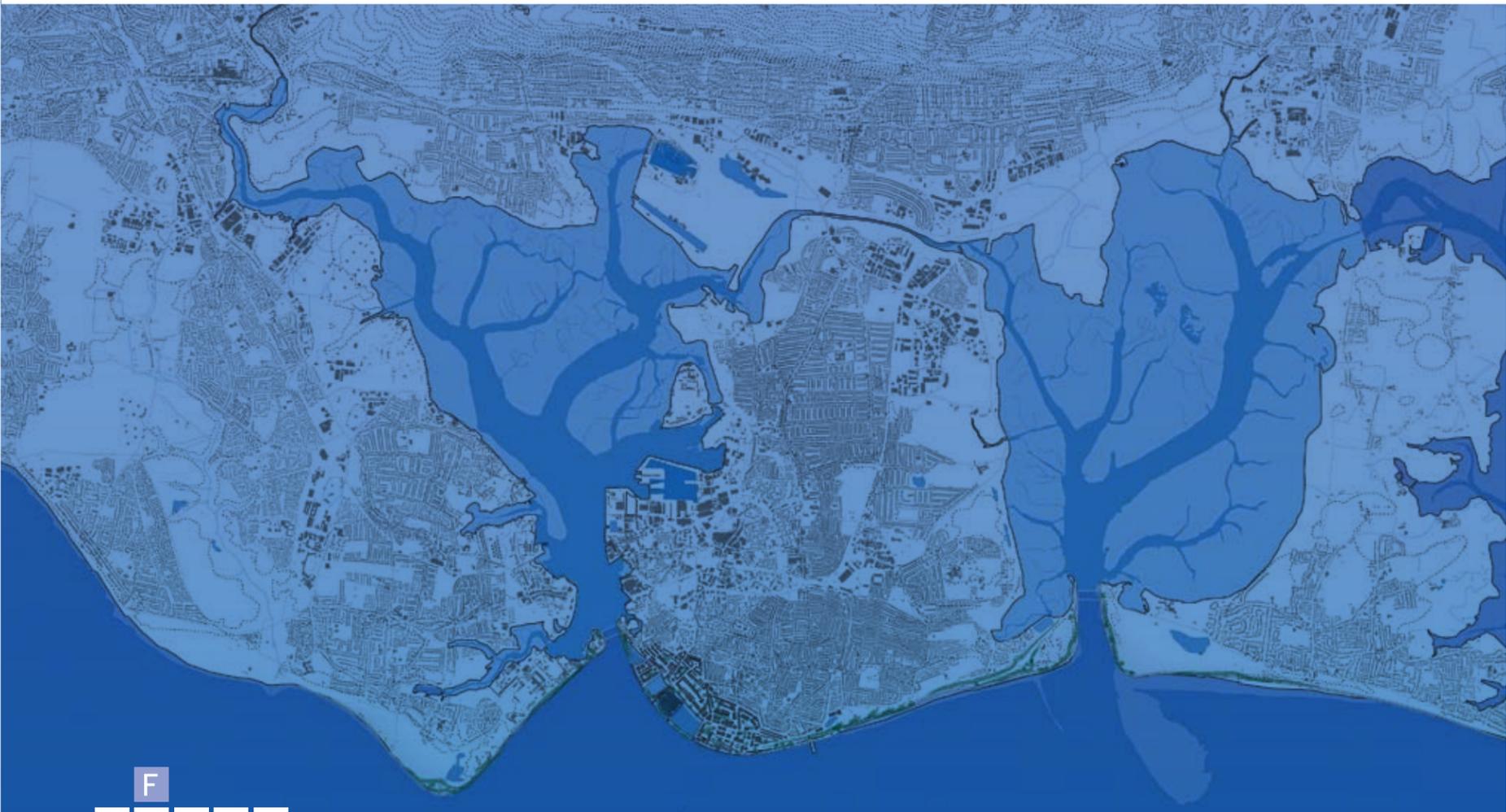




FACING UP TO RISING SEA-LEVELS: RETREAT? DEFEND? ATTACK?

THE FUTURE OF OUR COASTAL
AND ESTUARINE CITIES



F
B U I L D
T I N G
U R E S
S

ice
Institution of Civil Engineers

FOREWORD

This publication is a joint project between Building Futures and the Institution of Civil Engineers. Together we are well placed to scrutinise the current practice of coastal flood management in the urban context and lead on thinking about the future. Building Futures has been in existence since 2000. It is the Royal Institute of British Architects' think tank, charged with looking forward to prepare the profession and those we work with for the opportunities ahead and the challenges that we will face. The Institution of Civil Engineers (ICE) is a global membership organisation that promotes and advances civil engineering around the world.

This is a think piece – designed to provoke longer-term thinking across a wide audience: from government, to policy-makers, to planners, to architects and engineers and to the general public. Our proposals are extremes; and they need to be in order to tackle the scale of the problem. During the scoping phase of the project it was identified that, while there are serious problems to be addressed across the entirety of the UK coastline, we would focus this project on cities. Clearly the urban context is where we find the most acute problem: one tidal flood event can damage so many people's homes and critical infrastructure in an extremely short period of time. Furthermore, the consequences will be long-lasting. The problems and challenges posed by future population growth, urban migration patterns and housing demand will fall predominantly on cities, exaggerating the problem.

Facing Up to Rising Sea-Levels is a companion to a wider programme of research on flooding carried out by the RIBA and the ICE. In 2007, Building Futures published *Living with Water: Visions of a Flooded Future*, which focused on the Thames Gateway and strategies to cope with increased flooding. The RIBA Policy unit has recently published *Designing for Flood Risk*, the 7th RIBA Climate Change Toolkit. This design-led document gives users a general understanding of the main issues that flood-risk gives rise to, followed by an overview of current policy, and legislation. It offers design strategies for an integrated approach to the control and mitigation of flood risk. Last year the ICE produced *Flooding: Engineering Resilience*, a document making recommendations to central and local government on how to improve the infrastructure relating to the management of present and future flood risks. Both the ICE and RIBA have recently recognized the need for a cross built environment response to reducing urban flood risk and formed an inter-institutional flood group comprising of ICE, RIBA, Royal Town Planning Institute, Royal Institution of Chartered Surveyors, Chartered Institution of Water and Environmental Management, Landscape Institute and the Royal United Services Institute.

Facing Up to Rising Sea-Levels is accompanied by a touring exhibition aimed at raising awareness to a broad audience and challenging that audience to understand that difficult decisions will have to be made for our futures to be positive ones. For more information on the exhibition, please visit: www.buildingfutures.org.uk or www.ice.org.uk/facing-up

DICKON ROBINSON
Chair of Building Futures

+ The length of the UK coastline is around 12,429 km or 7723 miles, compared to the coastline of Italy (7,600km), Spain (4,964km), France (3,427km) or The Netherlands (451km).¹

+ Home insurance firms are set to lose £4 billion a year by 2035 on repairing flood water damage.²

+ Annual flood defence spending must be increased to a minimum of £750M (currently c. £500M) just to maintain design-specification levels of protection.³

+ Around 10 million people, in 5.5 million properties, live in flood risk areas in England and Wales, with 2.6m of those properties at direct risk of flooding from rivers or the sea.⁴

+ In England the cost of claims from flooding in June and July 2007 exceeded £3.5bn.⁵

+ In January 1953, over 300 people died and over 24,000 homes were flooded on the east coast of England after flood defences were breached as a consequence of extremely high winds and a tide at dangerous levels.⁶

+ In Hull, after 100mm of rain fell in 24 hours in the Summer of 2007, 600 streets, nearly 9000 homes and 91 of the city's 99 schools were flooded. 1300 businesses were affected.⁷

+ A recurring theme is of inadequate consultation, co-operation and unity between the public agencies.⁸



INTRODUCTION

“SO, WHAT’S THE PROBLEM...?”

The future of the UK’s coastal and estuarine cities is affected by two things: the changing physical environment and man-made constraints. The changing environment consists of rising sea-levels, sinking landmasses and an increase in storm frequency. These long-term trends require urgent adaptation. What we can tackle with immediate effect are the man-made constraints to long-term sustainable management of the coastline. These constraints include limited financial resources, unclear communication between numerous stakeholders and planning to an inappropriate timescale.

CHANGING ENVIRONMENT

SEA-LEVEL RISES

Sea-levels are *unmistakably* rising. As the oceans warm, they expand. This has been the primary contributor to the historic sea-level rise which has recently accelerated from around 1.7mm per year over the 20th century to 3mm since the 1990s.⁹ Another contributor is land-based ice melting. This is much harder to predict, but the effect of an Antarctic or Greenland Ice-Sheet melt would be catastrophic and cause a much a faster rise in sea-level. The recently published United Kingdom Climate Projections 09 (UKCP09) forecasts a range up to 76cm by 2095, but with a revised ‘extreme’ figure for vulnerability testing of 190cm.¹⁰

As sea-levels rise, the amount of wave energy that reaches the shoreline increases so much that wave overtopping and damaging wave impacts on our beaches and structures rise beyond design conditions.

LANDMASS SINKS

The landmass in the South of the UK is sinking relative to the North. Since the last glacial period the United Kingdom is experiencing *isostatic rebound*. This is when heavy ice-sheets depress a landmass over centuries, the landmass starts to rebound upwards as the ice recedes. In the UK this upward rebound is still taking place in Scotland and the very North of England, causing the landmass in the south to sink.

STORM FREQUENCY AND INTENSITY

Storm frequency and intensity is predicted to increase over the 21st century. Storm surges increase the normal sea-level by a significant amount. If this happens during an especially high tide, the effects are dramatic within a very short length of time. For example, during the 1953 flood, Southend saw a 2.9m surge. Within a 100 year return period, a large surge like this is very likely to occur.

SEA-LEVEL RISE, LANDMASS SINK AND INCREASED STORM FREQUENCY MEAN COASTAL FLOODING IS SET TO OCCUR MORE FREQUENTLY AND WITH GREATER SEVERITY, INCREASING THE RATE OF COASTAL EROSION. OUR COASTAL CITIES AND TOWNS NEED TO BE PREPARED FOR THIS FUTURE BY TAKING ACTION.



MAN-MADE CONSTRAINTS

WHO TALKS TO WHO?

LIMITED RESOURCES

The most pressing of all our attributed problems is a LACK OF FUNDING. The UK does not have sufficient funds to defend the entire coastline. The process of withdrawing maintenance in places has already started: communities are being informed that new policies include “no-active-intervention”, effective immediately or within 20 years.

The PROPERTY and INSURANCE markets have a significant amount of influence on the situation. Properties lose nearly all their market value if they can no longer be insured. Until 2013 the insurers will provide cover to properties with less than a 1.3% chance of flooding per year, which is equivalent to 1 in 75 year flood.¹¹ This may change and higher risk areas will face increased premiums or lose their cover. The insurance sector has no incentive to ‘better’ homes and make them more flood-resistant following a claim; however, if customer loyalty was guaranteed, there could be a strong financial argument for improving the flood resilience of homes.

COMMUNICATION

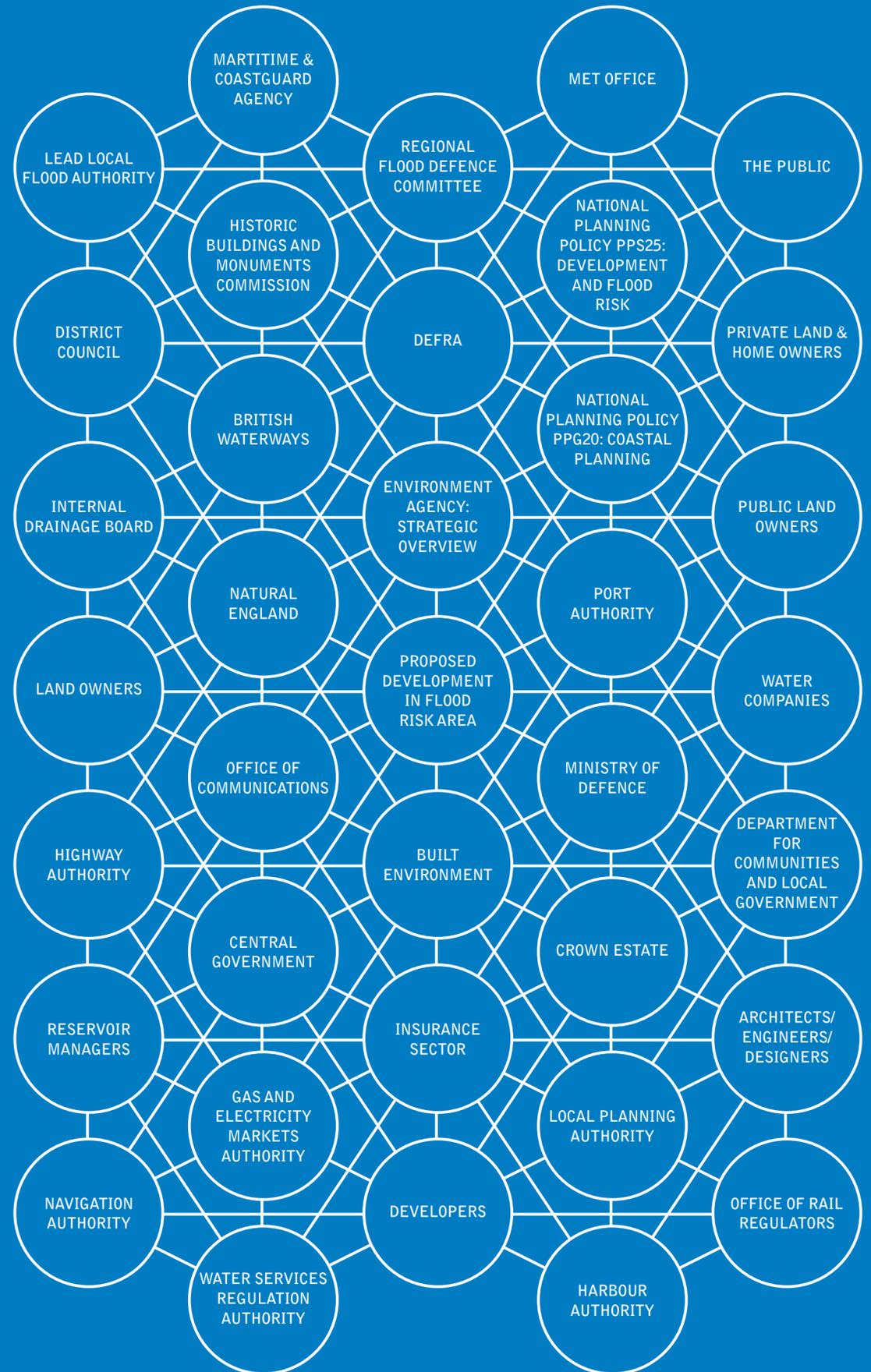
The huge number of STAKEHOLDERS involved in issues to do with flooding lead to serious problems in communication. This can drastically slow and complicate the decision making process, leading to inaction or delayed responses. The diagram opposite begins to show the complications involved.

