LOCAL FLOOD RISK MANAGEMENT STRATEGY 2022 – 2028

Appendix 3 Flood risk in Kingston upon Hull

Hull City Council

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Overview

Kingston upon Hull is located on the River Hull where it meets the Humber Estuary in north-east England. More commonly known as Hull, it took its frequently used name from the river rather than from the royal charter from which the Kingston ('king's town') name is derived. In Roman times, the Humber shoreline lay some half a mile further north than it does today, and the area on which the modern city now stands was wet, marshy and subject to regular flooding until at least the twelfth century.

As communities grew on the pockets of higher land amongst the wetlands, flood defences were built along the Humber estuary to protect communities from both the daily tides and more irregular flood events. The historic flood defences were built to keep tidal water from coming into the city. They were not primarily engineered to help water that entered the city in other ways, such as rainfall, flow out of the city. Therefore, ditches were also cut to channel away excess surface water, thereby helping to drain the surrounding land. Some of the drains created hundreds of years ago are still visible in the landscape today, such as Holderness Drain and Beverley and Barmston Drain. So how has Hull's history with living with water shaped the way we perceive, understand and manage water today?

Living with Water baseline survey

In a survey carried out in 2018 of more than 450 households:

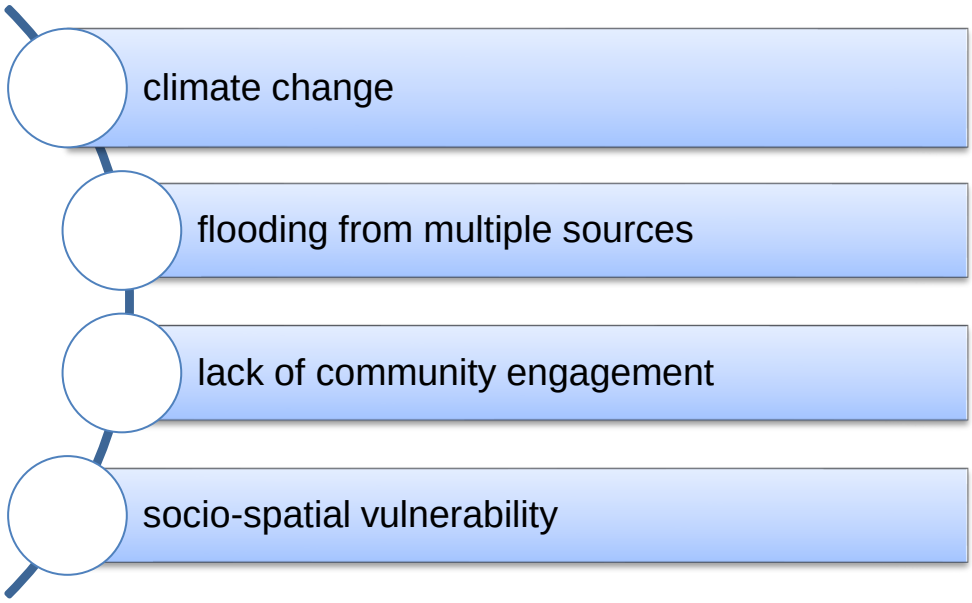
- *33% said flooding damaged their home in 2007*
- *20% had to evacuate their homes*
- *12% were left out of their home for more than 6 months*
- *Just over 20% of people are signed up to receive Environment Agency flood warnings*
- *More than 30% of people have not done anything to prepare for a future flood.*

Hull household flooding survey report can be viewed here.

As was the case in many parts of Britain, flooding used to be a much more normal occurrence in Hull, but since water in the city has been engineered and heavily managed, people's perceptions of water have changed. Today, people tend to view flooding as unacceptable and something to be avoided wherever possible. However,

climate change experts predict that sea levels will rise, and heavy rainfall and storms will become more frequent. In the future, we can expect to see more water in areas where we are not currently accustomed to seeing it.

Water knows no boundaries. It flows on the path of least resistance and as the city has developed over time, the path of least resilience has often been in the same location as key infrastructure, including roads and homes. So how do we deal with the possibility that Hull may flood more frequently in the future? We must find new ways to live with water, and to support individuals and communities to build resilience to flooding.

