

Local Climate Impact Profile for Stockton on Tees

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Introduction

Local Climate Impact Profile for Stockton-on-Tees.

Stockton Borough Council's Climate Change Action Plan focuses on the two areas where the Council is tackling Climate Change:

Mitigation – Dealing with the *causes* of climate change with its main focus being the reduction of carbon dioxide emissions.

Adaptation - Focusing on the *effects* of climate change - planning for and adjusting to the impacts of extreme weather events caused by climate change, some of which are already happening.

Until recently the majority of Government action surrounding climate change has been focused on the management of carbon emissions and the huge task of reducing the UK's emissions by 60% by 2050. However, before mitigation has chance to take effect, the impacts of climate change will continue to develop over the next 30 – 50 years as current CO² emissions continue to take effect. There is, therefore, a growing urgency to anticipate, plan for and manage the effects of climate change.

This Local Climate Impacts Profile (LCIP) forms the first stages of creating a robust framework for climate resilience with the Local Authority of Stockton.

It uses frameworks set out by the UK Climate Impacts Programme (UKCIP.org.uk) and draws on the Local Climate Impacts Study for the North East recently completed by North East Climate Change Adaptation (adaptne.org.uk).

North East Climate Change Adaptation has produced a climate model for the North East. This model predicts principal climate changes for the region by the 2050's. Changes in climate, such as rising temperatures or falling annual rainfall can be predicted using modelling scenarios based on CO² emission levels over the next few decades. However, the most serious impacts will come from extreme weather events which are far harder to predict, therefore mitigating against vulnerability to extreme weather is vital. The region has already experienced such events in the form of flash flooding, storm damage, and heat waves of 2003 and 2006. A local climate study uses local weather events to build up a profile of how weather events impact on the area's business, travel, economy and housing. The purpose of this LCIP is to:

- build up a portfolio of local weather events and their impact on the Stockton area

- Use the findings of the North East Climate Change Adaptation LCIP together with the findings for the Stockton area to build up a resilient local climate impact profile for Stockton-upon-Tees Borough Council.
- Identify thresholds for weather events in Stockton which should trigger actions to prevent loss of service and damage to infrastructure.

Local Perceptions of Climate Change in Stockton on Tees

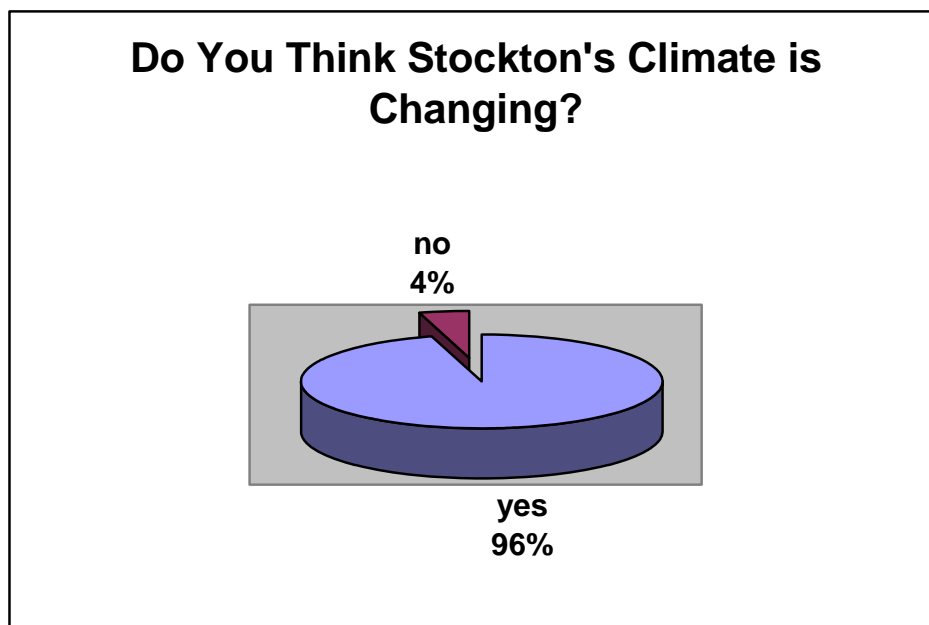
Climate Change Questionnaire

In 2007 Stockton's residents were surveyed on their opinions and issues about climate change in the borough.

A total of 92 responses were received.

The majority of respondents feel that the world's climate is changing and that this is mainly due to human behaviour.

Two thirds of respondents were concerned about climate change in Stockton and strongly believe (92%) that something can be done about it, with the main responsibility falling on national government.



Have you been affected by the following weather events?

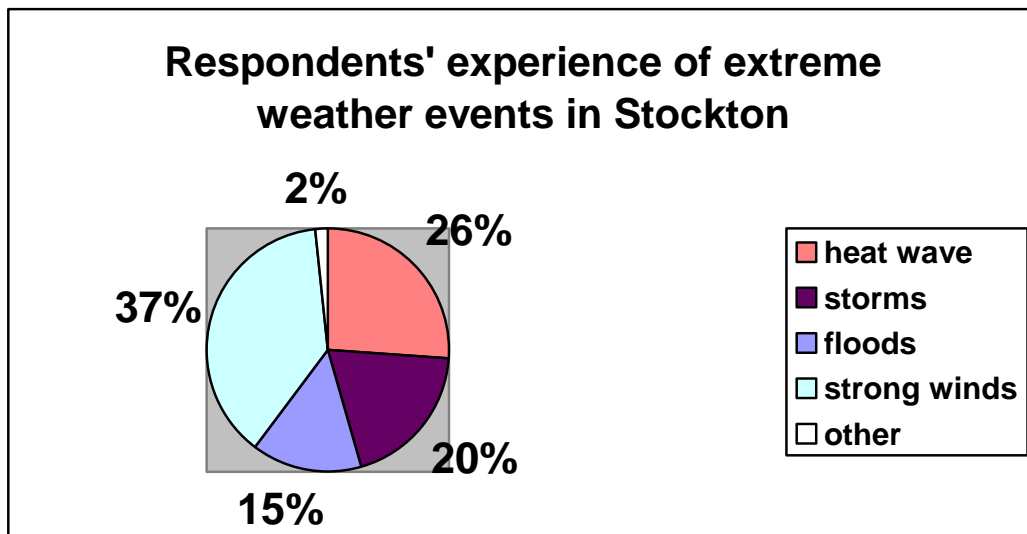
44% of respondents had been affected by heat waves.

