

Flood Risk Management Strategy

North East Local Plan District

This section provides supplementary information on the characteristics and impacts of river, coastal and surface water flooding. Future impacts due to climate change, the potential for natural flood management and links to river basin management are also described within these chapters.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

Section 3: Supporting information

3.1	Introduction	277
3.2	River flooding	278
	• Deveron catchment group	279
	• Ythan catchment group	287
	• Don catchment group	293
	• Dee catchment group	301
3.3	Coastal flooding.....	309
	• Inverbervie to Girdle Ness coastal area.....	310
	• Girdle Ness to Cairnbulg Point coastal area	316
	• Cairnbulg Point to Portgordon coastal area	322
3.4	Surface water flooding.....	329

3.1 Introduction

In the North East Local Plan District, river flooding is reported across four distinct river catchments. Coastal flooding is reported over three distinct coastal areas and surface water flooding is reported across the whole Local Plan District.

A summary of the number of properties and Annual Average Damages from river, coastal and surface water flooding is outlined in Table 1.

	Total number of properties at risk ¹	Annual Average Damages	Local authorities
River catchments			
Deveron catchment group	360	£1.3 million	Aberdeenshire Council The Moray Council
Ythan catchment group	330	£2.9 million	Aberdeenshire Council Aberdeen City Council
Don catchment group	3,100	£5.9 million	Aberdeenshire Council Aberdeen City Council
Dee catchment group	10,000	£13.5 million	Aberdeenshire Council Aberdeen City Council
Coastal flooding			
Inverbervie to Girdle Ness coastal area	70	£40,000	Aberdeenshire Council Aberdeen City Council
Girdle Ness to Cairnbulg Point coastal area	20	£160,000	Aberdeenshire Council Aberdeen City Council
Cairnbulg Point to Portgordon coastal area	30	£66,000	Aberdeenshire Council The Moray Council
Surface water flooding			
North East Local Plan District	4,100	£5.2 million	Aberdeenshire Council Aberdeen City Council The Moray Council

Table 1: Summary of flood risk from various sources within the North East Local Plan District

¹ Total number of residential and non-residential properties at risk of flooding.

3.2 River flooding

North East Local Plan District

This chapter provides supplementary information on river flooding at the catchment level. It provides an overview of the catchment's natural characteristics, flood risk and the existing actions to manage flooding. It outlines the likely impact of climate change and the potential for natural flood management.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

In the North East Local Plan District, river flooding is reported across four river catchment groups (Figure 1).

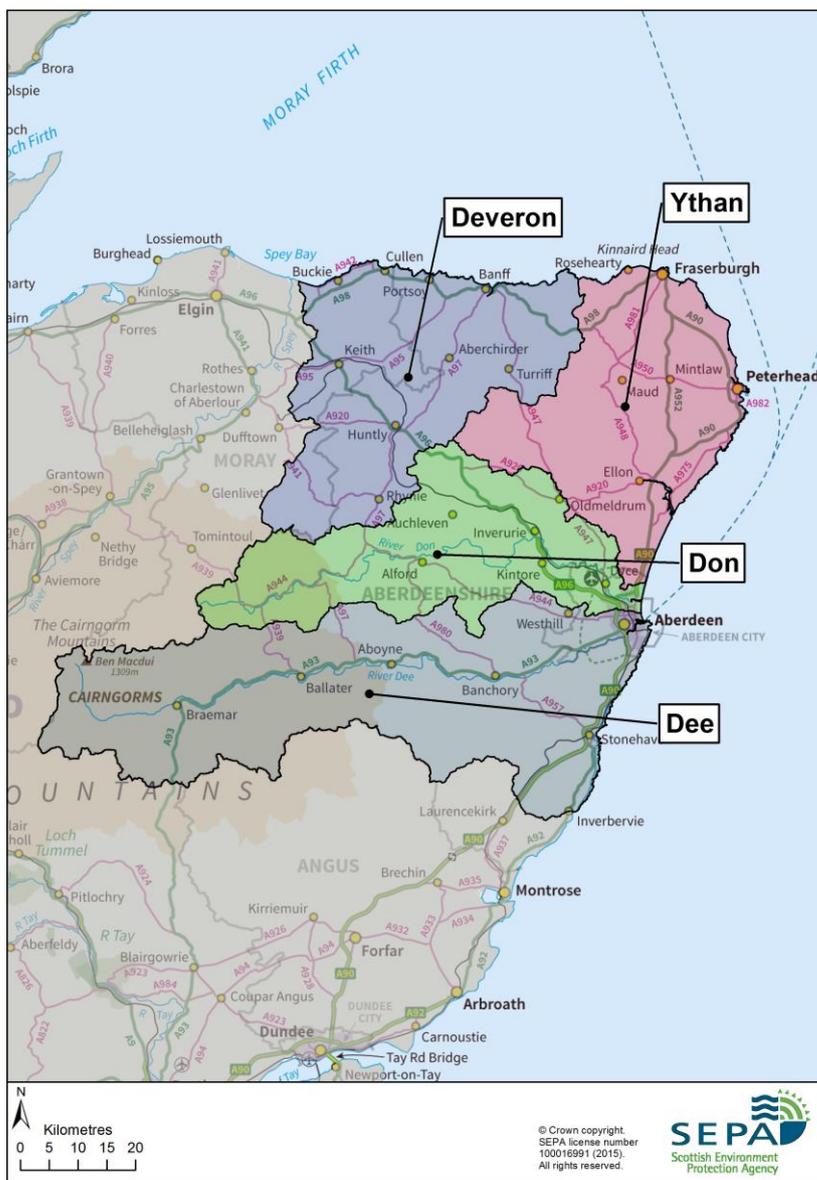


Figure 1: River catchment groups in the North East Local Plan District

River flooding Deveron catchment group

Catchment overview

The Deveron river catchment group covers an area in the north west of the Local Plan District from Buckie along the coast to Pennan, and south to Rhynie. It has an area of approximately 1,600km² (Figure 1). The largest river is the River Deveron. Tributaries of the Deveron include the Burn of Turriff, River Isla and River Bogie with their confluences close to the towns of Turriff, Keith, and Huntly respectively. In the north and west of the area, smaller watercourses including Burn of Boyne, Burn of Buckie and Burn of Durn flow north straight out to the coast.

The predominant land covers are arable, horticulture and improved grassland, which together cover 55% of the area. Heather and heather grassland in the south west of the catchment and coniferous woodland are also important. The area has a highly variable annual rainfall of between 400mm and 1200mm with the wettest areas being inland.

The catchment contains seven Potentially Vulnerable Areas:

- Portgordon (06/01)
- Portsoy (06/02)
- Banff (06/03)
- Macduff (06/04)
- Newmill (06/06)
- Turriff (06/07)
- Huntly (06/10).

Flood risk in the catchment

There are approximately 220 residential properties and 140 non-residential properties at risk of river flooding. Around 46% of the residential and 32% of the non-residential properties at risk are located within the Potentially Vulnerable Areas.

Main areas at risk

The main areas that have greater than 20 residential properties at risk of river flooding are shown in Table 1.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Huntly	80	£370,000
Banff and Macduff	60	£220,000

Table 1: Main areas at risk of river flooding

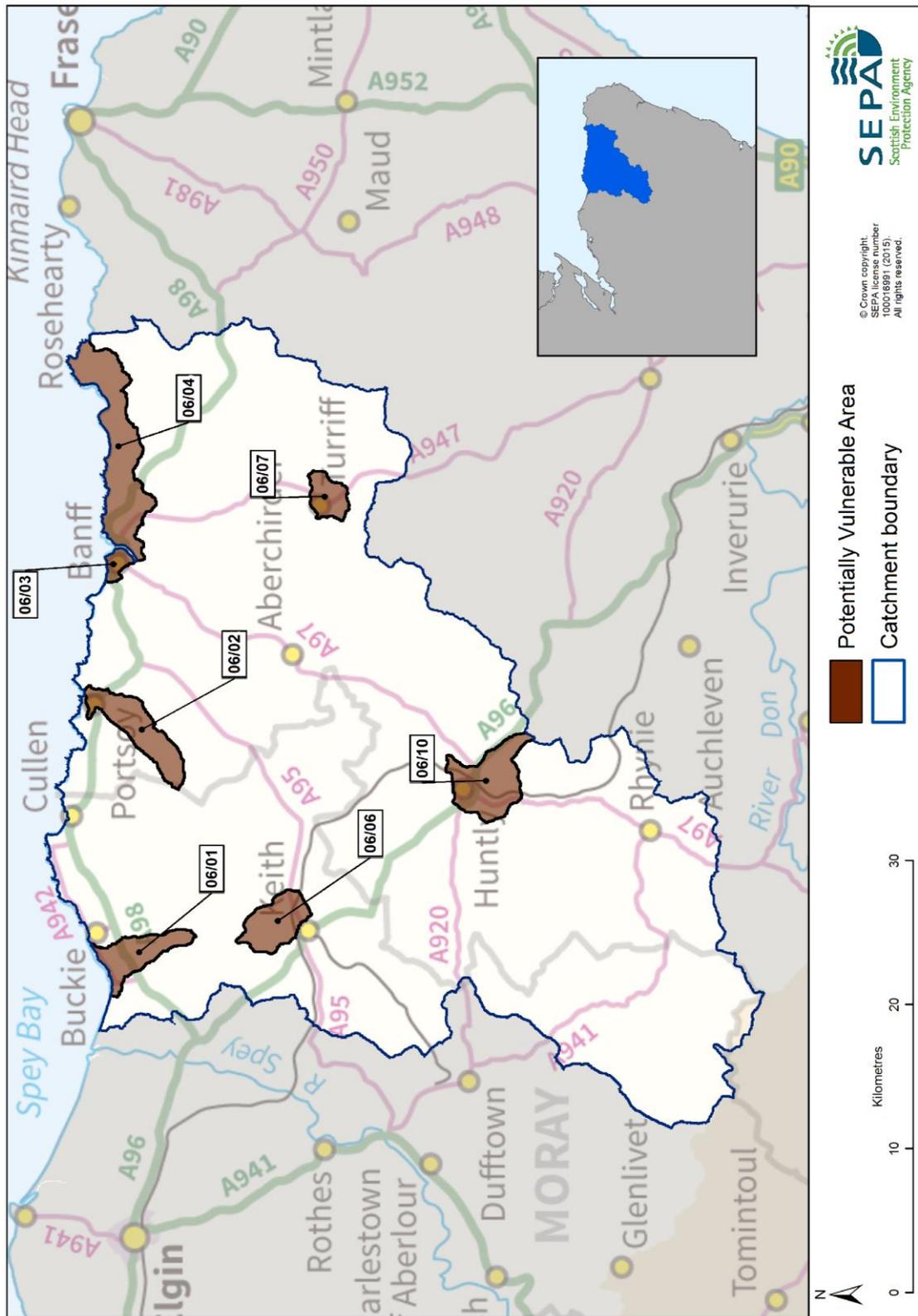


Figure 1: Deveron river catchment group and Potentially Vulnerable Areas

Economic activity and infrastructure at risk

The Annual Average Damages from river flooding in the Deveron catchment area are estimated to be £1.3 million. This accounts for around 5% of the total Annual Average Damages for the North East Local Plan District. The damages are distributed as follows:

- 49% non-residential properties (£660,000)
- 28% residential properties (£380,000)
- 7% emergency services (£90,000)
- 7% roads (£89,000)
- 6% agriculture (£84,000)
- 3% vehicles (£35,000).

Figure 2 shows the location of Annual Average Damages from river flooding across the area. The areas of highest damage are in Banff and Huntly.

Table 2 shows the approximate numbers of further infrastructure assets which are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	<10	Healthcare facilities.
Utility assets	<10	Fuel extraction sites.
Roads (excluding minor roads)	390 locations	Notably the A96, A97 and A98
Railway routes	50 locations	Inverness to Aberdeen
Agricultural land (km ²)	38	n/a

Table 2: Infrastructure at risk of river flooding

Designated environmental and cultural heritage sites at risk

There are approximately 30 designated cultural heritage sites at risk of river flooding. These sites include scheduled monuments, gardens and designed landscapes and listed buildings.

Less than 1km² of designated environmental area is at risk of river flooding, including Special Areas of Conservation and Sites of Special Scientific Interest.