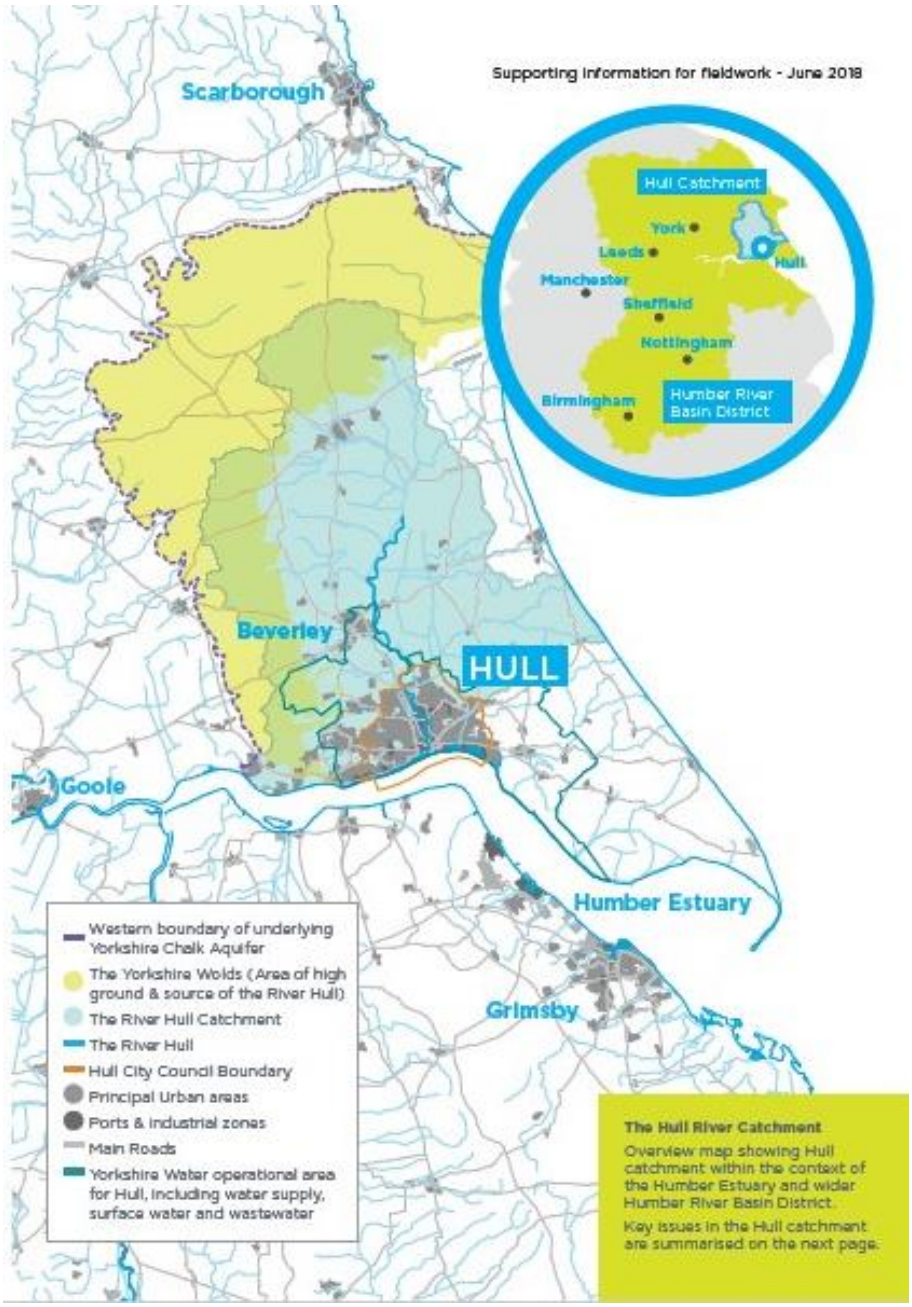


Examples of shocks and stresses identified by Living with Water - City Water Resilience Approach project (Arup).

Location

Hull is located in north-east England on the northern bank of the Humber Estuary. The River Hull flows from its source in the Yorkshire Wolds in East Riding of Yorkshire, through the middle of Hull, discharging into the Humber Estuary.

