ADAPTATION BASELINE

ADAPTATION BASELINE

Dublin's energy agency Codema has produced this adaptation baseline in line with the guidelines contained in the *Local Authority Adaptation Strategy Development Guidelines 2018* and the *National Adaptation Framework*. This Climate Change Action Plan has been peer reviewed to the requirements of the *Local Authority Adaptation Strategy Development Guidelines 2018*.

The objective of this baseline is to document the occurrence of past climatic events, their frequency, the specific areas in Dublin City that are most vulnerable and the risks associated with such events. This adaptation baseline also highlights the need for emergency planning to be continually updated in line with extreme weather events.

From the adaptation baseline, we can assess the current and future risks that will affect Dublin City. These risks are assessed and addressed by putting actions in place to build a more resilient City that is robust, resourceful and is able to adapt in response to changes in climate and in times of crisis. The actions are a mix of grey and green solutions, which try to balance engineered solutions with nature-based resilience. A more exhaustive list of all actions, including adaptation actions, may be found in each of the action areas contained in this Climate Change Action Plan.

BACKGROUND AND METHODOLOGY

Ireland has a total population of 4,761,865, of which approximately 1.9 million people live within five kilometres (km) of the coast; within this, 40,000 reside less than 100 metres away from the sea[14]. Ireland has a number of climate challenges, such as coastal flooding, sea level rise, coastal erosion, pluvial flooding, extreme weather events and extreme temperatures. Dublin, being an urban City, has different challenges and risks compared to more rural areas.

The Dublin City area is 117 km^2, and comprises of 52 km of coastline, including Dublin Port and the Liffey Estuary. Three main rivers (the Liffey, the Tolka, and the Dodder) flow through the City, in addition to a number of small rivers such as the Wad, Poddle, Santry, Mayne and the Camac. Both the Poddle and Dodder run through most of the south of the City and South Dublin County; these rivers, in turn, flow into the River Liffey via the City Centre.

The River Liffey and River Camac drain areas within County Kildare, South Dublin County, the City Centre and the west side of the City, before flowing into Dublin Bay. Before discharging into Dublin Bay, the River Tolka and its tributaries drain areas within County Meath and north of the Royal Canal.

According to the most recent Census (2016)[14], the Dublin City area currently has a population of 554,554, with 240,553 households, and these figures are expected to rise in the future. The 2016 Census highlights that by 2031, population in the Greater Dublin Area (GDA) will increase by just over 400,000, and this increase would account for approximately two thirds of the total projected population growth in Ireland. A rise in population will increase the impacts of climate change due to additional pressure on drainage systems that are already working near capacity. Also, it is estimated that Ireland will need an additional 550,000 more homes by 2040, compared to 2017[4], and this will lead to a decrease in pervious or green surfaces, exacerbating flooding due to enhanced run-off.

These geographic and demographic characteristics make Dublin City sensitive to a set of climate change risks, which differ from rural, landlocked or sparsely populated regions.

As explained in the previous section, this plan follows the ICLEI Five Milestone Approach. As part of the second milestone (Research), information was collected from a range of departments to gather actions in each area. This was conducted through a series of one-to-one meetings between Codema and staff from all internal departments of Dublin City Council, and collaborative workshops with staff from all four DLAs. Additional data and information was also gathered from multiple national sources, including the Office of Public Works (OPW), Met Éireann and the Environmental Protection Agency (EPA).

BASELINE

Table 1 on the following page summarises the climatic events recorded by Met Éireann that have occurred in the Dublin Region over the last 32 years. These events were recorded due to their unique intensity and abnormal weather patterns. The effects (see description) of these major events are not purely economic; they also highlight social and environmental impacts and vulnerabilities, as further described in the following sections.

Table 1 Major Climatic Events in Dublin (Source: Met Éireann & Flooding.ie)

TYPE	DATE	DESCRIPTION
Hurricane Charley	August 1986	Pluvial – worst flooding in Dublin in 100 years.
Pluvial & Strong Winds	February 1990	Heavy rain and consequently flooding, with long periods of strong winds. All weather stations reported gale gusts.
Pluvial/Fluvial	June 1993	100 mm of rain fell in Dublin and Kildare (more than three times the normal amount).
Extreme Temperatures	June - August 1995	Warmest summer on record, with mean air temperatures over two degrees above normal in most places. Temperatures rose to around 30°C on a number of days and night time minimum temperature remained above 15°C for many weeks.
Windstorm	December 1997	Conditions were severe in much of Leinster, especially the south and east. In the Dublin area there were record gusts of 150 km/h, with maximum 10-minute winds of storm force.
Fluvial	November 2000	250 properties flooded in Dublin, 90.8 mm of rain fell. Significant disruption and damage, especially in the area of the Lower Tolka catchment.
Coastal	February 2002	Second highest tide ever recorded. This caused sea defences to be overtopped. 1,250 properties flooded in Dublin, €60m worth of damage.
Fluvial	November 2002	Similar to the 2000 flood, 80 mm of rain fell in Dublin. This led to high river levels in the River Tolka, which caused extensive flooding along the catchment.
Extreme Temperatures	Summer 2006	Warmest summer on record since 1995.
Pluvial	August - September 2008	North City - 42.9 mm of rain fell in two hours, which was a 1-in-100-year event. 19 areas of North Dublin had severe flooding, many of which had no previous history of such flooding. Over 150 residential properties were inundated, as well as commercial premises, public buildings, major roadways, etc.
Pluvial	July 2009	This was a 1-in-50-year event. Several areas within the Dublin City Council boundary were affected. One of the worst affected areas was Donnycarney in North Dublin. Reports of spot flooding in Raheny, Clontarf, Drumcondra, Finglas, Sandymount, Cabra, Finglas and Glendhu Park in Ashtown.
Extreme Cold	December 2010	It was the coldest of any month at Dublin Airport, Casement Aerodrome and Mullingar in 50 years. Casement Aerodrome's temperature plummeted to -15.7°C on Christmas Day, the lowest temperature ever recorded in Dublin.
Pluvial/Fluvial	October 2011	This was between a 1-in-50 and a 1-in-100-year event across the majority of Dublin. 1,100 properties were flooded, 318 road flooding incidents occurred, 1,200 electricity customers had no power supply in the City Centre, and a fatality in the City as a result.
Coastal	January 2014	The highest tide ever recorded, at 3.014 metres ODM recorded at Alexandra Basin. Four buildings flooded.
Storm Darwin	February 2014	A 1-in-20-year event, with gusts of 100-110 km/h in Dublin. Considerable damage to housing and other buildings. 8,000 ha of forests damaged. Status: Yellow
Storm Ophelia	October 2017	First storm to come from a southerly direction, with damaging gusts of 120 to 150 km/h. 100 large trees blown over in Dublin City. Status: Red
The Beast from the East and Storm Emma	February – March 2018	Met Éireann issued its first Status Red warning on record for snow. Closure of all schools in the City, many businesses affected, water and power restrictions or outages. Status: Red
Extreme Temperatures	Summer 2018	Drier and warmer weather than normal throughout Ireland, with drought conditions in many areas, including Dublin. Temperatures reached 28°C, with above-average sunshine and heat wave conditions. Water restrictions were in place for the country for the majority of the summer. Status: Yellow
Storms Ali and Bronagh	September 2018	Storm Ali brought widespread, disruptive wind, which led to the delay or cancellation of most flights to and from Dublin Airport. Storm Bronagh passed over the east of Ireland bringing heavy rain. Mean wind speeds between 65-80 km/h and gusts between 110-130 km/h. Status: Orange

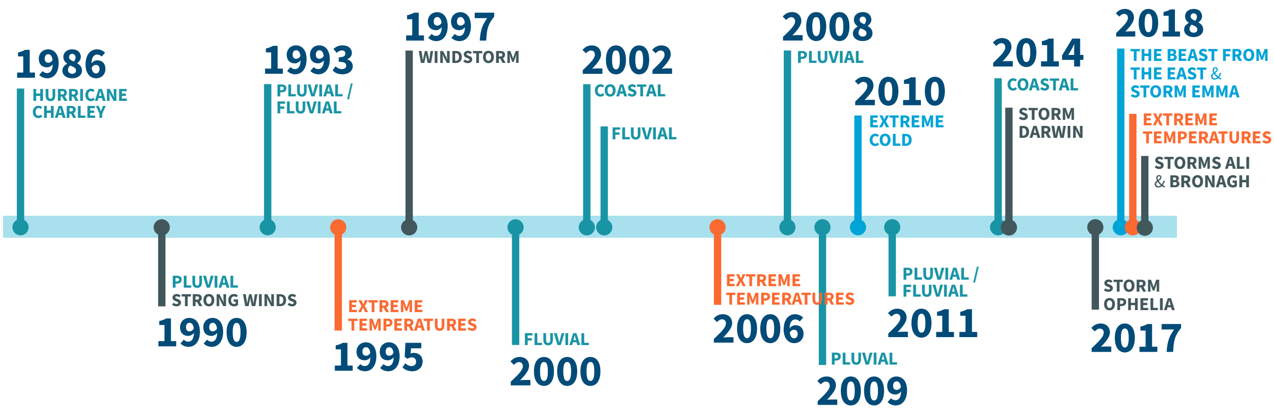


Figure 4 Timeline of Major Climatic Events in Dublin

CLIMATIC EVENTS, TRENDS & RISKS

Dublin City's geographic and demographic characteristics make it vulnerable to certain risks. As a City, Dublin creates its own unique micro-climate and this can intensify current and future climate impacts. An example of this is the urban heat island effect, making it warmer than the surrounding semi-urban and rural areas. This is mainly due to heat absorption from built-up areas in the City, waste heat generated from urban activities and a lack of tree cover, which can reduce temperatures in the City through shading. Flood risks are also higher in cities due to the amount of impervious surfaces and lack of vegetation (pervious surfaces); this results in enhanced rainwater run-off, which may result in flooding.

Risks may be categorised as:

1. **Economic loss**, which includes damage to infrastructure and the disruption of daily activities
2. **Social loss**, including damage to human life, health, community and social facilities
3. **Environmental and heritage loss**, which takes into consideration the sensitivity of the environment (the natural, cultural and historical environment), habitats and species.

