Scottish Environment Protection Agency
Buidheann Dìon Àrainneachd na h-Alba

For the future of our environment

# Explanatory note on the difference between our planning guidance and the Future Flood Maps

**Version 5**

25 February 2025

## Update Summary

| Version | Description |
|---|---|
| Version 2 | Update to reflect change to peak river flow projections (UKCP 2018) |
| Version 3 | Updates to reflect NPF4 adoption |
| Version 4 | Updated to reflect update to the coastal future flood maps in November 2023 |
| Version 5 | Updates primarily to reflect release of the surface water and small watercourses future flood maps in February 2025. Update formatting style. |

**Note that SEPA's guidance on Climate Change Allowances for Flood Risk Assessment in Land Use Planning represents SEPA's most up to date position on climate change related flood risk for land use planning, and the Future Flood Maps provide a strategic level indication of future sensitivities only.**

**As per National Planning Framework 4 (February 2023), for planning purposes, a site 'at risk of flooding' or 'in a flood risk area' means there is 'an annual probability of being flooded of greater than 0.5% which must include an appropriate allowance for future climate change'. This risk of flooding is indicated on SEPA's Future Flood Maps. For site specific assessments, an appropriate allowance for climate change should be taken from the latest available guidance and evidence available for application in Scotland. There are key differences between the Future Flood Maps and the guidance, and these are detailed and explained below.**

## Non-technical explanation

SEPA's Future Flood Maps (referred to as the maps hereafter) provide information on how the areas at risk of river, surface water or coastal flooding in a 0.5% Annual Exceedance Probability event may change due to climate change. These maps will be used as an initial baseline screening tool to identify areas at risk of flooding for land use planning purposes.

Users should be aware that the climate change uplifts used in some of the maps are currently based upon different projections to those used in SEPA's guidance on Climate Change Allowances for Flood Risk Assessment in Land Use Planning. Where the maps are based on different sources of climate change uplifts compared with the guidance users may wish to consider this when deciding whether a site specific flood risk assessment is required.

In short, for **coastal flooding** the maps use allowances that are smaller than those in the guidance, except for the maps in the Outer Hebrides where from November 2023 the allowances used have the same basis as the allowances in the guidance.

For **fluvial flooding,** the river maps and guidance are not consistent at the present time for both larger and smaller catchments. For catchments larger than 50 $km^2$, the maps generally use allowances that are smaller than those in the guidance.

These differences exist because both the maps and the guidance are based on UK climate projections, which are frequently refined over time due to improvements in both our understanding of the climate system and to climate modelling. Work required to update the maps in line with the projections is more resource-intensive than that required to update the guidance. As we have made a clear commitment to keep the guidance up to date so that it reflects the best scientific information available, it is likely to be the case that some differences will persist between the maps and the guidance for some time to come, though their precise form will evolve. We will keep the difference between the two products under continual review, with the longer-term aim of ensuring both are in alignment.

Flooding from watercourses with catchment areas between 3$km^2$ and 10$km^2$ is represented in *both the river and the surface water and small watercourses maps,* with different uplifts used in each map. The surface water flood map also includes representation of risk from very small watercourses with catchment areas less than 3$km^2$. More information on the different uplifts used in each map can be found in the river and the surface water flooding sections below.

For **surface water flooding** and for **flooding from small watercourses with a catchment area less than 10$km^2$** the uplifts used in the surface water and small watercourses maps and the allowances in the guidance are based on the same climate projections. Though the uplifts have been applied in the maps in a more detailed way by varying uplift by storm duration.

More detail on the current difference is provided below.

# Technical detail

## Emissions Scenario

The climate change allowances used for both the maps and the guidance are based on the UK Climate Projections.

The river and coastal maps are generally based on UK Climate Projections 2009, which was the best information available at the time when the national flood hazard modelling was carried out in 2011-2013. However, the more recent UK Climate Projections 2018 were used in the development of the guidance on sea level rise, peak river flow and peak rainfall intensity projections. They were also used from November 2023 for the coastal maps for the Outer Hebrides and from February 2025 for the surface water flood maps for all of Scotland.