There is much concern in the PUBLIC MINDSET about development on the floodplain. On the other hand, living in close proximity to water is desired by many. There appears to be a lack of understanding of flood ‘RISK’, and what should be considered as an acceptable risk. For instance, does the public really understand what a 1 in 200 year flood is, or what the flood zones mean?

TIMESCALE

In the TIMESCALES that coastal stakeholders work to, there is a dramatic difference. Coastal Groups draw up 100 year Shoreline Management Plans (SMP), while local planning usually has a 15-20 year horizon. The political term of four years causes a lack of consistency in our political leadership. Starting to reconcile the timescales is a difficult challenge, but city planners need to stretch their horizon, while the SMPs need to maintain their long-sighted overview.

MANY OF OUR MOST IMPORTANT CITIES AND TOWNS ARE SITUATED IN AREAS OF TIDAL FLOOD RISK ON THE COAST OR ON ESTUARIES. HISTORICALLY THESE CITIES HAVE GROWN ON THE ECONOMIC STRENGTH OF THE PORTS AND THEIR ASSOCIATED TRADES. MORE RECENTLY TOURISM HAS BEEN A SIGNIFICANT ECONOMIC DRIVER. WHETHER IT IS FOR THEIR TOURISM OR THEIR PORTS AND TRADE, THESE CITIES ARE PART OF THE NATION’S FABRIC.



THE MISSING VISION

WE NEED TO TURN A NEGATIVE PROBLEM INTO SOMETHING POSITIVE!

There are ways in which this can be achieved. We can secure a future for the coastal cities vulnerable to sea-level rise. Our coastal communities contribute to our economy, are part of our history, and are home to millions of residents; **the UK needs a proactive approach** to managing our changing environment and coast.

There is an urgent need to act now. If the issue is ignored the likely consequences are serious, including hazardous fast-flowing floods, potential loss of human life, residents displaced from homes, enduring psychological damage, loss of critical coastal habitats, abandonment of cities, billion pound damage bills and local economic collapse. **Taking a long-term view of the future of a city and adapting accordingly can alleviate all these likely consequences of sea-level rise.**

The North Sea storm surge of 1953 is still a grave reminder of the consequences of tidal flooding in the UK. The death toll was estimated at over 300. **Today our coastline is much more densely populated and so the scale of disaster has drastically increased.** The devastating effect Hurricane Katrina had on the city of New Orleans in 2005 and the recent 2007 flooding in the UK should be a stern prompt to action.



WHAT NEEDS CHANGING?

LIMITED RESOURCES

We need to think creatively about more **ECONOMICALLY SUSTAINABLE** solutions to flood risk management. Developers will only take on flood-management if there is commercial gain. But this private sector funding will be needed to fill the gap if Government funding does not increase sufficiently. Can flood management be profitable? While government funding is set to increase, and has doubled in recent years, it is still not enough to tackle the problem alone. Therefore initiatives should be taken to set up multi-objective projects that could be multi-funded.

The role of **ARCHITECTS AND ENGINEERS** should be to embrace flood risk within design. Innovation and creativity is starting to emerge in a growing body of architectural and engineering design work relating to flood risk. The challenge to designers is to continue to find positive solutions to adapt, resist or mitigate future flood risk, adding value to the development.

COMMUNICATION

We need **JOINED-UP, COORDINATED THINKING** and **ACTION** by all the interested and affected parties. The large number of stakeholders involved with flooding makes this a complicated process, but it is hoped that the new Flood and Water Management Bill will establish much clearer responsibilities. The issue of flooding needs one central, strategic body and the Environment Agency has been chosen for this task; however, they may need greater resources.

There also needs to be much better **COMMUNITY ENGAGEMENT** in the process. The communities need to fully understand the actual risk they face, as well as the incentives to act now and have a long term vision. The public needs to understand the long-term history and future of coastal change. They should be consulted with regularity during the decision-making process to facilitate this.

TIMESCALE

There needs to be a **LONG-TERM STRATEGIC VISION** embedded into current planning, especially land-use allocations. The 100 year Shoreline Management Plan (SMP) needs to address the future of coastal towns and cities, without automatically assuming that a hold-the-line policy is correct. At the same time, local planning in coastal cities needs to see beyond its usual 15-25 year horizon and begin the process of adapting the urban environment to face the rising tides. Both local planning timescales and SMPs will require strong leadership from the Government and an ability to take tough decisions. The scale of planning interventions will need to be as large as the problem.

STORIES FROM HOME



MANAGED COASTAL REALIGNMENT

"In suitable physiographic settings, areas sacrificed to the sea will develop into salt marshes or coastal mud flats. This alleviates the problems associated with 'coastal squeeze' in front of sea walls. Marshes in particular have a rough surface and shallow water and therefore are effective at absorbing tidal and wave energy, and therefore reduce the erosive power of the sea. They also accrete tidally-borne sediment naturally and can represent a self-maintaining sea defence that (within limits) can keep pace with rising sea-level. This may involve recycling and stabilizing sediments mobilized by erosion elsewhere.

"The habitat thus created is of high biodiversity and conservation value, not only for its indigenous organisms and ecosystem services but also for migrating birds. In any event we are legally obliged, by the EU Habitats Directive, to replace areas of salt marsh and mudflat lost to erosion and development."

Professor A J Davy, University of East Anglia

RECYCLED MARINE INFRASTRUCTURE

Designs that previously won the RIBA Sustainable Living by Design and the Corus Architectural Student Award show the proposal for creating a floating city in the Thames Gateway using decommissioned ships and oil platforms. Tony Lau's design allows for greater flexibility in planning, while tackling the issue of future flooding head on.



ADAPTIVE ARCHITECTURES; RAISING LIVING AND RESILIENCE

The Turnaround House by Nissen Adams is: 1. An adaptable house that responds to a flood, without compromising living during the rest of the year. 2. A house that meets the occupants' needs at all times. 3. 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 floor 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.

INNOVATIVE SEA DEFENCES

This ICE Merit Award nominated scheme in Cleveleys is exemplary of best practice. The defence scheme benefits the community not only by offering protection from tidal flooding, but also by increasing the amenity to the beach. It is unlike other coastal defences in that it does not alienate the community from its proximity to the sea.



STORIES FROM ABROAD



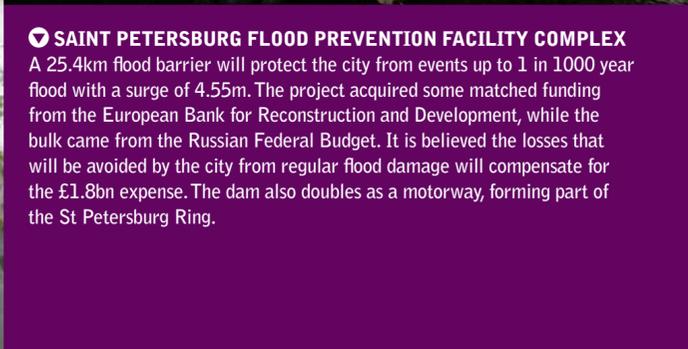
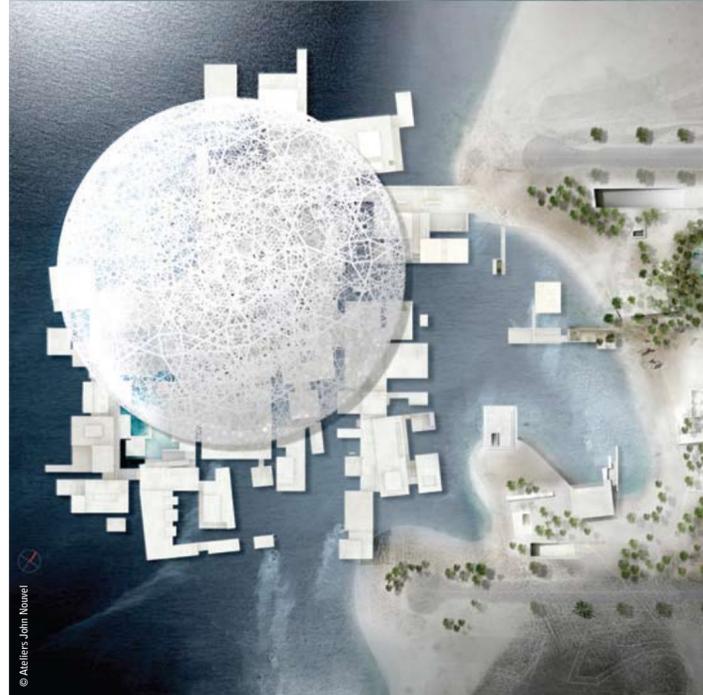
FLOATING / AMPHIBIOUS HOMES

Dura Vermeer designed this floating community in Maasbommel, Netherlands. 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. They 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.

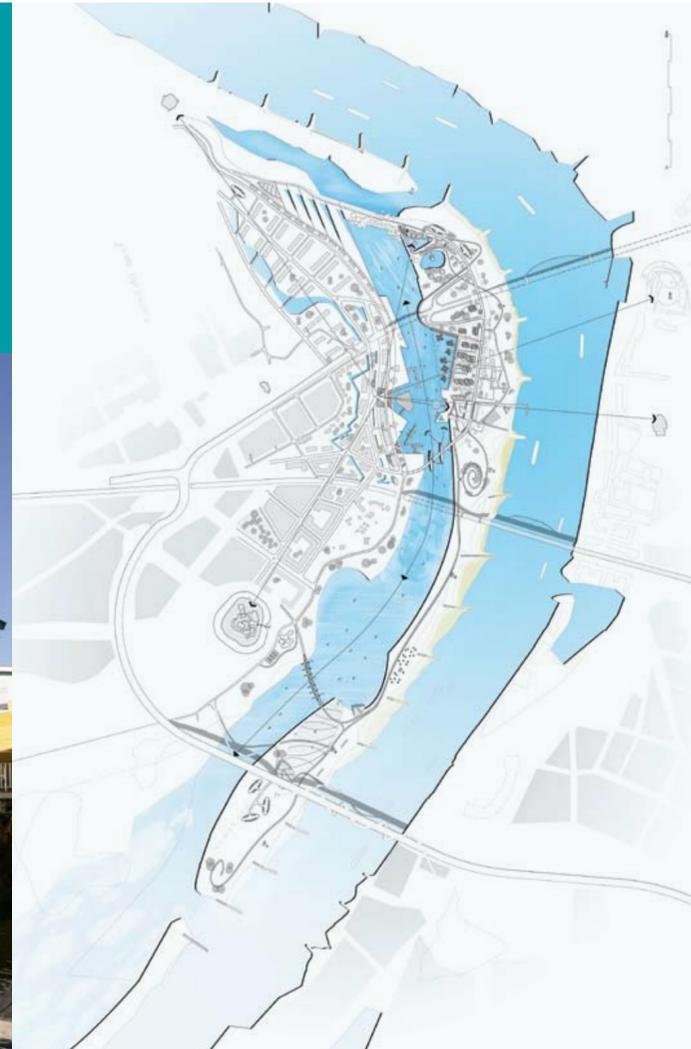


SAINT PETERSBURG FLOOD PREVENTION FACILITY COMPLEX

A 25.4km flood barrier will protect the city from events up to 1 in 1000 year flood with a surge of 4.55m. The project acquired some matched funding from the European Bank for Reconstruction and Development, while the bulk came from the Russian Federal Budget. It is believed the losses that will be avoided by the city from regular flood damage will compensate for the £1.8bn expense. The dam also doubles as a motorway, forming part of the St Petersburg Ring.



BUILDING OUT INTO THE WATER
Some projects currently underway, like the Louvre in Abu Dhabi designed by John Nouvel, build directly onto what was once water. Acknowledging the value proximity to water brings, these schemes can justify the extra cost of building in their own flood defences.



BUILDING ON STILTS
Dutch Architects, MVRDV, designed this housing typology for the Lower Ninth Ward of New Orleans. Working with Make It Right, good building design has incorporated flood risk to rebuild a district lost in the 2005 floods. The stilt design allows the space below to be used for car parking, while residents and the property are safe from flooding.



INTEGRATED DESIGN SOLUTIONS

New designs are being created by an extensive dyke relocation programme in the Netherlands as part of the 'Room for the River' programme.

Integrated design proposals for a leisure retreat destination draw upon the 'Life' approach (developed with Defra funding).

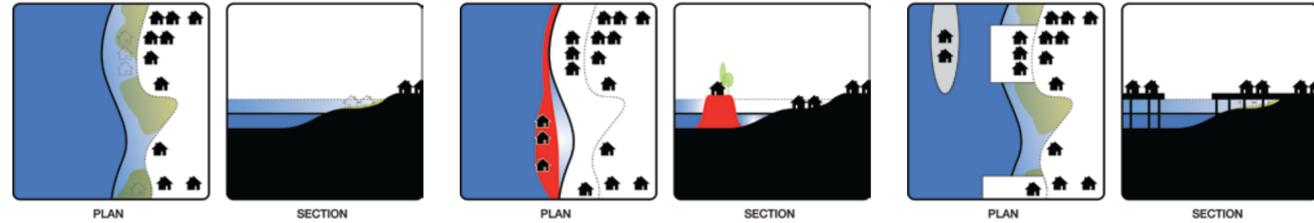
The proposals combine water (hydrology) with river ecology, flood resilient development and sustainable infrastructure to create an energy and water self-sufficient 'eco-leisure' destination. It will be a showcase for international architectural and technical innovation.

Baca Architects are the authors of the Life project and have undertaken this work in Nijmegen.



WHAT CHOICES CAN WE MAKE?

WHAT IF WE LOOK AT THE LONG TERM FUTURE OF OUR COASTAL CITIES AND IMAGINE WHAT STRATEGIES MIGHT NEED TO BE ADOPTED? WHAT CHOICES DO WE HAVE TODAY TO ENSURE THAT BY THE NEXT CENTURY SEA-LEVEL RISE WILL HAVE BEEN MANAGED IN A WHOLLY POSITIVE MANNER? THERE ARE THREE BROAD APPROACHES TO THE FUTURE OF COASTAL MANAGEMENT: RETREAT? DEFEND? AND ATTACK?



RETREAT?

To retreat is to step back from the problem and avoid a potentially catastrophic blow. It is to move critical infrastructure and housing to safer ground and to allow the water into the city to alleviate flood risk. This is critically different from *abandonment*, as we propose a long-term planned and *managed process*.

Managed Retreat, or Managed Realignment is a method of removing or breaching coastal defences, allowing tidal seawater to flood areas previously protected. The line of defence is then relocated landwards. An advantage of this is to reduce the flood risk to vulnerable sites further inland and along the coast by moderating the tide and wave energy. However, the main driver is a reduction of 'whole-life' costs to the defence scheme and increased long-term sustainability. Much needed inter-tidal habitat is also created, such as salt-marsh and mud-flats.

In retreating, investment in existing structures and infrastructure is lost as the area is claimed or reclaimed by the sea. New investment must also be made in relocating communities and infrastructure out of harm's way. However, money is saved by significantly decreased investment in flood defences.