Risks in cities are exacerbated, which means we need to assess the impacts of not only extreme weather and climatic events, but also climatic trends, such as urban flooding, sea level rise and increasing temperatures. These events and trends should not be considered as independent, as they influence each other. The slow, gradual increase in temperatures and sea level rise will contribute to the increased frequency and intensity of extreme weather events and flooding.

Table 2 on the following page shows a 30-year overview of different climate variables (cold snaps, heat waves, storm surges, coastal erosion, etc.), which are grouped into three types of events and trends (extreme weather events, sea level rise and flooding). This table summarises the current effects of climate change variables, projected changes in the next 30 years, and confidence in these projections.

The climatic events and trends that Dublin City is facing are:

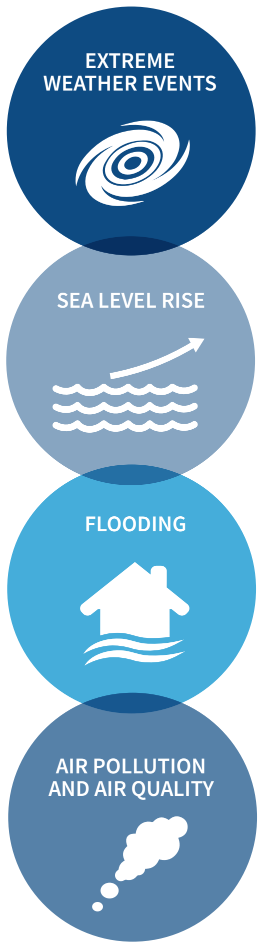
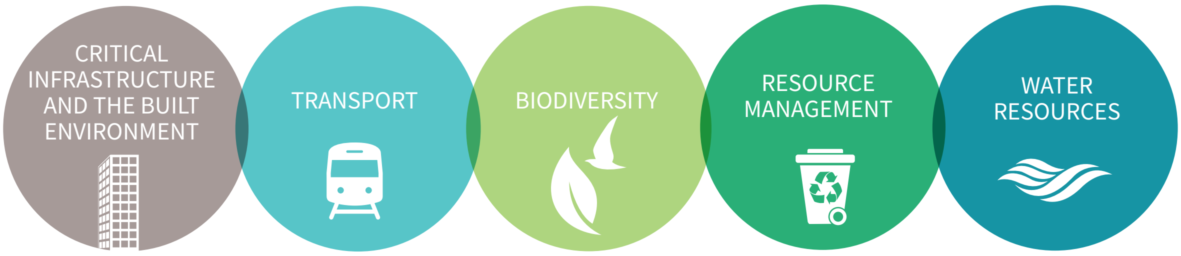


Table 2 Climate Variables Projection: 30 Year Overview

CLIMATIC EVENTS & TRENDS	PARAMETER	OBSERVED	CONFIDENCE	PROJECTED CHANGES
Extreme Weather Events	Cold Snaps	Increasing average air temperatures may result in a decrease in the frequency of cold snaps	Medium	Projections for 2050 indicate an increase in mean annual temperature, in the range of 1-1.6 °C. This will result in milder temperatures and a decrease in the frequency of cold snaps
	Heat Waves	Average air temperatures are increasing and may result in an increase in the frequency and intensity of heat waves	High	Eight heat waves have been recorded in Ireland over the last 30 years (more than 5 days at temperatures exceeding 25°C). Projections for 2050 predict a mean annual temperature increase of 1-1.6°C, which will intensify the temperature and duration of heat waves
	Dry Spells	Precipitation is becoming more seasonal and is likely to cause drier periods in the summertime	High	Ireland as a whole will experience drier summers, with a decrease of up to 20% in summer precipitation under a high emission scenario. This will result in longer periods without rainfall, which will affect water-sensitive regions and sectors
	Extreme Rainfall	The number of days with rainfall greater than 0.2 mm and 10 mm has gradually been increasing	Medium	The frequency of extreme rainfall is expected to keep on increasing over the years, especially in the autumn and winter seasons
	Wind Speeds	Wind speeds are increasing slightly in the winter periods and decreasing over the summer time	Low	Long term trends cannot be determined accurately; although it is anticipated that wind speed will change in a minor way, the frequency of wind storms is expected to increase in the winter periods and decrease in summer
Sea Level Rise	Sea Level Rise	Seas and oceans surrounding Ireland are rising and will keep doing so	High	Future projections indicate a sea level rise of an average of 3-4 mm per year worldwide, but a 6-7 mm rise per year in Dublin Bay was recorded between the years 2000 and 2016
	Wave Heights	Sea waves and wave height are determined by wind speed and direction. As wind speeds and wind storms become more frequent, wave heights also increase	Medium	Projected changes in wave heights remain uncertain. However, significant wave heights (the mean height of the highest 1/3 of waves) show an increasing trend of 14 cm per decade
	Tides	Increasing sea levels are resulting in record high tides (greater than 2.9 metres)	High	Sea levels will continue to rise and will result in increased levels of high tides
	Storm Surges	Surges can become more frequent as extreme weather events, such as intense rainfall and high wind speeds, become more frequent	Low	The frequency of intense cyclones and strong winds is expected to rise in the north-east Atlantic. By 2050, storm surge heights between 50 and 100 cm are likely to increase in frequency
Flooding	Coastal & Tidal	As both sea level rise and wave heights increase, the frequency of coastal and tidal flooding also increases	High	A rise in both sea levels and wave heights is projected to increase, which will lead to an increase in coastal flooding
	Fluvial	Increased rainfall intensity, high river flows and high tides contribute to an increase in fluvial flooding	High	Projections show both high tides and the intensity of rainfall days are increasing, which, in turn, will result in an increase in fluvial flooding
	Pluvial	Increased rainfall intensity will likely lead to an increase in pluvial flooding	Medium	It is predicted that the probability of flood events occurring will increase and the number of heavy rainfall days per year is also projected to increase, resulting in a greater risk of pluvial flooding. This is exacerbated by land use planning, including the covering up of permeable spaces, i.e. front gardens of residential properties
	Groundwater	High tides and the increase in intensity of rainfall are causing groundwater levels in tidal areas to flood more frequently	Medium	It has been projected that high tides will increase as sea levels rise, as will the intensity of rainfall. Both these factors will lead to an increase in groundwater flooding

To better understand the impact that future climate risks have on Dublin City, five impact areas were identified, which include all the different sectors in the City. These are:



These were chosen to mirror the action areas used throughout this Climate Change Action Plan (Energy and Buildings, Transport, Nature-Based Solutions, Resource Management and Flood Resilience), which reflect DCC's remit.

The influence of future risks on the impact areas was assessed through the use of risk matrices. Risk matrices calculate the overall future risk incurred by the different sectors in the City. The projected changes (Table 2) give an overview of the future risks that Dublin City is likely to face in the coming years. A future risk may be defined as a product of likelihood and consequence:

Future Risk = Consequence x Likelihood

The consequences of the future risks (the level of damage caused by a climatic event or trend) range from critical to negligible consequences:

The likelihood is the probability of these future risks occurring, and these range from almost certain, likely, possible, unlikely to rare:

Both the likelihood and consequences are given a range of ratings from one to five and the result of their product is the future risk, which can be either high (most urgent to address), medium or low risk:

Consequence	
Critical	5
Major	4
Moderate	3
Minor	2
Negligible	1

x

Likelihood	
Almost Certain	5
Likely	4
Possible	3
Unlikely	2
Rare	1

=

Future Risk	
High Risk	[15-25]
Medium Risk	[7-14]
Low Risk	[1-6]

Risk matrices for different climatic events and trends may be found in the risk section of Extreme Weather Events, Sea Level Rise and Flooding. A more in-depth analysis about risk matrices and the method by which they are calculated may be found in Appendix I. An additional in-depth analysis of these risks and their consequences on the delivery of the local authority's services and functions will be carried out. Future iterations of this Climate Change Action Plan will benefit from this assessment, and this information may be gathered through the facilitation of climate change risk workshops for the four Dublin Local Authorities.

EXTREME WEATHER EVENTS

Dublin City has experienced an increase in extreme weather events, and this is evident from the Timeline of Major Climatic Events (Figure 4). While we cannot attribute all these events to climate change, they are the most evident consequence of climate change.

Their effects are in the form of prolonged periods of extreme cold or heat, which cause snow and heat waves, hurricane gusts due to violent winds, and heavy rainfall resulting in flooding.

Globally, temperatures are increasing and are expected to continue increasing during summer, with extreme cold spells in the winter months. Meanwhile, average precipitation is expected to decrease during the summer and autumn period, with extreme rainfalls in the winter time. The frequency of extreme wind conditions, particularly during the winter, is also expected to increase.

BASELINE ASSESSMENT

Dublin City has experienced extreme weather events within the last 15 years; many of these are summarised in Table 1 earlier on in this chapter. In February and March 2018, Dublin City experienced its greatest snowfall since the winter of 1982, with depths of up to 55 cm. This was coupled with extreme cold and blizzard-like conditions, as a result of Storm Emma coming from the Atlantic, and the 'Beast from the East', which also impacted most of Europe. Met Éireann issued its first-ever Status Red warning for snow nationwide, which led to severe disruption to the City for a prolonged period. The continuous heavy snowfalls and deep snowdrifts resulted in the closure of all schools across the country, while many businesses in Dublin City were forced to close, and several homes and businesses experienced power outages. High demands were placed on the country's water network, with as many as 1.2 million households and businesses in and around the City affected by water outages or curtailments in the days after Storm Emma[15]. DCC's Corporate Services received a total of 1,875 calls between the 28th of February and the 3rd of March, which included calls related to emergency services, heating and homeless citizens. The Dublin Fire Brigade mobilised a total of 1,354 incidents during the same period.

Dublin's rainfall is also changing - in the last decade, the number of days with rainfall greater than 0.2 mm has been gradually increasing, as are days with over 10 mm of rain. This can be seen in Figure 5 below. Furthermore, data from Met Éireann shows that from 1961-2010, there was a 5% increase in average yearly rainfall[16,17].