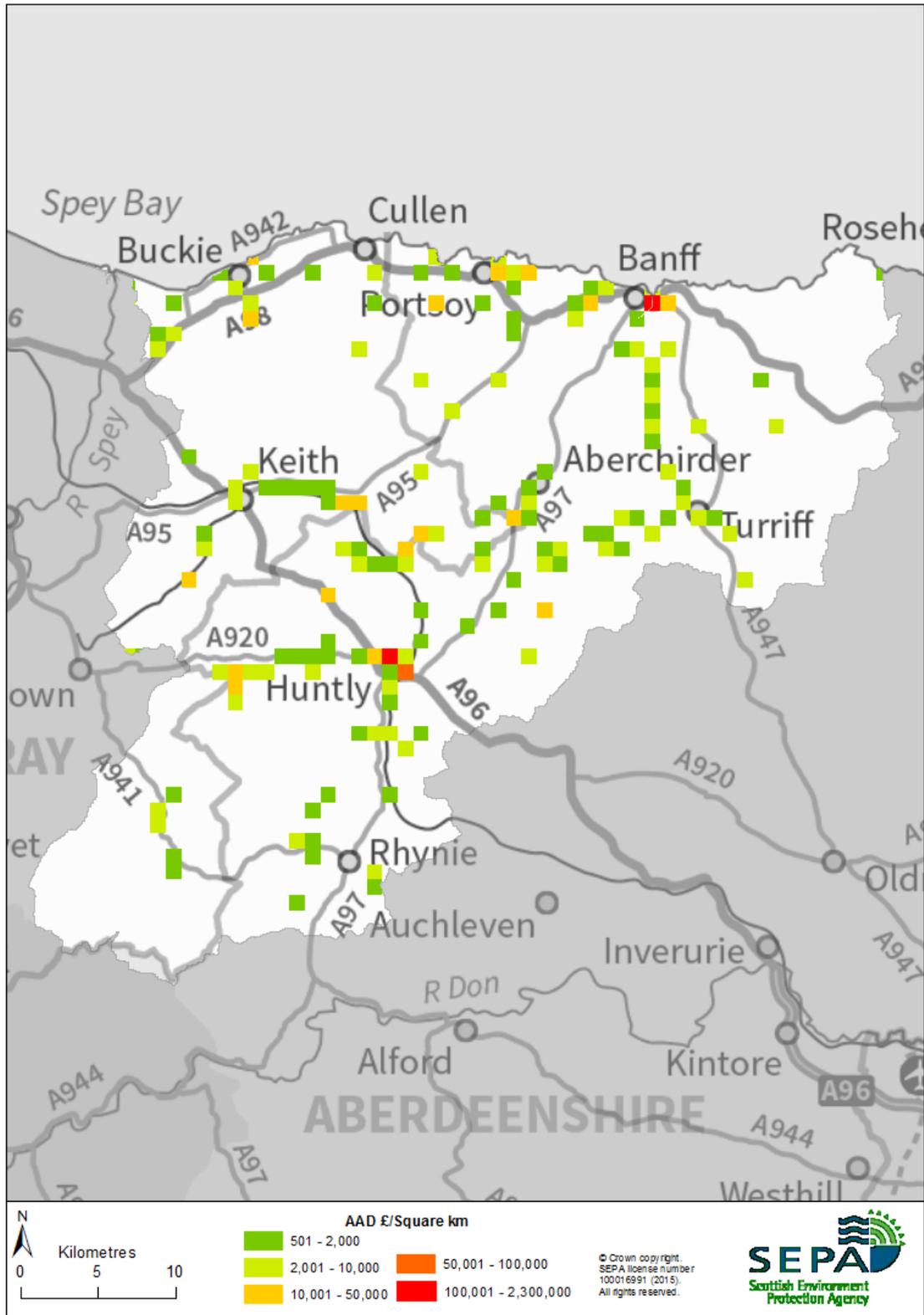


Figure 2: Annual Average Damages from river flooding

History of flooding

During 2009 there was a significant river flood from the Meadow Burn in Huntly that caused a nursing home to be evacuated. Floods have also been recorded from the River Deveron, River Bogie, Turriff Burn and the Soy Burn in Portsoy.

There have been no recent river flooding issues within Banff out with the golf course area. This is believed to be due to the road embankment acting as a flood defence, holding water away from the town. This would significantly reduce the likelihood of river flooding to Banff and the estimated number of properties reported above to be at risk of flooding.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

River flood warning schemes

There are five flood warning areas for river flooding in the Deveron group river catchment, which are listed in Table 2. These are the areas where SEPA has detailed models set up to predict flooding on specific rivers. There are flood warning areas on the River Deveron and Burn of Turriff at Turriff, the River Deveron and River Bogie at Huntly, the River Isla at Keith, and the River Deveron at Banff (Figure 3).

Flood warning area	Residential properties within flood warning area	% of properties registered (January 2014)
Banff	329	15%
Huntly (Bogie)	13	38%
Keith	34	32%
Millton and The Meadows	68	100%
Turriff	11	27%

Table 2: Flood warning areas



Figure 3: Flood warning areas

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- The Moray Council does not provide flood guards to private property owners. However, the flood team provides advice on how property owners can protect their own property.

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Deveron catchment catchment may increase by 24%¹. This would potentially increase in the number of residential properties at risk of river flooding from approximately 220 to 310 and the number of non-residential properties from 140 to 170.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Runoff reduction

The areas of potential for runoff reduction in the Deveron catchment group tend to be small and scattered, with the only significant continuous area of potential in the south west of the catchment. There is very little potential of runoff reduction either within or immediately upstream of any of the Potentially Vulnerable Areas within the catchment, with the exception of Portsoy (06/02). Therefore, it is unlikely that runoff reduction measures would have any significant impact on flood risk within the majority of the Potentially Vulnerable Areas.

¹ From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

Floodplain storage

The most significant continuous areas of potential for floodplain storage are along the valleys of the River Deveron, River Bogie and River Isla. All of the Potentially Vulnerable Areas in the North East Local Plan District show potential for floodplain storage, particularly Banff (06/03), Keith (06/06), Turriff (06/07), and Huntly (06/10).

Sediment management

The majority of the river systems have substantial reaches that are either in approximate balance or moderately eroding. However, there are also significant lengths of river that are predominantly highly eroding or depositing, which can contribute to flood risk. The Potentially Vulnerable Areas showing the largest amount of erosion or deposition are Portsoy (06/02), Keith (06/06), and Huntly (06/10).

River flooding Ythan catchment group

Catchment overview

The Ythan river catchment group (Figure 1) covers the north eastern corner of the Local Plan District, from north of Aberdeen to west of Rosehearty. It has an area of approximately 1,400km². The largest rivers are the River Ugie and the River Ythan, which flow south-eastwards to the coast at Peterhead and Newburgh respectively. The River Ugie drains the central area, whilst the River Ythan drains the southern area to the west of Ellon. There are also numerous smaller watercourses that drain the area and flow straight out to the coast.

The predominant land covers are arable and horticulture, and improved grassland, which together cover 78% of the area. Annual rainfall is between 400-900mm with the wettest areas being inland.

The catchment contains four Potentially Vulnerable Areas as follows:

- Fraserburgh and Rosehearty (06/05)
- Peterhead (06/08)
- Methlick (06/09)
- Ellon (06/12).

Flood risk in the catchment

There are an estimated 230 residential properties and 100 non-residential properties at risk of river flooding. Approximately 36% of residential and non-residential properties at risk are located within the Potentially Vulnerable Areas

Main areas at risk

The only urban area that has greater than 20 residential properties at risk of river flooding is Ellon (Table 1).

Location	Residential and non-residential properties at risk of flooding	Annual Average Damages
Ellon	80	£220,000

Table 1: Main areas at risk of river flooding

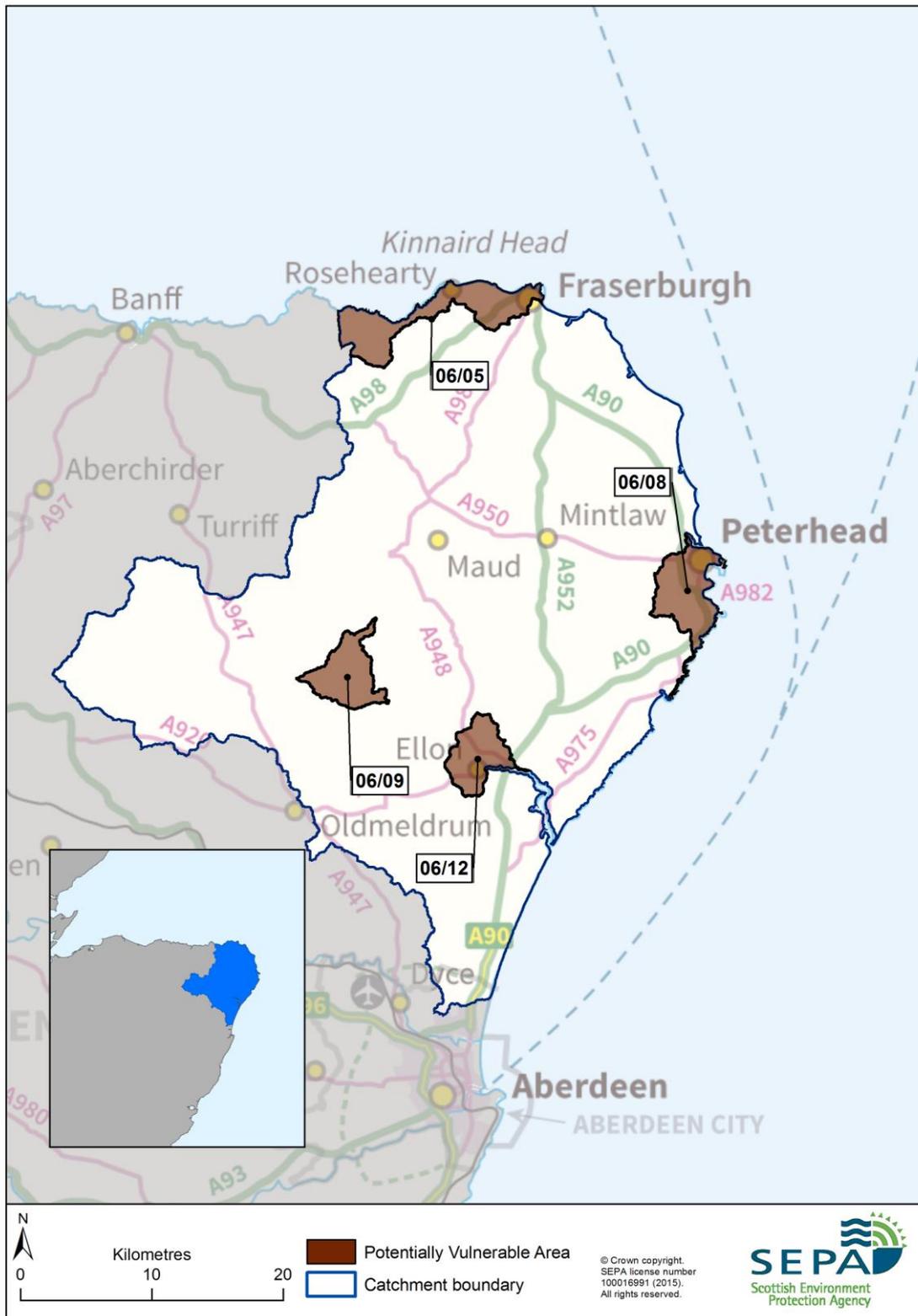


Figure 1: Ythan river catchment group and Potentially Vulnerable Areas

Economic activity and infrastructure at risk

The Annual Average Damages from river flooding in the River Ythan catchment area are estimated to be £2.9 million. This accounts for 10% of the total for the Local Plan District. The damages are distributed as follows:

- 65% non-residential properties (£1.9 million)
- 23% residential properties (£670,000)
- 6% emergency services (£180,000)
- 3% agriculture (£93,000)
- 2% roads (£62,000)
- 1% vehicles (£25,000).

Figure 2 shows the location of Annual Average Damages from river flooding. The areas of highest damage are in Ellon and Peterhead.