To date, several pilot sites of managed realignment have been created and the monitoring process is showing promising results. However, these sites were previously free from human habitation. **HOW DO WE RETREAT FROM A POPULATED AREA, AND ONE WITH INFRASTRUCTURE CRITICAL TO THE NATION?** Is it possible and practical to retreat from such an area?

DEFEND?

To defend is to ensure the sea water does not enter the existing built environment. This will require built defences to ensure the standard of protection will be met in the distant future as sea-levels rise. Although it is currently an expensive policy to adopt, can the defences themselves be designed in a way to make them economically and commercially viable?

Many of the hard engineered defences of the 20th century have been criticised for being unsustainable, reducing access to water, damaging to coastal habitats and costly to maintain and improve. However, they have provided protection and reduced risk from flooding, allowing activities to go on uninterrupted in the built environment. But what if the defences themselves served a dual function? For instance, could the defence structure be a part of a commercial development allowing for the developer to benefit from the proximity to water? Alternatively, there are several land uses suitable to locate within the inter-tidal zone that could be incorporated into a sustainable response to rising sea-levels, including public recreational space.

By choosing to defend, the existing built infrastructure of a city is protected from floods and does not need to be relocated to higher ground or rebuilt after flooding. However, as mentioned above flood defence is an extremely costly endeavour.

Currently, defensive practice is conducted in a piecemeal fashion, owing to the number of bodies involved and funding available. **COULD A CITYWIDE DEFENCE SCHEME BE IMPLEMENTED AND CREATIVELY FINANCED, PROTECTING THE CITY FROM ANY SEVERE TIDAL FLOOD?** The proposed line of defence is able to 'hold', 'advance', or 'retreat' the existing line of defence where necessary to accommodate the future needs of the city.

ATTACK?

To attack is to advance and step seaward of the existing coastline. There is massive development potential to be gained for coastal cities by building out onto the water. This further reduces the need to sprawl into the countryside and ensures their sustained social and economic vitality. Although it leaves parts of the city still vulnerable to flooding, can the long term benefit of new development outweigh this risk?

We have several means of building out onto the water and they have been practiced for centuries. Stilts that allow waters to rise, fall and surge underneath inhabitable space have been used on piers around the world, as well as individual buildings. Floating structures, from boats to pontoons, have been used for housing and civil infrastructure. Land reclamation is practiced extensively in some parts of the world, creating new land for development.

HOW CAN THESE PRACTICES OF NEW MARINE DEVELOPMENTS BE IMPLEMENTED IN A SUSTAINABLE MANNER? These strategies of Attack could unlock a vital planning tool and give flexibility to our extremely dynamic 21st CENTURY cities. Moreover, it could encourage a new breed of developers to fill this gap as demand for the prime waterfront sites grows. This commercial competition will need to be matched in long-term management and responsibility. If new development in coastal cities starts to prepare for rising sea-levels now, the livelihood of the city could be maintained for generations to come.

SCOPING OUT THE OPTIONS...

IN JULY 2009, BUILDING FUTURES AND THE INSTITUTION OF CIVIL ENGINEERS HOSTED A DESIGN CHARRETTE, BRINGING TOGETHER A NUMBER OF PROFESSIONALS FROM VARIOUS RELEVANT SECTORS. WE HAD A SELECT GROUP OF TOP ARCHITECTS, CIVIL ENGINEERS, CITY DESIGNERS, PLANNERS, DEVELOPERS, POLICY-MAKERS, ECOLOGISTS AND FUTUROLOGISTS. THE BRIEF WAS TO PRODUCE BOTH ARCHITECTURAL AND INFRASTRUCTURAL RESPONSES TO RISING SEA-LEVELS; ADDRESSING THE ISSUE WITH OUR THREE PROPOSED FUTURE SCENARIOS: RETREAT? DEFEND? ATTACK?

We chose two cities to look at as case studies, the cities of KINGSTON-UPON-HULL and PORTSMOUTH.

Three teams were formed: **RETREAT, DEFEND** and **ATTACK**, and issued with the following briefs.

RETREAT BRIEFING SCENARIO: THE NEXT 100 YEARS

As sea-levels have risen, available landmass has been reduced. Coupled with this, storm frequency and intensity have increased. We have reached a critical point whereby hard engineered defences are neither a sustainable nor financially viable solution. It has become impossible for properties at risk to be underwritten. The only option is to Retreat. Retreat in this context is to move the line of defence landwards – if any actual 'line' remains.

APPROACH: A FEW POINTS TO CONSIDER

- How can this process be managed in a controlled way?
- Which sites in the city need to be retreated from on what timescale?
- Does the city choose densification on existing sites within the city that have a lower flood risk?
- What happens to the rural land at the margins of the city?
- Does the city start an entire relocation programme?
- What happens to the land left behind? Recreation land use or urban agriculture?
- If we can accept living with water and accept its fluctuations, what retro-fit architecture and infrastructure would keep the city functioning?
- Are there architectures that could retreat with the rising tides on a local scale?
- Above all, any schemes should not only incorporate their own flood risk alleviation, but attempt to lower the risk of surrounding sites as well.

DEFEND BRIEFING SCENARIO: THE NEXT 100 YEARS

There is already a large and growing funding deficit on flood defences; annual budgets for maintenance do not nearly match annual average damage costs to the built environment. But maintenance is only half the picture: improvements need to be made as sea-levels continue to rise and landmass continues to sink. Government funding is no longer able to cover this exclusively, but the benefits of defence outweigh the costs. The private sector is asked to incorporate the defensive challenge into its development schemes.

APPROACH: A FEW POINTS TO CONSIDER

- How can defence systems become commercially viable?
- Will they be mixed-use? Residential or commercial?
- Will the structures be permanently inhabitable?
- Will the defences make provision for social amenity or utility and therefore be made desirable for local residents?
- What will be happen at the fringes of the city?
- With any defensive policy there is always the risk of breach. Therefore, what architectures and infrastructure would be suitable behind this line of defence, anticipating the risk?
- Above all, any schemes should not only incorporate their own flood risk alleviation, but attempt to lower the risk of surrounding sites as well.

ATTACK BRIEFING SCENARIO: THE NEXT 100 YEARS

The population density of the UK has increased and with it the pressure to expand sea-ward. Increased public understanding of the risks of living with water and the need to accommodate water sustainably have meant that there is increased willingness to experiment with living arrangements and structure. Taking inspiration from overseas practices of building out onto the water, combined with new technologies, both the public and private sector confidently invested in building in front of the line of defence.

APPROACH: A FEW POINTS TO CONSIDER

- How could we make space for future development in front of the existing line of defence, regardless of sea-level rise?
- How viable is land reclamation and expansion?
- How would communities be encouraged to settle at these points?
- What would be the commercial opportunities of these new extensions?
- How might they be sustainable?
- What further function, beyond creating development opportunity, could the proposed schemes serve?
- Could they reduce flood risk to the existing city?
- How will the city adapt if no further defence is being provided?
- Could they moderate coastal erosion and long-shore drift?
- How could floating or amphibious architectures be incorporated into the schemes?

Dickon Robinson, Mike Althorpe, Laura Allen (hidden), Professor AJ Davy, Beth Bear, Mark Smout, Holly Lewis, Nick Hardiman



Julia Hamson, Ewan Willars, Robert Barker, Charlie Peel, Christophe Egret, Ben Hamer, Ben Adams



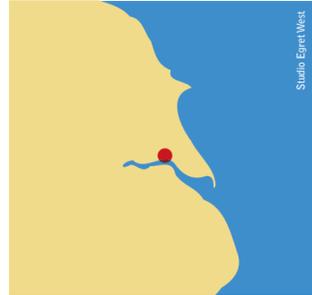
Julia Hamson



CASE STUDY: KINGSTON-UPON-HULL



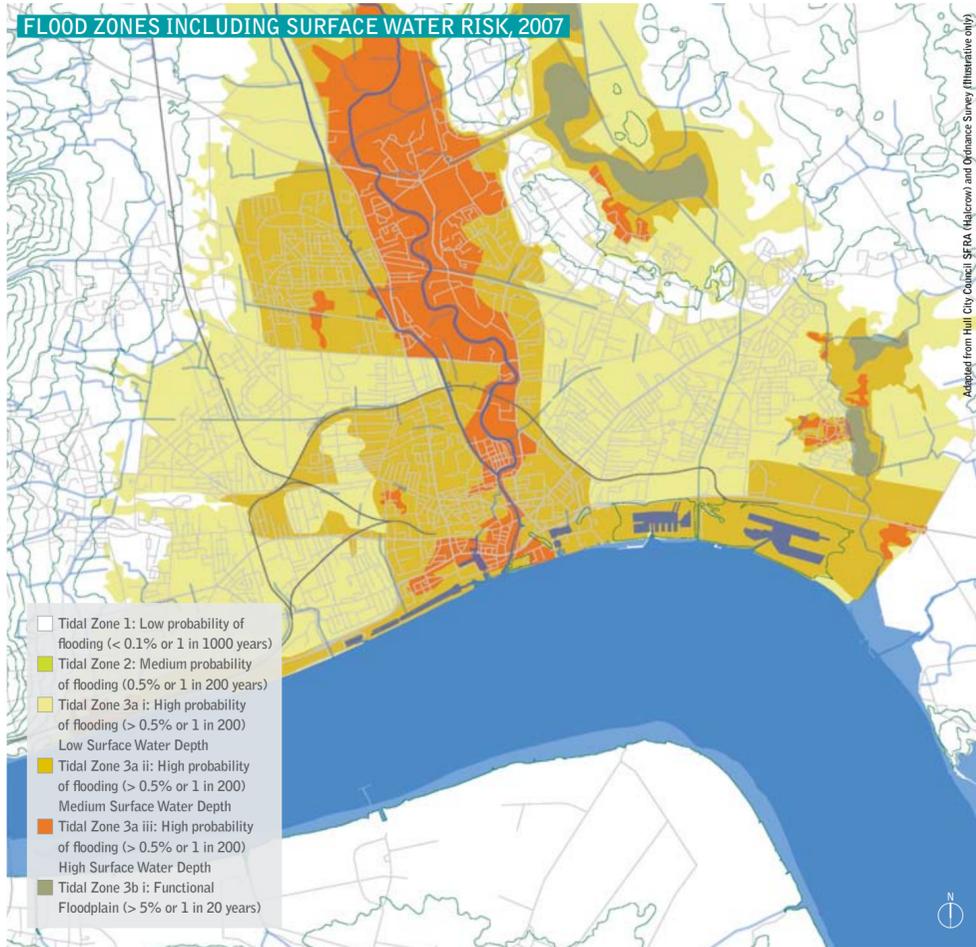
Studio Epret West



Studio Epret West



© Associated British Ports



Kingston-upon-Hull sits 25 miles from the North Sea on the north bank of the Humber Estuary. The River Hull bisects the city, flowing from north to south. Historically the city has many ties to the water, both military and commercial. It has a population of nearly 250,000, and relies on the port and waterfront to support its economy. The city underwent major reconstruction following the Second World War.

According to the Associated British Ports, "the Port of Hull is one of the UK's leading foreign-trading ports. Regular short-sea services operate to Europe, Scandinavia and the Baltic states, and the port also benefits from worldwide deep-sea connections. Hull is the UK's leading softwood timber-handling port and regularly handles in excess of 1.5 million cubic meters of timber, in addition to large volumes of other forest products."¹²

The draft Regional Spatial Strategy for Hull (2005) states that flood risk will not be "a barrier to achieving regeneration and economic regional and sub-regional priorities."¹³ Hull City Council recognise, "While... Hull is vulnerable to flooding, development in the City is critical to support sustainable regeneration, and consequently the plan aims to secure the City's long term, sustainable, existence, building in management of flood risk."

FLOODING

One startling characteristic of Hull is the relative flatness of the city which ranges from 2-4 metres above sea-level. Some areas of Hull already lie on reclaimed land at, or below, sea-level.

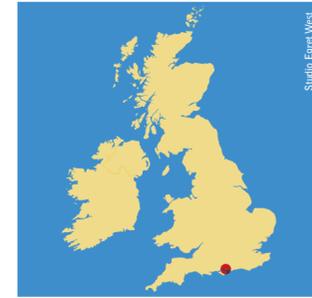
The Environment Agency own and operate a Tidal Surge Barrier at the mouth of the River Hull. This prevents surge tides from flooding upstream, protecting approximately 10,000 people from flooding. Recently it has been used between 8 and 12 times a year when exceptional tides have been expected.

In 2007 Hull was severely affected by the summer floods. This was due to substantial and prolonged rains. Coupled with run off from surrounding high ground and the flat topography of the city, this rain resulted in standing water, affecting 20% of the city's housing and costing an estimated £100 million in damages to schools alone.

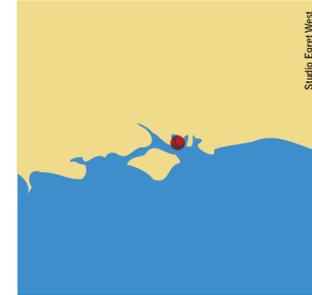
"It is estimated that over 8000 houses and 100 businesses were flood damaged. None of Hull's flood defences were breached or failed, but the city's drainage infrastructure was unable to cope."

- + THE CITY IS LOW-LYING
- + THE RIVER HULL IS LIABLE TO FLOODING
- + DUE TO ITS FLATNESS, THE CITY HAS TO BE CONSTANTLY DRAINED BY PUMPS
- + THE HUMBER IS A TIDAL ESTUARY
- + WHEN A SURGE TIDE IS PREDICTED, THE HULL BARRIER IS CLOSED
- + THE PORTS ARE OF NATIONAL STRATEGIC IMPORTANCE

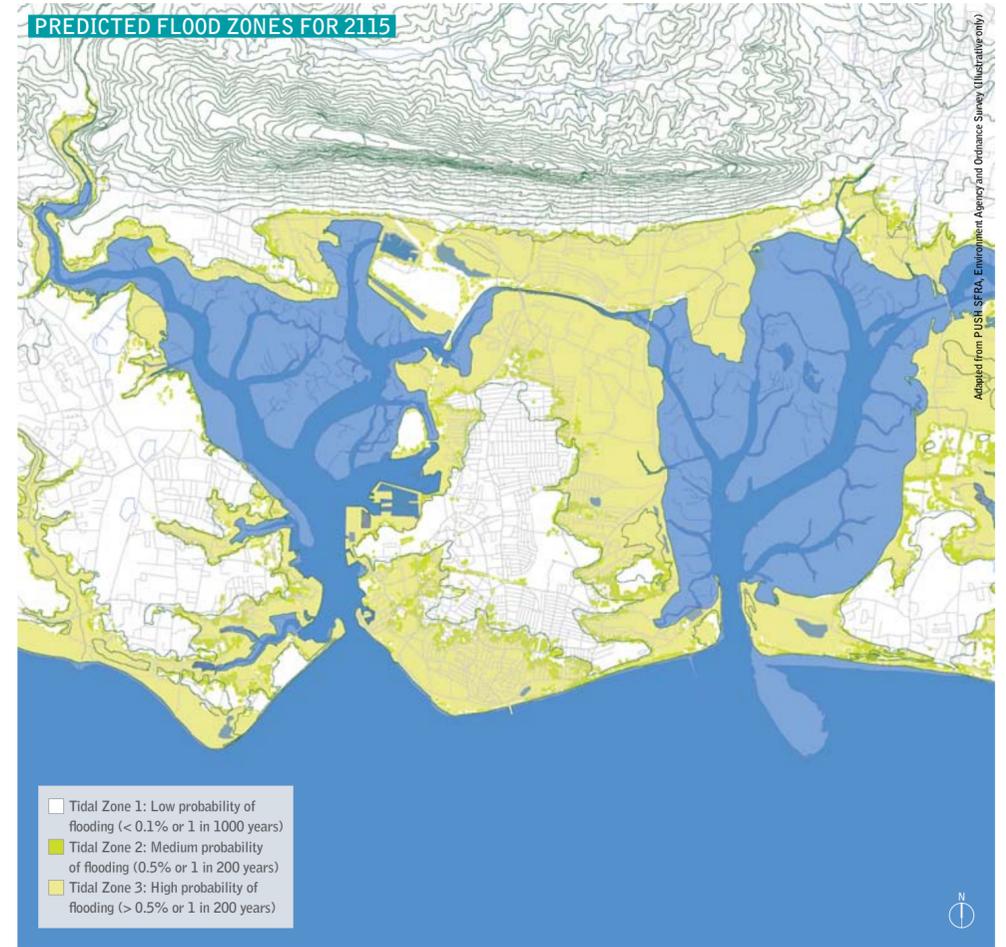
CASE STUDY: PORTSMOUTH



Studio Epret West



Studio Epret West



The City of Portsmouth is located on Portsea Island on the south coast of England. It sits between the sheltered but busy Portsmouth Harbour to the west and quieter Langstone Harbour to the east. The City of Portsmouth has a population of 200,000 and has the highest density in the UK. It also forms part of a much larger urban conurbation including Fareham, Gosport, Havant, and Porchester, with a combined population of approximately half a million.