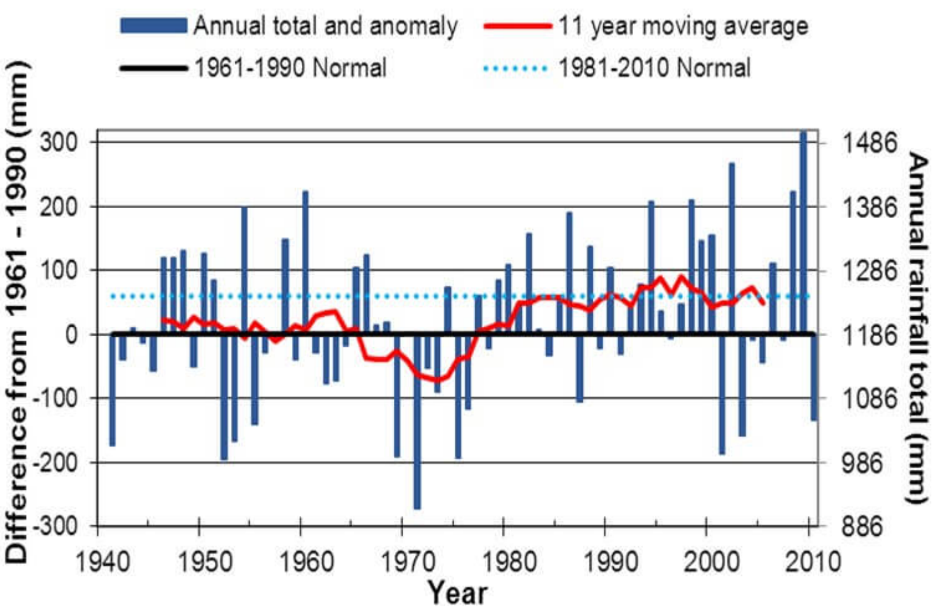


Figure 5 Annual Rainfall (1941-2010) (Source: EPA / Dwyer)

As seen in Figure 6 below, Met Éireann has already identified a 0.5°C increase in temperature, based on available data from 1961-2010, and these temperature rises are set to continue. Based on medium to low emission and high emission scenarios, *"Projections indicate an increase of 1–1.6°C in mean annual temperatures, with the largest increases seen in the east of the country."*[18] This will see new challenges for Dublin City in terms of the urban heat island effect and loss of biodiversity. In addition to surface temperature, sea temperature will also increase, having an adverse effect on the marine environment.

Wind is characterised by speed and direction, which allows us to measure the strength and frequency of weather systems as they move across Ireland. Consistent wind speed data is only available for the last 15-20 years, due to changes in measurement equipment and techniques, so long term trends cannot be determined accurately[19].

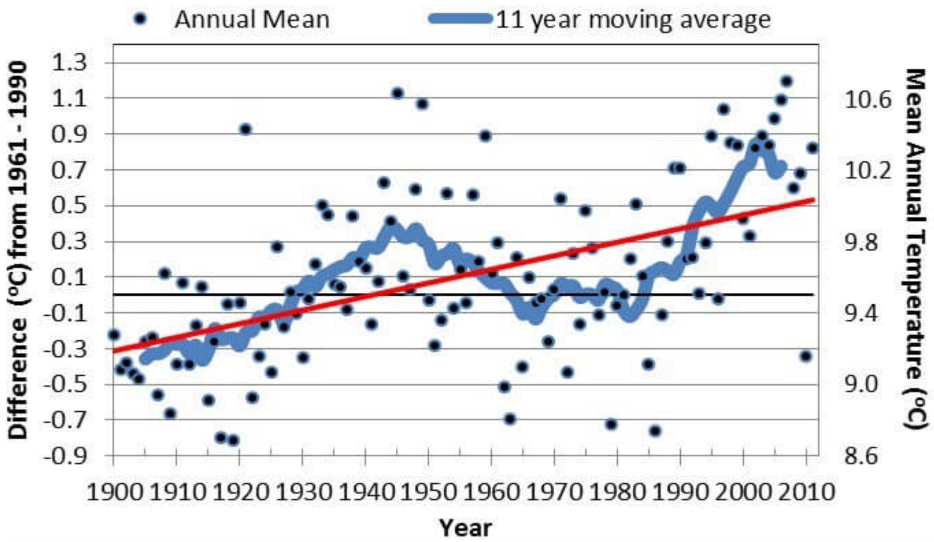


Figure 6 Mean Surface Air Temperature (1900-2011) (Source: EPA / Dwyer)

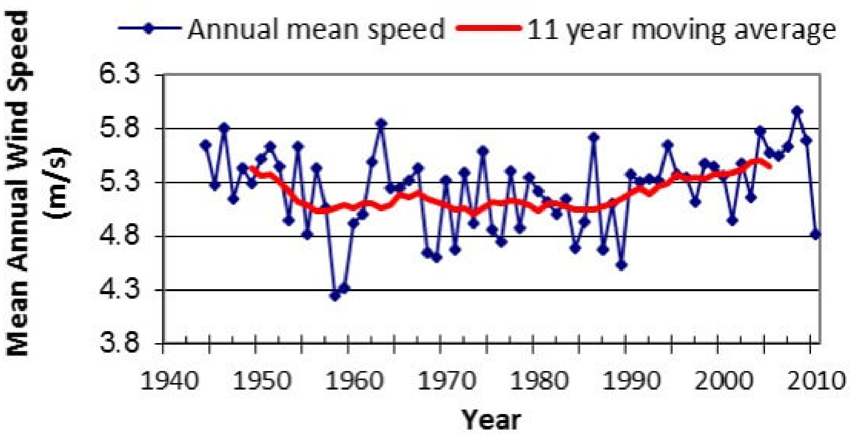


Figure 7 Dublin Airport Wind Trends (1944-2010) (Source: EPA / Dwyer)

EXTREME WEATHER RISKS

Dublin's extreme weather risks are very much linked to the characteristics of the City. Dublin City's temperatures are already increasing, as it experiences urban heat island effects due to its physical characteristics (e.g. prevalence of concrete buildings retaining heat) and a lack of cooling and shading from natural vegetation. Rising temperatures impact the City's air quality, which degrades as the concentration of pollutants increase. Recently, in the summer of 2018, Ireland experienced extreme temperatures, which caused heat wave and drought conditions, and resulted in a hosepipe ban for most of the summer, due to water shortages throughout the country.

URBAN HEAT ISLANDS
Urban heat islands occur as a result of the high thermal capacity of buildings. Research has shown that built-up urban areas retain heat for longer periods of time than rural areas; consequently, urban areas are often 5 to 10 degrees warmer than rural areas.

As shown in the Timeline of Major Climatic Events (Figure 4), the frequency of extreme cold spells in Ireland has increased, and this presents additional risks to Dublin City. During Storm Emma, prolonged periods of cold resulted in water pipes freezing and then bursting as the temperatures started to rise, which left homes in the City without water.

These extreme weather events pose significant risks to critical assets such as electricity infrastructure. Violent gusts of wind during Storm Ophelia caused damage to power networks, resulting in 385,000 homes and businesses being left without electricity across Ireland. Such strong winds also put the City at risk of coastal flooding, due to sea surges caused by both sea level rise and extreme weather. Due to the characteristics of Dublin City, prolonged heavy rainfall events typically result in urban flooding, which is mainly caused by a lack of pervious surfaces. Flooding also puts groundwater supplies at risk, as these can be contaminated due to the high infiltration of flood water.

FUTURE RISKS

Met Éireann predicts that Ireland as a whole will experience wetter and milder winters, with a 10-15% increase in rainfall, and drier summers[16,17]. *"Projections suggest average temperatures will continue to increase, with warming across all seasons. A warming climate may cause stresses to vulnerable populations, such as children and the elderly. This can also affect water quality and may cause pollutant contamination to surface water that may be attributed to a decrease in water flows during the warming summer and autumn months. Areas to the east are expected to see the strongest increase over the coming decades."*[17] Meanwhile, precipitation projections indicate an increase of up to 20% in heavy rainfalls during the winter and autumn seasons[17] .

Although no long-term wind speed trend can be accurately determined, it has been projected that extreme wind speeds will increase during the winter periods[17]. This would greatly affect critical infrastructure such as communication and transportation, which may be disrupted by the violent winds. Also, this increase in extreme wind events, coupled with sea level rise and coastal storms, may lead to increased wave heights and could result in habitat loss and damage, due to coastal and soil erosion.

EXTREME WEATHER ADAPTATION ACTIONS

The aim of compiling extreme weather adaptation actions is to reduce the effects of these events. Some of these adaptation actions are also addressed in other sections (Flooding and Sea Level Rise).

Some of the actions that have been adopted by Dublin City Council include:

- Communication at national and local level with the general public, promoting appropriate behaviour and actions to be taken to limit impacts during extreme weather events
- Emergency planning strategies, continually aligned with extreme weather events
- Monitoring and forecasting of extreme weather events, which include accurate and timely weather-related alerts, real-time time surveillance, evaluating and monitoring
- The use of nature-based solutions (such as green roofs and SuDs) to reduce the risk of flooding arising from extreme rainfall events
- Energy-efficient buildings to ensure preparedness to extreme temperatures. DCC has an ongoing Fabric Upgrade Programme to continuously improve the efficiency of its social housing stock. Furthermore, all new developments in Ireland have to be energy efficient, and must comply with nearly Zero Energy Building (nZEB) standards after 31st December 2020 and public sector bodies must be compliant by the 31st of December 2018 for all new buildings