Table 2 shows the approximate numbers of further infrastructure assets that are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	0	n/a
Utility assets	10	Includes; electricity substations and fuel/mineral extraction sites
Roads (excluding minor roads)	400 locations	Notably the A90 and A920
Railway routes	n/a	n/a
Agricultural land (km ²)	37	n/a

Table 2: Infrastructure at risk of river flooding

Designated environmental and cultural heritage sites at risk

There are 20 cultural heritage sites, including scheduled monuments, listed buildings and gardens and designed landscapes, at risk of river flooding.

Approximately 10km² of designated environmental area is at risk of river flooding. These include Special Areas of Conservation, Special Protection Areas, and Sites of Special Scientific Interest.

History of flooding

There have been several localised floods from the River Ythan and from the River Ugie. Smaller watercourses have also caused localised flooding.

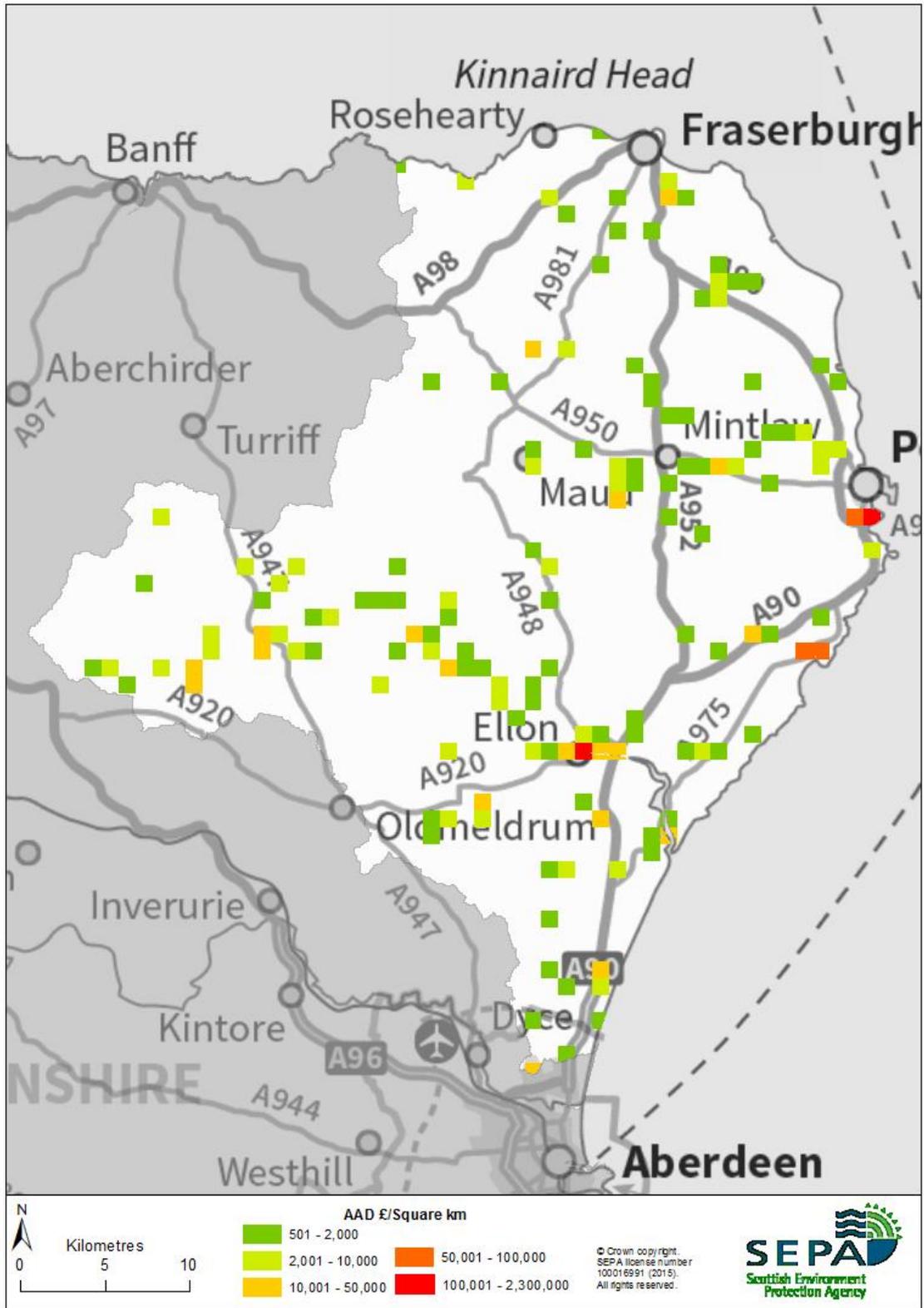


Figure 2: Annual Average Damages from river flooding

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

Property level protection

Aberdeenshire Council offers a small range of flood protection products to residents, which are suitable for all types of flooding. These are sold to residents at cost price with free delivery across Aberdeenshire.

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Ythan catchment may increase by 24%¹. This would potentially increase in the number of residential properties at risk of river flooding from approximately 230 to 280, while the number of non-residential properties at risk does not change.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Runoff reduction

There is limited potential for runoff reduction in the Ythan catchment group and what does exist tends to be small scattered areas. None of the Potentially Vulnerable Areas show any significant potential of runoff reduction either within or immediately

¹ From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

upstream. Runoff reduction measures would not have any significant impact on flood risk in the Ythan catchment group, however may provide local benefits.

Floodplain storage

There are significant areas of high potential for floodplain storage within the Ythan catchment group. The most significant continuous areas of high potential are along the valleys of the major rivers, including the River Ugie and its tributaries, and the River Ythan. The Potentially Vulnerable Areas covering Peterhead (06/08), Methlick (06/09), and Ellon (06/12) all show potential for floodplain storage. It is likely that floodplain storage could reduce flood risk and may be considered further for these areas. The Potentially Vulnerable Area covering Fraserburgh (06/05) shows less potential though and floodplain storage may not provide as great an impact on flood risk here.

Sediment management

The River Ugie system is predominantly in balance, therefore measures to manage sediment is unlikely to reduce flood risk in the Peterhead (06/08). The River Ythan system is more varied and has significant lengths of predominantly eroding or depositing reaches, in particular through Methlick (06/09). The reaches through Ellon (06/12) include areas of moderate erosion and deposition. Therefore, measures to manage sediment in these Potentially Vulnerable Areas could potentially reduce flood risk.

River flooding Don catchment group

Catchment overview

The River Don flows eastwards from the Cairngorm Mountains towards Aberdeen where it flows into the North Sea. It has a catchment area of approximately 1,300km² (Figure 1).

The predominant land covers are arable, horticulture, and improved grassland, which together cover approximately half of the catchment, predominantly in the east. Coniferous woodland is also significant in the east, with heather and montane habitats dominant in the west. The catchment has an annual rainfall of between 400-900mm with the wettest areas being in the west.

There are five Potentially Vulnerable Areas:

- Inch (06/11)
- Inverurie and Kintore (06/13)
- Heugh-head (06/14)
- Aberdeen City – Bridge of Don (06/15)
- Aberdeen City – Denmore (06/16).

Flood risk in the catchment

Note: The assessment of river flood risk in Aberdeen City is based on more detailed modelling derived from the Aberdeen integrated catchment study.

There are approximately 2,600 residential properties and 530 non-residential properties at risk of river flooding in the River Don catchment area. Approximately 96% of residential properties and 82% of non-residential properties at risk of river flooding are located within the Potentially Vulnerable Areas.

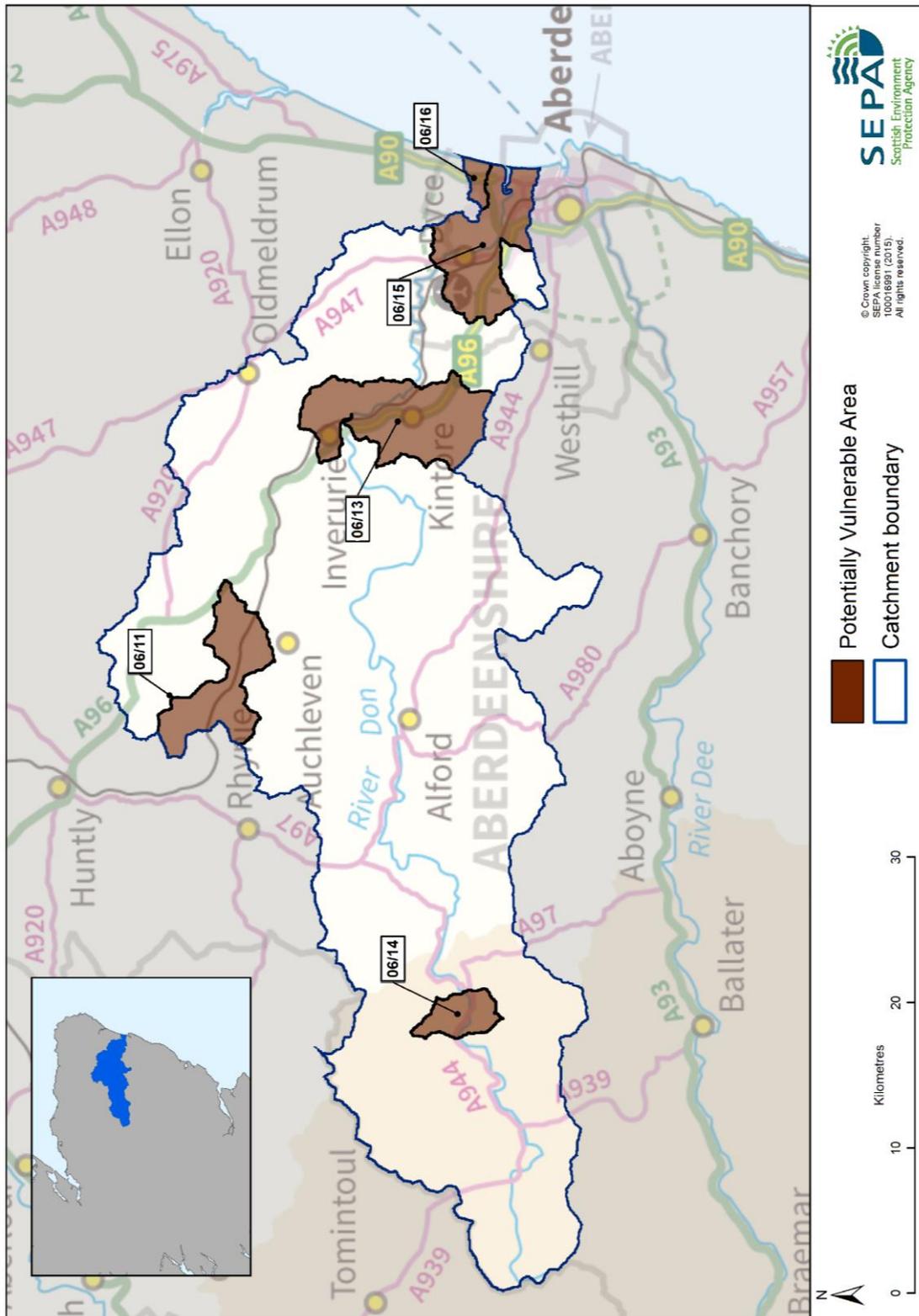


Figure 1: Don river catchment group and Potentially Vulnerable Areas

Main areas at risk

The main urban areas that have greater than 20 residential properties at risk of river flooding are shown in Table 1. Aberdeen City (North) is the area with the greatest number of properties at risk in the River Don catchment group. It includes properties at risk of flooding from smaller, often culverted, watercourses in the north of the city.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Aberdeen City North	2,200	£2.1 million
Dyce	270	£2.0 million
Insch	80	£220,000
Inverurie and Port Elphinstone	160	£270,000
Kintore	30	£87,000

Table 1: Main urban areas at risk of river flooding

Economic activity and infrastructure at risk

The Annual Average Damages from river flooding for this catchment area are estimated to be approximately £5.9 million. This accounts for around 21% of the Annual Average Damages for the North East Local Plan District. The damages are distributed as follows:

- 53% non-residential properties (£3.2 million)
- 36% residential properties (£2.1 million)
- 5% emergency services (£330,000)
- 2% roads (£130,000)
- 2% agriculture (£120,000)
- 1% vehicles (£48,000).

Figure 2 shows the location of Annual Average Damages from river flooding across the area. The areas of highest damage are in Aberdeen City (North) and Dyce.