Much of the coastline is owned by the Ministry of Defence as the city is home to a major naval base. Her Majesty's Naval Base Portsmouth is the largest in the UK, with two thirds of the surface fleet docking there. In peak times there are over 17,000 people working there and supporting the local community.

More recently, commercial shipping and ferries and recreational boating industries and ports have grown in the harbour. The City Council have invested significantly in the port's infrastructure in the last 30 years, however, the port's annual surplus is used to reduce council tax to residents.

FLOODING

The city is very dense and surrounded by water on all sides. Much of the city is built right up to the water's edge, especially in the city centre and the old city. The city is relatively low lying and the majority of it is only 3m above sea-level. The threat is dominantly from tidal flooding as there are no significant rivers. However, with so much of the area being covered with impermeable surfaces, water is not quickly absorbed nor is the flow slowed down.

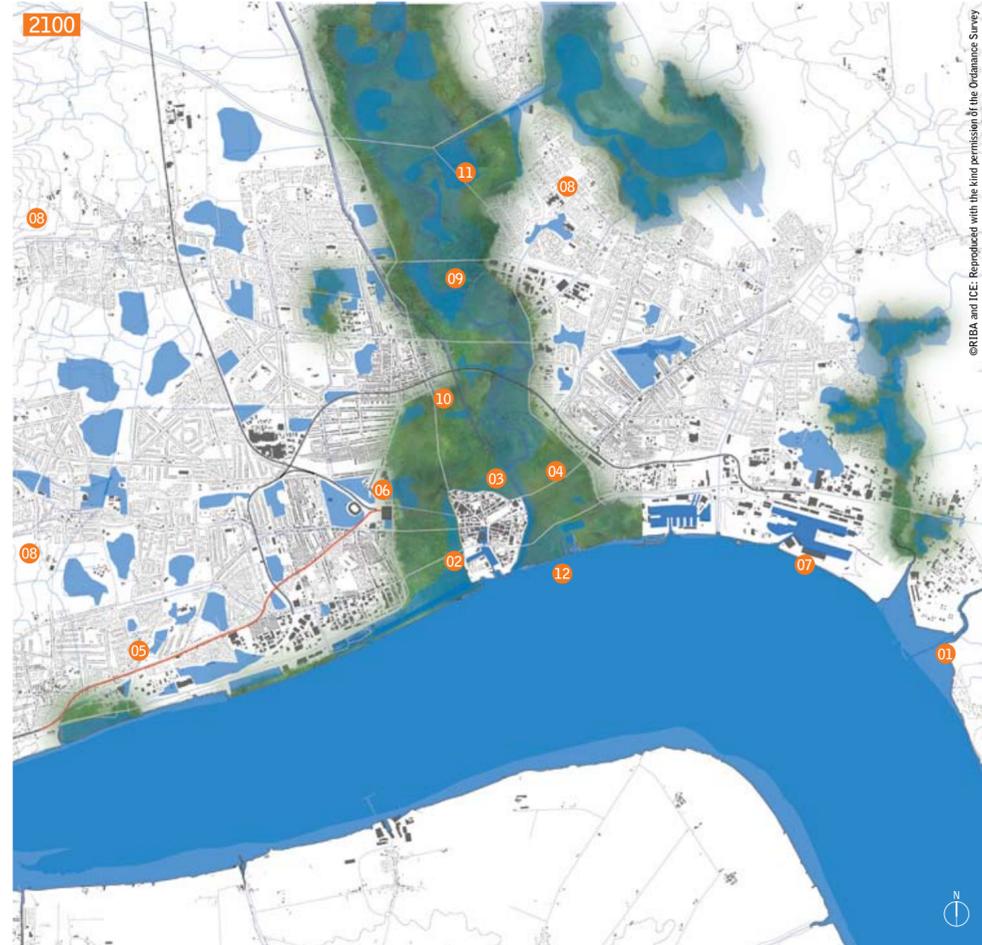
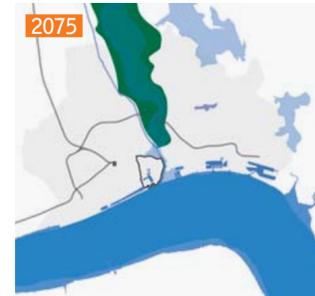
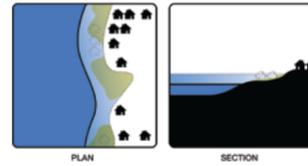
Around 20% of properties on Portsea Island lie within the Environment Agency's flood zones. If the current defences are breached there will be fast flowing, potentially extremely hazardous water.

Much of the backshore of Portsea Island is comprised of reclaimed land (former intertidal areas were drained and protected). Some of this reclaimed land is now used for ports, Naval property, urban development, infrastructure (road and rail), and public recreation.

- + MOST OF THE CITY IS SITUATED ON AN ISLAND
- + THE CITY IS EXTREMELY DENSELY POPULATED
- + THE HARBOURS ARE IN CONSTANT USE WITH RECREATIONAL AND COMMERCIAL VESSELS
- + THE CITY IS EXPOSED TO THE OPEN SEA TO THE SOUTH
- + MUCH OF PORTSMOUTH HARBOUR IS USED BY THE ROYAL NAVY
- + THERE ARE SEVERAL NATIONAL MONUMENTS ON THE COAST

HULL RETREATS

WHAT IF A RADICAL, LONG-TERM PLANNING STRATEGY WERE IMPLEMENTED ACROSS THE CITY OF HULL? COULD WE TURN THE SEVERE RISK OF A FLOODED FUTURE INTO A POSITIVE ATTRACTION WITH A 'DESTINATION-MAKING' INTERVENTION? IF WE LET WATER INTO LARGE SWATHES OF THE CITY, WILL IT ALLEVIATE THE RISK ELSEWHERE? WE COULD CHOOSE TO SAVE SOME PARTS OF THE OLD CITY, WHILE ALLOWING THE LOW-LYING LAND EITHER SIDE OF THE RIVER HULL TO FLOOD AND BECOME AN INTER-TIDAL SALT MARSH. WHAT WOULD THE CITY LOOK LIKE? CAN RESIDENTS OF HULL SEE WATER AS AN ASSET, NOT A THREAT?



01 To alleviate the short term risks, sites surrounding the old city and the port were retreated to the east and west of Hull.

02 The historic centre of Hull, deemed to have significant assets, was defended against future tidal flooding. The new walls followed the main existing arteries around the city centre, effectively becoming a raised promenade. The wall was built to resist a rise in sea-levels from 2010 ordinance datum.

03 The design allowed for the walled defence to be raised further and, towards the end of last century, this was implemented to cope with a further predicted sea-level rise.

04 The old city, now an island, was linked to East and West Hull by several pedestrian, traffic and rail bridges.

05 The railway that used to come in from the west along the bank of the Humber was elevated and moved further inland. The port is still served by freight rail, but this line had to be improved and elevated.

06 The passenger rail-station was relocated further up the track and outside the old city island. It was built on stilts to allow for increased flooding and the planned marsh. This kept the increased rail traffic out of the city centre as well as forming a unique arrival into the city.

07 The walls of the port were maintained and improved by the port owners who undertook part of the cost. The cost of maintaining and improving these flood defences was small compared to the cost of relocating Hull Port, which is vital to the UK economy.

08 Since the radical planning policy was adopted in 2010, housing and infrastructure (schools, hospitals, etc) were built to the east and west of the city. Here the natural topography raised those new developments out of harm's way.

The structured relocation programme was implemented, informing the affected residents of the timeframe and proposed new housing. A compensation package was part funded by the savings achieved by not building and maintaining

new flood defences. This compensation to residents and businesses eased the move, though it was met with initial opposition.

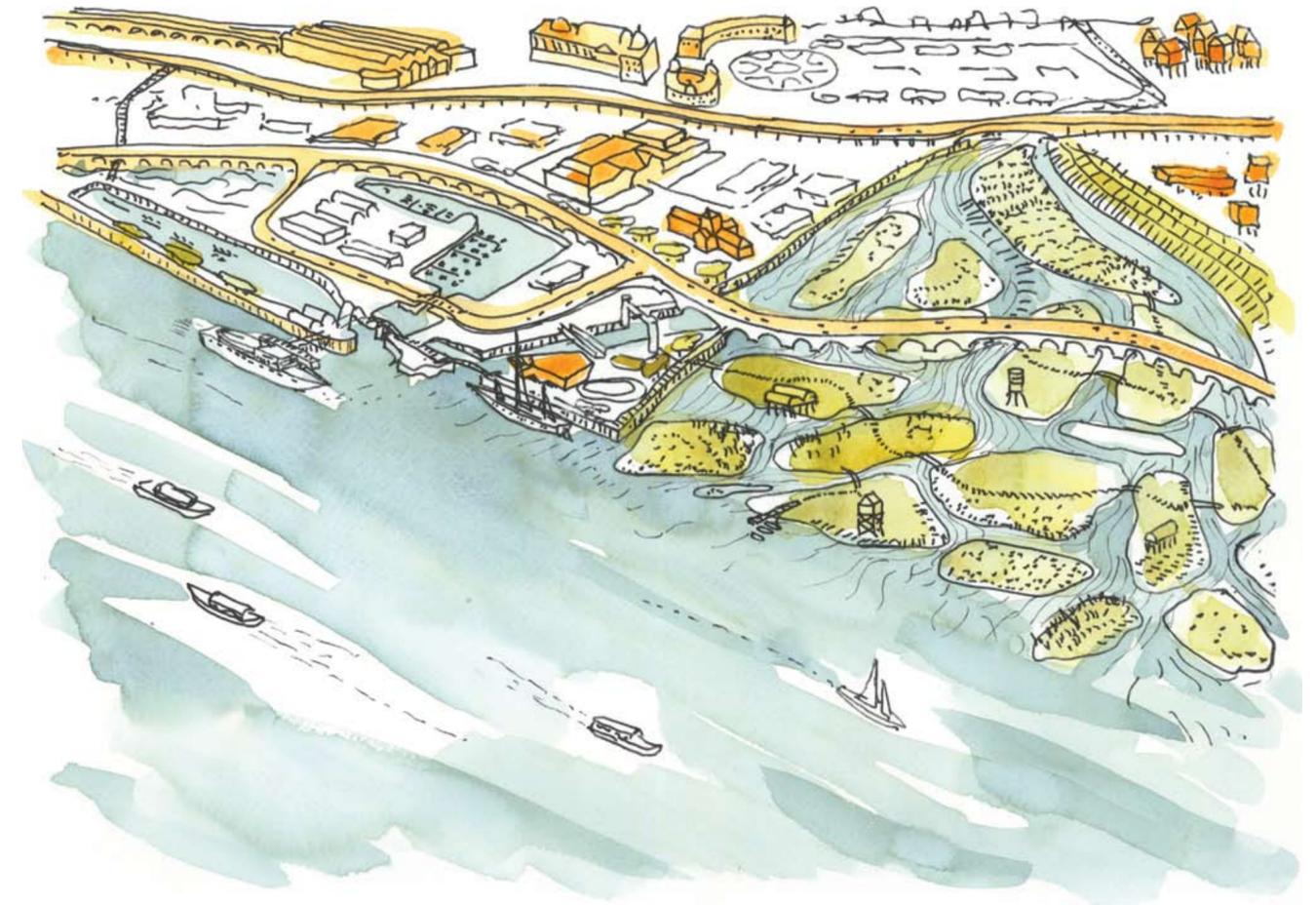
09 To compensate for development on previously green space, the built environment all the way up the River Hull was gradually removed. The removed material was recycled into the civic infrastructure and new buildings. With the right plant species introduced, the banks of the Hull slowly formed salt marsh, being host to diverse flora and fauna.

10 Recreation areas and educational centres were created for activities within this evolving landscape.

11 The marsh proved successful in absorbing the effects of fluvial (river) flooding in Hull. The vegetated space is also able to absorb the energy of a short tidal surge, frequently experienced in recent years.