RISK MATRIX

Table 3 Extreme Weather Events Risk Matrix

IMPACT AREAS	DESCRIPTION	PARAMETER	CONSEQUENCE	LIKELIHOOD	FUTURE RISK
Critical Infrastructure & the Built Environment	Projected increases in temperature, wind speeds, cold snaps and rainfall will put a stress on the built environment, particularly on critical infrastructure (such as electricity and communication networks) and residential developments (with the most vulnerable populations being particularly at risk)	Cold Snaps	4	3	**12**
		Heat Waves	2	4	**8**
		Dry Spells	3	5	**15**
		Extreme Rainfall	4	3	**12**
		Wind Speeds	5	2	**10**
Transport	Increases in wind speeds, cold snaps and rainfall will put a stress on transport networks, which may lead to disruption of transport services during extreme events	Cold Snaps	5	3	**15**
		Heat Waves	2	4	**8**
		Dry Spells	2	5	**10**
		Extreme Rainfall	3	3	**9**
		Wind Speeds	4	2	**8**
Biodiversity	Projected increases in temperature, wind speeds, cold snaps and rainfall will put an increased stress on biodiversity, by causing damage, habitat loss and increasing the prevalence of invasive species	Cold Snaps	5	3	**15**
		Heat Waves	4	4	**16**
		Dry Spells	4	5	**20**
		Extreme Rainfall	4	3	**12**
		Wind Speeds	3	2	**6**
Waste Management	Projected increases in temperature, heat waves and droughts may increase the risk of fires in landfill sites and can also increase the prevalence of vermin and odour	Cold Snaps	2	3	**6**
		Heat Waves	4	4	**16**
		Dry Spells	4	5	**20**
		Extreme Rainfall	5	3	**15**
		Wind Speeds	1	2	**2**
Water Resources	Projected increases in temperature, cold snaps and rainfall will affect flows and quality of water resources. Temperature increases and dry spells will result in a reduction of water resource availability, whilst cold snaps can cause disruption of water services	Cold Snaps	5	3	**15**
		Heat Waves	4	4	**16**
		Dry Spells	5	5	**25**
		Extreme Rainfall	5	3	**15**
		Wind Speeds	1	2	**2**

SEA LEVEL RISE

The rise in sea levels in Ireland is mainly due to climate change, and the seas and oceans surrounding our island are rising at approximately 35 mm per decade[20]. The main cause of sea level rise is an increase in temperatures; as these temperatures increase, our oceans absorb more of this heat and expand. As the oceans become warmer, glaciers and polar ice caps start to melt and cause sea levels to rise.

Coastal flooding is influenced by sea level rise, and since Dublin is a coastal City, rises in sea level and coastal tides would significantly impact the City and its infrastructure. Continual rise of sea levels and the increase in the frequency, magnitude and intensity of coastal storms will further exacerbate existing complications of flooding, coastal erosion and deposition.

Coastal and estuarine flooding are both very much affected by sea level rise. Changes in sea levels will cause the extent of estuaries to increase and thus result in the infiltration of tides further upstream in rivers. This would mean that areas along rivers that are already at risk of flooding will be at increased risk of sea level rise. Rising sea levels also provide a higher base for storm surges, which increases their intensity.

Approximately 20% of Ireland's coastline is eroding[20]. These coasts are particularly more susceptible to erosion, as they are typically made up of unconsolidated sediments, as is the case along the eastern coast (Dublin).

BASELINE ASSESSMENT

Following recent extreme flood events and predictions of sea level rise due to climate change, Dublin City Council carried out a review of the capacity of the existing coastal flood defences to provide protection for urban areas. As a coastal City, Dublin is facing rising sea levels. Mean Sea Level (MSL) is the average of all the high and low tides over the course of a year. Over the last 15 years, the Annual Average Sea Level (AASL) in the Dublin Region has been rising faster than initially projected (Figure 8).

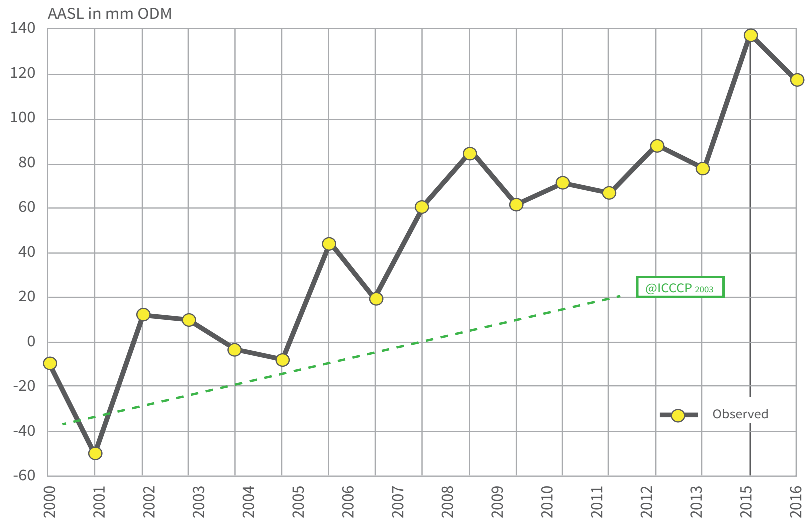


Figure 8 Dublin Annual Average Sea Level 2000-2016 (Source: DCC)

Data collected by DCC shows the AASL for the years 2014, 2015 and 2016 amounted to 78 mm, 138 mm and 114 mm Observed Difference in Mean (ODM), respectively. This compares to values in the period between 2000 and 2004, which were much closer to 0 mm ODM.

The highest tide ever recorded in Dublin City was on the 3rd of January 2014, reaching 3.014 metres at Malin Head. The second highest tide recorded was on the 1st of February 2002, at 2.950 metres at Malin Head. These were the highest tides recorded for the last 400 years, and possibly longer for Dublin Bay. To reduce vulnerability to sea level rise, a minimum safety of four metres above present sea level in the east coast of Ireland is recommended; this accounts for a rise in sea level of 0.5 metres, a storm surge of 2.95 metres, and a safety margin[21].

It is important to note that sea level rise, while an important phenomenon to understand for Dublin City, is only one element that contributes to flooding issues in the City. It is also important to understand the other elements which, when combined with rising sea levels, contribute to flooding. This includes combinations of extreme tide levels, which are made up of astronomic tides and storm surges (fluctuations in water level due to atmospheric pressure, wind speed, seiches, etc.) and wave action.

SEA LEVEL RISE RISKS

Risks associated with sea level rise can be categorised as economic, social and environmental. The risks associated with sea level rise in Dublin City include:

- **Coastal deposition and damage to existing defences** from increased wave heights at the coastline. This will greatly affect coastal habitats, with estuaries and wetlands particularly vulnerable
- **Changes in coastal morphology**, changes in sea level with an increase in intensity of coastal storms tend to exacerbate coastal erosion and deposition risk
- **Salt water intrusion of groundwater** with rising sea levels means that the risk of inundating groundwaters is even greater
- **Increased groundwater levels** in tidal regions, with more flooding of old basements
- **Risks to wastewater infrastructure** - sea level rise can result in overflows from combined drainage systems being unable to function, resulting in increased flood risk on land. Also, as wastewater treatment plants and sewage pumping stations are often located close to the coast, these facilities are at particular risk
- **Damage to critical infrastructure and housing** from coastal flooding and sea level rise. This results in economic and social risks to Dublin City, especially since housing and major infrastructure (roads, DART lines) are along the coast
- **Increased wave heights and high tides** producing damage further inland and upstream. This makes Dublin City especially vulnerable, as increased wave height and high tides can affects tidal rivers like the Liffey

Figure 9 Areas at Flood Risk in Dublin due to Predicted Future Sea Level Rise (Source: DCC - Leahy)

FUTURE RISKS

"In terms of relative land vulnerabilities, Dublin, Louth and Wexford are at highest risk. Under a projected sea level rise of 6m, it is estimated that close to 1,200 km² of land area would be at risk."[17] Future projections indicate continued sea level rise will be 3-4 mm per year globally[20], but 6-7 mm per year is the recorded average sea level rise in Dublin Bay for the period between 2000 and 2016. This, coupled with increased wave heights, tides and frequency of coastal storms, means that coastal communities will face increased economic, social and environmental vulnerabilities. At the same time, intense rainfall will also see fluvial influences in the tidal area downstream.

Figure 9 on the previous page shows the coastline in Dublin City that is at risk in yellow; this is an area of economic and environmental importance to the City, as it is home to a large part of Dublin's technology sector and the Dublin Bay UNESCO Biosphere (see case study on Page 88). An increase in temperature results in a rise in sea surface temperature, which results in the continual increase in sea level rise. A rise in sea levels also has a knock-on effect for other risks, as it increases the intensity of storm activity and wave action. Models comparing 1900-1961 data show that for the period between 2031-2060, storm surge heights of between 50-100 cm will increase in frequency[17]. This will make Dublin City very vulnerable, and would result in increased loss of land, damage to infrastructure and coastal flooding.

The amount of rainfall (specifically in the summer) is expected to decrease as a result of climate change, and Dublin City will become more reliant on groundwater to supply freshwater as a result.

RISK MATRIX

Table 4 Sea Level Rise Risk Matrix

IMPACT AREAS	DESCRIPTION	PARAMETER	CONSEQUENCE	LIKELIHOOD	FUTURE RISK
Critical Infrastructure & the Built Environment	Increases in sea levels and wave overtopping, along with increased occurrence of coastal storms, will put the built environment at risk. This will include housing and critical infrastructure, which are typically built along the coast	Sea Level Rise	5	5	**25**
		Wave Height	4	3	**12**
		Tides	4	4	**16**
		Storm Surges	4	2	**8**
Transport	Projected rises in sea level, wave heights and occurrence of coastal storms will put transport services (such as roads and the DART) that are along the coast and close to tidal rivers at increased risk	Sea Level Rise	4	5	**20**
		Wave Height	4	3	**12**
		Tides	3	4	**12**
		Storm Surges	4	2	**8**
Biodiversity	Rising sea levels, wave heights and occurrence of coastal storms will greatly affect coastal habitats, with estuaries and wetlands being particularly at risk	Sea Level Rise	4	5	**20**
		Wave Height	4	3	**12**
		Tides	3	4	**12**
		Storm Surges	4	2	**8**
Waste Management	Increases in sea levels and tides will put pressure on sanitation systems (these are typically situated at low levels) located close to the coast	Sea Level Rise	4	5	**20**
		Wave Height	4	3	**12**
		Tides	4	4	**16**
		Storm Surges	2	2	**4**
Water Resources	Rising sea levels, wave heights and tides put water supply and aquifers at risk. Therefore, sea level rise will need to be constantly managed to avoid flooding and salt water intrusion of groundwater, which may lead to a greater risk of inundating groundwaters	Sea Level Rise	4	5	**20**
		Wave Height	3	3	**9**
		Tides	4	4	**16**
		Storm Surges	3	2	**6**

SEA LEVEL RISE ADAPTATION ACTIONS

The priority of these actions is to reduce and address the current and future effects of sea level rise. Some of the solutions that have been adopted by Dublin City Council include:

- Approaches that reduce coastal flooding and erosion through the addition of artificial sediments, dune rehabilitation and restoration
- Grey solutions, which include infrastructure such as seawalls that protect nearby infrastructure from coastal flooding and sea level rise. Infrastructure for adaptation is designed to best available information and flood proofed through areas located above current and projected floor levels
- Restoration of wetland ecosystems along the coast, in order to provide natural protection against flooding and erosion
- Regulatory measures such as creating development and buffer zones, to ensure that no development takes place in areas subjected to coastal flooding

Some of these adaptation actions may be seen in Figure 10 below, which depicts the tidal flood extents and the areas that have been defended in the Dodder Catchment.