Table 2 shows the approximate numbers of further infrastructure assets which are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	30	Includes; healthcare facilities, educational buildings and emergency services.
Utility assets	60	Includes; electricity sub-stations, telecommunications and fuel extraction sites.
Roads (excluding minor roads)	390 locations	Notably the A96, A947 and A944
Railway routes	50 locations	Inverness to Aberdeen
Agricultural land (km ²)	45km ²	n/a

Table 2: Infrastructure and agricultural land at risk of river flooding

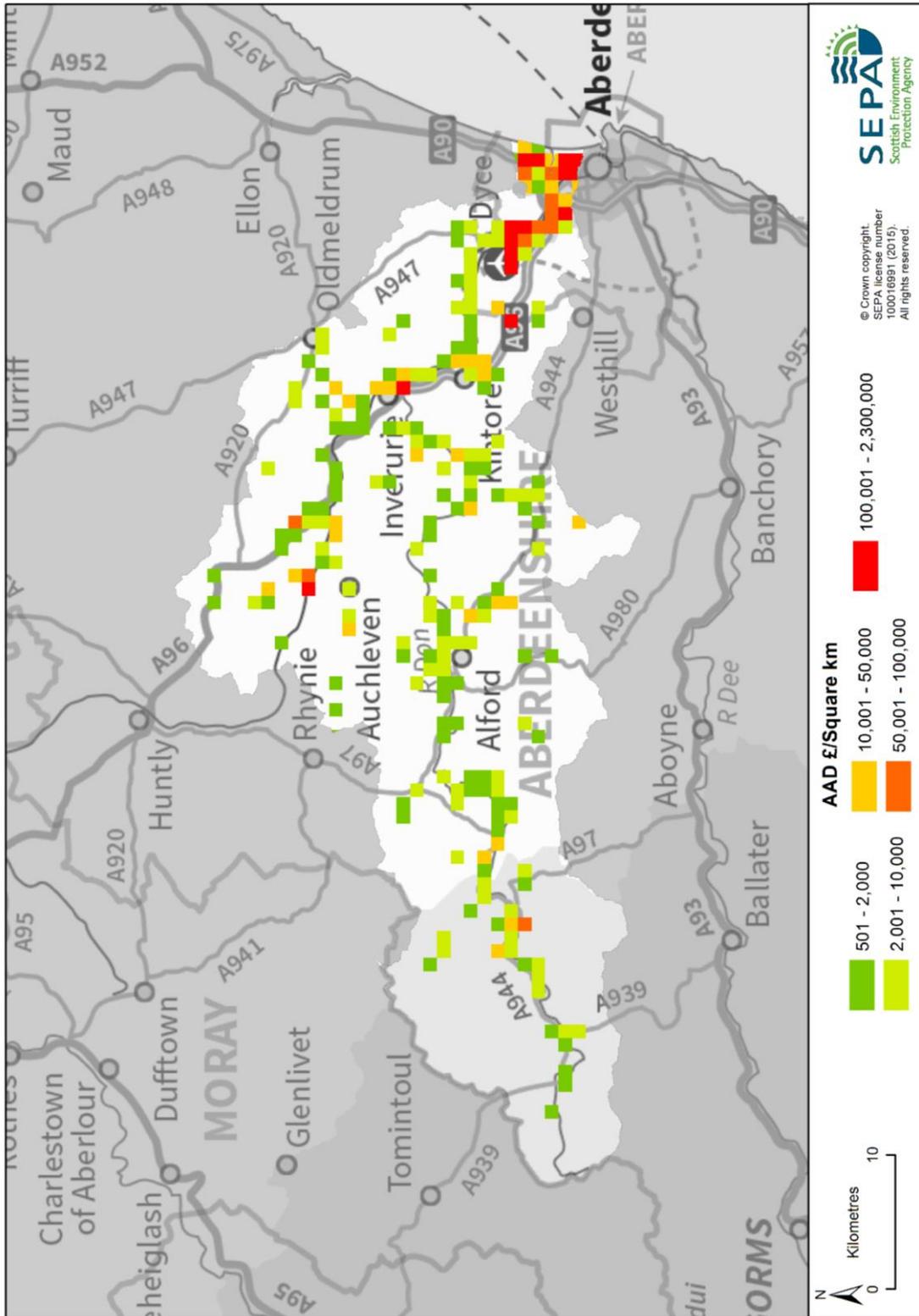


Figure 2: Annual Average Damages from river flooding

Designated environmental and cultural heritage sites at risk

There are approximately 40 cultural heritage sites at risk of river flooding in this catchment, including A-listed buildings, scheduled monuments, gardens and designed landscapes. Less than 1km² of designated environmental area is at risk of river flooding.

History of river flooding

The Bridge of Don area experienced flooding in 2000 and 2001, when problems with the drainage system resulted in ponding. This was exacerbated by gullies surcharging due to the high water level in the Glashieburn and properties in Lochside Drive, Jesmond Drive and Brook Crescent were affected. Regular surcharging of the combined sewer in Jesmond Drive has been reported as has flooding at Ellon Road due to debris accumulation blocking the watercourse.

There was significant river flooding in 2002 from the Tuach Burn and Valentine Burn, which resulted in the inundation and evacuation of a nursing home. There have also been localised floods recorded caused by flooding from the River Don, Strath Burn, Loch Burn and Gas Burn. Many of these floods caused localised flooding to properties.

Large parts of north east Scotland were affected by flooding due to Hurricane Bertha in August 2014. The railway line at Huntly was submerged and the road network was affected.

Large parts of Aberdeen were affected by surface water flooding in July 2015. Many manhole covers became dislodged, roads were submerged and Aberdeen airport's terminal building was flooded.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

River flood warning schemes

There are four flood warning areas for river flooding on the River Don catchment, which are listed in Table 3. These are the areas where SEPA has detailed models set up to predict flooding on specific rivers. The majority of the flood warning areas are associated with the River Don. The locations of the flood warning areas are shown in Figure 3.

Flood warning area	Number of properties within flood warning area	% of properties registered (January 2014)
Aberdeen City (Don)	442	18%
Inverurie	213	29%
Kemnay	48	46%
Kintore	64	33%

Table 3: Flood warning areas

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- Aberdeen City Council provides grants towards the fitting of flood guards on individual properties.

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Don catchment may increase by 24%¹. This would potentially increase in the number of residential properties at risk of river flooding from approximately 2,600 to 4,200 and the number of non-residential properties from 530 to 680.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

¹ From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

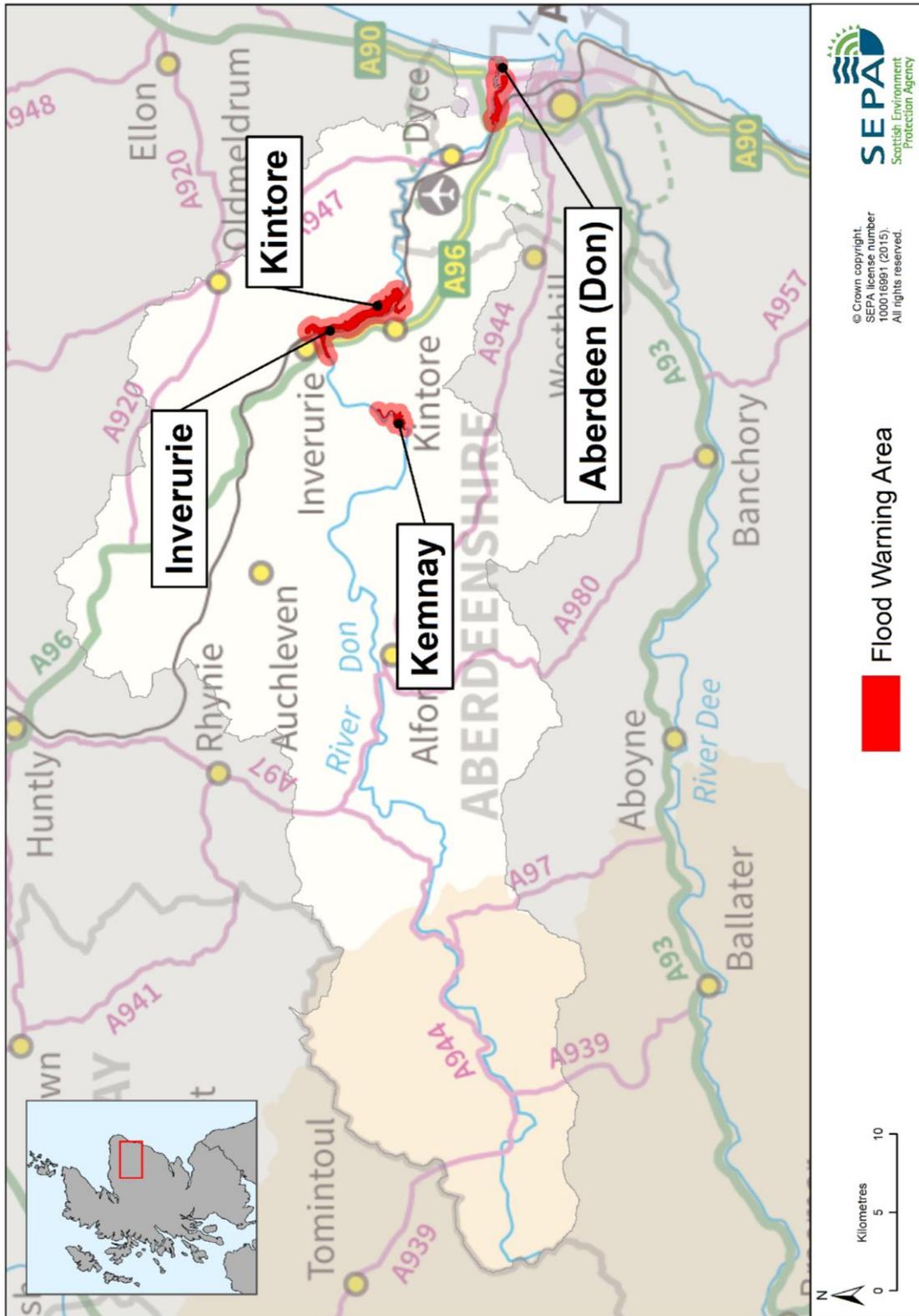


Figure 3: Flood warning areas

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Runoff reduction

The main area with potential for runoff reduction in the River Don catchment group is located in the west. Other areas of potential tend to be small and scattered. None of the Potentially Vulnerable Areas show any significant areas of runoff reduction potential either within or immediately upstream. Therefore, it is unlikely that runoff reduction measures would have any significant impact on flood risk on the River Don although runoff reduction may be effective on the smaller tributaries.

Floodplain storage

There are significant areas of potential for floodplain storage within the River Don catchment. All of the Potentially Vulnerable Areas show some areas of high potential for floodplain storage. In particular Inverurie and Kintore (06/13) and Aberdeen City Bridge of Don (06/15) show significant potential and this is more evident when considered in conjunction with Aberdeen City Denmore (06-16). It is likely that floodplain storage could improve flood risk and should be considered further for these Potentially Vulnerable Areas.

Sediment management

The majority of the catchment is either in approximate balance or undergoing moderate erosion. The reaches through Heugh-head (06/14) include areas of deposition and high erosion. There are also long reaches of depositional areas through Inverurie and Kintore (06/13). Therefore, measures to manage sediment in these Potentially Vulnerable Areas could potentially reduce flood risk. Through Inch (06/11) and Aberdeen City Bridge of Don (06/15) the rivers are either in approximate balance or undergoing moderate erosion and consequently there is not as much opportunity to reduce flood risk through sediment management measures in these Potentially Vulnerable Areas.

River flooding Dee catchment group

Catchment overview

The Dee river catchment group covers the southern part of the North East Local Plan District (Figure 1) and has an area of approximately 2,200km². The largest river in the catchment is the River Dee, which flows in a generally eastwards direction to the coast at Aberdeen where it discharges to the sea. The catchment area also includes coastal rivers to the south, including the River Carron and River Cowie in Stonehaven.

The predominant land cover in the upland areas in the west is montane habitat, which covers 23% of the catchment. Coniferous woodland, heather and improved grassland each cover around 15% of the area. Improved grassland, arable and horticulture dominate the east of the catchment. The bulk of the catchment area has an annual rainfall of between 400-900mm with the more mountainous areas in the west receiving between 900mm-1,200mm per annum.