Hull is an urbanised area and is surrounded by agricultural land and towns within the East Riding of Yorkshire to the north, east and west, and the Humber Estuary on its southern side.



(Image credit: Arup, City Water Resilience Approach)

Characteristics

- Hull is a low-lying area with little relief.
- Over 90% of the city is below the high tide level.
- The land around the edges of the city is higher, making the city shaped like a bowl.
- The highest point in the city is found in Sutton.
- Hull is reliant on pumping to manage water levels.
- 84% of surface water drains into the combined sewer network.

Drainage features

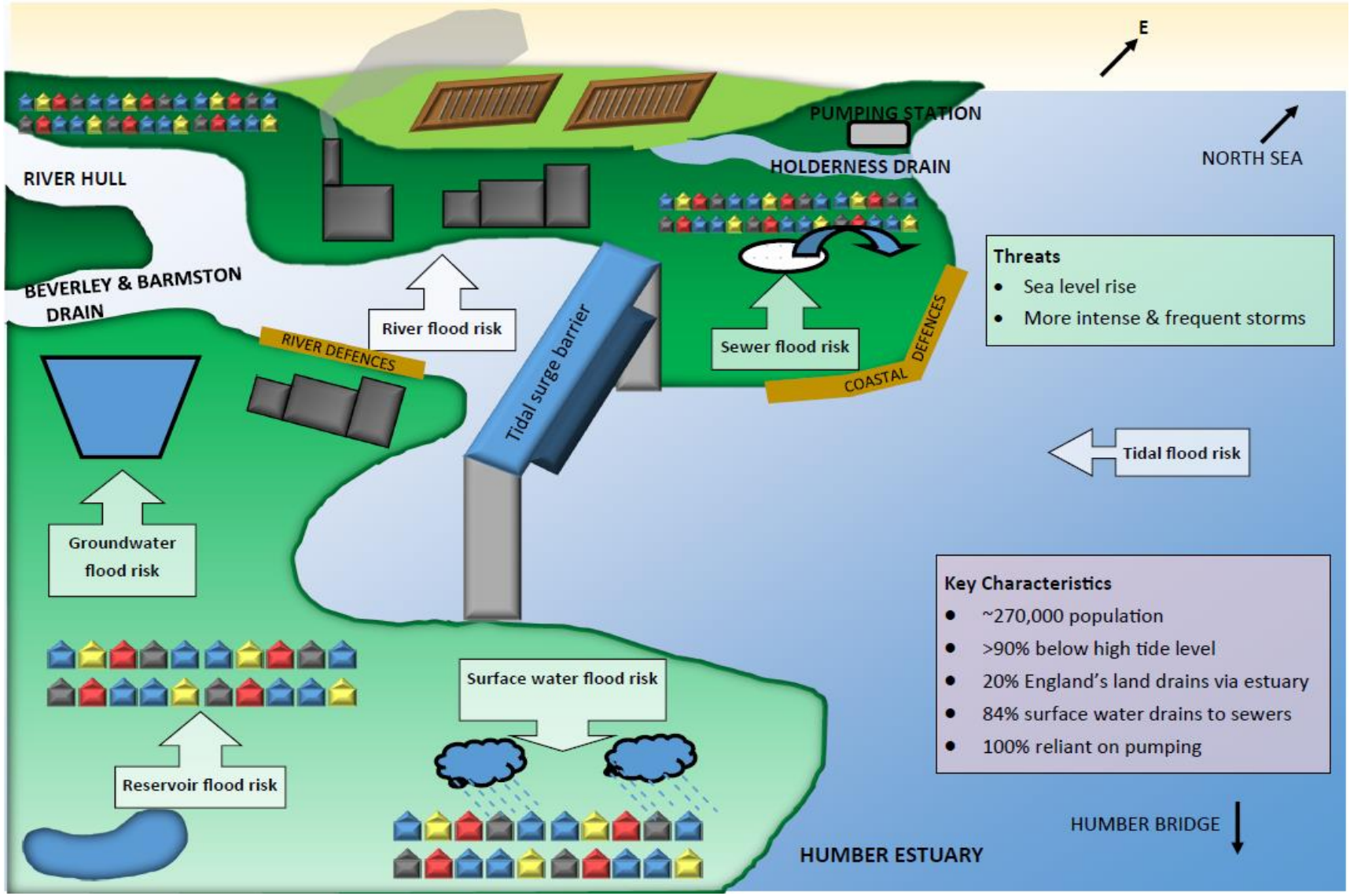
- The River Hull catchment is part of the Humber river basin district.
- The River Hull is groundwater fed and carries water from its source north of the city, through the middle of Hull and into the Humber.
- There are two drains, which are designated as main rivers, flowing parallel to the River Hull on either side of the city: Beverley and Barmston drain on the west, and Holderness Drain on the east. The Beverley and Barmston drain flows into the River Hull and the Holderness Drain discharges directly into the Humber Estuary (see appendix 5 for drainage map).
- Other designated main rivers include Cottingham Drain to the west of the River Hull, and Sutton Cross Drain and Old Fleet Drain in the east of the city.
- There is a cluster of smaller watercourses at the north-western edge of Hull that are within East Riding of Yorkshire and flow into Hull's drainage system.
- These watercourses transfer water from the areas surrounding the city into and through Hull. Water flows either into the trunk sewer system or by flowing into HCC managed watercourses, which then discharge into the sewer system, and eventually into the Humber.
- The Yorkshire Wolds lie to the west of the city, dipping eastwards towards the city so surface water naturally flows east, towards Hull. As a result, rainfall falling in the south-east Wolds must pass through Hull's hydrological drainage system to be able to discharge into the Humber Estuary.