The UK Climate Projections provide information on a range of possible futures depending on the level of action taken to control the concentration of greenhouse gases in the atmosphere (referred to as different emissions scenarios), and how the climate responds to changes in the concentration of greenhouse gases (exceedance probability for a particular level of change in a variable within an emissions scenario).

In both the maps and the guidance, a high emissions scenario has been used, which assumes limited or no global action to tackle climate change so that emissions continue to rise. This high emissions scenario differs in the way it has been defined in the UK Climate Projections 2009, where it is referred to as the High Emissions Scenario and the more recent UK Climate Projections 2018, where it is referred to as Representative Concentration Pathway 8.5. However, both are broadly consistent in terms of the assumed global temperature increase by the end of century.

## Coastal flooding

As noted above, for coastal flooding the maps use allowances that are smaller than those in the guidance, except for the maps in the Outer Hebrides, which were updated in November 2023.

The **maps for most of Scotland** are based on the UK Climate Projections 2009 High Emissions Scenario 95th percentile for the year 2080, while the allowances in the guidance are

based upon UK Climate Projections 2018 Representative Concentration Pathway 8.5 (high emissions scenario) 95th percentile for the year 2100.

Projections for global sea level rise increased between UK Climate Projections 2009 and UK Climate Projections 2018 largely due to improved understanding of land ice melt, so that the UK Climate Projections 2018 are higher than the UK Climate Projections 2009 for the same time frame and equivalent emissions scenario, however, there is also a difference in the time frame used for the guidance and the maps.

Comparison of the level of sea level rise used in the maps with the UK Climate Projections 2018 shows that the scenario the maps for most of Scotland are based upon is broadly equivalent to the UK Climate Projections 2018 50th percentile for 2100, for a high emissions scenario. This means that with limited global action to tackle climate change there is a 1 in 2 chance that the actual level of sea level rise will be higher than that in the maps by 2100, but only a 1 in 20 chance it will be higher than that in the guidance by 2100.

The **maps in the Outer Hebrides** are based on uplifts from the UK Climate Projections 2018 Representative Concentration Pathway 8.5 (high emissions scenario) 95th percentile for the year 2100 which is the same as the basis for the allowances in the guidance.

**Table 1** includes a summary comparison of the information used in the maps relative to the guidance.

There are a small number of other areas where alternative uplifts have been used within the maps, where the available scenario was used if it was suitably consistent with the UK Climate Projections 2009 High Emissions 95th percentile for year 2080 scenario generally used for the coastal maps. See Table 3 of the Appendix of the Future Flood Map Summary on SEPA's Developing Our Knowledge web page for more information.

## River flooding

### Catchments > 50km$^2$

For catchments larger than 50km$^2$, the maps are based on flow uplifts for river basin regions from the Centre for Ecology and Hydrology 2011 report (CEH 2011 report) for SEPA, "An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of

climate change[1]". There are some areas where alternative uplifts have been used within the maps - see Table 2 of the appendix of the Future Flood Map Summary on SEPA's Developing Our Knowledge web page.

The allowances in the guidance, for river catchments >50km$^2$ excluding catchments in Orkney and Shetland, are peak river flow allowances based on a 2020 study commissioned by the Environment Agency (and contributed to by SEPA to ensure outputs covered Scotland) and carried out by the UK Centre for Ecology and Hydrology to assess the impact of climate change on fluvial flood peaks (this study is referred to as 'CEH 2020 study[2]' henceforth). The CEH 2020 study used the UK Climate Projections 2018 (UKCP18). The guidance recommends peak rainfall intensity allowances are used for catchments of any size in Orkney and Shetland as CEH 2020 study data was only available for catchments with an area greater than 100km$^2$.