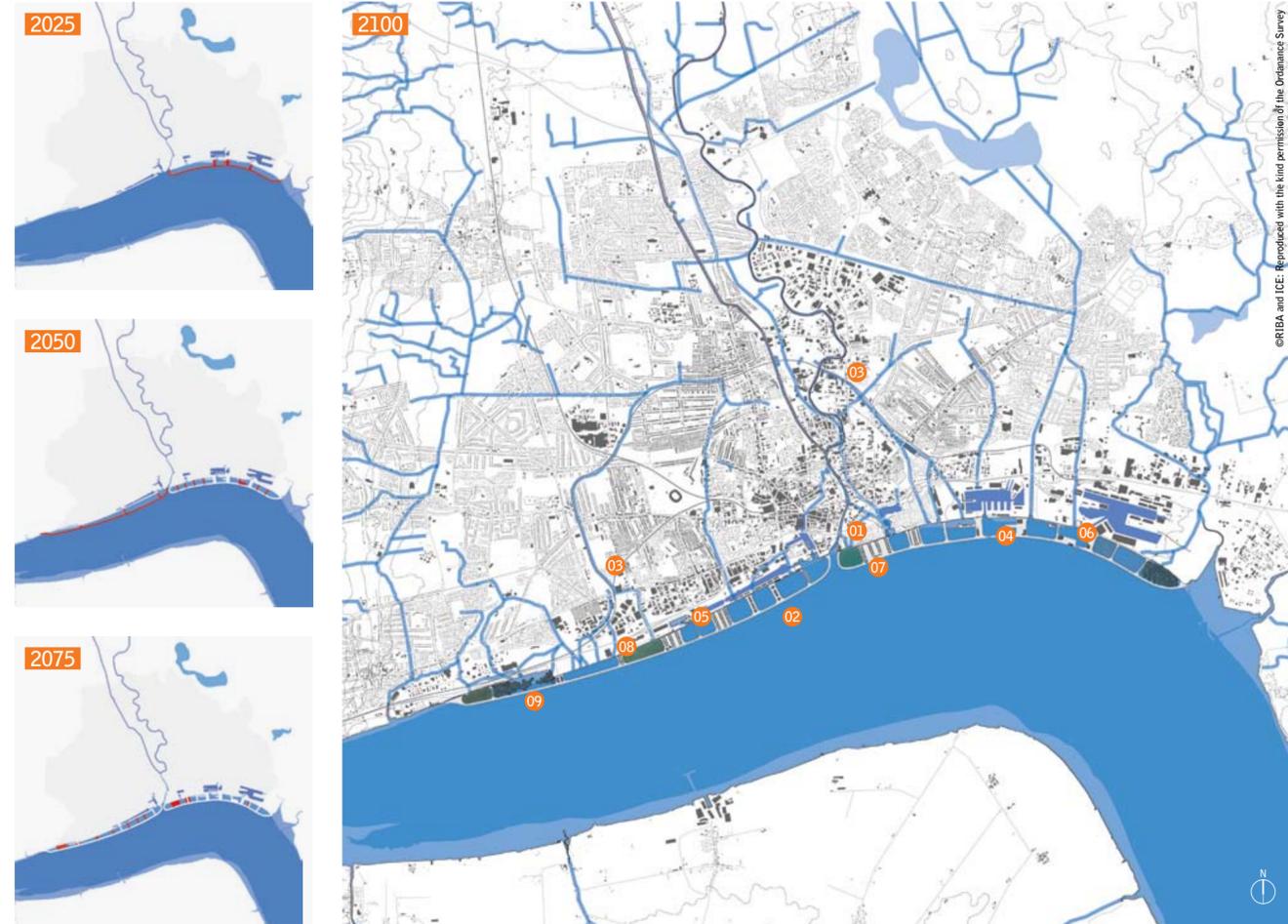
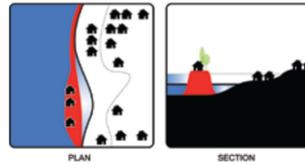
12 Tidal stream generators placed in the Humber produce enough energy to sustain the old city island.

In 2080 the city was rebranded New Hull prompting new investment as well as an increased tourist trade and cultural institutions wanting to be signified by their location in this unique city. The city is still the exemplary model for sustainable living.



HULL DEFENDS

WHAT IF THERE IS SUFFICIENT INVESTMENT INTO SECURING HULL'S FUTURE FROM TIDAL FLOOD RISK? COULD A COMPREHENSIVE, CITY-WIDE SCHEME THAT ENCOURAGES DEVELOPERS TO BUILD CONFIDENTLY WITHIN THE CITY BE PUT IN PLACE? NINETY PERCENT OF LAND IN THE CITY IS AT RISK FROM FLOODING. WHILE DEFENDING FROM SEA-LEVEL RISE, THE RIVER HULL ALSO POSES A SIGNIFICANT THREAT AND WILL NEED TO BE ADDRESSED. HOW CAN THIS DEFENCE STRATEGY BE FUNDED? PERHAPS BY MAKING THE DEFENCE PART OF A COMMERCIAL DEVELOPMENT WITH VARYING LAND USES.



01 The Hull Barrier was kept in place and needed maintenance and improvements around 2050. Although costly, this allowed the city, its community and its infrastructure to remain in its current location.

02 The entire frontage of the city was protected. Instead of building a common sea defence wall, in the early years of the 21st century a series of smaller reservoirs were formed behind a new thicker outer wall.

03 A network of creeks was carved through the city, using as many of the pre-existing waterways as possible. The reservoirs are kept below the existing city level, allowing gravity to drain both fluvial (river) and pluvial (rain) flood events out of the city via the creeks. This has taken the pressure off the previously over-stressed pumping systems that were in place.

04 The reservoirs drain at low tide, twice a day, with further pumping systems in place as a safety precaution. The energy from this is tapped by tidal power turbines and generators.

05 The walls of the reservoirs were designed to be wide enough in places to allow for both development and activities to take place on top of them. This development helped to offset the cost of building new defences.

06 To the east of the city the port extends out into the new defence, allowing room for expansion and growth. The deep water berths could be located on the wall, ensuring that docking time is not increased.

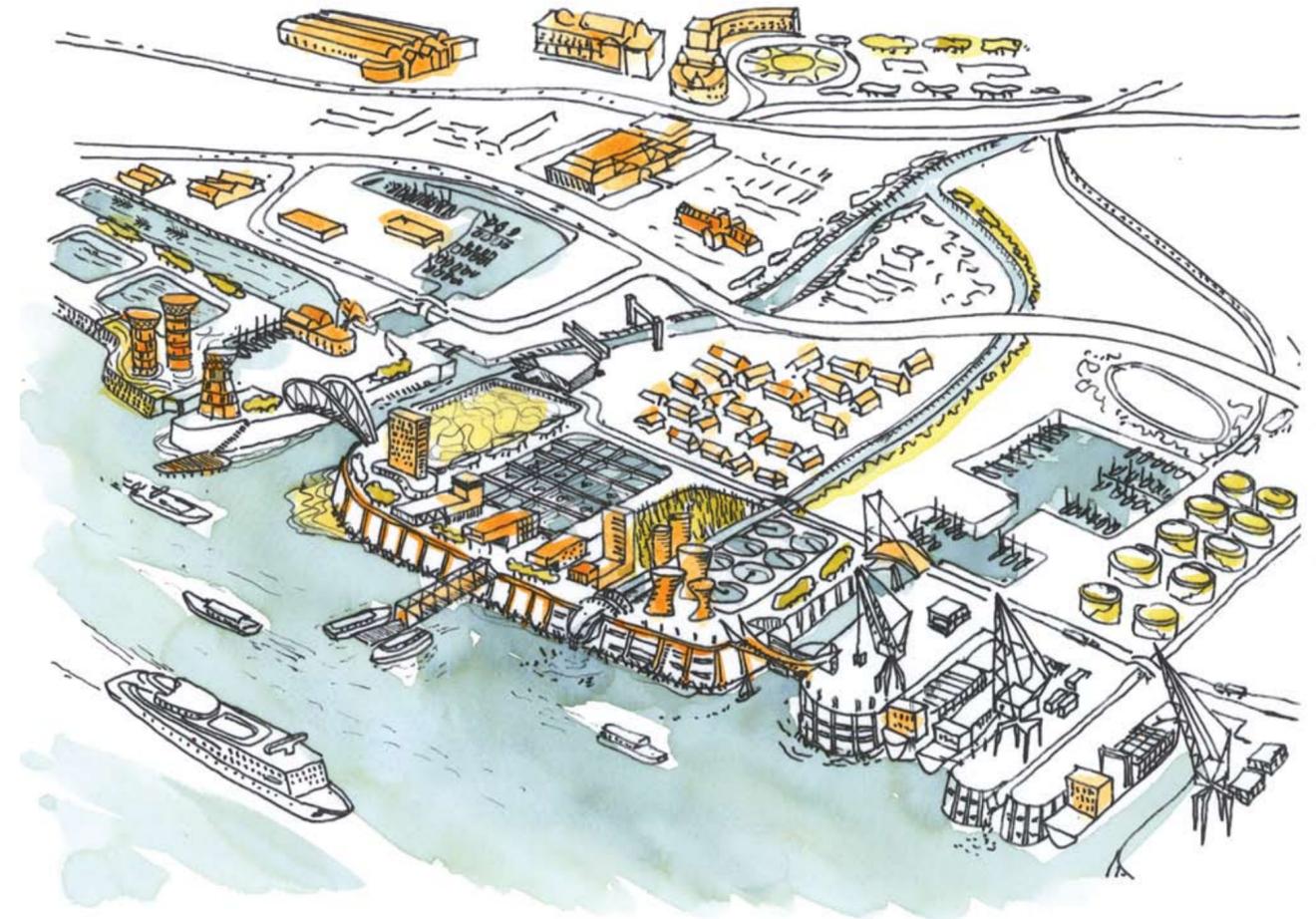
07 At the centre of the city frontage is mixed-use development: commercial, residential and recreational. This premium real estate, being located close to the water as well as close to the existing amenities of the city centre generated much of the capital for the initial scheme developed in 2010.

08 Reservoirs have been successfully used for grey water storage and reed beds.

09 Water-based recreational activities such as canoeing, sailing, and swimming take place within some of the reservoirs that are not polluted with fluvial (river) or pluvial (rain water) runoff.

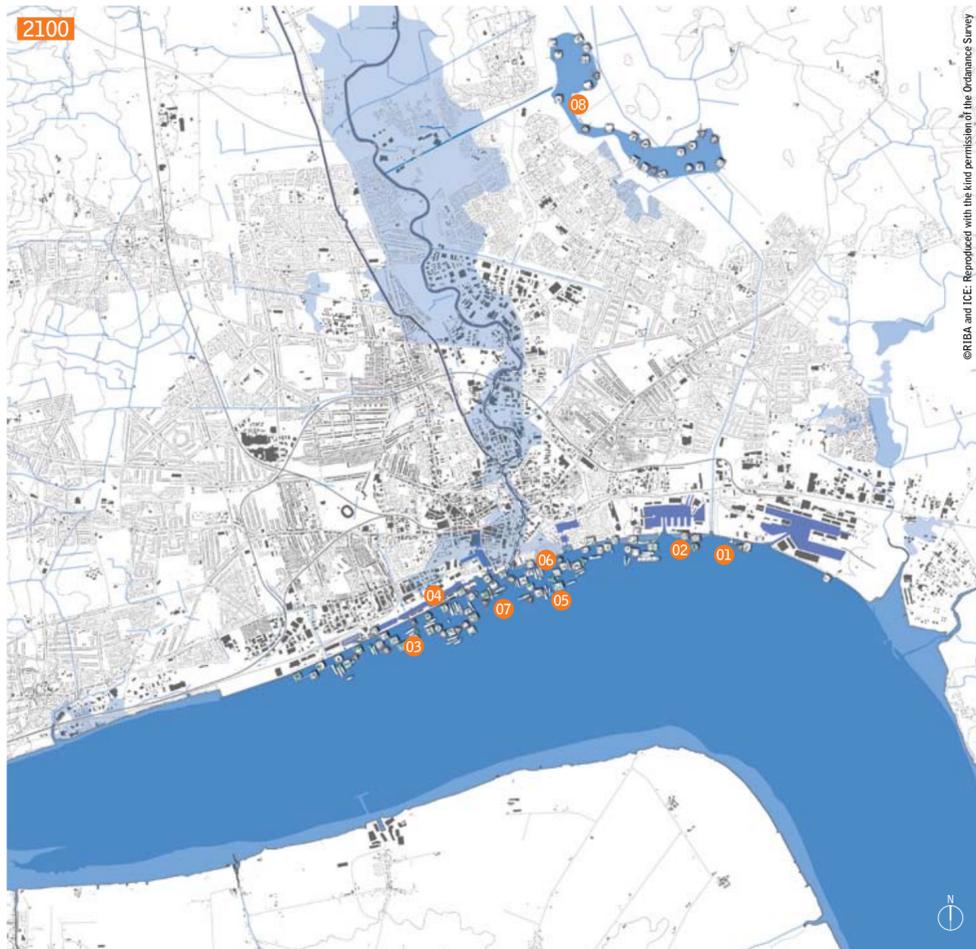
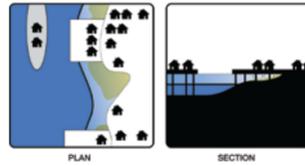
10 Where the wall thickens, performing arts spaces and other art venues have introduced more cultural vitality to the waterfront and the city as a whole.

11 Fish farms and other forms of urban agriculture have provided more local produce for the city. Local markets have grown up off the back of this and are now fully established.



HULL ATTACKS

WHAT IF WE CAN RECYCLE DISUSED MARINE INFRASTRUCTURE TO CREATE A TOTALLY NEW WATERFRONT FOR HULL, BUILDING OUT ONTO THE HUMBER ESTUARY? THE CITY COULD FORM A DIFFERENT RELATIONSHIP WITH WATER: EMBRACING IT AND BEGINNING TO MOVE ITS INFRASTRUCTURE ONTO FLOATING OR STILT STRUCTURES. DECOMMISSIONED OIL PLATFORMS, RETRO-FITTED NAVAL VESSELS, AND SMALLER HOUSEBOAT COMMUNITIES COULD START TO SHAPE A UNIQUE AND DISTINCT FUTURE FOR HULL.



eRIBA and ICE. Reproduced with the kind permission of the Ordnance Survey

01 One decommissioned North Sea oil platform was recycled, floated and then towed up the Humber as far as the port to the east back in 2013. After dropping its legs back down it formed the re-commissioning platform for other rigs.

02 A whole industry that fabricated our water community built up around the port with some of the infrastructure already being in place.

03 Combinations of static platforms and floating structures, created from re-used marine infrastructure, were networked together and developed into a mix of residential, recreational and commercial 'land'.

Some infrastructure, such as sewers, waste disposal and water storage, was easily managed on the water, so as not to overload the mains. It has since been connected to the existing and improved onshore networks.

04 Planning ensured each rig has at least two bridges and routes onto watercraft in case of emergency evacuation. At least every third rig had to be connected to the mainland.