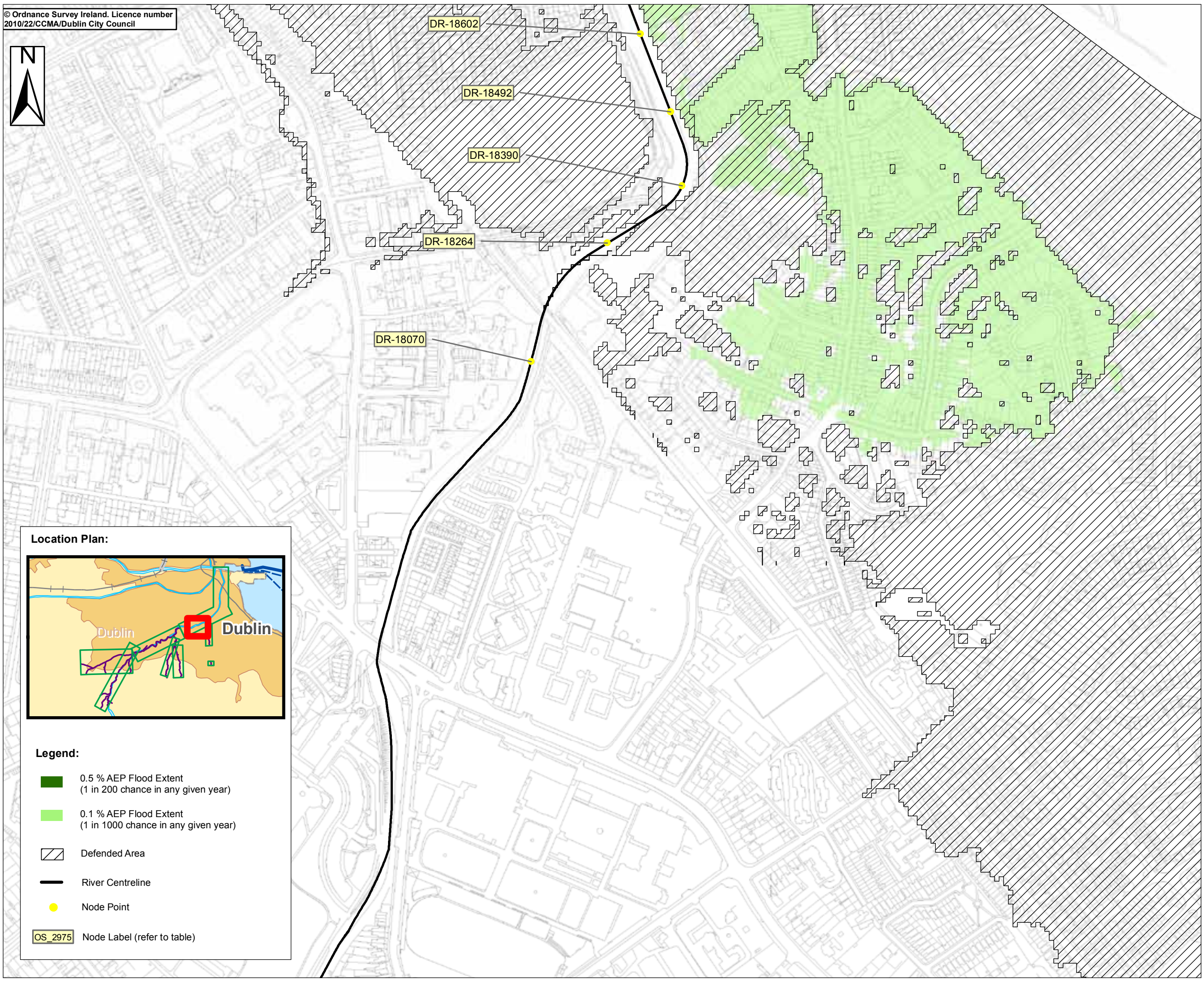


Figure 10 Dodder Tidal Flood Extents (Source: Adapted from RPS/OPW)

FLOODING

The effects of urbanisation and climate change both impact and increase the risk of flooding. This is the case for Dublin City, which is a coastal city and has a complex system of rivers, canals, surface-water sewers, foul sewers and urban watercourses.

Flooding can have multiple causes, including sea level rise, run-off water, heavy rainfall, extreme events, storms and tidal surges. Dublin City experiences several types of flooding, including:

- **Coastal and tidal flooding** resulting from storm surges, wave action causing flooding by overtopping flood defences, or other extreme weather events that cause sea levels to rise above the norm and force sea water onto land
- **Fluvial flooding** is caused by rainfall (extended or extreme), resulting in rivers exceeding their capacity
- **Network flooding** resulting from urban drainage systems being inundated with water and exceeding their capacity
- **Pluvial flooding** from intense and sudden rainfall running over-ground and exceeding capacity of local drainage systems is a key risk across the whole City
- **Groundwater flooding** results when groundwater rises up from an underlying water table and can flood surface and sub-surface infrastructure; occurs during sustained rainfall events and affects low-lying areas of the City
- **Flooding from dam** discharges or breaches

BASELINE ASSESSMENT

As outlined earlier in Table 1, there are very few records of significant flooding events between the years 1986 and 2000. More extreme weather events have been noted between the years 2000 and 2002, and from 2008 onwards, as can be seen from the Timeline of Major Climatic Events (Figure 4), their frequency increased at a significant rate.

It is important to note that flood risks may not be attributed to just one cause and could be due to multiple factors that result in major flooding. This is demonstrated in Figure 11, which shows the locations of the different flooding types that occurred in October 2011. The increased pressure on sewers and drainage systems caused multiple flooding of this critical infrastructure.

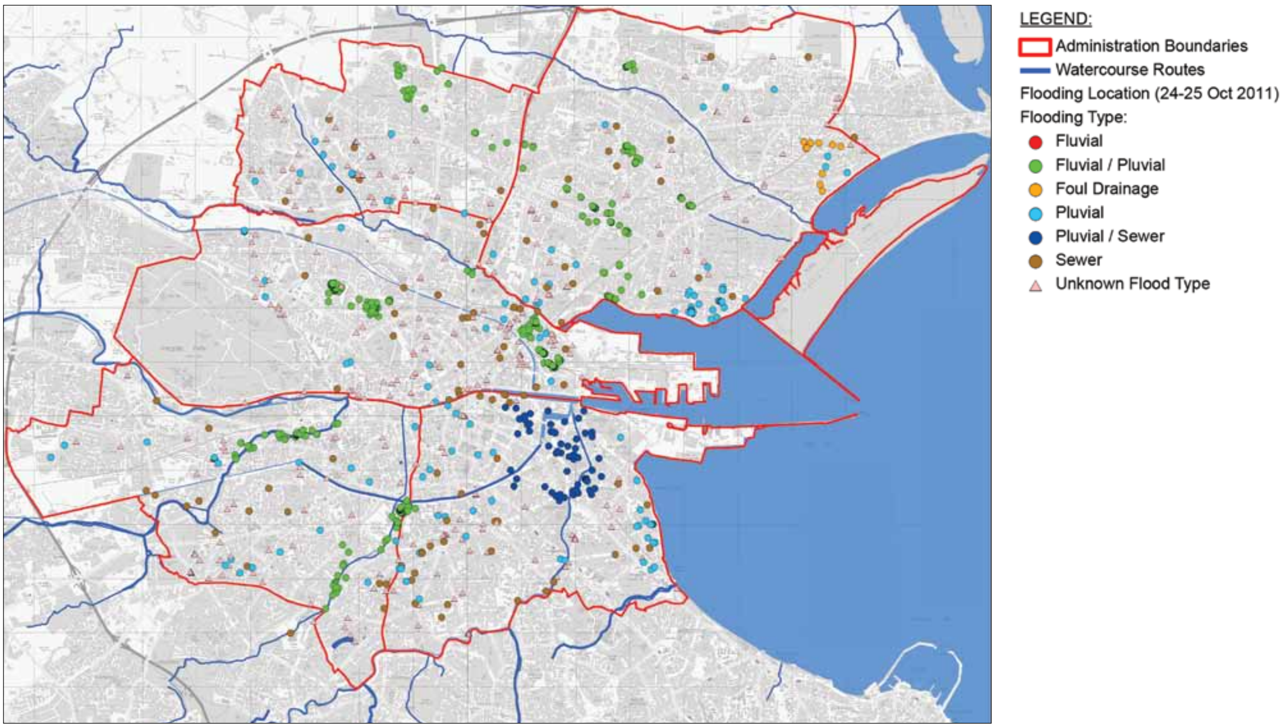


Figure 11 Identified Flood Type at Reported Flood Locations (Source: Adapted from OPW/ JACOBS)

FLOOD RISKS

Dublin City faces significant flood risks; in addition to being a coastal City, much of the City is built on reclaimed land at the mouth of the River Liffey, into which the River Poddle, River Dodder and River Camac flow, as shown in Figure 12 (rivers in red are at risk of flooding).

The extent of flood damage due to rivers may also be seen in Figure 13, which depicts the potential risk from the River Dodder. This shows how even just one river flooding would impact on a large population and would cause significant damage to the surrounding area.