The catchment includes seven Potentially Vulnerable Areas as follows:

- Aberdeen – Westhill (06/17)
- Aberdeen City – Deeside (06/18)
- Peterculter (06/19)
- Aboyne (06/20)
- Banchory and Torphins (06/21)
- Ballater (06/22)
- Stonehaven (06/23).

Flood risk in the catchment

Note: The assessment of river flood risk in Aberdeen City and Peterculter is based on more detailed modelling derived from the Aberdeen integrated catchment study.

There are approximately 8,400 residential properties and 1,800 non-residential properties at risk of river flooding in the River Dee catchment area. Approximately 97% of residential and 91% of non-residential properties at risk of flooding are located within Potentially Vulnerable Areas, with the majority in Aberdeen City Deeside (06/18).

Main areas at risk

The main areas that have greater than 20 residential properties at risk of river flooding are shown in Table 1.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Aberdeen City - South	8,300	£10.5 million
Stonehaven	630	£620,000
Peterculter	200	£310,000
Ballater	190	£220,000
Aboyne and Tarland	90	£240,000
Banchory and Torphins	20	£60,000

Table 1: Main areas at risk of river flooding

Economic activity and infrastructure at risk

The Annual Average Damages from river flooding in this catchment area are approximately £13.5 million. This accounts for 46% of the Annual Average Damages for the North East Local Plan District. The damages are distributed as follows:

- 57% residential properties (£7.7 million)
- 33% non-residential properties (£4.5 million)
- 5% emergency services (£670,000)
- 2% agriculture (£330,000)
- 2% vehicles (£210,000)
- 1% roads (£110,000).

Figure 2 shows the location of Annual Average Damages from river flooding. The areas of highest damage are in Aberdeen City.

There are also significant damages shown in Stonehaven, Peterculter, Ballater, Aboyne and Tarland.

Table 2 shows the approximate numbers of further infrastructure assets that are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	10	Includes; healthcare facilities, educational buildings and emergency services.
Utility assets	40	Includes; electricity sub-stations, telecommunications and fuel extraction sites.
Roads (excluding minor roads)	550 locations	Notably the A93
Railway routes	30 locations	Inverness to Aberdeen Aberdeen to Dundee
Agricultural land (km ²)	71km ²	n/a

Table 2: Infrastructure and agricultural land at risk of river flooding

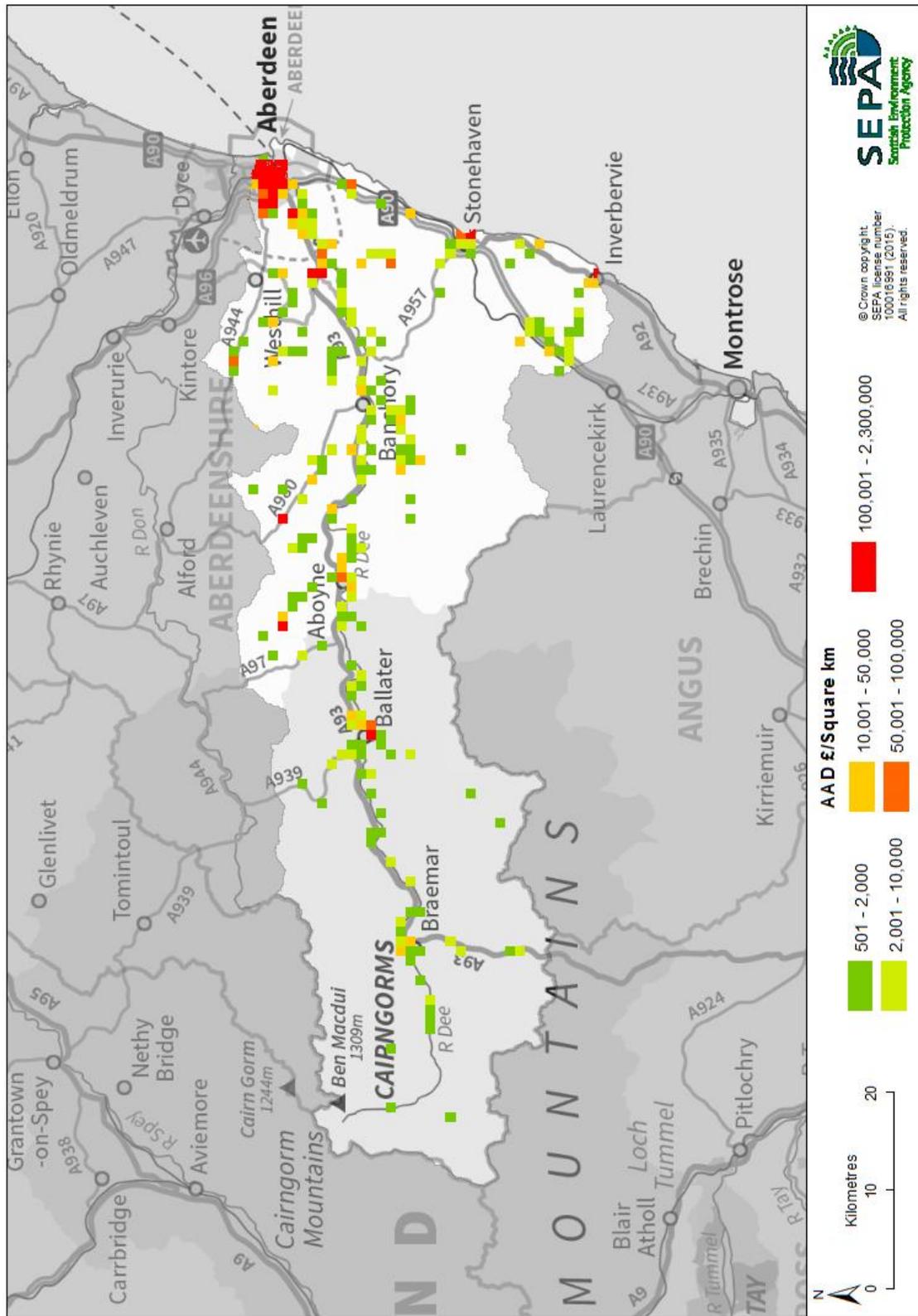


Figure 2: Annual Average Damages from river flooding

Designated environmental and cultural heritage sites at risk

There are 63 cultural heritage sites at risk of river flooding, including A-listed buildings, scheduled monuments, gardens and designed landscapes.

There are 63km² of designated environmental sites at risk of flooding. These include Sites of Special Scientific Interest, Special Protection Areas and Special Areas of Conservation, including the River Dee Special Area of Conservation (SAC).

History of flooding

Flooding in Aberdeen City is a complex issue due to the interactions between culverted watercourses, sewers, rivers and heavy rainfall. Floods are often due to the interaction of different sources of flooding, for example surface water flooding due to high river levels preventing the sewers and drainage systems discharging.

Historic flood events on the River Dee have been reported in 1789, 1790, 1829, 1873, 1876, 1881, 1882, 1892, 1894, 1909, 1920, 1922, 1926, 1927, 1928, 1929, 1938 and 1946. The Den Burn is reported to have flooded in 1869, 1872, and 1874.

The Cults Burn has caused flooding at Inchgarth Road due to blockages on the watercourse backing it up from the River Dee.

Floods in 2009 and December 2012 from the River Carron resulted in many properties in Stonehaven being evacuated. Extensive damage was caused to residential and non-residential properties.

The Tarland Burn has caused flooding in Tarland and Aboyne, most notably in 2002.

The River Dee flooded in August 2014, destroying a bridge at Mar Lodge Estate. The A93 between Braemar and Ballater was closed and several smaller roads were also affected in Aberdeenshire. The caravan park in Ballater was evacuated after the River Dee burst its banks.

Large parts of Aberdeen were affected by flooding in July 2015, when heavy rainfall caused the drainage system to overflow, dislodging manhole covers. Many roads were affected by flooding, including Market Street, Guild Street and Holburn Street. Cars on Polmuir Road started to float due to the depth of the water. A nursery had to be evacuated due to flooding in its basement.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

River flood warning schemes

There are six flood warning areas for river flooding in the Dee (Aberdeenshire) river catchment, listed in Table 3. These are the areas where SEPA has detailed models set up to predict flooding on specific rivers. The locations of the flood warning areas are shown in Figure 3.

Flood warning area	Number of properties within flood warning area	% of properties registered (January 2014)
Aberdeen (Dee)	45	13%
Aboyne	92	22%
Ballater	218	35%
Banchory	49	29%
Maryculter	10	100%
Stonehaven	878	36%

Table 3: Flood warning areas

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- Aberdeen City Council provides grants towards the fitting of flood guards on individual properties.

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the Dee catchment by 2080 may increase by 24%¹. This would potentially increase in the number of residential properties at risk of river flooding from approximately 8,400 to 11,000 and the number of non-residential properties from 1,800 to 2,100.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

¹ From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Runoff reduction

There are significant areas of potential for runoff reduction in the south and west of the Dee catchment. However, these are a significant distance from the Potentially Vulnerable Areas. None of the Potentially Vulnerable Areas themselves show any significant areas of runoff reduction potential either within or immediately upstream of their boundaries. Therefore, it is unlikely that runoff reduction measures would have any significant impact on flood risk in the Dee catchment area. Runoff reduction may however be effective in the case of localised flooding.

Floodplain storage

There are significant areas of high potential for floodplain storage within the Dee catchment area. All of the Potentially Vulnerable Areas show some areas of high potential for floodplain storage.

Sediment management

The majority of the river systems in the Dee catchment area have substantial reaches that are either in approximate balance or moderately eroding. However, there are also significant lengths of river that are predominantly highly eroding or depositing, which can contribute to flood risk. The Potentially Vulnerable Areas showing the largest amount of erosion or deposition are Aberdeen – Westhill (06/17), Aberdeen City - Deeside (06/18), Aboyne (06/20), and Banchory and Torphins (06/21).

3.3 Coastal flooding

North East Local Plan District

This chapter provides supplementary information on coastal flooding at a coastal area level. It provides an overview of the natural characteristics of the coast, a summary of flood risk within the coastal area and a brief history of flooding. It further explains the potential climate change effects on future flood risk and summarises the potential for natural flood management.

Information about the objectives and actions to manage flood risk are provided in the relevant Potentially Vulnerable Area chapters in Section 2.

In the North East Local Plan District, coastal flooding is reported in three coastal areas (Figure 1).



Figure 1: Coastal areas within the North East Local Plan District

Coastal flooding Inverbervie to Girdle Ness

Coastal overview

The Inverbervie to Girdle Ness coastal area covers approximately 55km of coastline from Inverbervie in the south, to Girdle Ness, Aberdeen in the north (Figure 1). There are several towns and villages located close to the coastline including the southern areas of Aberdeen and the towns of Portlethen, Newtonhill, Stonehaven and Inverbervie. The coastal area contains two local authorities; Aberdeen City Council and Aberdeenshire Council.

The coastal area is characterised by cliffs with numerous headlands enclosing small bays. There are few beaches along this section of coast and these tend to be pocket or bay head type beaches bounded by headlands or rock abrasion platforms. The nearshore bathymetry is variable and the coastline indented, therefore the wave conditions at the coastline are highly variable.

The Bervie Water in Inverbervie and the Carron and Cowie rivers in Stonehaven are the main rivers which outfall to the sea along this stretch of coastline.

There is one Potentially Vulnerable Area in this coastal area; Stonehaven (06/23).

Flood risk in the coastal area

Main areas at risk

Within the Inverbervie to Girdle Ness coastal area, there are approximately 50 residential properties and 20 non-residential properties at risk of coastal flooding. All of the residential properties and an estimated 91% of the non-residential properties at risk of coastal flooding are located within the Stonehaven Potentially Vulnerable Area.

Economic activity and infrastructure at risk

The Annual Average Damages from coastal flooding in the Inverbervie to Girdle Ness coastal area are approximately £40,000. The Annual Average Damages are distributed as follows:

- 70% residential properties (£28,000)
- 16% non-residential properties (£6,300)
- 8% roads (£3,200)
- 4% emergency services (£1,600)
- 1% vehicles (£400)
- <1% agriculture (£120).

Flooding from wave overtopping is not fully represented in the general assessment of flood risk and the Annual Average Damages from coastal flooding are known to be significantly underestimated. The number of properties at risk of flooding may also be underestimated. In addition some properties have suffered from structural damage due to wave overtopping even if the properties themselves have not been flooded internally.