**Catchments < 50km$^2$**

For catchments smaller than 50km$^2$ the maps and guidance are also inconsistent at present.

The guidance recommends the use of peak rainfall intensity uplifts for catchments <30km$^2$ and for river catchments of any size in Orkney and Shetland. The peak rainfall intensity allowances are based on the analysis of the UKCP18 local projections published in 2021 by the FUTURE-DRAINAGE[3],[4] project and applied on a river basin region basis.

For river catchments between 30km$^2$ and 50km$^2$ (excluding those in Orkney and Shetland) the guidance recommends use of either peak rainfall intensity uplifts or peak river flow uplifts from the CEH 2020 study, depending on which uplift would produce a greater increase in flow.

[1] Kay, A., Crooks, S., Davies, H., & Reynard, N. (2011). An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change. Wallingford: Centre for Ecology and Hydrology.

[2] Kay, A.L., Rudd, A.C., Fry, M., Nash, G., Allen, S. 2021. Climate change impacts on peak river flows: combining national-scale hydrological modelling and probabilistic projections. Climate Risk Management 31 (2020).

[3] FUTURE DRAINAGE: Guidance for Water and Sewerage Companies and Flood Risk Management Authorities: Recommended uplifts for applying to design storms, 2021, Prepared by Murray Dale, JBA Consulting

[4] Chan, S.C.; Dale, M.; Fowler, H.J.; Kendon, E.J. (2021): Extreme precipitation return level changes at 1, 3, 6, 12, 24 hours for 2050 and 2070, derived from UKCP Local Projections on a 5km grid for the FUTURE-DRAINAGE Project. NERC EDS Centre for Environmental Data Analysis. https://dx.doi.org/10.5285/18f83caf9bdf4cb4803484d8dce19eef

The scenario used in the *river maps*, however, uses the peak river flow uplifts from the CEH 2011 report for all catchment sizes >3km$^2$ and in all river basin regions, including Orkney and Shetland. SEPA's river flood maps do not include modelling of flooding from very small watercourses with catchment areas less than 3km$^2$.

SEPA's surface water and small watercourses map (referred to as the surface water flood map) includes representation of flooding from small watercourses with a catchment area of <10km$^2$. Watercourses with catchment areas between 3km$^2$ and 10km$^2$ are represented in *both the river and surface water maps*. For more information on the uplifts used in the surface water map, see the surface water flooding section below.

## Surface water flooding

The guidance states that peak rainfall intensity uplifts should be used for surface water flooding.

A future surface water and small watercourses flood map has now been published. The maps used rainfall uplifts for short duration rainfall based on uplifts from the 2021 FUTURE-DRAINAGE[5] project. The FUTURE-DRAINAGE project used analysis of the UK Climate Projections (UKCP18) high resolution (UKCP Local) projections for Representative Concentration Pathway 8.5 (RCP8.5).

The surface water maps use mean rainfall intensity uplifts calculated for each river basin region for each storm duration for the 100 year return period, 2070 time horizon[6] and for the central estimate from the FUTURE-DRAINAGE project. The uplifts were applied to present day 200 year return period rainfall depth estimates.

The *surface water* maps and the guidance for peak rainfall intensity uplifts are based on the **same scenario and source of climate projection information**. Though the allowances in the guidance are based on the 3-hour storm duration, whilst uplifts used in the maps varied by

[5] FUTURE DRAINAGE: Guidance for Water and Sewerage Companies and Flood Risk Management Authorities: Recommended uplifts for applying to design storms, 2021, Prepared by Murray Dale, JBA Consulting

[6] 2070 is the central year for the 2061-2080 time period, which is the latest period available in the UKCP Local projections used to develop the rainfall uplifts.

storm duration (1-, 6-, 12-hour). The allowances used in the maps are generally smaller than those in the guidance.