Geology

- The underlying geology of Hull is chalk. The chalk is covered by thick deposits of clay material, which was deposited during the last post-glacial period.
- Chalk is highly permeable and so acts like a sponge to absorb water that can be used to recharge the aquafer, which provides Hull with drinking water.
- On top of the chalk, are large clay deposits. Clay is impermeable, which means that water cannot infiltrate down into the underlying chalk in some places. This results in high surface water flows during rainfall events.
- The geology in East Riding of Yorkshire consists of exposed chalk in the upper reaches of the River Hull catchment, where the most northerly chalk streams in England are located. Impermeable clay deposits cover the middle and lower reaches of the River Hull catchment.

People

- Hull has a population of around 260,000 people living in 121,000 homes.
- Over 95% of these homes are at risk of at least one type of flooding, Hull has the overall highest number of homes at risk of flooding within England.
- Hull is one of the most deprived local authorities in England under the Index of Multiple Deprivation.
- People living in areas with high levels of deprivation are less likely to be able to prepare, plan and recover from a flood event. They are also less likely to be able to adapt to future risk, which increases vulnerability to future flood events.
- Additionally, having adequate home insurance that covers damage from flood events is also an issue. The government started an insurance scheme for homes in high flood risk areas in partnership with insurers: FloodRe. This scheme aims to make flood cover more affordable for homeowners in areas of high flood risk. The cost of insurance in Hull is currently the highest outside of London and so many people are discouraged from having it. FloodRe is also only available on homes built before 2009. It is assumed that homes built after 2009 are built with flood resilience measures.



Conceptual model showing flood risk in Hull

Types of flood risk

- Hull is at risk of six main types of flood risk.
- Some areas of Hull are at risk from more than one type of flood risk.
- The hydrological drainage system in Hull is very closely linked and so it can be hard to determine the source of flooding.
- Water must flow through different parts of the drainage system and so a blockage in one location can cause knock-on effects in other areas.

Surface water, also known as pluvial, flooding

- Surface water flooding happens after heavy rainfall when water cannot drain away. This could be the result of prolonged rainfall so receiving systems are already full, or as a result of intense localised rainfall which can't get into the receiving system quickly enough.
- Some surface water is soaked up by the natural environment, for example by grass or trees.
- If water cannot be soaked up then it pools on the surface, particularly in low spots and causes surface water flooding.
- Surface water flooding can occur anywhere at any time.
- Surface water flooding could occur in the same place many times or in areas that have not flooded previously.
- The severity of surface water flooding depends on where it rains heavily, the land use in the area within the drainage area, and the areas capacity to drain water away.