33% of respondents had been affected by storms

25% of respondents had been affected by floods

64% of respondents had been affected by strong winds

3% of respondents had been affected by other events:



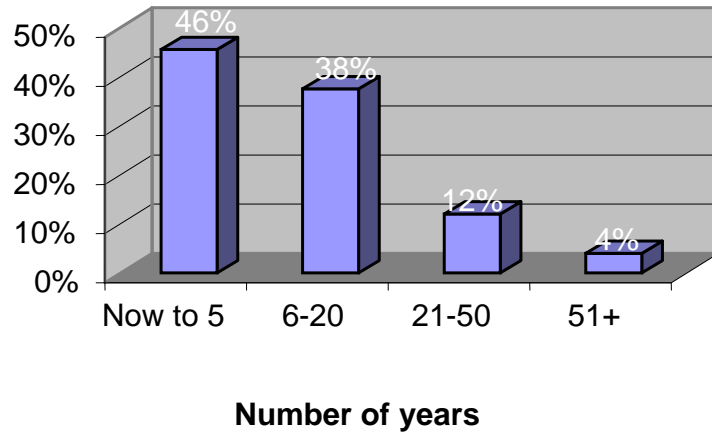
Do you think they are the results of climate change?

Yes 76% No 24%

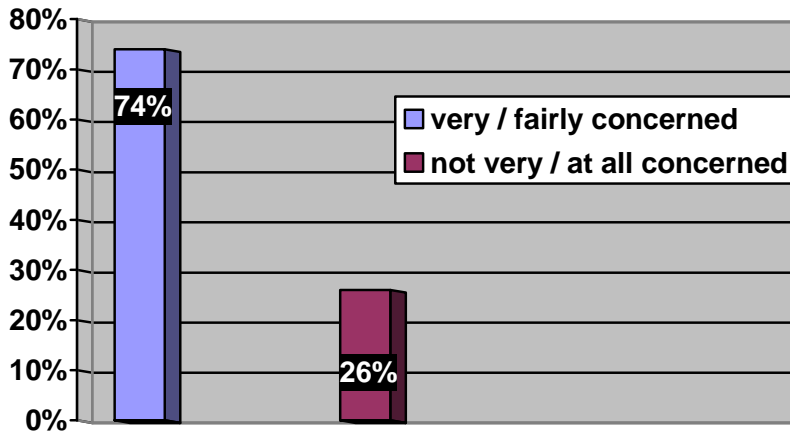
Do you think you may be affected by climate change in the future?

Yes 95% No 5%

How soon do you think you will be affected by climate change?

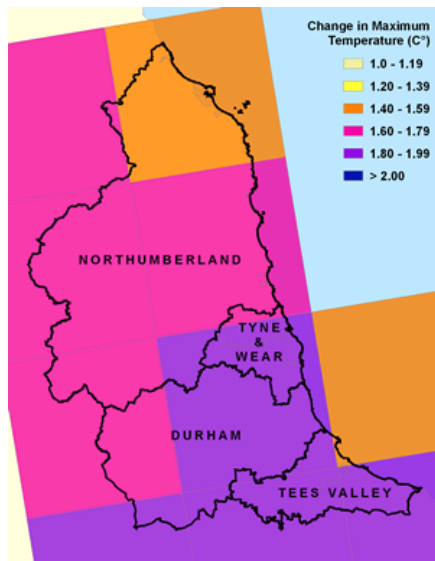


How concerned are you about the impacts of climate change in Stockton?



Projected Climate Change in the Tees Valley

The North East Climate Change Adaptation Study has produced a comprehensive climate change study of the North East of England – Climate scenarios for the North East are predicting that by the 2050's the average annual daily temperature will have risen by almost 2%¹



The temperature on an average winter's day will be 8.4°C
(1.3°C warmer than today's average of 7.2°C)

The temperature on an average summer's day will be 20.3°C
(2.4°C warmer than today's average of 17.9°C)

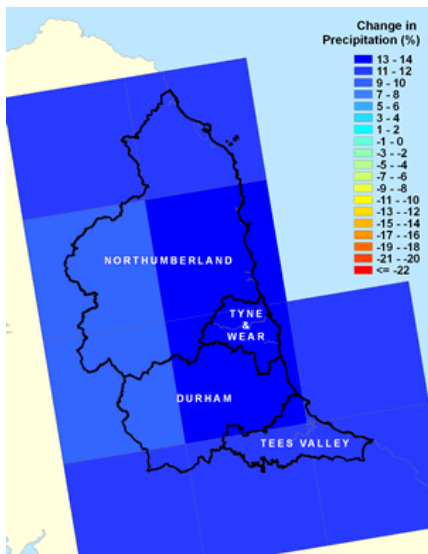
- Heat waves lasting several days could increase by 7-fold by the 2050s compared to the 1970s.
- Short spells of uncomfortably hot weather lasting 1-2 days are projected to be around 40 times more likely in the 2050s compared with the 1970s baseline.
- Some climate projections suggest that by the 2050s, we will experience a hot summer like that of 2003 every other year, and it will occur every year by the 2080s.