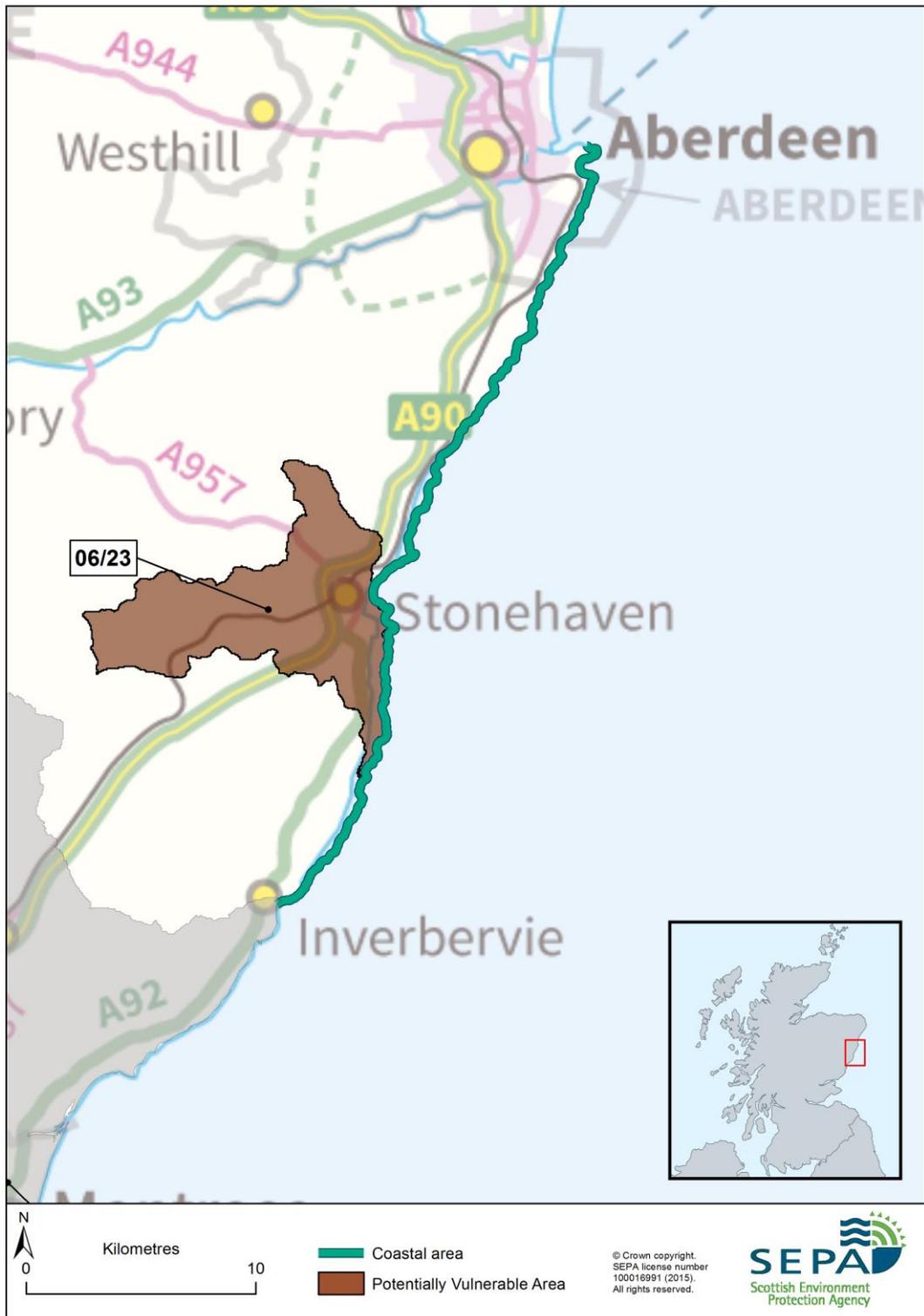


Figure 1: Inverbervie to Girdle Ness coastal area and Potentially Vulnerable Areas

Figure 2 shows the location of Annual Average Damages from coastal flooding across the area. Most of the economic damages from coastal flooding are attributed to flooding in Stonehaven. The main road affected by coastal flooding is the A957, but a number of minor roads are also impacted.

Table 1 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
Community facilities	0	n/a
Utility assets	0	n/a
Roads (excluding minor roads)	3	Including A957
Railway routes	0	n/a
Airports	0	n/a
Agricultural land (km ²)	0.04	n/a

Table 1: Infrastructure and agricultural land at risk of coastal flooding

Designated environmental and cultural heritage sites at risk

There are five designated cultural heritage sites at risk of coastal flooding in this area. Two are scheduled monuments and three are listed buildings.

Less than 1km² of environmental designated area is at risk of coastal flooding including Special Protection Areas and Sites of Special Scientific Interest.

History of coastal flooding

In December 2012 Stonehaven was affected by significant coastal flooding. This was caused by high tide levels combined with strong onshore easterly winds which generated large waves. There was extensive damage to properties, local amenities, vehicles and seafront businesses. Two sheltered housing complexes on David Street had to be evacuated and some businesses were closed down as a result of the damages incurred. The town's only supermarket was also affected. Wave overtopping is a regular occurrence which causes flooding to seafront businesses at Cowie. Less severe flooding and damage to structures occurred in October 2014 as a direct result of wave overtopping.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapter in section 2 of this document.



Figure 2: Annual Average Damages from coastal flooding

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this coastal area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- Aberdeen City Council provides grants towards the fitting of flood guards on individual properties.

Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may increase sea levels. The magnitude of sea level rise varies around the coastline.

For the UKCP09 high emissions scenario, the predicted average sea level increase for the Inverbervie to Girdle Ness coastline is 0.5m by 2080. This may increase the number of residential properties at risk of coastal flooding from approximately 50 to 130 and for non-residential properties from 20 to 60. Coastal flood modelling by SEPA has not taken into account the impacts of a future climate on wave overtopping or storminess, which could increase the number of properties affected by coastal flooding.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place.

This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Estuarine surge

The assessment shows that there are no opportunities for estuarine surge attenuation in the Inverbervie to Girdle Ness coastal area.

Wave energy

There are several areas in this coastal area which have potential for wave energy dissipation. The main area of potential is around Stonehaven. There are also smaller areas of potential at Nigg Bay near Aberdeen, Braidon Bay and Bervie Bay, Crawton, Doonie Point, and Cove Bay.

Coastal flooding Girdle Ness to Cairnbulg Point

Coastal overview

The Girdle Ness to Cairnbulg Point coastal area covers approximately 80km of coastline from Girdle Ness, Aberdeen in the south to the eastern end of the Moray Firth in the north (Figure 1). There are several towns and villages located close to the coastline including Aberdeen, Balmedie, Cruden Bay, Boddam, Peterhead and Inverallochy. The coastal area contains two local authorities; Aberdeen City Council and Aberdeenshire Council.

The coastal area is characterised by wide sandy bays such as at Balmedie and Cruden Bay and rocky cliffs with small bays enclosed by headlands. The nearshore bathymetry is variable and the coastline indented, therefore the wave conditions at the coastline are highly variable.

There are several large rivers which outfall along this stretch of coastline including the River Dee and River Don in Aberdeen, the River Ythan at Newburgh and the River Ugie at Peterhead.

There are five Potentially Vulnerable Areas:

- Peterhead (06/08)
- Ellon (06/12)
- Aberdeen City – Bridge of Don (06/15)
- Aberdeen City – Denmore (06/16)
- Aberdeen City – Deeside (06/18).

Flood risk in the coastal area

Main areas at risk

Within the Girdle Ness to Cairnbulg Point coastal area there are fewer than ten residential properties and approximately 20 non-residential properties at risk of coastal flooding. None of the residential properties and an estimated 83% of the non-residential properties are located within Potentially Vulnerable Areas.

The majority of non-residential properties at risk are in Peterhead and Aberdeen City. The residential properties at risk are all located in the Newburgh area where the River Ythan flows into the sea. Although no residential properties were identified as being at risk of coastal flooding in any of the Potentially Vulnerable Areas it is evident from historical events that a number of residential properties in Potentially Vulnerable Areas are affected by overtopping waves including in Peterhead and at Footdee in Aberdeen.

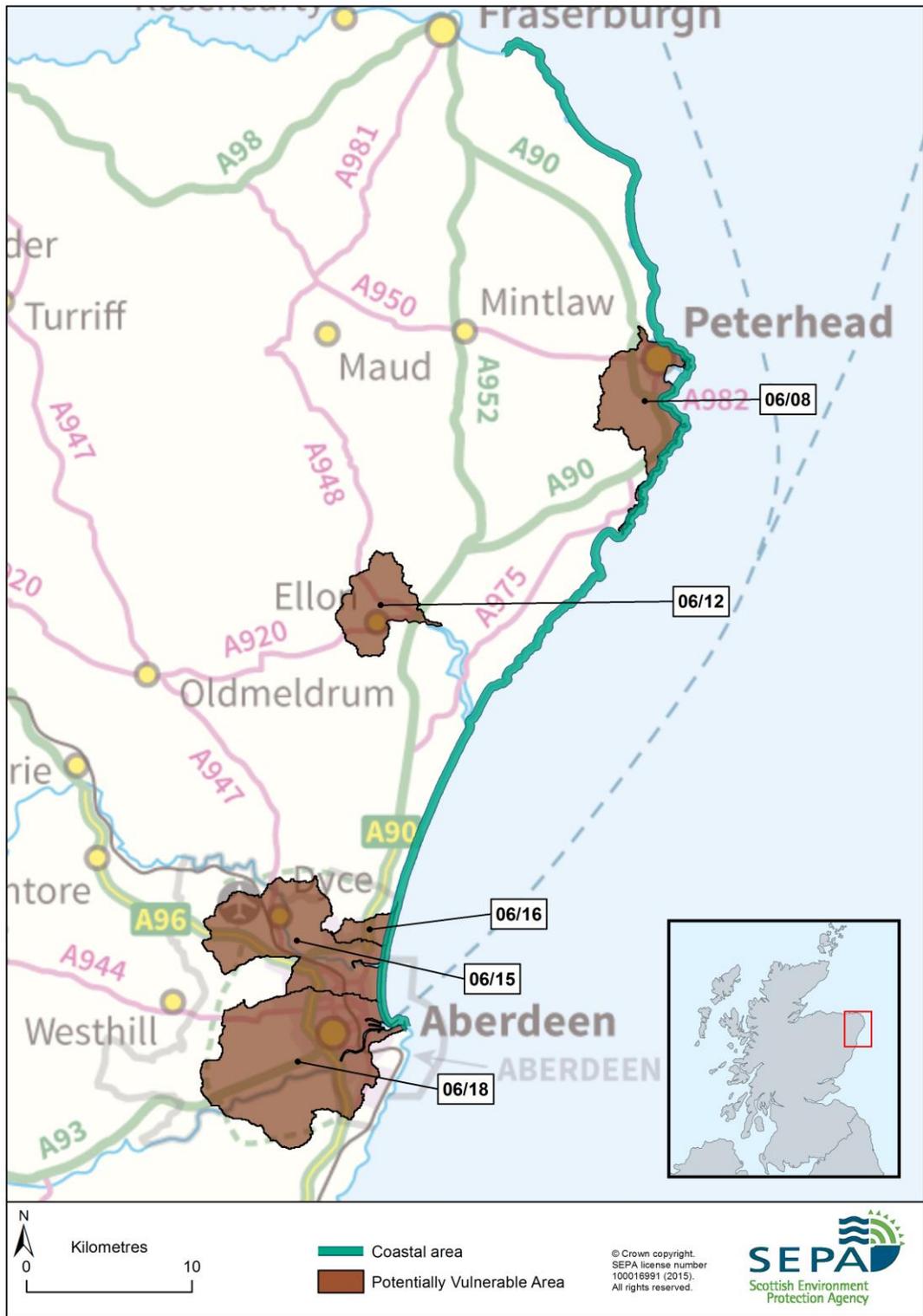


Figure 1: Girdle Ness to Cairnbulg Point coastal area and Potentially Vulnerable Areas

Economic activity and infrastructure at risk

The Annual Average Damages from coastal flooding in the Girdle Ness to Cairnbulg Point coastal area are estimated to be £160,000. The Annual Average Damages are distributed as follows:

- 79% non-residential properties (£130,000)
- 13% roads (£22,000)
- 5% emergency services (£7,700)
- 1% residential properties (£2,600)
- 1% agriculture (£2,000).