River, also known as fluvial, flooding

- Flooding from rivers and watercourses happens when the amount of water within the channel is greater than the capacity of the channel.
- Water either spills over the banks onto the floodplain, or in extreme circumstances can cause part of the bank to collapse; causing water to flow very quickly out of the channel.
- River flooding generally happens after periods of heavy rainfall when there are greater volumes of water travelling through a river catchment, or if

there is a blockage within a river channel, which could cause water to back up and overflow onto the floodplain.

Tidal, also known as coastal, flooding

- Tidal flooding happens when very high tides overtop land along the coast that is normally dry.
- Many coastal areas are protected by flood defences and so only experience tidal flooding when defences are exceeded, for example during storm surges or abnormally high tides.
- Coastal flooding can also occur when winds are strong and cause water to be sprayed onto land.

Sewer flooding

- Sewer flooding happens when sewers become blocked or if sewers become full, which can also lead to surface water flooding.
- Sewers are more likely to become full during periods of heavy or prolonged rainfall.
- A blockage, such as fatbergs, which form as a result of people tipping fats, oils and grease along with wet wipes and nappies into the sewer system, could prevent water from flowing and could back up, potentially into people's homes and gardens.
- Sewer flooding can be a health hazard if raw sewage comes into contact with people and/ or enters properties.
- Sewer flooding is a risk all over the city and areas most at risk are those immediately around sewer inflows on the surface.

Groundwater flooding

- Groundwater flooding happens when water levels underground are raised, normally this happens after long periods of rainfall.
- The water table is high in west Hull and so is more susceptible to groundwater flooding.
- If groundwater levels raise and water has nowhere to go, it will raise out of the surface. This can happen in springs where water will then flow into watercourses.

- However, if there are obstructions underground then groundwater may be forced to come up to the surface and into structures, like homes.

Reservoir flooding

- Reservoir flooding can happen when a water storage area becomes full and overtops or if the walls holding up a reservoir fail.
- There are several reservoirs to the west of Hull in the East Riding of Yorkshire.
- These reservoirs store surface water to reduce the risk of flooding to Hull by preventing the drainage system from being overwhelmed during heavy rainfall.
- The reservoirs are designed to discharge water into the drainage system in Hull in a controlled way i.e., when there is capacity in Hull's drainage system to take more water without increasing flood risk in the city.
- However, if these storage areas become full and cannot be discharged then reservoir flooding could happen.

Each of these types of flood risk can happen at the same time. For example, storm surges could occur simultaneously with rising sea levels. The impacts of climate change are expected to bring more frequent storm events and so Hull is vulnerable to the effects of multiple sources of flood risk at any time.

Reported flood events

Before the introduction of the Flood and Water Management Act 2010 in England, there was no official guidance on how to report a flood. The most significant flood events in Hull occurring prior to the 2010 legislation was the surface water flooding of June 2007 and the North Sea storm surge of January 1953. As a result of the 2007 flood event, HCC commissioned an independent review of the flooding in Hull. The review determined the causes of the flood event and made recommendations on future flood risk management in Hull.

LLFAs must investigate significant flood events as described in Section 19 of the Flood and Water Management Act 2010. Significant flood events are defined as when the inside of five or more properties or key infrastructures, such as roads or hospitals, are impacted or damaged. LLFAs can also be commissioned where lessons can be learnt by investigating events, such as the failure of a flood risk management asset.

Section 19 reports should include:

- An assessment of events leading up to the flooding
- The number of properties flooded
- Identify the RMA(s) responsible for the management of the source of flood risk
- Evaluate whether the RMA(s) have / is planning on responding to the flood.

Section 19 reports make suggestions of future flood risk management measures to prevent the same kind of flood happening again. Where this is not possible, engagement with communities is key to improving people's resilience to plan for and recover faster from flooding.

HCC have completed the following Section 19 reports:

- August 2012 – surface water flooding
- December 2013 – tidal flooding
- August 2014 – surface water flooding
- October 2019 – river and surface water flooding

Historic flooding

Hull has a long history of living with water and flooding. Prior to 2007, there were many incidents of flooding in Hull and the surrounding areas. These were recorded in civic records, newspapers, poems and personal diaries, but they were not formally recorded by risk management authorities. The University of Hull's Arts and Humanities Research Council-funded *Risky Cities* project explores Hull's long history of living with water, using this to raise climate awareness and build flood resilience for the future (https://riskycities.hull.ac.uk). By learning from the past, we hope we can learn to better live with water in the future. Some examples of past flood events that have shaped the landscape and perceptions of flooding in the city are highlighted below (credit to the Risky Cities project for providing the information).