05 Energy is provided locally to the 'rigs' via tidal stream generators in place on the Humber bed.

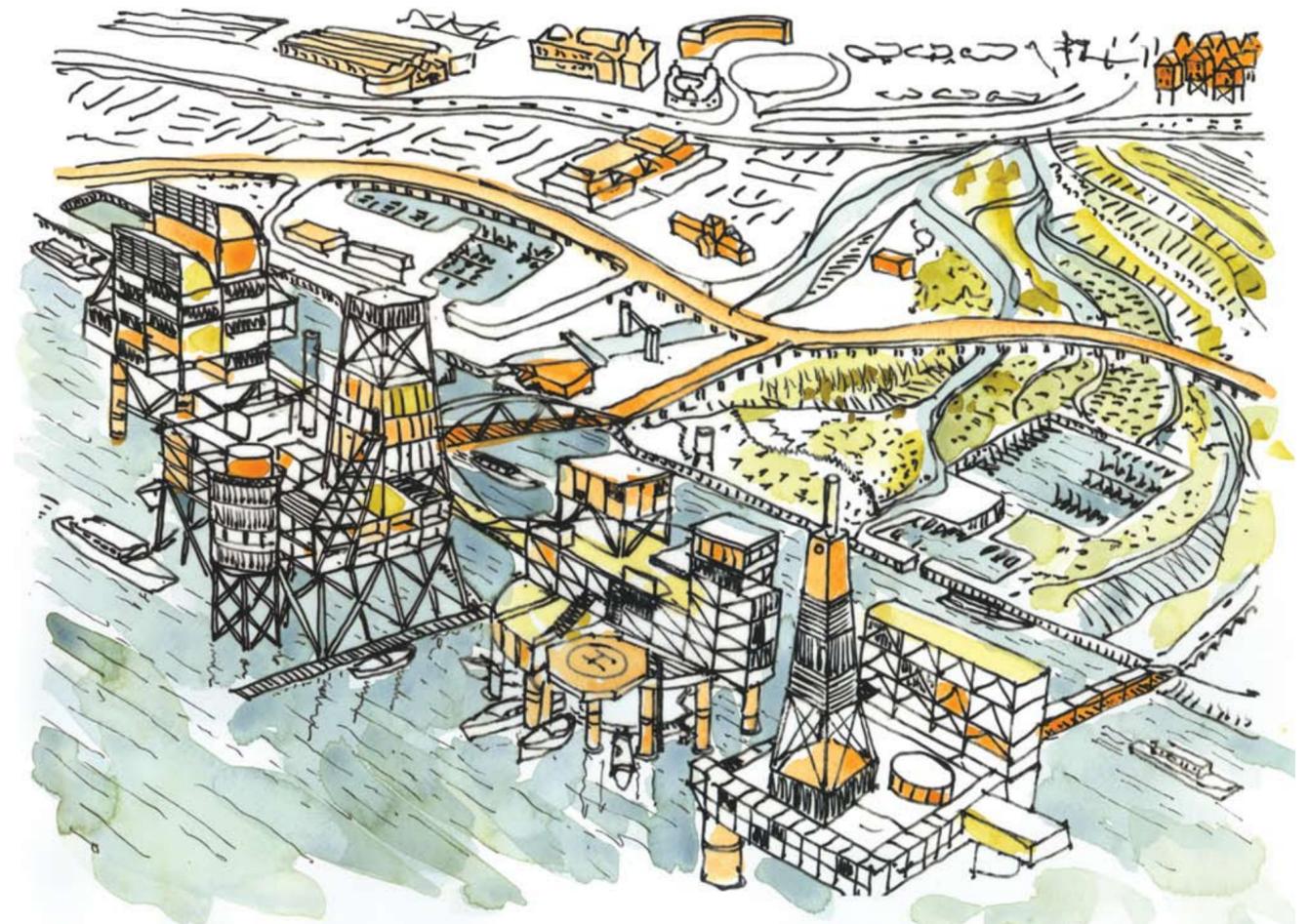
06 Some rigs now consist of sports grounds, theatres or recreational space.

07 An academic complex forms one of the most spectacular rigs, with a University at its centre.

The flexibility of 'land-use' on the rigs and their positioning and ease of re-positioning have allowed for a much more dynamic planning process in the city.

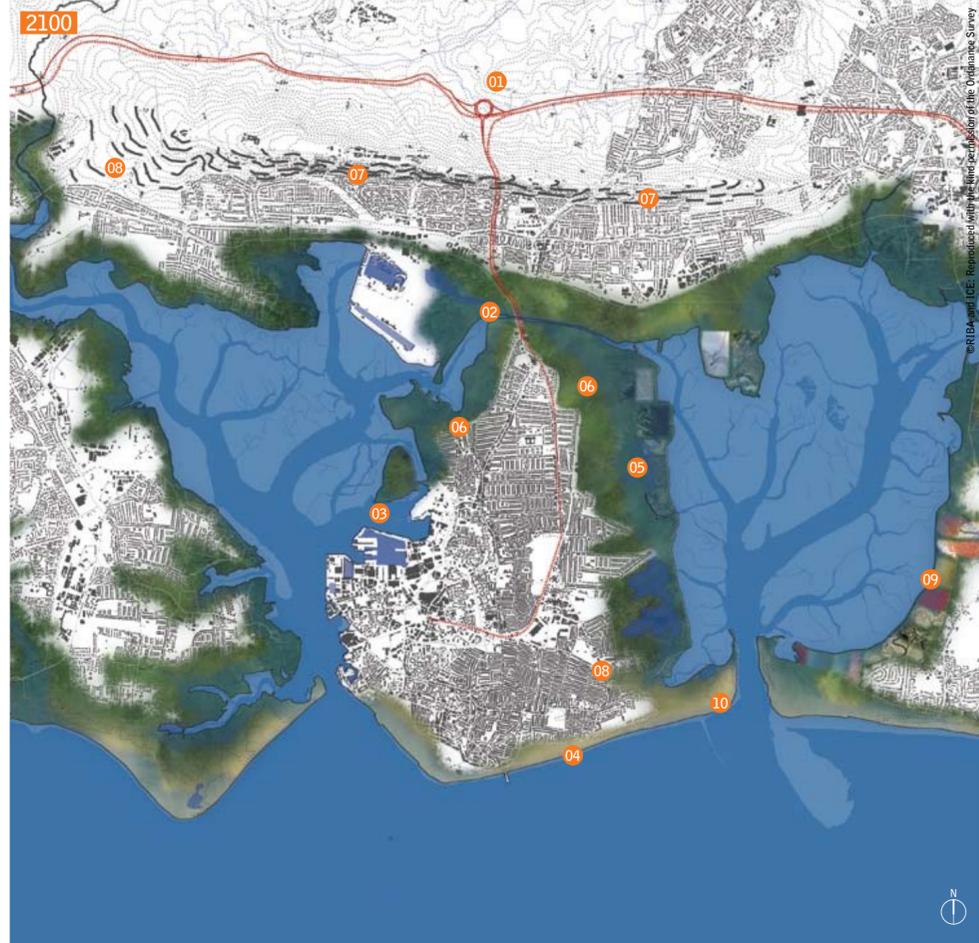
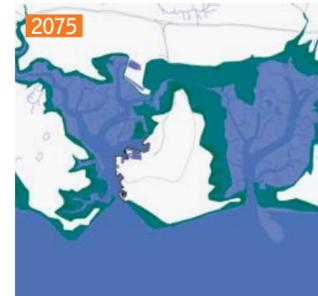
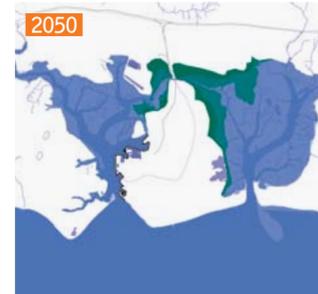
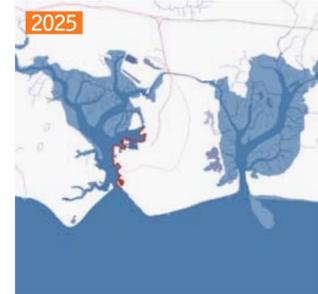
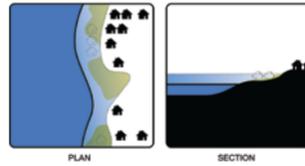
08 The functional floodplain to the north-east of the city started to be inhabited by floating communities later in century. Without the fast flowing currents of the Humber, these communities were made up of smaller houseboats. Many of these were floated up the River Hull and new canals and set down in their new location.

The city left behind was slowly adapted to cope with increased flooding. Buildings were retro-fitted to cope and land use changed radically from residential to recreational.



PORTSMOUTH RETREATS

WHAT IF THE LONG COASTLINE SURROUNDING PORTSMOUTH AND ITS HARBOURS BECOMES TOO GREAT A LENGTH TO DEFEND? WE COULD RETREAT FROM THE FRINGES TO THE HIGHER GROUND WITHIN THE CENTRE OF PORTSEA ISLAND. THIS LOSS OF DEVELOPED LAND WOULD NEED TO BE COMPENSATED FOR AND NEW, TERRACED HILLSIDE SETTLEMENTS COULD TAKE ON AND MAINTAIN THE EXISTING AND GROWING POPULATION. WHAT LAND USES WOULD BE APPROPRIATE AT THE 'WET' FRINGES OF THE CITY?



01 The M27 that served as the east to west link across the south coast – from Southampton to Chichester – was relocated to safer ground behind the hills to the north of the city. Although this relocation was costly, it was a smaller investment than protecting the existing route from long-term flooding.

02 The major elevated artery connects the mainland and M27 traffic to the shrunken island. It also serves the 'through-traffic' heading to the continent via the ports.

03 Due to their importance to national security and economy, the naval base and ports to the west of the city were defended and maintained, remaining in situ.

04 The frontage that faces south to the open sea was revived as a public beach.

05 The fringes of the east of Portsea Island were planned for salt marsh restoration in 2010. Within 20 years a fully established marsh had formed and was naturally accreting. It compensated for the habitats slowly lost to rising sea-levels. Now the recreational area is visited daily by thousands of residents and tourists alike. It boasts diverse wildlife, including several rare species of bird.

06 The UK's largest urban salt-marsh sheep farm was established by 2030, providing a revenue stream for the work undertaken. Salt-marsh lamb sells at a premium. The sheep will be able to move to higher ground as the tide slowly rises.

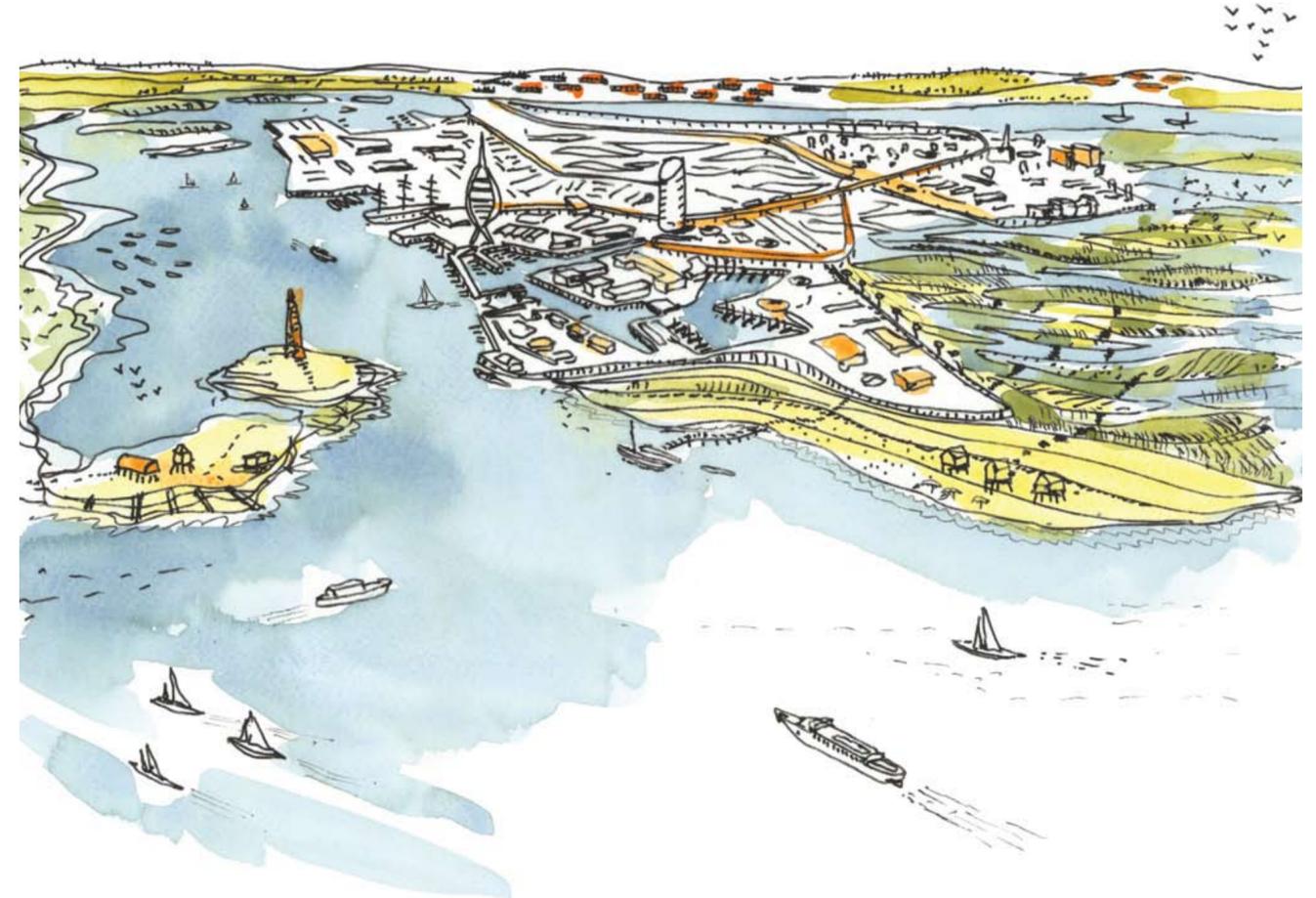
07 New development took place safely atop the ridge of hills to the north. The dense hillside terraces have proved a successful and popular community model, and have further been spared from high insurance premiums that would have been incurred in the flood zones.

08 Over the 21st century, the existing buildings on the edges of Portsea Island found new uses that are more appropriate to flood risk. Residential houses began to dwell on the top floors; repositioning the access routes above ground level and linking the buildings together for times of floods.

09 The Hayling Island coast is now host to a variety of industries that work with the water; for instance algae farming and alternative energy production.

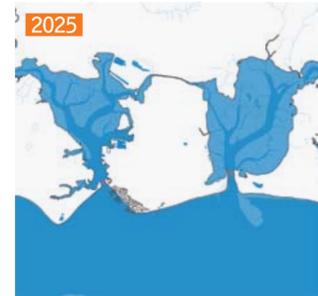
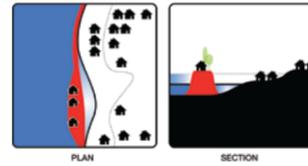
10 After lengthy consultation it was accepted that the loss of some national monuments such as coastal forts, was inevitable for the future of the city. The demand to maintain some of them was matched in private funding to protect the specific sites.

Ultimately Portsmouth Island may have to be abandoned in the distant future. Hence the development and defences to the island were time-limited and are recyclable.



PORTSMOUTH DEFENDS

WHAT IF THE TOTAL LINE OF DEFENCE CAN BE SHORTENED, SAVING MILLIONS IN DEFENSIBLE INFRASTRUCTURE? IF THE HARBOUR ENTRANCES ARE PROTECTED BY GATES, WE NO LONGER NEED TO DEFEND THE INNER PERIMETER TO BOTH HARBOURS. AN INHABITED WALL COULD LINE THIS SECTION OF THE SOUTH COAST. THE WALL COULD HOLD THE LINE, ADVANCE THE LINE, OR RETREAT AS APPROPRIATE; ENSURING THAT THE CITY IS IMPERVIOUS TO A TIDAL FLOOD. WITHIN AND ON TOP OF THE WALL, DEVELOPMENT COULD TAKE PLACE, WITH A COMMERCIAL INCENTIVE TO FUND THE INITIATIVE AND SECURE LONG-TERM INVESTMENT.