Flooding risks are further complicated by riparian rights. Some property or land-owners who own land that is adjacent to a watercourse, or has a watercourse running through it, are riparian owners and have certain legal responsibilities to maintain the watercourse. Dublin City Council therefore works to inform residents and business owners of their riparian responsibilities.

Figure 12 Dublin City Rivers at Risk of Flooding (Source: EPA)

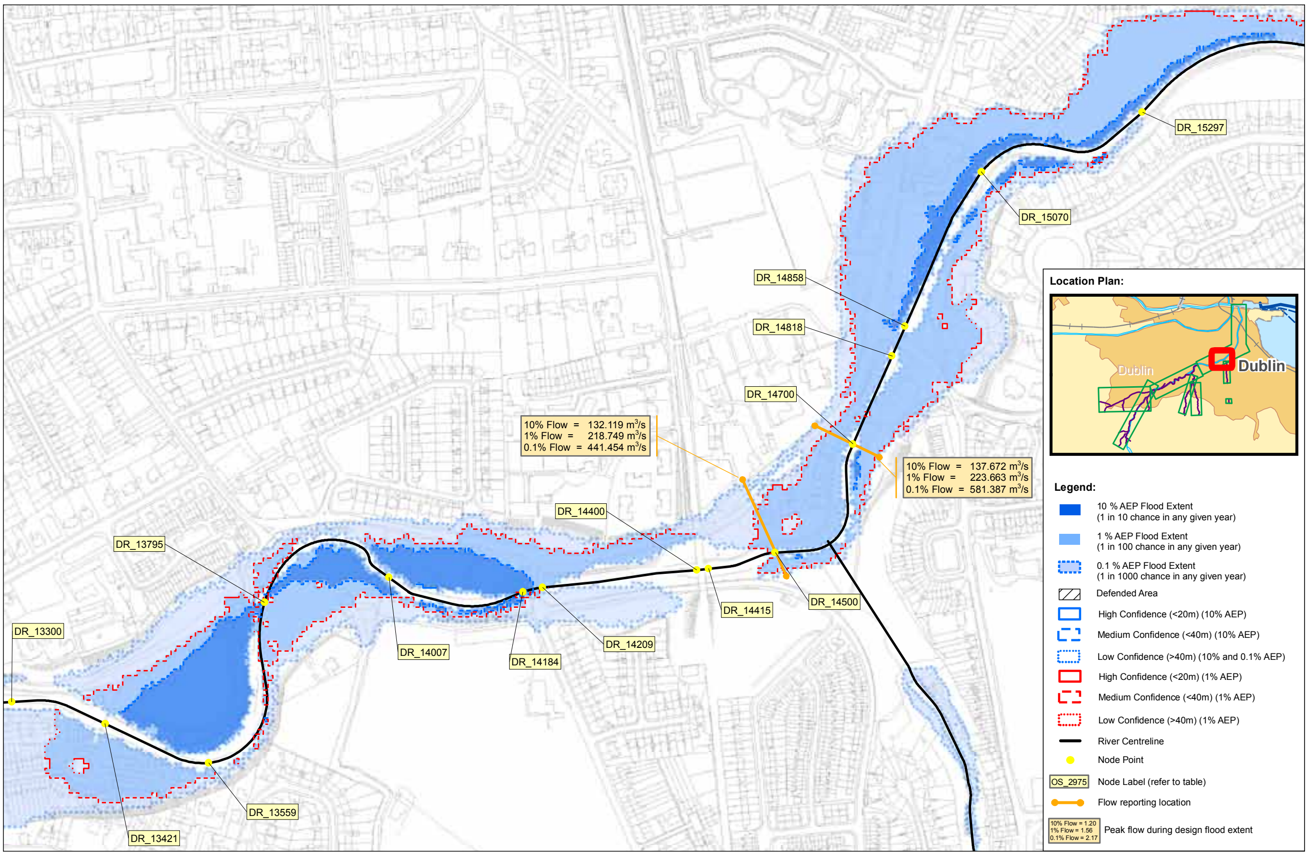


Figure 13 Dodder Flood Extents (Source: Adapted from OPW/RPS)

FUTURE RISKS

With climate change, it is predicted that the probability of flood events occurring will increase, e.g. a 1-in-100-year event may become a 1-in-25-year event instead. The number of heavy rainfall days per year is also projected to rise, resulting in a greater risk of both fluvial and pluvial flooding.

Figure 14 on the opposite page depicts a pluvial study carried out in Dublin City and the Annual Exceedance Probability (AEP) is used. This represents the probability of an event of this severity (or greater) occurring in any given year. The 1% AEP can be expressed as odds (e.g. 100 to 1) of the event occurring in any given year.

Future flood risks will be dependent on urban settlement patterns, land use and the quality of flood forecasting, warning and response systems in place. Dublin City is especially vulnerable to future risks, due to the projected population growth over the coming years. This increased risk of flooding will affect Dublin City's already vulnerable systems, in terms of increased pressure on water and sanitation systems, and damage to critical infrastructure and property.

RISK MATRIX

Table 5 Flooding Risk Matrix

IMPACT AREAS	DESCRIPTION	PARAMETER	CONSEQUENCE	LIKELIHOOD	FUTURE RISK
Critical Infrastructure & the Built Environment	Coastal, fluvial, pluvial and groundwater flooding will put additional stress and risk on the built environment. This additional risk will cause all areas in the built environment to suffer (businesses, residential, critical infrastructure, etc.)	Coastal & Tidal	5	5	**25**
		Fluvial	5	5	**25**
		Pluvial	4	4	**16**
		Groundwater	4	3	**12**
Transport	Increases in coastal, fluvial and pluvial flooding will cause road damage, which can lead to disruptions to all transport services	Coastal & Tidal	5	5	**25**
		Fluvial	5	5	**25**
		Pluvial	4	4	**16**
		Groundwater	4	3	**12**
Biodiversity	Flood events can cause loss of habitats and damage to ecosystems	Coastal & Tidal	4	5	**20**
		Fluvial	3	5	**15**
		Pluvial	2	4	**8**
		Groundwater	2	3	**6**
Waste Management	Flooding of landfill sites increases the risk of surface and groundwater contamination	Coastal & Tidal	4	5	**20**
		Fluvial	3	5	**15**
		Pluvial	4	4	**16**
		Groundwater	5	3	**15**
Water Resources	Increases in flooding incidents put more pressure on water systems, which are typically located at the lowest elevation possible and are therefore at a greater risk of flooding	Coastal & Tidal	5	5	**25**
		Fluvial	4	5	**20**
		Pluvial	4	4	**16**
		Groundwater	5	3	**15**

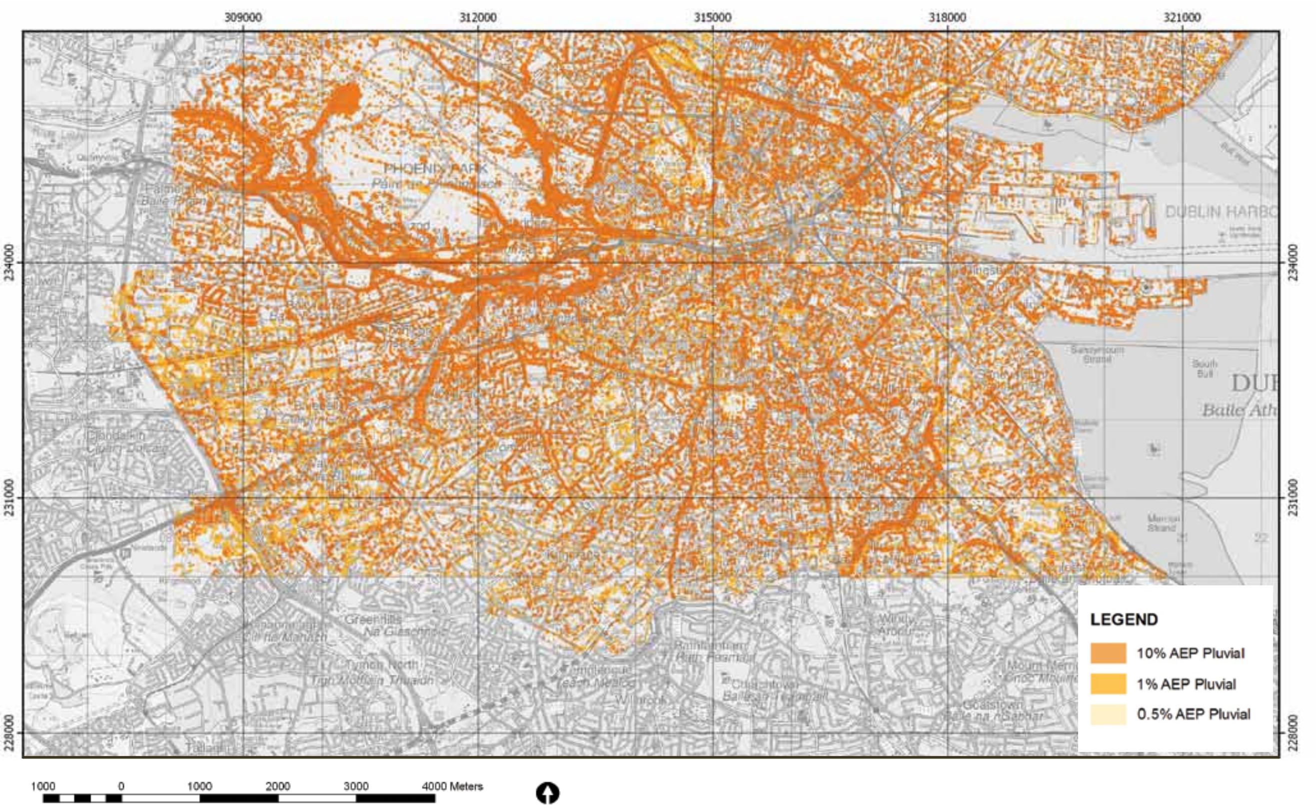


Figure 14 Dublin Pluvial Study (Source: Adapted from OPW / RPS)

FLOODING ADAPTATION ACTIONS

The purpose of flooding adaptation actions is to reduce the effect of flooding events, and they should tackle both current and future risks from flooding. The objectives of flood adaptation actions are:

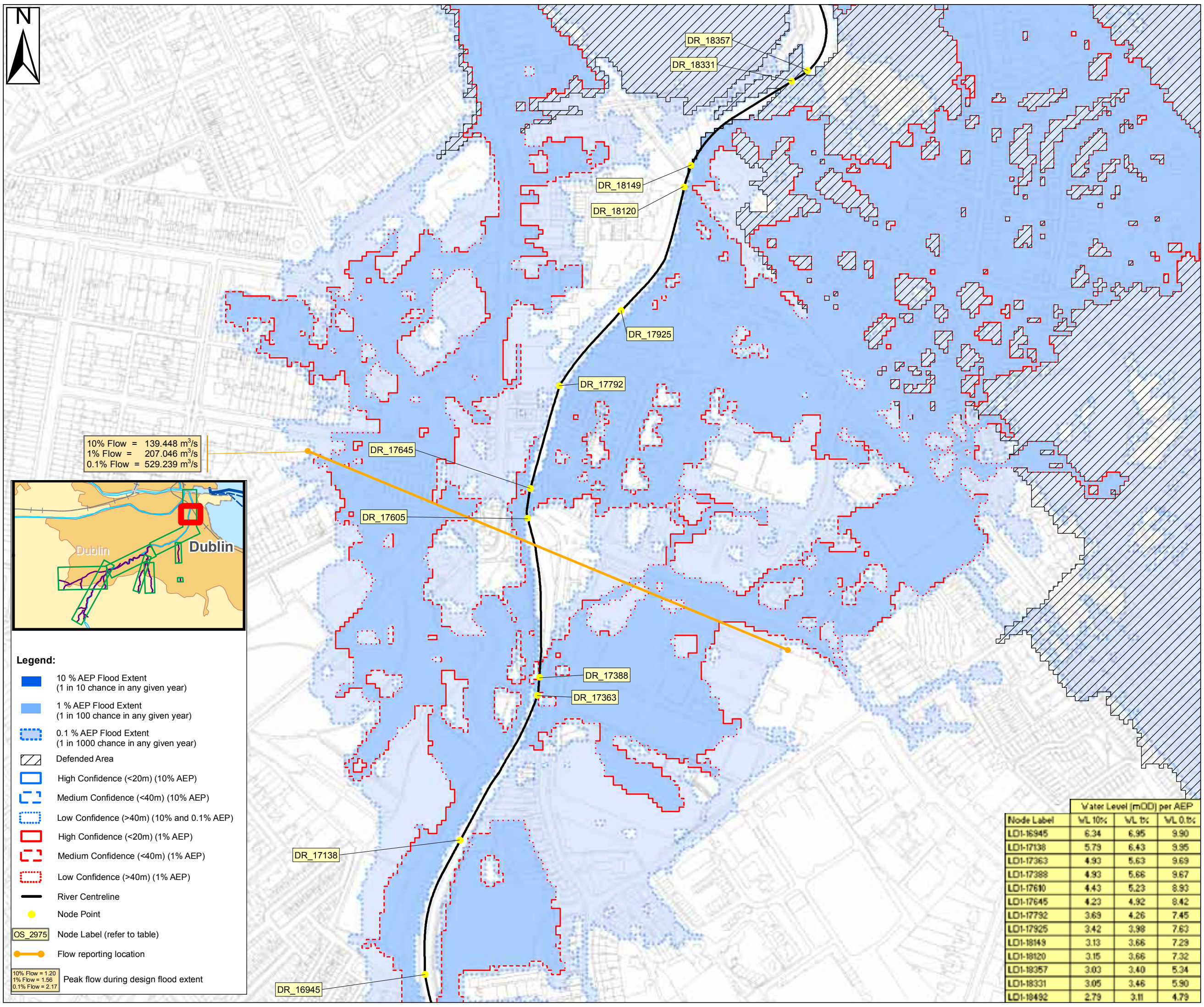
1. **Economic** – ensure that expenditure for flood risk management is based on risk
2. **Social** – reduce risk to life and health, while protecting key infrastructure and ensuring that there is no increased risk to other areas
3. **Environmental and heritage** – protect, and enhance if possible, biodiversity and cultural heritage

Dublin City has increased flood resilience through the use of spatial planning and infrastructural projects (which include nature-based solutions). Some of these adaptative measures include:

- **Community and business flood resilience measures** – such as coastal flood forecasting and monitoring systems to forecast coastal surges and local flood risk groups. This also includes engaging with local flood risk groups and individual retrofitting flood defence measures
- **Site specific measures** – this may involve using existing natural landscapes or existing infrastructure to reduce flooding
- **Generic measures** – such as Sustainable urban Drainage Systems (SuDS), which is mandatory for all new developments. If SuDS cannot be provided for at the site, then there must be an alternative means of reducing run-off. To reduce flood risks in new developments, the *Greater Dublin Strategic Drainage Study* states that no new development is permitted within 10-15 metres on either side of watercourses, planning applications must include a surcharge risk assessment and drainage systems must be isolated from basements
- **Flood management** - the use of *The Planning System and Flood Risk Management Guidelines* from the Office of Public Works (OPW), as a measure for flood management and adaptation. These guidelines are to be properly implemented and included in any development, planning and flood mitigation/adaptation measures
- **Flood resilient design** - provide for flood resilience in the early stage of the design process, including the use of Light Detection and Ranging (LIDAR) surveying methods

This is the case for the Dodder catchment area, where flood risk management measures are used to control and manage flood risk to urban and rural areas. This includes:

- Making use of existing defence structures, such as riparian boundary walls
- Operation of the lower Bohernabreena reservoir; this was used as additional storage during a major storm event to reduce flooding in the catchment area
- Raised property floor levels and limited development in the area
- SuDS
- Flood defence asset surveys as part of a Catchment Flood Risk Assessment and Management (CFRAM) study carried out on the Dodder (see Figure 15 on the next page)
- Tidewatch, which is a flood forecasting system
- Overland flow mapping through Light Detection and Ranging (LIDAR)
- Retrofitting flood defence measures such as flood doors, air vent covers, etc.



Node Label	Water Level (mOD) per AEP		
	WL 10%	WL 1%	WL 0.1%
LD1-16945	6.34	6.95	9.90
LD1-17138	5.79	6.43	9.95
LD1-17363	4.93	5.63	9.69
LD1-17388	4.93	5.66	9.67
LD1-17610	4.43	5.23	8.93
LD1-17645	4.23	4.92	8.42
LD1-17792	3.69	4.26	7.45
LD1-17925	3.42	3.98	7.63
LD1-18149	3.13	3.66	7.29
LD1-18120	3.15	3.66	7.32
LD1-18357	3.03	3.40	5.34
LD1-18331	3.05	3.46	5.90
LD1-18492	2.79	3.11	4.79

Figure 15 Location of the Surveyed Defended Areas (Source: Adapted from OPW / RPS)

AIR POLLUTION AND AIR QUALITY

Air quality is a measurement of the concentration of specific pollutants harmful to human health. Changes in climate, especially increases in temperature, will impact the concentration of pollutants in the air; as temperatures increase, so too will the concentration of pollutants. This is also the case with the changing strength and frequency of high wind speeds due to climate change, which may cause pollutant dispersion and could potentially affect a larger area and population.

Air quality policy focuses on the reduction of pollutants, both greenhouse gases (GHGs) and the more immediate, harmful particulates and dioxins. Reducing the concentration of GHGs (i.e. mitigation) means lessening or eliminating the use of carbon-based fuels and moving to renewable sources of energy and carbon absorption by vegetation[22,23,24].

BASELINE ASSESSMENT

Presently, the air quality in the Dublin Region is good, with levels of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), and particulate matter (PM_{10} and $PM_{2.5}$) all within acceptable levels of European Union (EU) guidance. New guidance from the World Health Organisation (WHO) concentrates on the health implications of air quality (even air quality that is within the acceptable levels) and how to mitigate against this. In order to ensure robust, localised mitigation for health issues, accurate data is needed on the air quality of a region. There are currently 13 active air quality monitoring stations located across Dublin; however, they do not monitor all GHGs and particulate matter at each station. In recognition of the need for more robust data, Dublin City Council is currently working with the EPA to collect data on air quality in the Dublin Region under the new national Ambient Air Quality Monitoring Programme (AAMP). The use of sensors to collect localised, accessible, real-time data will assist in the development of policy to address air quality and pollutants, such as the *National Clean Air Strategy*, which is to be released in 2019.

AIR POLLUTION AND AIR QUALITY RISKS

Air pollutants depend greatly on the climate and characteristics of the area. Dublin's emissions from the transport sector, construction industry and the burning of waste and emissions from industrial activities, all make the City vulnerable to pollutants.

Air pollution and air quality risks mainly relate to health and risks to ecosystems. Vulnerable citizens (children, pregnant women, the elderly and those of ill health) are the most likely to be at risk. The risk to health may include worsening respiratory issues and a reduction in lifespan. Meanwhile, ground level poor air quality may put food production (e.g. crops) at risk due to elevated ozone concentration. Excessive pollutants may result in acid rain from air pollution and eutrophication, which is caused by pollutants being distributed to plants and rivers from run-off water.

This is also exacerbated by prolonged increases in air temperatures. Air quality monitors on the national ambient air quality monitoring network detected elevated ozone concentrations during the summer 2018 heat wave, with increased levels of ground level air pollution.

FUTURE RISKS

Existing risks may be further exacerbated in the future, especially with a projected population growth. As the City's population grows, so does the need for transportation and transport networks, energy, waste disposal and housing. Any new technologies (biomass, etc.) introduced to tackle climate change will need to be assessed for impacts on air quality.

Emissions of air pollutants, particularly PM_{10} and NO_X (nitrogen oxide), from road traffic and residential solid fuel, burning of peat, coal and wood, remain the biggest threat to air quality in urban areas[25]. Even though the new standards for car emissions have resulted in cleaner fuels and reduced emissions, Ireland has still seen an increase in both the number of cars and their engine sizes. Also, there has been a shift to diesel engines in recent years, which are lower in CO_2 but are higher in particulate matter.