Photo credit: Hull Live

Alfred Gelder Street, Hull

September 1969

Following a tidal surge

1250 - 1500

- There is evidence of the earliest flood defences along the Humber being built, along with a network of ditches and sluices to drain surface water into the Humber.
- There were frequent storms and floods recorded in Hull from c.1250 onwards.
- It may have been a large flood in the 1250s which diverted the River Hull into its present course and allowed the Old Town to be laid out on its present site. The silting up of the old, westerly course of River Hull may also have contributed.
- There is evidence of flooding in Hull in 1365, the 1390s and 1401. In 1396, for example, documents record that the town was given money to help it recover from a series of flood events.
- Records also show how people discussed who should be responsible for maintaining the banks and ditches.

1500 - 1800

- Severe inundations are reported in 1527 and 1571, possibly as a result of tidal surges.
- In 1642 and 1643, the sluices were opened and the land around the town was deliberately flooded in order to help protect Hull from attack during the Civil Wars.
- A major storm hit the town in 1646, causing significant flooding in Drypool. Subsequently, disputes about the misuse and neglect of historic wooden flood defences arose as people blamed this for the flooding.
- In 1764 flooding is recorded in Marfleet and Sutton.

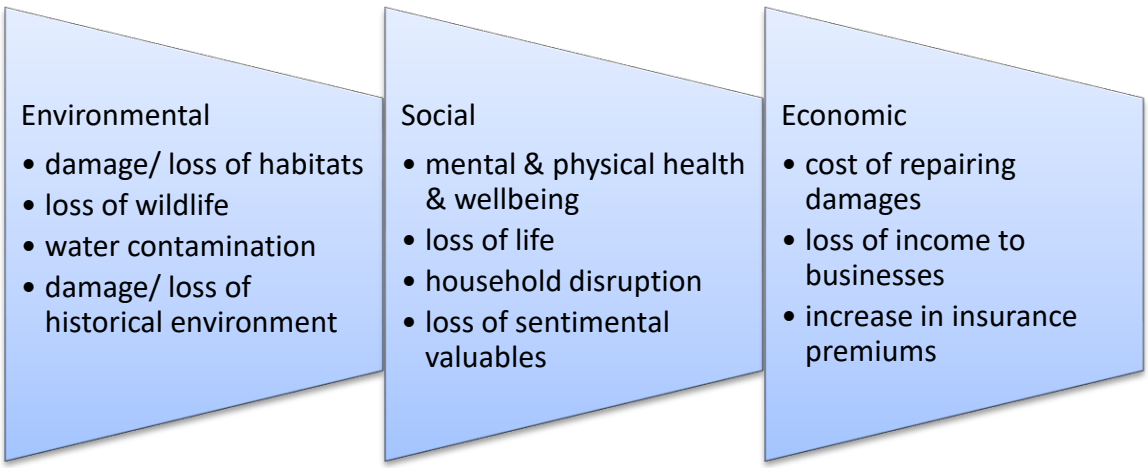
1800 - 2000

- Frequent winter flooding occured throughout the 19th and 20th centuries. Tidal flooding was the main source of flooding until the tidal surge barrier was constructed in 1980.
- There are records of flooding occuring in January 1850, December 1921, October 1923. March 1928, September 1930, March 1936, January 1953, October 1954, November 1954, December 1959, January 1965, January 1976.

Effects of flooding

Flooding can have very different impacts on people and places depending on their level of preparedness, resilience, and response. If a place and / or community is completely unprepared for a flood, then they are likely to be impacted more severely and recovery time will be longer. Most of the impacts of flooding are traditionally associated with negative effects.

Impacts of flooding can be summarised as:



There are also many indirect impacts. A recent survey found that after the surface water flooding in Hull in 2007:

- 25% of people found that their essential travel was disrupted,
- 24% of people said their work was impacted,
- 18% of people said the flooding negatively impacted their financial situation,
- 20% of people said that flooding affected another member of their household's health and wellbeing.