01 The new tide gates were built at the beginning of the 21st century, ready to protect the harbour from extreme tidal surges. With improved meteorology these surges can be predicted up to seven days in advance, and information easily disseminated to the relevant stakeholders when the gates will close.

02 The regular shipping routes and ferry lines were relocated outside the harbour, to reduce the traffic to and from the harbour mouth. Naval vessels were also relocated outside the harbour when possible to reduce traffic.

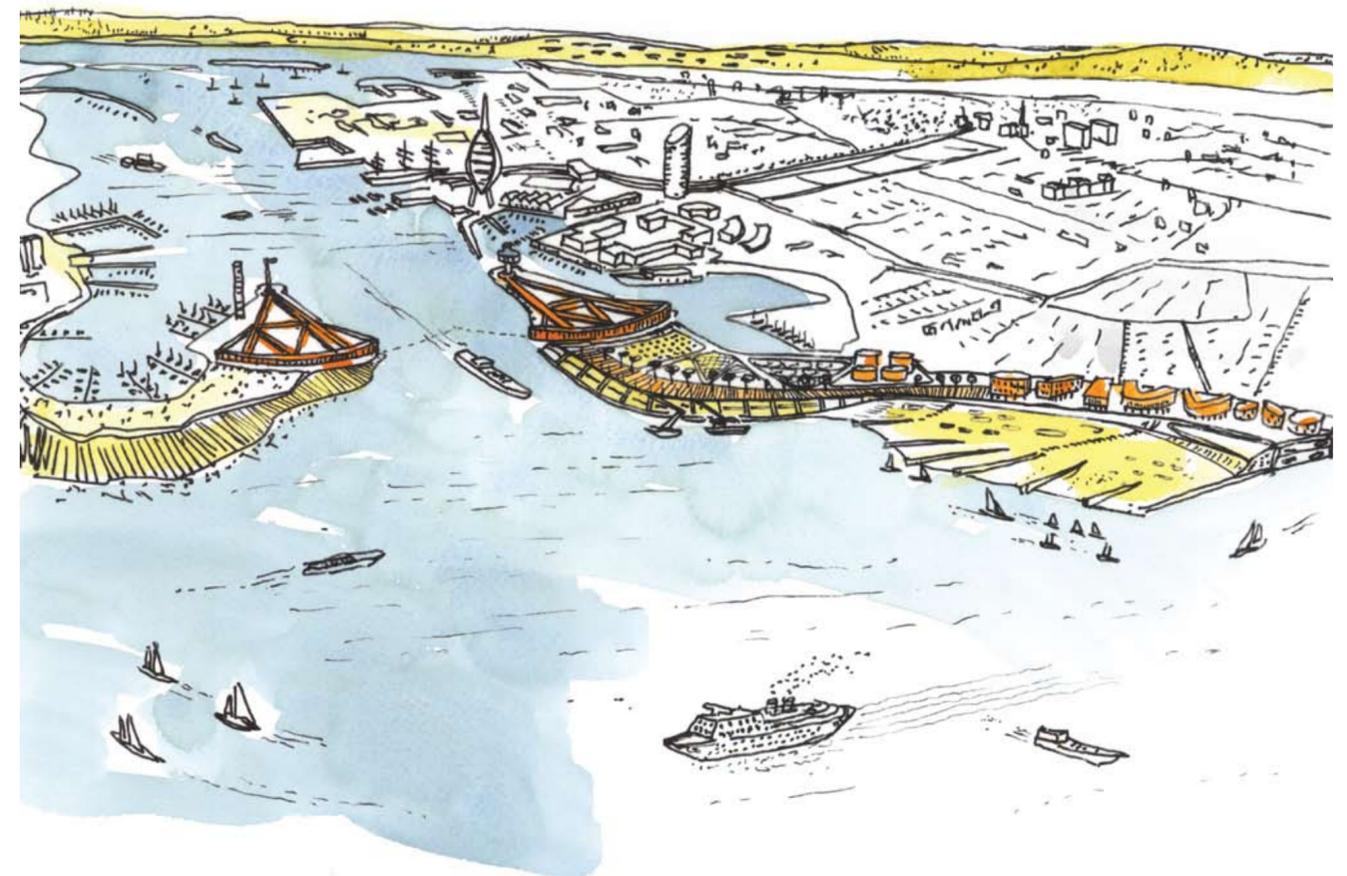
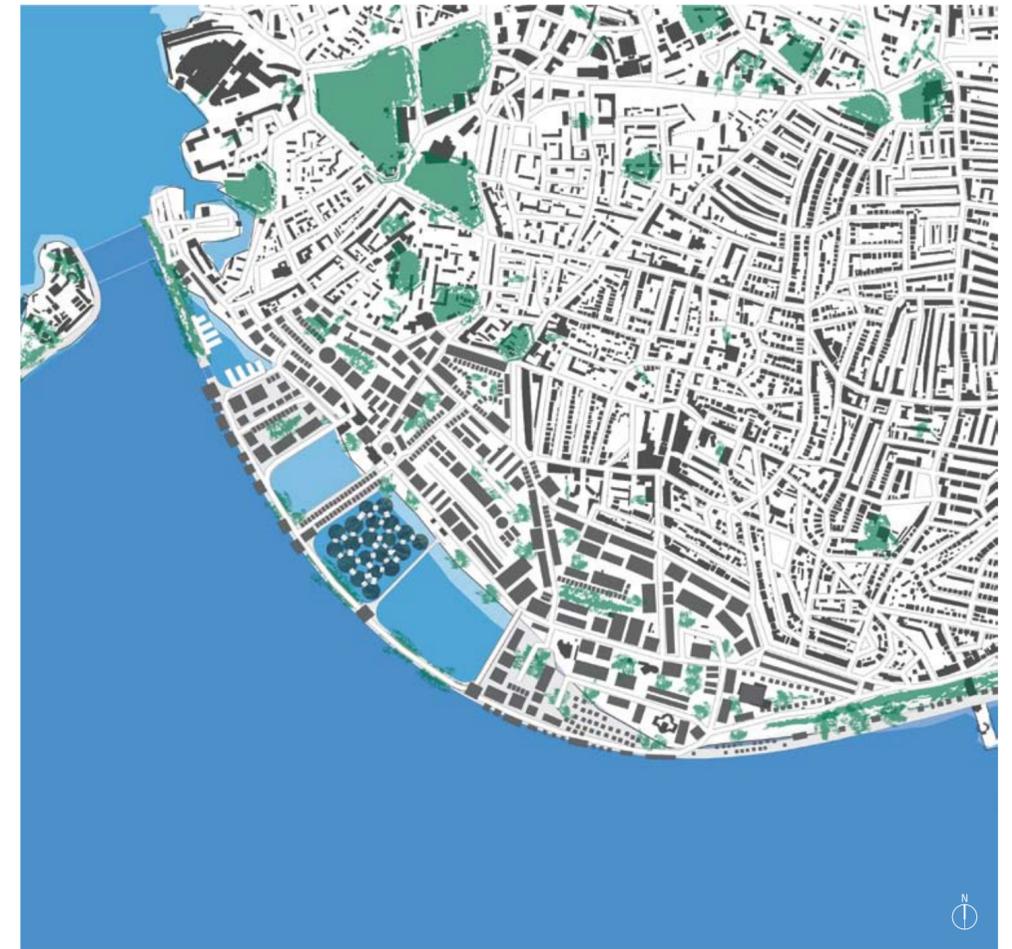
03 The new wall was constructed as a 'living wall', inhabited with commercial, residential and recreational development. Over a twenty year programme to build, starting on Portsea Island, developers pitched for segments of the wall to develop but also in part to maintain. These privately and publicly funded maintenance programmes were put in place for a 200 year liability, ensuring the long-term underwriting of properties.

04 The basic typology of the inhabited wall was extended along the whole length of the coastline. While the seaward side of the wall is defensible, the thickness of the wall can be inhabited by street level units for shops or offices.

05 The line was extended seawards in places to accommodate new space for development. The plots close to the city centre ports were sold at a premium, providing opportunities on the new, prime real estate. This high value development helped to offset the cost of the new defences.

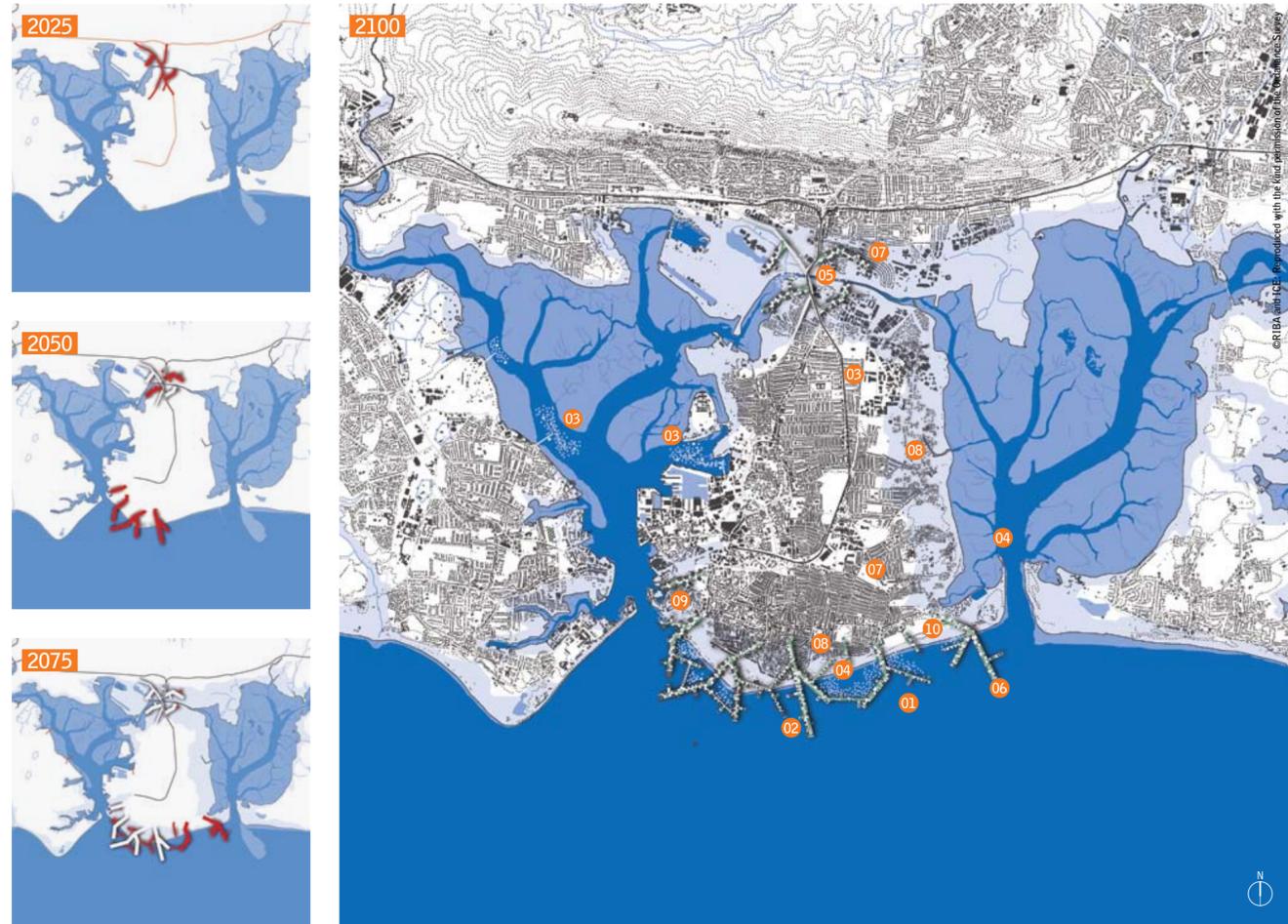
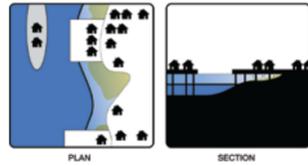
06 The wall retreats from the coast in places to allow recreational space seaward of the line of defence. In these places the maintenance costs have been significantly lower as the land takes the energy out of the waves.

07 In places, park land was extended out of the city and onto the 'green promenades' that allow views and public access to the beach.



PORTSMOUTH ATTACKS

WHAT IF THE CITY OF PORTSMOUTH, THAT IS ALREADY SHORT OF DEVELOPABLE SPACE, COULD GROW OUT INTO THE SEA IN A SERIES OF INTERCONNECTED PIERS? THESE PIERS WOULD BE FULLY INHABITABLE, LARGE ENOUGH TO ACCOMMODATE MEDIUM-RISE BUILDINGS, PARKS AND TRANSPORT LINKS. SOME PIERS COULD ACCOMMODATE INDUSTRY, OTHERS RESIDENTIAL.



01 In 2010 schemes were drawn up for large two tiered piers that would emerge from the city, linking into the existing streets and rail infrastructure. These plans were implemented over the next 20 years, forming the major infrastructure of the city today.

The lower tier of the pier is used for traffic, which frees the top of the tier for pedestrian space.

02 The top tier of most piers was developed into mixed-use streetscapes, with residential, commercial and recreational spaces.

03 Floating communities began to cluster behind and in-between the piers within the sheltered waters of the harbours.

04 Between the outer piers to the south, marinas were created, protected by the effective breakwaters of the pier stilts.

05 The artery linking Portsea Island to the mainland was the first of these major infrastructural adjustments. The main connection was the road and rail bridge. Following this, development to the east and west of it began as further piers joined on to it.