Dublin City has had an increase in construction and development over recent years, and construction is projected to grow with the increased demand for housing from a growing population. As construction and demolition in the City increases, so do airborne emissions and dust particles, which further aggravate health issues in the population.

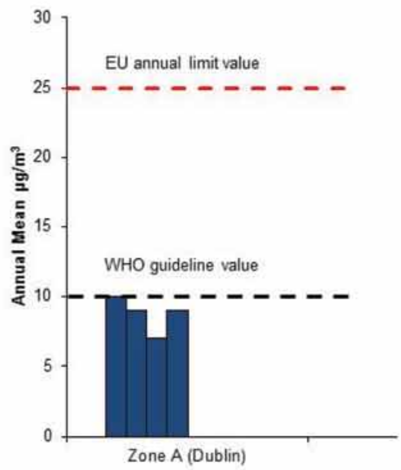


Figure 16 Annual Mean $PM_{2.5}$ (Fine Particulate Matter) Concentrations at Individual Stations in 2016 (Source: EPA)

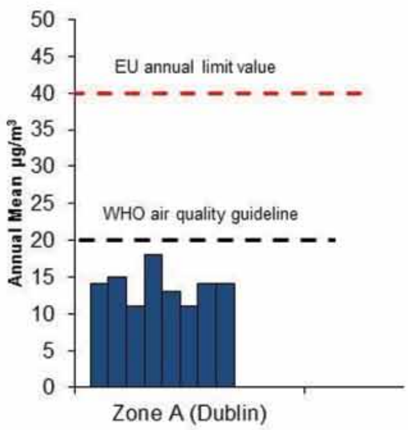


Figure 17 Annual Mean PM_{10} (Particulate Matter) Concentrations at Individual Stations in 2016 (Source: EPA)

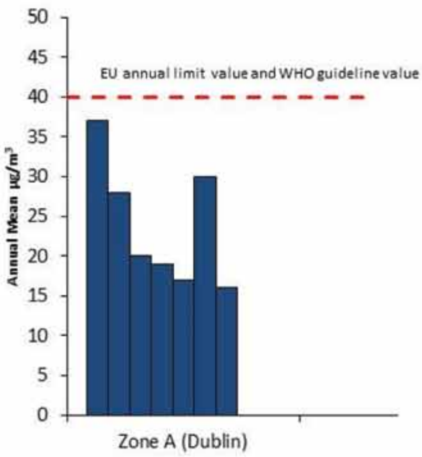


Figure 18 Annual mean NO_2 (Nitrogen Dioxide) Concentrations at Individual Monitoring Stations in 2016 (Source: EPA)

AIR POLLUTION AND AIR QUALITY ADAPTATION ACTIONS

Air pollution and air quality adaptation actions aim to reduce and monitor the effects from air pollution. This is done through policy and legislation to regulate pollutants generated from different energy sectors in Dublin City. The two sectors that impact most on air quality are home heating and transport. A shift from the burning of solid fuel to cleaner, more energy efficient methods of home heating and a move away from the use of private diesel and petrol powered motor cars to alternative modes of transport such as walking, cycling and electric vehicles will result in cleaner air and a healthier environment for citizens. This is especially important in our at-risk urban environments. To incentivise and complement these behavioural changes in the public, it is imperative that Ireland adopts policy solutions that can marry the twin issues of ambient air quality and climate change mitigation. The government's *National Clean Air Strategy*, which is due for publication, should point the way forward in terms of policy solutions for Ireland in this regard.

Actions adopted by Dublin City Council include:

- Effective enforcement controls - *The Air Pollution Act 1987* to regulate and monitor illegal burning, excessive emissions from industry and dust emissions from the construction industry
- Transport policies to reduce pollutants. This includes the provision of cycle routes, increased park and ride facilities, a restriction on heavy goods vehicles in the City Centre and the expansion of Quality Bus Corridors (QBCs)
- Control of development whilst giving preference to high density occupancy developments that are close to public transport routes and amenities
- Environmental Impact Assessment (EIA) and Statements required for large developments that apply for planning permission. EIAs should provide details of impacts that the development will have on air quality
- Reviewing and updating of emission inventories, urban air quality modelling and ambient air quality monitoring

EMERGENCY RESPONSE PLANNING

The adaptation baseline has shown that extreme weather events due to a changing climate are increasing in both frequency and intensity, and can pose a risk to citizens and infrastructure. This highlights the need for emergency planning, with plans that are continually updated in line with these extreme weather events. The Major Emergency Management (MEM) Framework sets out the working relationship between the various agencies that make up the front line emergency response. The MEM Framework defines a major emergency as:

"Any event which, usually with little or no warning, causes or threatens death or injury, serious disruption of essential services or damage to property, the environment or infrastructure beyond the normal capabilities of the principal emergency services in the area in which the event occurs, and requires the activation of specific additional procedures and the mobilisation of additional resources to ensure an effective, co-ordinated response"[26].

The MEM Framework enables Principal Response Agencies (PRAs), which are made up of An Garda Síochána, the Health Service Executive and local authorities, to prepare and make a coordinated response to major emergencies. Small-scale events are dealt with by Principal Emergency Services (PES), which include An Garda Síochána, the Ambulance Service, the Fire Service and the Irish Coast Guard. Defence Forces, voluntary emergency services, transport companies and affected communities can support PRAs by managing major emergencies.

Figure 19 below shows the national, regional and local structures that have been set up to support the development of the Framework.

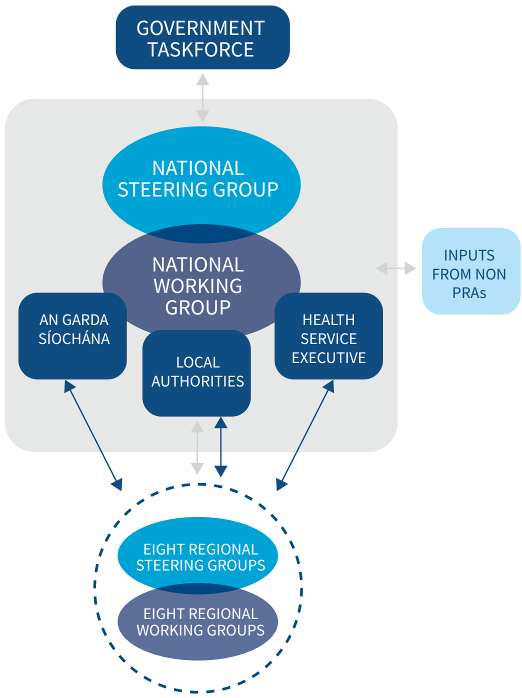


Figure 19 Structures for Implementation (Source: Major Emergency Management Framework)

EMERGENCY RESPONSE AT A LOCAL AND REGIONAL LEVEL

Dublin City Council is part of the Major Emergency East Region, and is a Principal Response Agency (PRA). The Dublin Fire Brigade is DCC's Principal Emergency Service (PES) and the Council administers the Dublin Fire Brigade on behalf of Dún Laoghaire-Rathdown County Council, Fingal County Council and South Dublin County Council. The *Dublin City Council Major Emergency Plan 2015*[27] includes an ongoing emergency programme that involves hazard analysis and risk assessment, response planning, recovery planning and involvement in inter-agency training, exercises and regional forums.

Each Council department undertakes an appraisal of their current procedures and operational plans to ensure compatibility with the major emergency planning documents.

When a major emergency is declared, senior management within the local authority, An Garda Síochána and the Health Service Executive establish a local coordinating group. Key roles in this group include a controller of operations, an on-site coordinator and DCC's Crisis Management Team (CMT).

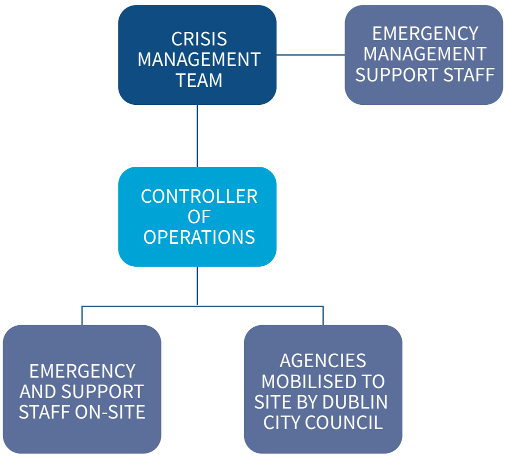


Figure 20 Local Authority Control of Resources (Source: DCC Major Emergency Plan 2015)

The CMT is a strategic level management team within DCC and reports directly to the Chief Executive. The CMT is assembled during a major emergency, and is responsible for the following:

- Manage, control and coordinate DCC's overall response to the major emergency
- Provide support to DCC's Controller of Operations on site and gain resources from DCC or externally
- Liaise with relevant government departments on strategic issues
- Ensure participation of DCC in the inter-agency coordination structures

EMERGENCY RESPONSE SERVICES & RESOURCES

The Dublin Fire Brigade provides the primary response to emergencies in the City. DCC supports this response by providing, amongst others, the following functions:

- Coordinating the delivery of services from all Council departments
- Making buildings such as leisure and community centres available to people displaced by the emergency
- Providing a volunteer Civil Defence organisation
- Providing advice and assistance with clean up after major flooding or pollution
- Assessing structural damage to buildings
- Coordinating and leading multi-agency meetings to plan community recovery

The Dublin Fire Brigade coordinates meetings, activities, training and support for the DCC Crisis Management Team, including carrying out a review of the Major Emergency Plan and Severe Weather Plans.

SUB-PLANS FOR RESPONDING TO SEVERE WEATHER & FLOOD EMERGENCIES

Severe Weather Plans are a sub-plan of the Emergency Plan, and can be activated in preparation, response to or recovery of a major emergency. Severe weather emergencies may pose significant threats to the areas within the local authorities' boundary, so therefore they are the lead agency for coordinating the response to severe weather events in their area. Met Éireann issues public service severe weather warnings to DCC, with the target time for issuing a warning being 24 hours before the start of the event, or up to 48 hours in advance when confidence is high.

DCC's Drainage and Wastewater Services Division has set measures to receive and respond promptly to public service severe weather warnings issued by Met Éireann, and has its own coastal flooding forecasting and monitoring systems to forecast coastal surges.