These projections are supported by the observations that we are already experiencing this upward trend with two heat waves occurring in the UK in the last 6 years.

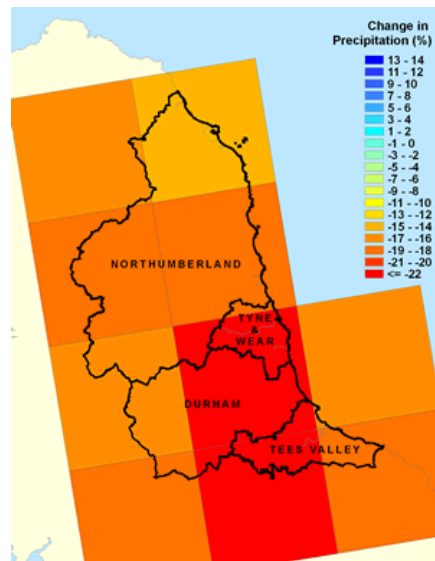
¹ EARWIG (the Environment Agency Rainfall and Weather Impacts Generator) developed for the Environment Agency by Newcastle University and University of East Anglia, and uses a 5km resolution which provides a much more detailed projection for local regional areas.

Average annual rainfall will decrease by 8.6%

Although projected average annual rainfall shows a decrease, it is expected that rainfall will become increasingly seasonal, with greater winter rainfall and a reduction in summer rainfall.

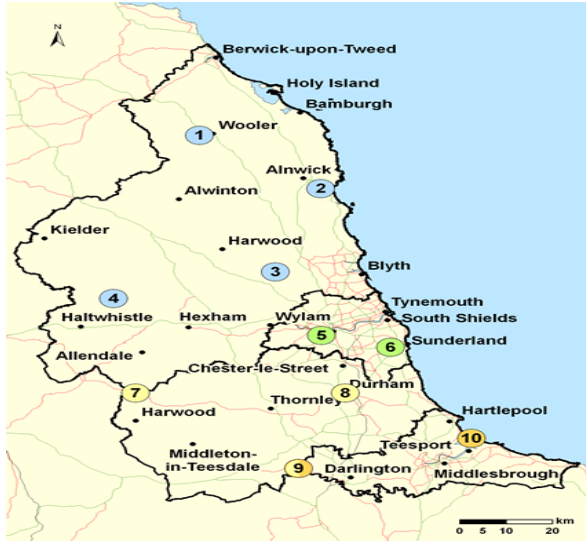


Winter rainfall will increase by 12.7%



Average summer rainfall will decrease by 33.2%

CLIMATE CHANGE IN THE TEES VALLEY



Assessments have been made using the Environment Agency’s Rainfall and Weather Impact Generator (EARWIG) for ten locations across the region to determine the climate changes projected by the 2050s.

The ten sites cover both urban and rural areas and extend from upland locations, through inland locations to coastal areas, giving a good Geographical coverage of the region as a whole (left). For more detailed information see www.adaptne.co.uk

**Average Seasonal Rainfall (mm)
Tees Valley**

	Area	Baseline	2050s	Change %
Annual Average	9	740	703	-5
	10	696	636	-8.6
Spring	9	57	56	-2.4
	10	50	48	-3.6
Summer	9	61	43	-28.8
	10	62	42	-33.2
Autumn	9	67	61	-8.5
	10	64	59	-7.1
Winter	9	61	74	+19.8
	10	56	63	+12.7

**Average Daily Temperatures (°C)
Tees Valley**

	Area	Baseline	2050s	Change
Annual Average	9	8.7	10.5	+1.8
	10	9.1	10.9	+1.8
Spring	9	7.2	8.9	+1.7
	10	7.7	9.3	+1.6
Summer	9	13.8	16.1	+2.3
	10	14.4	16.5	+2.1
Autumn	9	9.4	11.5	+2.1
	10	9.9	12.0	+2.1
Winter	9	4.0	5.2	+1.2
	10	4.5	5.8	+1.3

Recent Climate Impacts in Stockton on Tees

There is evidence that climate change is already affecting weather events in our region.

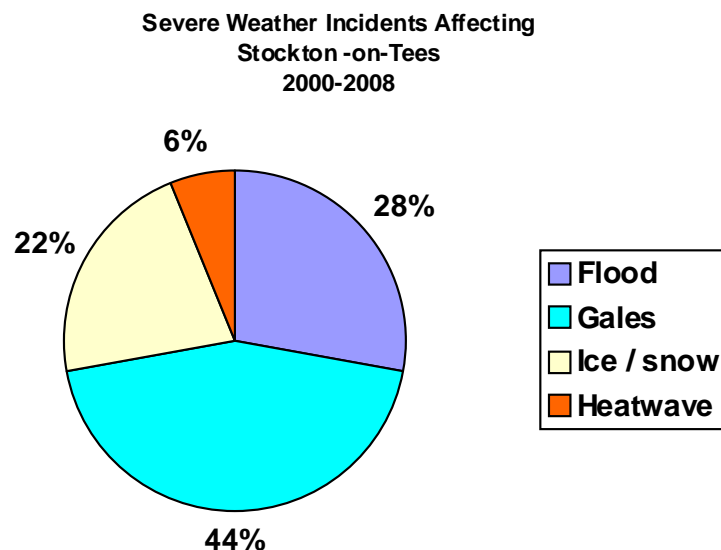
A brief research of local media weather archives covering the past eight years (2000 – 2008)² and further information was gained from the Met Office, The Health Protection Agency and Sustaine. These findings were recorded in the table below.

LOCAL WEATHER EVENTS since 2000

- **32 severe weather incidents which have directly affected Stockton Borough Council**

Including....