Figure 2 shows the location of Annual Average Damages from coastal flooding across the area.

Table 1 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
Community facilities	0	n/a
Utility assets	<10	Electricity sub-stations
Roads (excluding minor roads)	30 sections	Including A90, A920, A948, A975 and A982
Railway routes	5 locations	Aberdeen to Inverness
Agricultural land (km²)	1.2	n/a

Table 1: Infrastructure and agricultural land at risk of coastal flooding

Designated environmental and cultural heritage sites at risk

There are four cultural heritage sites at risk of coastal flooding in this area including garden and designed landscapes, scheduled monuments and listed buildings.

Approximately 10km² of environmentally designated area is at risk of coastal flooding including Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Sites of Special Scientific Interest (SSSI). The sites affected include the River Dee, Bullers of Buchan Coast and Buchan Ness to Collieston Coast.

History of flooding

The North Sea flood of 1953 resulted in flooding along the east coast, notably in Peterhead where cottages were destroyed. There have also been a number of localised floods, including storm surges in 1921 and 1949, which affected Aberdeen City. In December 2012 there were a number of houses evacuated and some were flooded in Peterhead with significant damage to the harbour-side businesses from wave overtopping during a coastal storm.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapter in section 2 of this document.

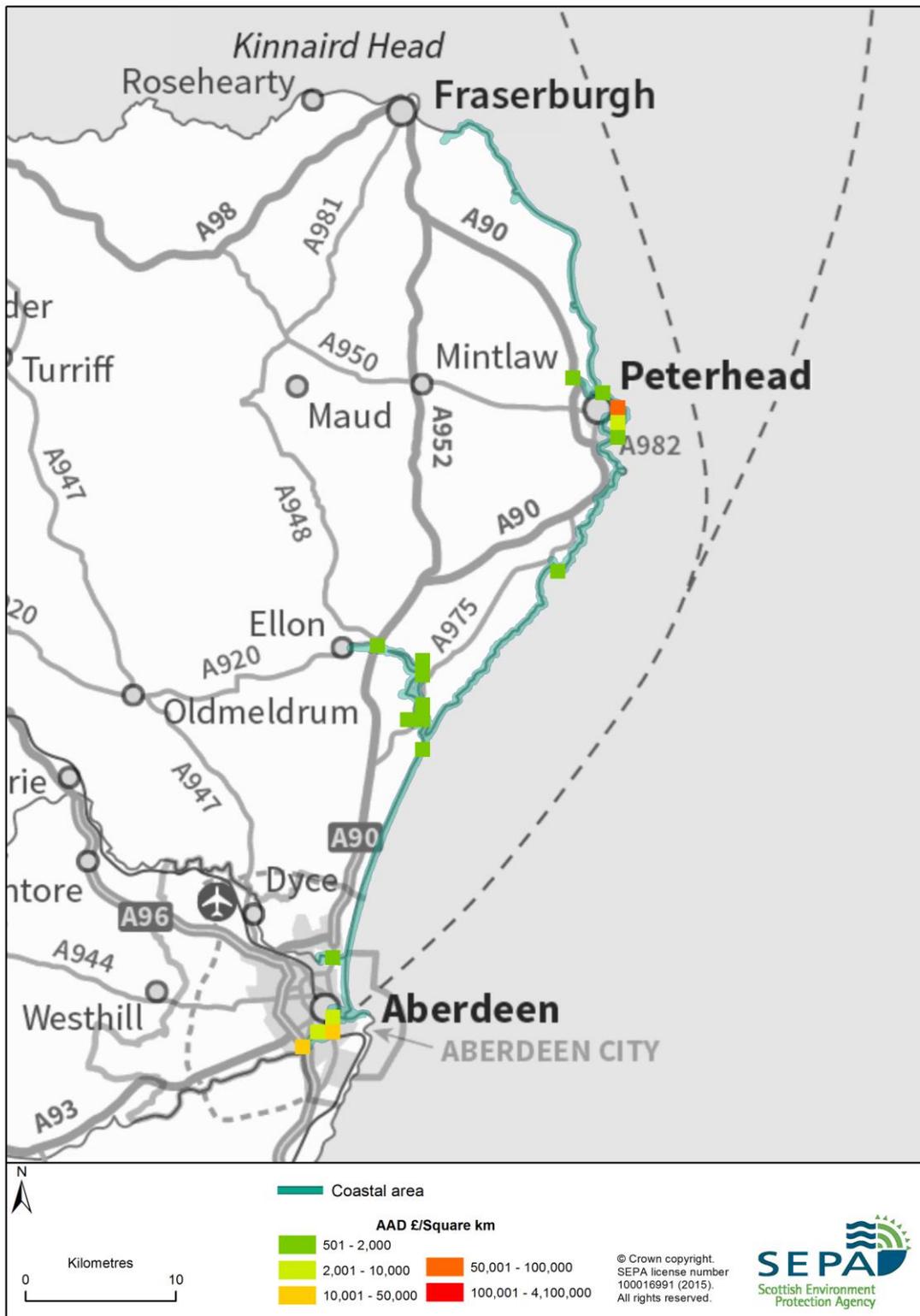


Figure 2: Annual Average Damages from coastal flooding

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

Flood protection schemes

A coastal protection scheme was completed in Aberdeen in 2006. This scheme comprises beach recharge and rock groynes to reduce the risk of failure of the existing seawalls, which provide erosion and flood protection to Aberdeen City.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this coastal area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- Aberdeen City Council provides grants towards the fitting of flood guards on individual properties.

Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may increase sea levels. The magnitude of sea level rise varies around the coastline.

For the UKCP09 high emissions scenario, the predicted average increase for the Girdle Ness to Cairnbulg Point coastline is 0.5m by 2080. This may increase the number of residential properties at risk of coastal flooding from fewer than 10 to 60 and the number of non-residential from approximately 20 to 30. Coastal flood modelling by SEPA has not taken into account the impacts of a future climate on wave overtopping or storminess, which could increase the number of properties affected by coastal flooding.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place.

This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Estuarine surge

The assessment shows there is limited opportunity for estuarine surge attenuation in the Girdle Ness to Cairnbulg Point coastal area. The areas of potential are relatively small and not continuous.

Along the River Don in Aberdeen there is a limited amount of potential for estuarine surge attenuation located between the A956 and Seaton Park. There are also some small areas of potential on the River Ythan, mainly in the vicinity of Newburgh downstream of the A975 road crossing and small isolated sections of potential for estuarine surge attenuation close to Loch of Strathbeg and South Inch (south of St Combs).

Wave energy

There is potential for wave energy dissipation along most of the coastline between Girdle Ness and Cairnbulg Point. There are areas of potential along the Aberdeen City frontage (where wave energy dissipation work in the form of beach replenishment has been carried out previously), in the centre of Newburgh Bay, in the Bay of Cruden, along the Peterhead frontage and between Rattray Head and Inverallochy.

Coastal flooding Cairnbulg Point to Portgordon

Coastal overview

The Cairnbulg Point to Portgordon coastal area covers approximately 88km of mainly north facing coastline along the outer Moray Firth (Figure 1). There are several towns and villages close to the coastline including Fraserburgh, Rosehearty, Macduff, Banff, Portsoy, Portknockie, Findochty, and Buckie. The coastal area contains two local authorities; Moray Council and Aberdeenshire Council.

The coastal area is characterised by a sequence of small bays between rocky headlands and cliffs. There are a few relatively short sections of sand and shingle beaches along the coastline for example to the east of Fraserburgh. The nearshore bathymetry is variable and the coastline indented, therefore the wave conditions at the coastline are highly variable.

The River Deveron, which outfalls at Banff Bay, is the only major river which discharges to the sea along this section of coast. However there are several smaller rivers and burns which outfall to the Moray Firth.

There are five Potentially Vulnerable Areas:

- Portgordon (06/01)
- Portsoy (06/02)
- Banff (06/03)
- Macduff (06/04)
- Fraserburgh and Rosehearty (06/05).

Flood risk in the coastal area

Main areas at risk

Within the Cairnbulg Point to Portgordon coastal area there are approximately 30 non-residential properties at risk of coastal flooding. An estimated 56% of these are located within Potentially Vulnerable Areas, with the majority located in Fraserburgh and Rosehearty (06/05). Although there are no residential properties identified to be at risk of flooding, historically properties have been subject to flooding due to wave overtopping.

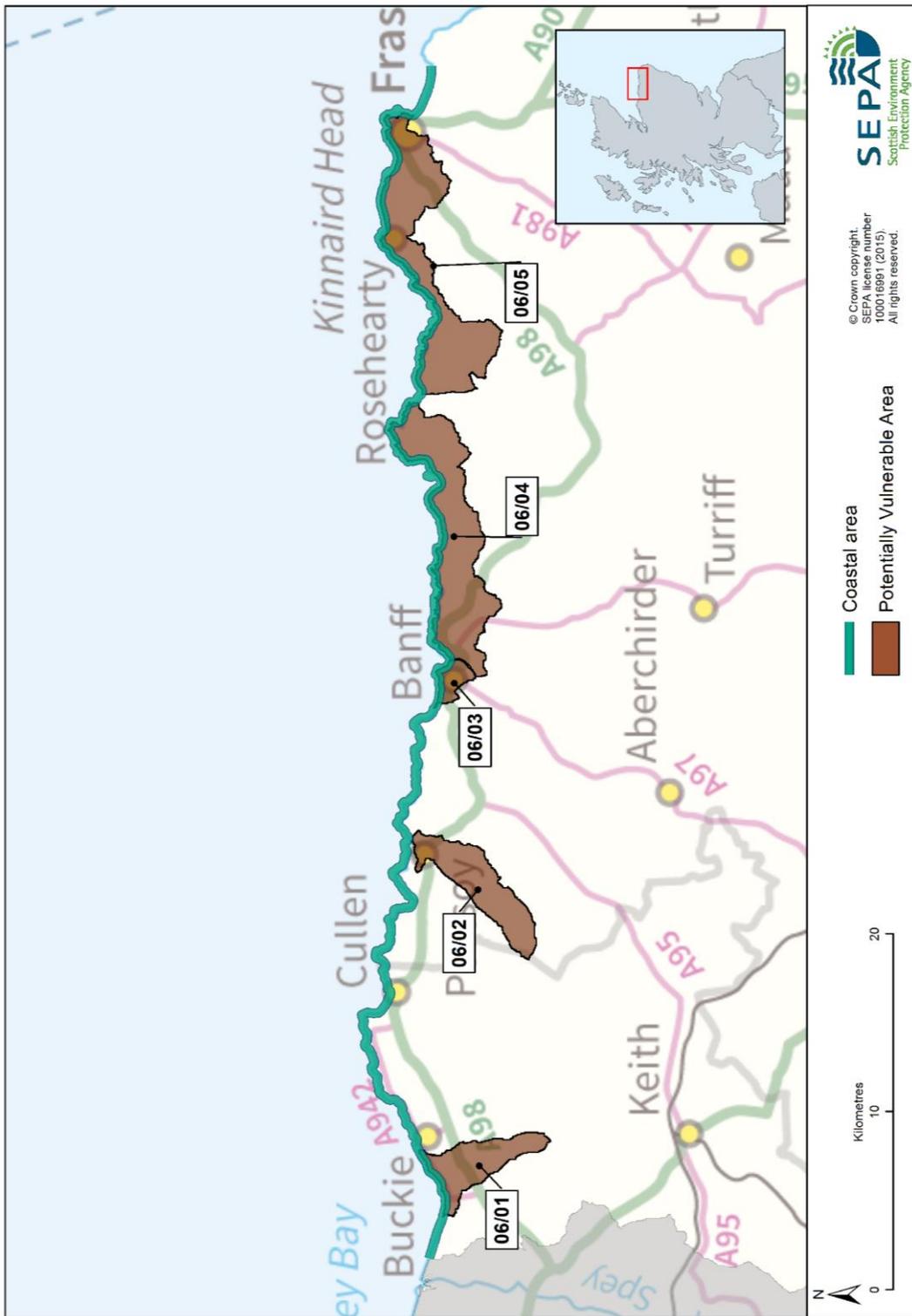


Figure 1: Cairnbulg Point to Portgordon coastal area and Potentially Vulnerable Areas

Economic activity and infrastructure at risk

The Annual Average Damages from coastal flooding in the Cairnbulg to Portgordon coastal area are estimated to be approximately £66,000. The Annual Average Damages are distributed as follows:

- 74% non-residential properties (£49,000)
- 10% residential properties (£6,400)
- 7% emergency services (£4,800)
- 7% roads (£4,700)
- 1% vehicles (£690)
- 1% agriculture (£560).