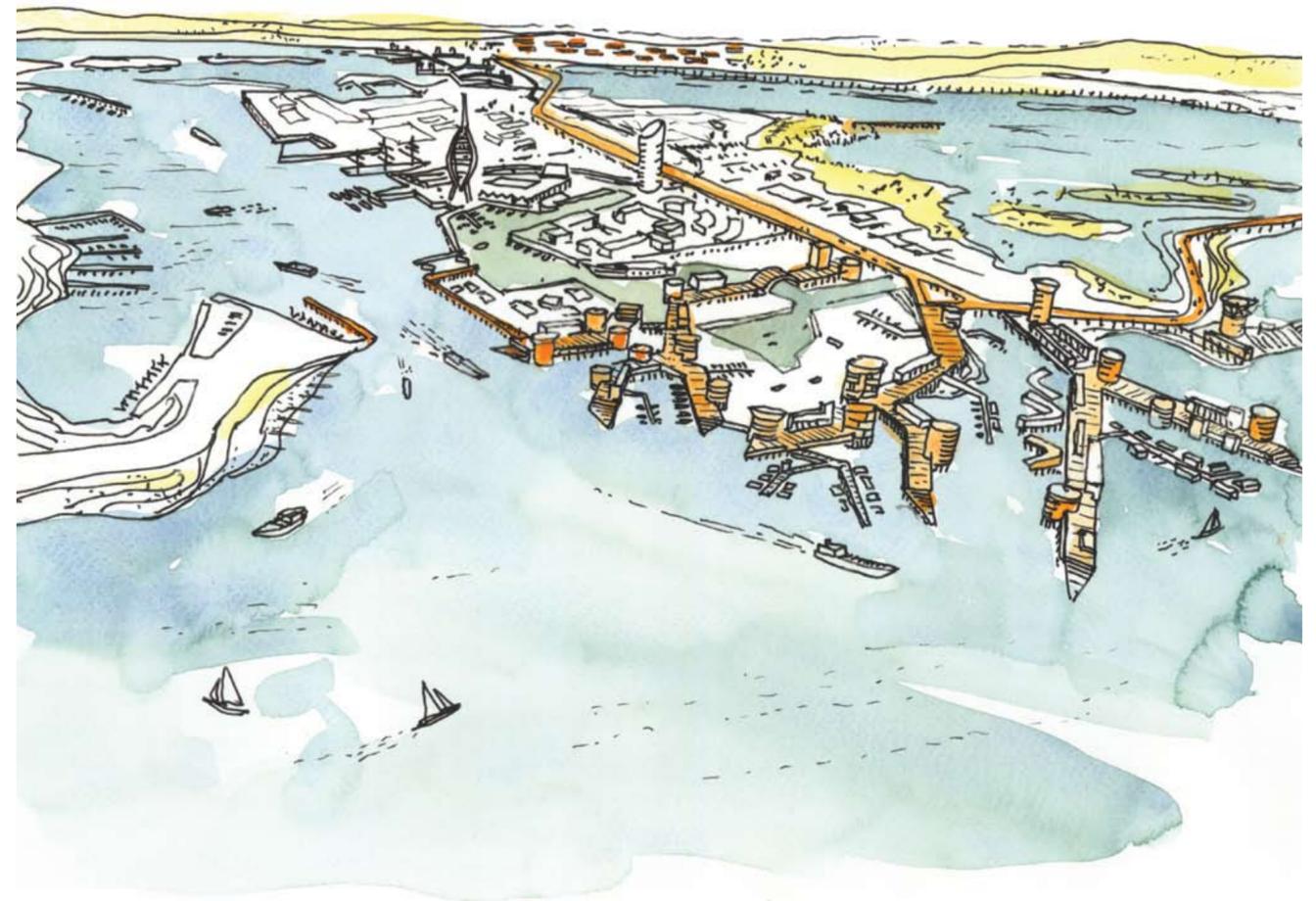
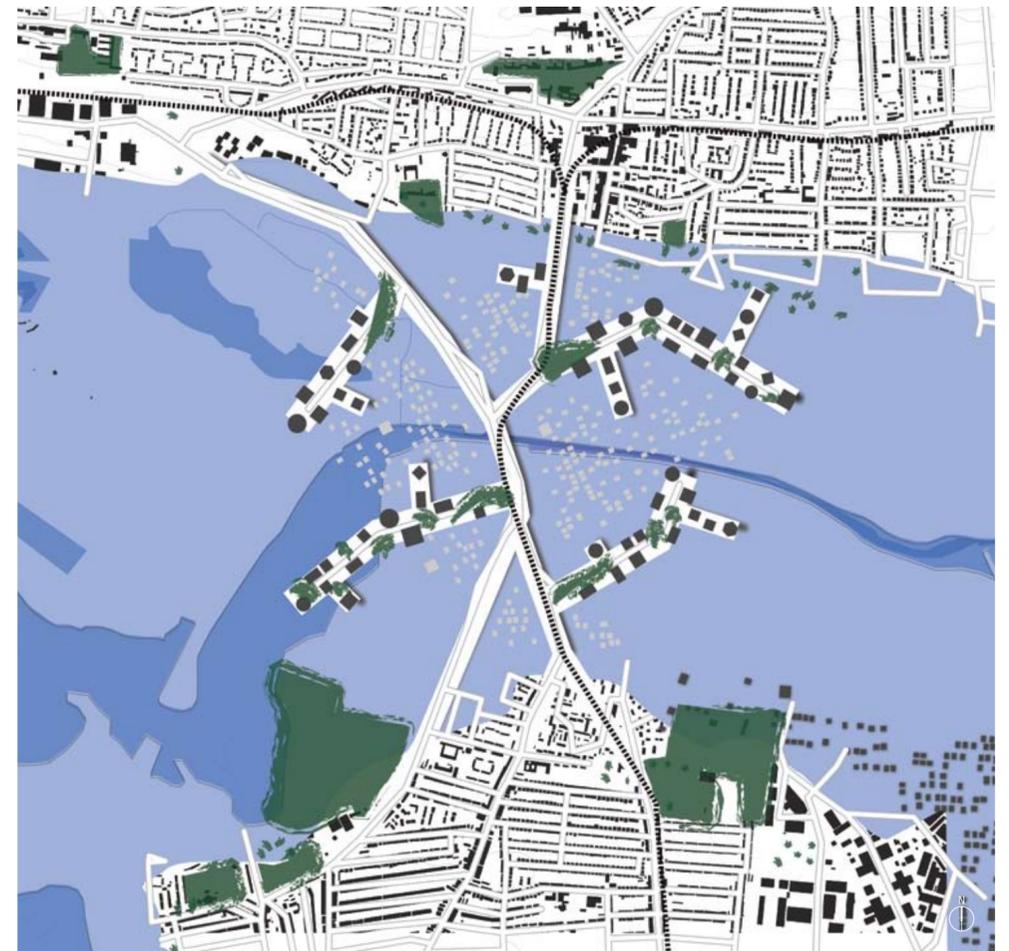
06 Services such as litter collection, recycling and sewage treatment were localised and collected from the end of the piers and floated to their respective handling plants. This scheme won international acclaim for the savings it made in energy.

07 Efficient urban allotments were installed allowing for local jobs, produce and community engagement on the new living piers.

08 The vulnerable, existing architecture within the city was retro-fitted to cope with increased risk of flood. Living space was moved upstairs and alternative evacuation routes were installed. Communities could be connected in times of a flood.

09 New development within the flood risk areas was built with regular high levels of water in mind. Some schemes consisted of stilt communities and others were able to float in times of a flood and later when the water levels rose significantly.

10 The piers now act as groynes; helping to 'hold the beach' and reduce longshore drift.



CONCLUSIONS

The scenarios presented in this publication begin to challenge the aspirations we have for our threatened towns and cities, pushing forward the horizon of our thinking. The solutions attempt to find opportunities from amongst the threats posed by climate change and sea-level rise. In each of our six scenarios, the extreme threat of flooding demands that extreme measures be taken. If we are to work towards solutions that go beyond the prosaic, three fundamental changes are required:

LIMITED RESOURCES

The finite resources the UK has for flood defences mean we cannot defend everywhere and must accept change in some guise. It will take good design strategies and creative financial solutions to solve the problem. Partnerships with the private sector will be crucial, and this will entail ensuring that the development opportunities are created which provide every prospect of generating a commercial return for investors.

COMMUNICATION

We need strong leadership and a competent, well-equipped body with strategic overview. In the UK we are failing to move beyond the status quo and traditional lowest common denominator solutions – the line of least resistance – demonstrating a lack of inspiration, ambition and long-term sustainability. If all the stakeholders have clear responsibilities and lines of communication then some of the progressive scenarios outlined in this document could begin to emerge. The public also needs to be better equipped to choose and engage with the futures they want for their communities.

TIMESCALES

Our system of planning and decision making is epitomised by a disjointed series of cycles and timelines that restrict our ability to plan in the long term; the 4 yearly electoral cycles, the 10-15 year local spatial planning framework, the 10-20 year infrastructure development timeline. This is out of sync with the long-term horizon for climate change; changes to our coastline that will present themselves in 50, 75 and 100 years time, the rapid changes expected to our climate and environment and the slow rate of urban replacement. Far-reaching solutions will address long term challenges, but only if we act now, working within a long-term proactive strategy. We must develop mechanisms that can integrate and we need to look beyond the short-term cycles of political decision making and plan making.

MESSAGES TO GOVERNMENT

- Flooding needs to be addressed by strong political leadership.
- A long term horizon needs to be addressed, possibly in the shape of a national spatial strategy, looking far beyond short-term electoral cycles and providing a long-term vision.
- New funding mechanisms that seek co-funding opportunities will enable future infrastructure development.
- Multi-functional flood defence infrastructures can be developed that benefit local people and businesses.
- The planning systems must do more to encourage integrated solutions and innovative long-term local strategies.

MESSAGES TO PLANNERS

- Tackle problems now with POSITIVE and PROACTIVE solutions, not when it's too late and the problem has become unmanageable in scale.
- Community engagement in decision-making and setting local aspirations is essential.
- Money should not be wasted on short-term, unsustainable developments and improvements to defences that cannot be maintained.
- Long-term planning must provide a framework for short term tactical actions.
- Solutions must be considered that cross local government and community boundaries.
- More action must be taken behind flood defences to ensure that the consequences of possible flooding are minimized – increasing site-level strategies of resilience and resistance (see the Joint Institutes' flooding policy).
- Take full consideration of the opportunities as well as challenges, and openly consider the local possibilities for retreat, defend, and attack strategies.

MESSAGES TO ARCHITECTS, ENGINEERS AND URBAN DESIGNERS

- Consult and communicate with all relevant stakeholders from the BEGINNING of the design process – especially the Environment Agency.
- Schemes should seek to fully exploit the amenity potential of water, waterways and wetlands in the urban environment.
- Inform the developer/client of development opportunities that can be created through creative and commercially viable flood management systems, encouraging integrated, multi-functional and economically advantageous solutions.
- Design-led approaches to flood risk management should shift from a reliance on flood defences to a holistic management of risk, combining defence and measures to alleviate the impact of floods.
- Structural measures, particularly defence works, should avoid disconnecting one part of a community from another and should preserve visual (and where possible physical) continuity between the community and rivers and coastline.
- New development or regeneration should be seen as an opportunity to change existing land use in urban areas to make space for water.

MESSAGES TO PUBLIC

- The coastline has always been dynamic and changing: that's what made the UK's much-loved coastline – its 1000+ islands, its headlands, bays, peninsulas and estuaries – what it is today.
- Letting water in can be seen in a positive light – not a defeatist policy.
- Designers, engineers and planners are beginning to learn how to better connect developments to water in a safe and controlled way.
- Access and proximity to water brings significant social and economic, as well as environmental benefits, providing a more pleasant urban environment, greater public amenity and reconnecting people and water, while enabling better ways to protect local homes and businesses from flood risk.
- Flood defence does not stop at a barrier – existing and new homes can be made more resilient and resistant to flooding, and should be part of an integrated community or city-wide strategy.
- Individuals can make a difference, providing soakaways and ensuring that the areas surrounding their properties are permeable to rainwater, installing flood resilience measures, installing green roofs and seeking to harvest rainwater.
- Flooding is a long-term threat to coastal towns and cities, requiring long term vision and far-reaching solutions. This will affect the future of your area. Only if the local community – in all its forms – get involved will the strategy truly reflect local aspirations and needs.

FURTHER READING

Joint Policy Statement on Managing Urban Flood Risk. (October 2009). A statement by the ICE, CIWEM, RIBA, RICS, RTPI, RUSI and the Landscape Institute.

Flood-proof houses for the future: A compendium of design. RIBA and Norwich Union

Designing For Flood Risk: RIBA Climate Change Toolkit. RIBA (2009)

Flooding: Engineering Resilience. Institution of Civil Engineers. (June 2008)

Living with Water: Visions of a Flooded Future. Building Futures RIBA. (2007)

Planning Policy Statement 25: Development and Flood Risk. + Practice Guide. Department of Communities and Local Government.

Building a better environment: A guide for developers. (Practical advice on adding value to your site) Environment Agency

The Life Project: Long-term Initiatives for Flood-risk Environments and The Life Handbook. Baca Architects and BRE for DEFRA (2009). IHS BRE Press.

THANKS

Our thanks to the number of professionals who partook in the design charrette where many of the ideas in this document were tested out. Included were: Ben Adams and Julia Hamson (Nissen Adams, University of Kingston); Laura Allen and Mark Smout (Smout Allen, Bartlett School of Architecture); Robert Barker (BACA Architects, Life); Professor Tony Davy (University of East Anglia); Nick Hardiman (Environment Agency); Anthony Lau (Tasou Associates, Cyclehoop); John Mackenzie (Van Oord); Kees van der Sande (Formation Architects); Keith Thorpe (Department of Communities and Local Government); Holy Lewis (We Made That).

Our thanks to Formation Architects who kindly lent us their space to host the charrette.

Finally, our thanks to the Ordnance Survey who kindly supplied the mapping data for the charrette.

1 The World Factbook: Central Intelligence Agency. <https://www.cia.gov/library/publications/the-world-factbook/geos/uk.html> (Last accessed 23-11-2009)
2 Time to break the cycle of flooding, Press Release, Co-Operative Financial Services, October 2009.
3 Climate Change Manifesto, Association of British Insurers, June 2007. http://www.climatewise.org.uk/storage/607/climate_change_final.pdf
4 National Flood Risk Assessment, Environment Agency, 2009. <http://publications.environment-agency.gov.uk/pdf/GEH00609BQDS-E-E.pdf>
5 Robert Runcie, Head of Flood Defence, Environment Agency in New Civil Engineer, August 2009. <http://www.nce.co.uk/news/water/robert-runcie-spending-for-a-rainy-day/5206306.article>
6 20th Century flooding and the Thames Barrier, Environment Agency, 2009. <http://www.environment-agency.gov.uk/homeandleisure/floods/105277.aspx> (Last accessed 23-11-2009)
7 Flooding Two Years On, Hull City Council, 2009 http://www.hullcc.gov.uk/portal/page?_pageid=221,589788&_dad=portal&_schema=PORTAL (Last accessed 23-11-2009)
8 The June 2007 floods in Hull, Final Report by the Independent Review Body, November 2007. <http://www.hull.ac.uk/geog/PDF/floodsinhull3.pdf> (Last accessed 32-11-2009)
9 IPCC: "Climate Change 2007: The Physical Science Basis". Pg. 409.
10 United Kingdom Climate Projections 09 (UKCP09). <http://ukcp09.defra.gov.uk/> (Last accessed 23-11-2009)
11 ABI: Revised Statement Of Principles On The Provision Of Flood Insurance (2008) http://www.abi.org.uk/Publications/Revised_Statement_of_Principles_on_the_Provision_of_Flood_Insurance1.aspx
12 <http://www.abports.co.uk/custinfo/ports/hull.htm> (Last accessed November 2009)
13 Quoted in "Hull City Council Strategic Flood Risk Assessment". November 2007. Halcrow Group Limited
14 Hull Spatial Strategy, Hull City Council, November 2007. pg.8.
15 Hull Spatial Strategy, Hull City Council, November 2007. pg.19.

STEERING GROUP

BUILDING FUTURES RIBA

Dickon Robinson

David West

Jane Wernick

Ewan Willars

INSTITUTION OF CIVIL
ENGINEERS

Ben Hamer

Alexandra Schofield

Graham Wilson

Beth Bear

EDITOR AND COORDINATOR

Charlie Peel

BUILDING FUTURES TEAM

Tamsie Thomson

Mike Althorpe

DESIGN

STUDIO EGRET WEST

Christophe Egret

David West

Virginia Melnyk

Bin Kim

Andrew Sutton