- **2 Incidents of heat wave in the North East** - causing 13 fatalities, 50 emergency admissions, field fires and melting tarmac on roads.
- **14 incidents of strong winds and gales** - causing damage to buildings, road closure due to uprooted trees and blown over lorries, and power cuts.
- **9 Flooding incidents** - where roads and properties have been affected by flash flooding, and annual events cancelled
- **7 incidents of snow storms and blizzards** - causing road closures and power cuts



² The eight year period, from 2000 – to 2008 was chosen purely as website archives for local newspapers only go back to 2000, making initial research quick and easy. It must be emphasised that these quantitative findings do not represent all the weather events that have affected Stockton Borough Council over the eight year period. They are limited to an indication of the kinds of events that are reported in the local media.

Taking these two facts into account, a trawl of local media has provided a very useful snapshot of the kind of extreme weather events currently being experienced in Stockton.

Heat Wave			
Date	Weather Event	Impact	Incident
Aug 4-13 2003	Heat wave	Soaring Temps	13 excessive deaths in NE (65+). 50 emergency admissions (75+) Over 2000 deaths nationally (Health Protection Agency)
July 2006	Heat wave	Met office issue heat wave warnings in North East on 18 th (level 2) & 19 th July (level 3) – Average temp over week was 33°C – (normal average = 21°C)	Jul 18 2006 By Evening Gazette Fire crews were on constant call-out this week as a summer heat wave helped cause field fires across Teesside. As temperatures soared past 30°C, officers said the dry grass was becoming more likely to catch fire. Councils across the County sent gritting lorries out to spread crushed rock dust on melting tar to create non-stick road surface.

Thresholds are pre-determined regionally via the Heat-Health watch system (NHS)

The threshold for the North East is 28°C day time temperature and 15°C night-time temp

If the daytime temp reaches 28°C on two consecutive days and 15°C on the intervening night Heat Wave action plan is triggered -

Heat wave action — triggered as soon as the Met Office confirms threshold temperatures will be reached in one or more regions. This stage requires social and healthcare services to target specific actions at high-risk groups.

Heat wave Emergency — reached when a heat wave is so severe and/or prolonged that its effects extend outside the health and social care system. At this level, illness and death may occur among the fit and healthy, and not just in high-risk groups.

Gales and Storms

Date	Weather Event	Impact	Incident
Dec 2001	Severe Gales	High winds – gusts of up to 70 mph	<p>Dec 28 2001 – Evening Gazette –</p> <p>Storm-force winds brought trees down and left thousands of homes without power today.</p> <p>Gusts of up to 70mph sent a century-old tree crashing to the ground early today.</p> <p>The tree, around four feet wide, blocked the road between Redmarshall and Bishopton, near Stockton. A second tree came down at the nearby Bishopton crossroads.</p> <p>Wind speeds reaching up to 65mph were recorded at Teesside Airport today.</p> <p><i>From the Northern Echo, first published Tues 29th Jan 02.</i></p>
Jan 2002	Storms	Storm force winds of up to 94mph	<p>Emergency services were swamped with a flood of calls after trees were uprooted, lorries overturned and flying debris hit passers-by.</p> <p>There was chaos on the roads, with truckers forced to pull over until the high winds subsided.</p> <p><i>From the Northern Echo, first published Tues 29th Jan 02.</i></p>
Jan 2002	Storms	Storm force winds of up to 94mph	<p>Billingham Campus School closed – after windows shattered – no pupils hurt</p> <p><i>From the Northern Echo, first published Wed 27th Feb 02.</i></p>
Feb 2002	Storms	Winds of 80mph plus torrential rain	<p>Environment Agency issued 16 flood warnings in the region – many road accidents caused by high winds and driving rain</p> <p><i>From the Northern Echo, first published Friday 2nd Jan 04.</i></p>
Jan 2004	Storms	Storm force winds	<p>Power lines brought down by heavy winds</p> <p>About 43,000 homes across the North-East and North Yorkshire were without electricity.</p> <p>about 7,000 homes and businesses were still without power after 24hrs</p>

Gales and Storms

Date	Weather Event	Impact	Incident
March 2004	Storms	75 mph winds	<p><i>From the Northern Echo, first published Mon22nd Mar 04.</i></p> <p>Both A1 and A66 closed following fatal accidents, causing massive tailbacks and jamming many roads.</p>
March 2004	Storms	75 mph winds	<p><i>From the Northern Echo, first published Monday 22nd Mar 2004.</i></p> <p>14,800 properties without power due to power line being blown down</p>
March 2004	Storms	75 mph winds	<p><i>From the Northern Echo, first published Monday 22nd Mar 2004.</i></p> <p>Billingham - shops evacuated following structural damage. Stockton High St cordoned off following structural damage</p>
7 Jan 2005	Severe Gales	Strong winds	<p>The Met Office has issued an emergency flash warning of exceptionally severe weather for Scotland, north and east England overnight, with winds gusting up to 90 m.p.h.</p> <p>Gusts of 70 m.p.h. are expected across much of the country, but gusts across southern Scotland, northern and eastern England may reach 90 m.p.h. in places. Considerable damage to trees, some structural damage to buildings and disruption to transport is expected.</p> <p><i>Reported in the Herald&Post Jan05</i></p> <p><i>'...Strong winds and heavy rain caused tens of thousands of pounds of damage to Billingham Campus Sports Centre, which had been under construction for about a year...'</i></p>
31 st August 2006	Severe Gales	Strong winds	<p>Storm damage causes cancellation of 20 trains between Newcastle, Sunderland and Middlesbrough</p>
Jan 2007	Storms	Gusts up to 80 mph plus Heavy rain	<p>15 January 2007</p> <p>Severe gales set to return</p> <p>The Met Office is warning of a return of severe gales through this week, with winds possibly gusting over 80 m.p.h., followed by a change to much colder weather during the weekend.</p>