Flooding from wave overtopping is not fully represented in the general assessment of flood risk. The number of properties at risk of flooding and the Annual Average Damages from coastal flooding may be underestimated.

Figure 2 shows the location of Annual Average Damages from coastal flooding across the area.

Table 1 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
Community facilities	0	n/a
Utility assets	0	n/a
Roads (excluding minor roads)	10 sections	Including A98 and the B9033
Railway routes	0	n/a
Agricultural land (km²)	0.4	n/a

Table 1: Infrastructure and agricultural land at risk of coastal flooding

Designated environmental and cultural heritage sites at risk

There are 14 cultural heritage sites at risk of coastal flooding in this area including garden and designed landscapes, scheduled monuments and listed buildings.

Approximately 2km² of environmental designated area is at risk of coastal flooding including Special Protection Areas and Sites of Special Scientific Interest. The sites affected include Troup Head, Pennan Head, and Lion's Head, Gamrie, together with Pennan Coast, Whitehills to Melrose Coast, Rosehearty to Fraserburgh Coast, Spey Bay and Cullen to Stake Ness Coast.

History of flooding

The North Sea flood of 1953 had a significant impact on this stretch of coastline, with properties and seawalls destroyed in Buckie, Portsoy, Crovie, Banff and Rosehearty. The village of Crovie was effectively abandoned after the event. In Macduff, properties were damaged and the cliff road destroyed in 1957.

There have been numerous smaller coastal floods recorded right across this coastal area impacting locally on property and infrastructure, for example in Portgordon where properties are flooded on a frequent basis.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapter in section 2 of this document.

Managing coastal flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

Coastal flood warning schemes

This coastal area benefits from the Moray Firth Coastal Flood Warning Scheme. There are four coastal flood warning areas, namely Portgordon to Cullen, Portsoy to Macduff, Gardenstown to Pennan and Roseharty to Fraserburgh (Figure 3).

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this coastal area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- The Moray Council does not provide flood guards to private property owners. However, the flood team provides advice on how property owners can protect their own property.



Figure 3: Flood warning areas

Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may increase sea levels. The magnitude of sea level rise varies around the coastline.

For the UKCP09 high emissions scenario, the predicted average sea level increase for the Cairnbulg Point to Portgordon coastline is 0.5m by 2080. This may increase the number of residential properties at risk of coastal flooding to approximately 390 and the number of non-residential from 30 to approximately 280. Coastal flood modelling by SEPA has not taken into account the impacts of a future climate on wave overtopping or storminess, which could increase the number of people affected by coastal flooding.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place.

This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

Estuarine surge

There is limited opportunity for estuarine surge attenuation in the Cairnbulg Point to Portgordon Coastal Area. The only area which has any potential is in Banff Bay where potential attenuation occurs between Macduff and Banff around the perimeter of Banff Bay extending up the River Deveron to Banff Bridge.

Wave energy

There are several areas along this section of coastline which have potential for wave energy dissipation. There are significant areas of potential for dissipation around the urban areas of Fraserburgh, Banff and Buckie with several of the bays also showing potential including Cullen Bay, Sandend Bay, Gamrie Bay and Fraserburgh Bay.

3.4 Surface water flooding

North East Local Plan District

This chapter provides supplementary information on surface water flooding across the Local Plan District. It provides an overview of the main areas at risk and the history of surface water flooding. The predicted impacts on infrastructure are also identified. The impacts on environmental sites and agricultural land have not been assessed.

Information about the objectives and actions to manage flood risk are provided in Section 2.

Flood risk

Within the North East Local Plan District, there are approximately 2,400 residential properties and 1,700 non-residential properties at risk of surface water flooding. 80% of the residential properties at risk of surface water flooding in the Local Plan District are located within Potentially Vulnerable Areas.

Main areas at risk

The areas which have greater than 50 properties at risk of surface water flooding are shown in Table 1. Table 1 also shows the estimated economic impact of surface water flooding in each area expressed as Annual Average Damages.

	Residential and non-residential properties at risk of surface water flooding	Annual Average Damages
Aberdeen City	1,900	£2.2 million
Stonehaven	260	£320,000
Inverurie and Kintore	210	£200,000
Fraserburgh and Rosehearty	130	£49,000
Dyce	120	£570,000
Westhill	100	£89,000
Peterhead	80	£280,000
Huntly	80	£73,000

Table 1: Main areas at risk of surface water flooding

Economic activity and infrastructure at risk

The Annual Average Damages in the North East Local Plan District from surface water flooding are estimated to be £5.2 million. This accounts for 18% of the total flood damages for the Local Plan District. The damages are distributed as follows:

- 54% non-residential properties (£2.8 million)
- 36% residential properties (£1.9 million)
- 5% emergency services (£270,000)
- 4% roads (£220,000)
- 1% vehicles (£46,000).

Figure 1 shows the location of Annual Average Damages from surface water flooding across the Local Plan District. The area with the largest Annual Average Damages is Aberdeen City.

Table 2 shows the approximate numbers of further infrastructure assets which are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	20	Includes; educational buildings, healthcare facilities and emergency services.
Utility assets	190	Includes; electricity substations, fuel extraction sites and telephone exchanges.
Roads (excluding minor roads)	3,800 locations	Notably parts of the A9
Railway routes	300 locations	Aberdeen to Inverness, Aberdeen to Dundee.
Airports	1	Aberdeen (Dyce) airport.

Table 2: Infrastructure at risk of surface water flooding

Designated environmental and cultural heritage sites at risk

Within the North East Local Plan District it is estimated that approximately 180 cultural heritage sites are at risk of surface water flooding. The sites at risk include scheduled monuments, designed gardens and landscapes, battlefields and listed buildings.

The impact of surface water flooding on environmental sites has not been assessed and is assumed to be relatively low.

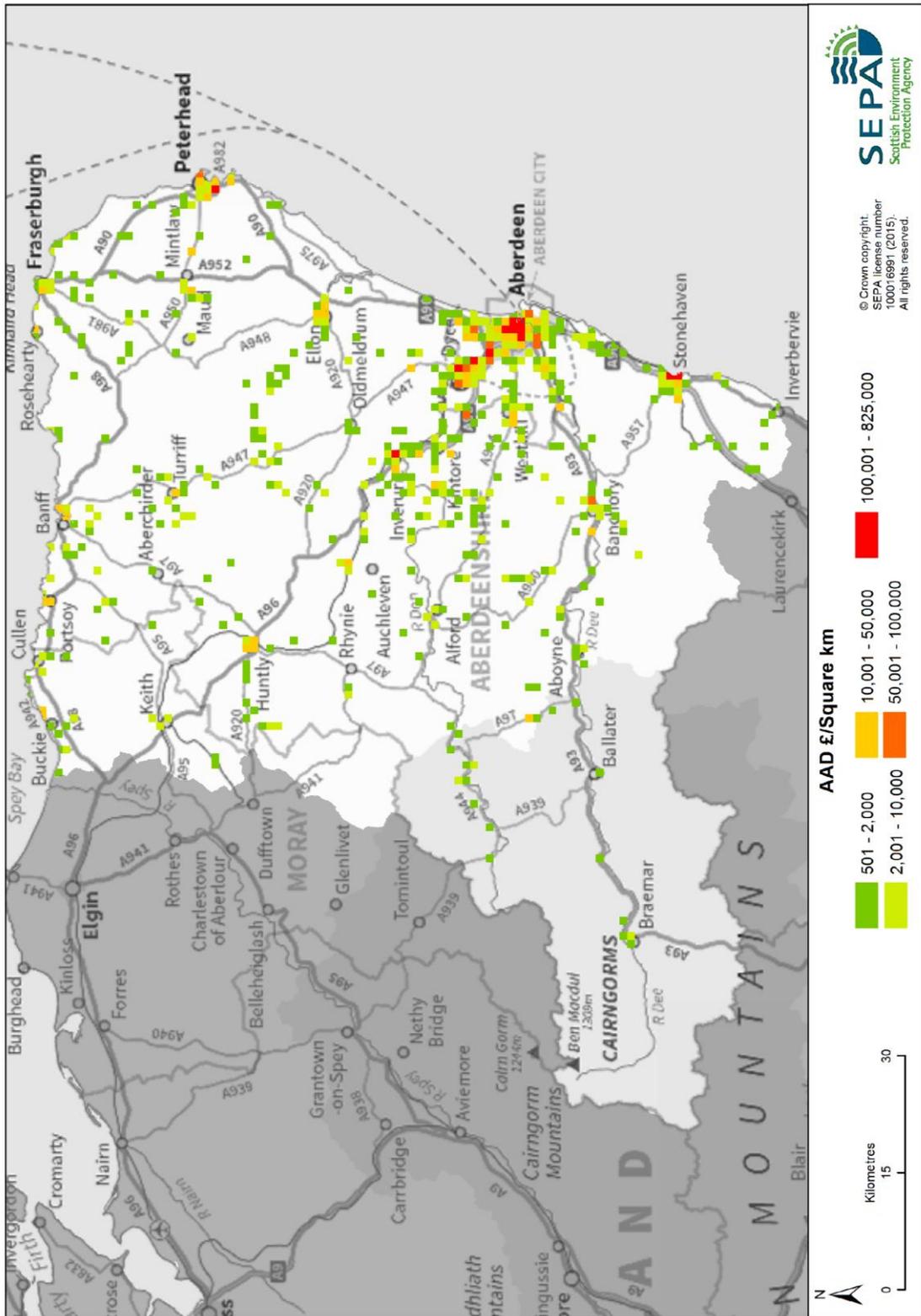


Figure 1: Annual Average Damages from surface water flooding

History of surface water flooding

In 1940 flooding occurred across low lying areas of Aberdeen, resulting in the flooding of around 50 properties. In 2012 there were several floods, including sewer flooding in the Merchant Quarter, Aberdeen and Fountainhall / Queens Cross area. The Middleton Park area of Aberdeen suffers from a high water table, which regularly causes basements there to flood. More recently in July 2015 there was extensive flooding across Aberdeen including in the Merchant Quarter. The airport terminal was also affected.

Outwith Aberdeen City, examples of localised events include flooding of residential properties in 2004 and in 2009 affecting properties in Fordyce and Aboyne. Historically, properties in Boddam, Rosehearty and Peterhead have also been affected by surface water flooding.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Existing actions that are in place to manage flood risk and that are in addition to the information presented in Section 2 are described below.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this area:

- Aberdeenshire Council provides a small range of flood protection products for individual property protection which are available for all types of flooding at cost price, with free delivery across Aberdeenshire.
- Aberdeen City Council provides grants towards the fitting of flood guards on individual properties.
- The Moray Council does not provide flood guards to private property owners. However, the flood team provides advice on how property owners can protect their own property.

Integrated catchment studies

A major study (the Aberdeen Integrated Catchment Study) is currently underway to develop a better understanding of the interaction between flooding from surface water, sewers, culverted watercourses, rivers and the sea in the Aberdeen area. The outcomes of this study will help to develop a better understanding of flood mechanisms and how flooding can be better addressed in the future. The study covers a wide geographical area including Aberdeen City, Westhill, Dyce, Peterculter, Portlethen and Stonehaven.

Surface water management priority areas

The areas at highest risk from surface water flooding have been identified as priority areas. These priority areas were identified using SEPA flood models, supplemented with evidence from historic surface water floods and, where available, more detailed modelling carried out by local authorities. These priority areas require surface water management plans to be prepared, the details of which can be found within the Potentially Vulnerable Area chapters in Section 2.

Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The surface water modelling undertaken considered climate change scenarios with a 20% increase in rainfall intensity.

Under these conditions it is estimated that the number of residential properties at risk of surface water flooding may increase from approximately 2,400 to 3,600 and the number of non-residential properties from approximately 1,700 to 2,000.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.