If flood water is managed in a different way, then floods can provide opportunity and minimise disruption. It is fair to say that this does not apply in all cases of flooding. It is not only flooding that we are at risk of, but also drought. During periods of drought, we experience water shortages that can have equally negative impacts on people and places. However, if we utilise excess water during times of flood then we could use it in times of drought. For tips on becoming more aware of local flood risk and tips on improving flood resilience, see appendix 5.

English Street, Hull 5th December 2013

50 residents evacuated

Over 260 homes and businesses flooded

Several main roads flooded

Climate change

- Experts have predicted that heavy rainfall and storms are going to become more frequent and more intense. We are already seeing evidence of this happening in Hull.
- The global climate is changing rapidly causing a shift in global temperatures. This affects the hydrological cycle and causes more water to be evaporated and then released as intense rainfall.
- This will increase water levels in rivers, raise groundwater levels and increase the amount of water falling across all regions.
- Climate change is also causing the melting of polar ice caps and glaciers which are causing sea levels to rise.
- Climate change is predicted to increase the frequency and intensity of storms and intense rainfall events.
- This will increase the risk of all types of flooding.
- Rising sea levels in the Humber will also make Hull more vulnerable to tidal flooding.
- Predicting climate change and the impact it will have on localised flooding is very difficult and so it is important that RMAs across the region continue to work together to increase the region's adaptability and resilience to future flood events.
- It is not possible to prevent all flood events from happening, partly because of people's preference to live near water, and so what we can do is work on our preparation, response, and recovery.

Adapting and mitigating impacts of climate change

- Hull's urban areas are separated by and surrounded by numerous open green spaces that provide habitats that support a variety of wildlife.
- These sites form a wider network of green and blue corridors across Hull and into the countryside.
- Hull's wildlife and habitats are highly influenced and threatened by flooding.
- Of particular concern are species and habitats associated with the internationally important Humber Estuary.
- Coastal squeeze caused by rising sea levels and development reduces the extent of intertidal areas, causing a loss of both feeding and roosting habitat for protected birds.
- Hull's rivers and drainage channels are some of the city's best wildlife habitats; they support a wide diversity of species and habitat types including reed bed, mudflat, and marginal vegetation.
- The presence of otter, water voles, grass snake, reed bunting and sedge warblers along the waterways, highlights their importance.
- Hull's most diverse natural sites not only support rare habitats such as reedbed, wet woodland and grassland, such as those at Noddle Hill Local Nature Reserve, but are also best placed to offer natural food management solutions for the city and are most able to adapt to increases in flooding.
- Saltmarsh and reedbed are instrumental in reducing tidal energy. Species rich grassland and wet woodlands with a variety of deep-rooted plants promotes better soil structure, permeability, infiltration and reduces overland flows.

Water vole along a watercourse in Hull

Protected in the UK under the Wildlife and Countryside Act, 1981.

Priority Species under the UK Post-2010 Biodiversity Framework.

Water voles are listed as endangered on both the Great Britain and the England Red List for Mammals

Potential for nature-based solutions to manage flood risk

- Looking ahead, it is important that we accept that the pattern and sources of flooding that the city is exposed to are intensifying and changing in nature.
- The role that the natural environment plays in protecting people's homes is now recognised as one of the most cost-effective ways of water management.
- We will likely come to rely on green open spaces to store flood waters to help avoid flooding of people's homes.
- Possibilities include rain gardens, creation of scrapes, bioswales, wetlands and ponds or creating large water storage areas.
- Wider environmental benefits of using nature-based solutions include habitat creation and carbon sequestration.
- By using natural flood management measures in the built and natural environment we can enhance people's wellbeing, the city and the local economy through improved water quality, enhanced visual amenity and increased biodiversity.
- Nature-based solutions tend to cost less, require less maintenance because they are self-sustaining, and so can be more cost-effective than traditional flood assets.

- Flood resilience is closely linked to climate resilience. Hull's Climate Change Strategy details how green open spaces can be used for climate resilience through carbon sequestration and flood resilience through water storage.

River Hull+ project

Timber lattices built onto flood defences

Habitat creation for birds and invertebrates

Funded by European Regional Development Fund