Gales and Storms

Date	Weather Event	Impact	Incident
March 2008	Severe Gales		<p>Mar 12 2008 Evening Gazette</p> <p>A road in Stockton has been closed due to the high winds.</p> <p>The A1046 Haverton Hill Road, off Portrack roundabout, has been shut due to a dangerous structure, Stockton Council said. Diversions are in place.</p>
18th Jan 2008	Storm	Strong winds + heavy rain/blizzards	<p>Northern Echo 18/1/08</p> <p>The Met Office has issued weather warnings for the whole of the North-East and North Yorkshire, with heavy rain and gusts of up to 80mph expected today - and snowstorms predicted for the weekend. The conditions are expected to cause delays on roads and public transport networks, and buildings could be damaged in the high winds.</p>
2 nd Feb 2008	Severe gales	Strong winds + heavy rain/blizzards	<p>Northern Echo 2/2/08</p> <p>Transport systems affected – continuing high winds over several days closes landfill sites and disrupts collection services.</p>

Severe weather warnings are issued by the Met Office using a set of fixed criteria for the whole of the country.

In the case of strong wind there are two thresholds:

Severe Gales = repeated gusts of up to 70 miles per hour over inland areas

Storms = repeated gusts of up to 80 miles per hour over inland areas

Floods			
Date	Weather Event	Impact	Incident
Oct 2000	Heavy rain	Localised flooding.	The Environment Agency issued widespread flood warnings after one-and-a-half inches of rain, half the entire monthly average, fell in the North-East in only six hours yesterday. Flooding to the A19 south of Stockton from the River Leven.
June 2002	Heavy Rain	Localised flooding	<p><i>From the Northern Echo, first published Monday 17th Jun 2002.</i></p> <p>Following a torrential downpour that lasted for about an hour, many roads in the region were blocked by standing water, with some even damaged in the deluge.</p> <p>Fire crews worked flat out across Teesside, tackling 149 calls between 6.30pm and midnight, most of the problems were recorded in the Seaton Carew, Billingham and Whinny Banks areas.</p> <p>The cellar of The Swan pub, in Wolviston Road, Billingham, was flooded with 12in to 18in of water.</p> <p>Gardens in the town's Grosvenor Road were also badly affected by water and Marsh House Avenue was flooded across both sections of the road.</p>
Oct 2002	Heavy Rain	Localised flash floods	<p>From the Northern Echo, first published Mon 28th Oct 02.</p> <p>The North-East received more than a tenth of its average October rainfall in only six hours.</p> <p>The Environment Agency issued flood warnings on the riverside footpaths next to the Ouse, in York, and on Lustrum Beck in Hartburn, Stockton.</p>
August 2003	Heavy Rain	Localised flash floods	<p><i>From the Northern Echo, first published Tuesday 12th Aug 2003.</i></p> <p>More than a month's rain (70mm) fell in a little over half an hour.</p>

Floods			
Date	Weather Event	Impact	Incident
			<p>Flood damage to a number of buildings in the region Including Several stores on Teesside Park North Tees Hospital</p> <p>The accident and emergency department at Middlesbrough General Hospital was shut for more than six hours after flooding in the basement knocked out all electricity. Impacting on other hospitals in area.</p>
August 2004	Heavy rain	Localised flooding from sewers due to blocked drains	<p>47 flooding incidents reported as heavy rain blocked drains and flooded homes. The worst locations hit were Eaglescliffe, Egglecliffe, Hardwick, Hartburn, Bishopsgarth and Fairfield in Stockton due to flooding from drains. (sustaine-adaptne)</p> <p><i>Evening Gazette June 05</i></p>
June 2005	Heavy Rain	Localised flooding	<p>A month's worth of rain - 70 millimetres - fell in three hours, bringing chaos to the North-East and North Yorkshire on Sunday. Several people had to be rescued from the rising waters by emergency services.</p> <p><i>Evening Gazette Jun 2007</i></p>
June 2007	Heavy Rain	Localised flooding	<p>Severe weather warning issued for North East - 25mm to 80mm of rain over three days predicted. Ground already sodden after prolonged wet weather. Flooded properties in Darlington, Middleton St George, Yarm, Ingleby Barwick, and Eaglescliffe, all near Stockton, Middlesbrough, and Peterlee.</p>
July 2007	Continual wet weather	Ground becomes waterlogged.	<p>Jul 25 2007 Herald & Post</p> <p>ONE of the biggest annual events on Teesside is the latest casualty of the horrendously wet summer.</p> <p>Cleveland Show organisers were yesterday forced to take the painful - but inevitable - decision to cancel the event scheduled for the weekend.</p>

Floods			
Date	Weather Event	Impact	Incident
			<p>But show organisers will still lose between £8,000-£10,000.</p> <p>26 July 2007 - The Met Office today can reveal the three months from May to July 2007 have broken records for this period, even before July is over.</p> <p>Provisional figures from the Met Office show that 387.6 mm of rain have already fallen across England and Wales, making it the wettest May to July since records began in 1766.</p>
Aug 2004	Continual wet weather	Ground waterlogged	Stockton Summer Show cancelled

Severe weather warnings are issued by the Met Office using a set of fixed criteria for the whole of the country. The rainfall threshold which will trigger a weather warning is where rain is expected to continue for at least two hours and to give at least 15 mm within a three hour period or, following previous heavy rain events, 25 mm/day.