The individual modelled storm duration outputs were merged together so the maps reflect the outputs from the modelled storm duration that had the higher predicted hazard in each model grid cell. More information on the modelling approach for the surface water maps can be found in the Surface Water Flooding Summary available on SEPA's Developing Our Flooding Knowledge webpage.

Within the future surface water flood map, uplifts for Orkney were applied to Shetland since Shetland is not covered by the FUTURE-DRAINAGE project, since the UKCP18 Local high resolution projections do not cover Shetland as it sits at the edge of the model area. This is consistent with the approach recommended in the guidance where uplifts from Orkney are also applied to Shetland as this is the nearest area for which data is available.

The future surface water flood map shows the predicted hazard from surface water and small watercourses with a catchment area of up to 10km$^2$. The map does not show risk from watercourses or large waterbodies which have an upstream catchment area greater than 10km$^2$.

## Planned guidance updates

The guidance will be updated based upon feedback from users and as new evidence on climate science evolves. When the guidance is updated, we will inform key stakeholders including flood risk consultants and planning authorities.

## Comparison summary

**Table 1** provides a useful summary comparison of the information used in the maps relative to the guidance.

**Table 1: Comparison of uplifts used in the maps and the guidance.**

| Flood Map | Future Flood Map Scenario | Land Use Planning Guidance Version 6 |
|---|---|---|
| **Coastal (sea level rise)** | **Outer Hebrides:**<br>UKCP18 RCP8.5 95th percentile for 2100.<br>Varies around the coast of the Outer Hebrides: 0.91-0.95m<br>**Rest of Scotland:**<br>UKCP09 High 2080 95th percentile (broadly equivalent to the UKCP18 RCP8.5 50th percentile for 2100)<br>Varies around coast: 0.46-0.63 m | UKCP18 2100 RCP 8.5 95th percentile<br>Applied by river basin region. Varies around coast 0.85-1.02 m |

| Flood Map | Future Flood Map Scenario | Land Use Planning Guidance Version 6 |
|---|---|---|
| **River (% uplift applied to high flows)** | Flow uplifts from CEH 2011 study using UKCP09 High 2080s (2070-2099) 67th percentile | For catchments > 50 $km^2$ excluding catchments in Orkney and Shetland:<br>Peak river flow allowances by river basin region based on the CEH 2020 study using UKCP18 RCP 8.5 2080s (2070-2099) 67th percentile.<br><br>For catchments 30-50 $km^2$ excluding those in Orkney and Shetland:<br>Depending on which uplift results in the greater increase in flow, either:<br>• peak river flow allowances based on the CEH 2020 flow uplift (as above).<br>• peak rainfall intensity uplift on river basin region basis using the 2021 FUTURE-DRAINAGE project (UKCP18 RCP 8.5, 50th percentile, 2070s time horizon, 3-hour duration).<br><br>For catchments < 30 $km^2$ or river catchments of any size in Orkney and Shetland:<br>Peak rainfall intensity uplift on river basin region basis using the 2021 FUTURE-DRAINAGE project (UKCP18 RCP 8.5, 50th percentile, 2070s time horizon, 3-hour duration). |

| Flood Map | Future Flood Map Scenario | Land Use Planning Guidance Version 6 |
|---|---|---|
| **Surface water and small watercourses (uplift to rainfall)** | Uplifts based on river basin region analysis of FUTURE-DRAINAGE 2021 project uplifts, RCP8.5 emissions scenario, central estimate (50th percentile) for the 2070 time horizon.<br>Uplifts for 1-, 6- and 12-hour storm durations.<br>100 year return period uplifts used as proxy for 200 year.<br>Orkney uplifts used for Shetland. | Peak rainfall intensity uplifts based on river basin region analysis of FUTURE-DRAINAGE 2021 project uplifts, RCP8.5 emissions scenario, central estimate (50th percentile) for the 2070s time horizon.<br>Single allowance using the 3-hour storm duration.<br>100 year return period uplifts used as proxy for 200 year.<br>Orkney uplifts recommended for Shetland. |

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