Ice / Snow			
Date	Weather Event	Impact	Incident
Dec 2000	Ice / Snow	Freezing temps & Heavy snow fall	<p><i>From the Northern Echo, first published Friday 29th Dec 2000.</i></p> <p>Only a few parts of the region escaped a covering of snow, with many parts getting up to four inches between Thursday night and yesterday morning.</p> <p>County Durham, Northumberland, Tyneside, Wearside, Teesside and North Yorkshire all suffered from the sub-zero conditions, with ice and snow persisting in places yesterday.</p>
Jan 2003	Ice / Snow	High Winds, freezing temps and heavy snow fall	The A66 eastbound was blocked and the A19 north of Billingham impassable due to sheet ice. Gritters were working throughout the night to clear it. <i>Northern Echo, 31st Jan 2003.</i>
Feb 2004	Ice / Snow	Heavy snow followed by rain which then froze	<p><i>From the Northern Echo, first published Saturday 28th Feb 2004.</i></p> <p><i>Schools closed</i></p>

Ice / Snow			
Date	Weather Event	Impact	Incident
			<p>Roads affected -Cleveland Police described road conditions throughout their area as extremely bad.</p> <p>There were accidents on both the north and southbound carriageways of the A19 in the Billingham- Wolviston section bringing rush-hour traffic to a standstill.</p>
Feb/March 2005	Ice / Snow	Third day of snowfall and freezing temps	<p><i>From the Northern Echo, first published Thursday 24th Feb 2005.</i></p> <p>Fresh snowfalls carpeted minor roads as an army of council gritter drivers worked around the clock to keep the major trunk roads - the A1, A69, A68 and A66 – clear</p>
March 2005			<p>28th Feb Met Office issues warnings of 80% chance of snow across the North East for the 1st&2nd March</p>
Jan 2008	Ice / Snow	Met office weather warning issued for blizzards/snow/rain/and freezing temps	<p>Schools closed. Roads affected by localised flooding and icy conditions.</p> <p><i>Reported in Eve Gazette 22 Jan 2008</i></p>
Feb 2008	Ice/ Snow	Weather warnings for strong winds/ice and snow	<p>Weather warnings given 1 Feb 2008 – <i>Northern Echo</i> Roads affected by icy conditions and strong winds.</p>

Severe weather warnings are issued by the Met Office using a set of fixed criteria for the whole of the country.

SNOW

The snowfall threshold trigger for issuing a weather warning is;

- Heavy Snow Snow falling at a rate of 2 cm/hour or more expected for at least two hours.
- Very Heavy Snow Snow falling at a rate of 2 cm/hour or more expected for at least two hours, accumulating to 15 cm or more.
- Blizzard Moderate or heavy snow accompanied by winds of 30 m.p.h. or more, with visibility reduced to 200 m or less; or drifting snow giving rise to similar conditions.
- Severe Blizzard Heavy Snow accompanied by winds of 30 m.p.h. or more, reducing visibility to near zero

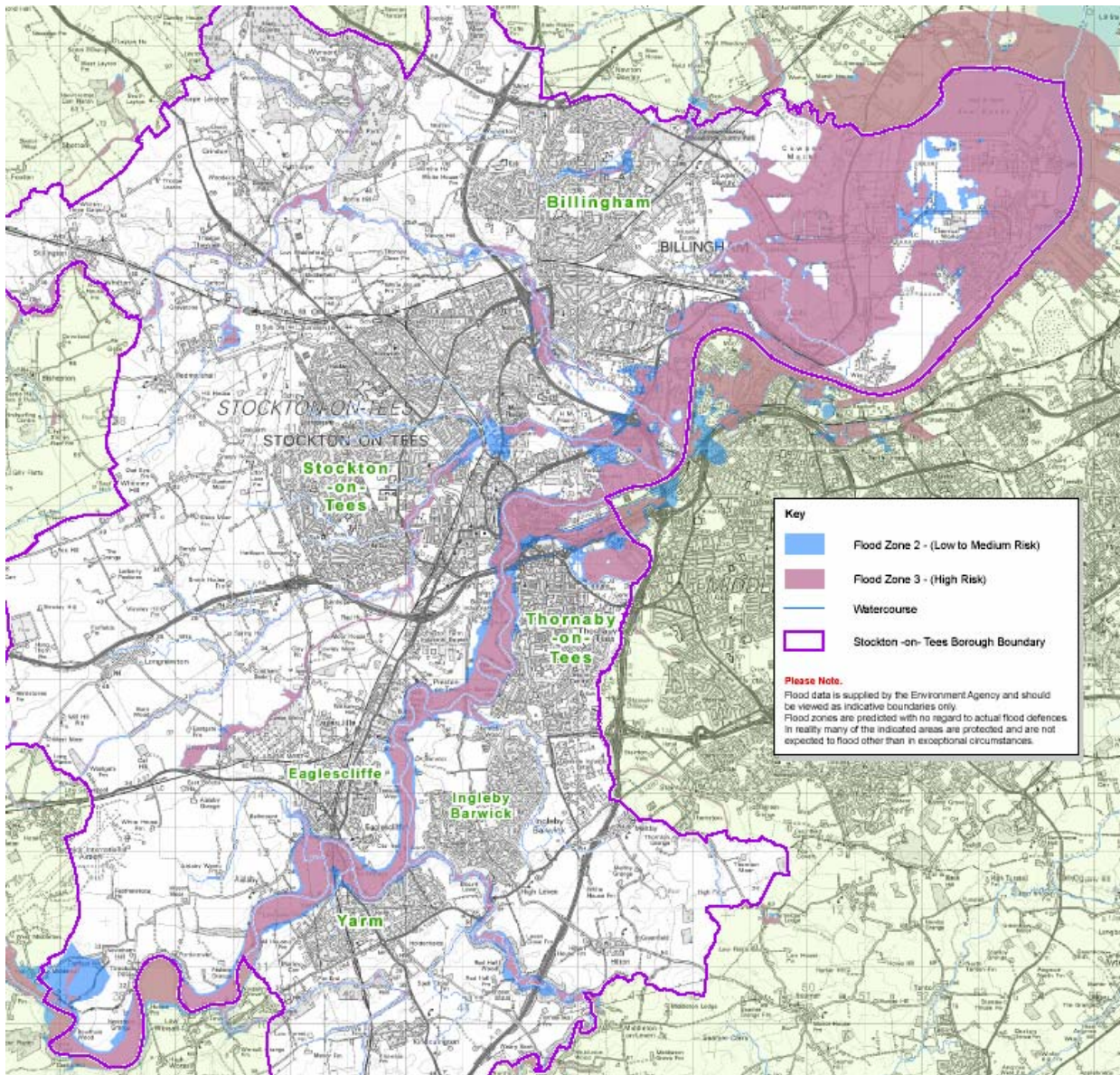
ICE

When rain falls onto surfaces with temperatures at or below zero; or condensation occurs on surfaces at or below zero; or already wet surfaces fall to or below zero. The ice is usually clear and difficult to distinguish from a wet surface. It usually forms in sheets.

Warnings are issued when any depth of ice is expected over a widespread area.

Assessment of the risks and impacts of flooding in the Borough of Stockton on Tees.

The Current Environment Agency flood zone map indicates the areas at risk from flooding from the River Tees or the North Sea.



Risk of flooding from the Tees or Tributaries

These indicate significant flooding from the Tees affecting areas around Yarm, Aislaby, Eaglescliffe, Thornaby, and Stockton. There is also significant flooding from the Coatham Beck affecting central areas of Stockton, and some flooding from a tributary to Bishopton Beck affecting Carlton. Some of the flooding from both of these rivers will only affect rural areas, although towns and properties situated at a low level near the rivers are likely to be affected.

Risk of tidal flooding

Tidal flooding is also a significant issue, with extensive flooding shown across the industrial areas of Teesport and Billingham from the Tees Estuary. This has an indirect effect on the backing up of tributary watercourses and producing flooding along a small watercourse in the north of Billingham.

Current flood defences

There are extensive river flood defences provided within the district, with approximately 21km of flood embankments and 200m of other defence structures provided around Yarm and Aislaby, around Eaglescliffe and Thornaby, through the centre of Stockton, and near Cowpen Bewley at Billingham. In addition, through the urban areas there are almost 300m of culverted watercourse.

Foul and separate surface water drainage systems are spread extensively across the urban areas within the district with various interconnected systems discharging to treatment works and into local watercourses. Typically foul systems will comprise a network of drainage sewers, often combining areas of separate and combined drainage, leading to a sewage treatment works. The foul/combined systems will be inter-linked, possibly via pumping, to a single local treatment works.

There are 9 sewage treatment works and 68 sewage pumping stations within the district. Various ancillary structures will be included through the system to assist network performance, primarily pumping stations, combined sewer overflows (CSOs), and storage tanks. CSOs provide an overflow release from the drainage system into local watercourses or surface water systems during times of high flows.

Surface water systems will typically collect surface water drainage separately from the foul sewerage. These may discharge directly into local watercourses, although more commonly in the more constrained urban areas of Stockton these are linked to discharge into the foul/combined system.

Current Impacts to Key Properties and Assets

The following table presents a summary of the key properties and assets currently identified to be at risk from flooding from rivers and the sea under the present day climate.

Asset Type	Stockton-on-Tees Council		
	Flood Zone 3 0.5-1% AEP	Flood Zone 2 ³ 0.1% AEP	Total No. of ASSETS
HIGH Vulnerability	78	85	504
Ambulance Station	-	-	2
Police Station	1	1	8
Fire Station	1	1	4
School	5	7	113
Hospital	-	-	1
Care Home	4	4	45
Prison	-	-	2
Camping Site	1	1	1
Power/Gas Station and Gas Works	1	1	3
Electricity Sub Station	64	69	321
Telephone Exchange	1	1	4
MEDIUM Vulnerability	66	78	549
Railway Stations	-	1	6
Port	-	-	1
Airport	-	-	1
Leisure Facility	2	3	43
Surgery/Health Centre	5	5	70
Community Centre	9	12	71
Day Nursery	5	7	28
College/University	2	2	4
Hotel/Guest House/Hostel	3	3	34
Self Catering Holiday Unit	-	-	8
Pubs and clubs	11	13	197
Petrol Filling Station	1	2	20

³ Flood Zone 3 shows the High Probability zone indicating areas that might be affected by a fluvial (river) flood with a 1% annual exceedance probability (AEP) (or 1 in 100 year return period of occurrence) or greater chance of happening each year. For tidal areas Flood Zone 3 shows areas that might be affected by a tidal flood with a 0.5% AEP (or 1 in 200 year return period of occurrence) or greater chance of happening each year.

Flood Zone 2 shows the Medium Probability zone indicating areas that might be affected by a fluvial (river) or tidal flood with a 0.1% AEP (or 1 in 1,000 year return period of occurrence) or greater chance of happening each year.

Major Landfill (including Hazardous)	1	2	3
Landfill (Non Hazardous)	1	2	16
Hazardous Waste Treatment & Incineration	2	2	2
Chemical Industry/Works/ IPCC sites	24	24	44
Fuel Combustion Works	-	-	1
LOW Vulnerability	43	50	113
Sewage Treatment Works	4	4	9
Sewage Pumping Stations	30	34	68
Cemetery/Crematorium	-	-	6
Animal/Vegetable/Food Industrial	-	-	1
Metal Industry/ Recycling Sites	1	3	5
Tipping Site	1	1	3
Waste Disposal/Treatment/ Incineration	-	1	1
Non Hazardous Waste Transfer/Treatment	7	7	20
Total	187	213	1166
*1 Flood zone 2 figures also include properties within the higher risk Flood zone 3.			

RESIDENTIAL IMPACT

Also the residential impacts to the local population have been determined. Residential properties are classed as medium risk vulnerability. The Environment Agency has a social flood vulnerability index which identifies the vulnerability of populations based on age and social deprivation.

The four selected variables are:

1. People aged 75 and over
2. People suffering from a long-term limiting illness
3. Lone parent households
4. Financially deprived households

Most of the borough area is in the medium vulnerability class, or above in southerly areas around Egglecliffe and Yarm. More vulnerable populations are identified across Stockton and Thornaby, with some areas of very high vulnerability shown in central areas and in Yarm, and these also tie in with the areas more likely to be affected by flooding.

Population at risk	Flood zone 2	Flood zone 3
Stockton-on-Tees	2,531	2,067

Future Impacts from River Flooding

Using climate change prediction models to the 2050s, Sustaine have identified the following additional assets as potentially be at risk in the future.

Police Station	1	Stockton-on-tees
Electricity Sub Station	4	-
Sewage Pumping Station	4	Stockton-on-tees, Yarm, Thornaby
Health Centre or Surgery	2	Stockton-on-tees, Yarm
Community Centre	2	Stockton-on-tees
Leisure Facility	2	Stockton-on-tees
Pub or Club	8	Stockton-on-tees
Landfill Non Hazardous Waste	1	Stockton-on-Tees
Guest House, Motel, Hostel	1	Stockton-on-Tees
RESIDENTIAL	708	Stockton-on-tees, Yarm
Rail	517m (11 No.)	-
Road-Primary	1,105m (10 No.)	-
Road-A	1,556m (20 No.)	-
Road-B	147m (1 No.)	-

In addition, along with changes in rainfall patterns, climate change will cause significant sea level rise along the North East coastline. Mean sea levels are expected to rise by approximately 250mm by 2050, based on current guidance from Defra, and extreme sea surge levels are likely to be even more exaggerated.

A recent strategy for tidal flooding in the Tees Estuary has been completed, and studies of the identification of the extents of future tidal flooding along the coastline are ongoing through the current revision to the Shoreline Management Plan. The River Tyne to Flamborough Head Shoreline Management 2 was completed in February 2007. This ascertains the specific areas which are likely to be affected by rising sea levels, and proposes recommended management methods to cope with the flooding.

Additional impacts of climate change on flooding and flood defences are also likely to become apparent, as follows.

- Flooding to critical infrastructure and housing stock (as highlighted).
- Direct and indirect impacts on vulnerable populations.
- Traffic impacts on main routes (regarding access and distribution of food and fuel, etc) affecting local and national businesses.
- Impacts on the co-ordination of emergency services during times of flooding if access routes become blocked by flood waters.
- Increasing call outs for emergency services to flooding events.
- Health and safety issues with flooding from sewers, CSOs and treatment works contaminating flood waters.
- Increased blockages in the system and more silt being washed into watercourses reducing capacity, requiring more frequent inspections and greater maintenance works.
- Culvert entrances becoming blocked by tree debris and vegetation during high storms.
- Extensions in the growing season, starting earlier and lasting longer, increasing requirements for vegetation clearance of watercourses to retain channel capacity.
- More frequent breaching of historic defences that have a low standard of protection will reduce the defence's efficiency and stability and require increased maintenance works. The likelihood of failure of the defences will be increased.

- Higher flood flows giving increased scour and erosion at defence toe, leading to undermining and slumping or collapse. (Northumberland County Council has increased budgets over recent years to deal with land slips due to the erosion of embankments by local watercourses).
- Drier conditions likely to cause cracking in defence embankments.
- Increasing vermin populations are likely to impact on the stability of defences. Rabbits and other rodents burrow into defence embankments weakening them and increasing the likelihood of collapse.
- Rising sea levels will impose increased loading on tidal defences. There will be an increased risk of overtopping and crest heights will need to be raised. There will be a more frequent risk of tidal flooding if standards not increased.
- With regard to sewer and surface water flooding, with increasing winter rainfall due to climate changes the occurrence of incidents at the known foul and surface water sewer flooding locations will become significantly more frequent during the winter months.

Other problem locations will arise due to the increasing magnitude of events, but it is difficult to easily ascertain where these may occur.

- Fast flowing surface water runoff in steeper urban areas where there are significant extents of impermeable area are likely to be the most susceptible.
- Also, low gradient areas within the main towns and low points on the road and rail networks will be vulnerable to increasing flooding, particularly where these are surrounded by steeper areas that will produce fast runoff flows from the projected more frequent and higher intensity storms. Northumbrian Water has noticed an increase in the frequency of high intensity summer storms that produce significant urban flooding over recent years, with significant flooding events having occurred in two of the last three years.
- Large industries along the Tees Estuary are likely to suffer from increased surface water flooding due to their large areas of impermeable surface. Flooding is likely to affect operations more frequently, with increased rainfall events compounded by higher tides restricting drainage outfalls from discharging.

Similarly to river flooding, the impacts of climate change will produce increases in the number and frequency of flooding events, particularly during the wetter winter period and during summer months due to high intensity thunderstorms. Other future impacts that are likely to arise are:

- Increased blockages of gulleys and grids with tree debris and detritus during high storms and heavy rain, meaning that flash flood events will not be able to drain, and producing increased localised flooding.
- The increasing trend for paving over gardens (development creep) combined with future intense rainfall further increasing capacity requirements within the drainage systems, exacerbating problems in urban areas and causing increased flooding problems.
- Increasing land runoff in steep areas with high intensity rainfall events.