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Applying climate change allowances to SuDS design

This factsheet is intended for designers, LLFAs and planners. Essentially those who are involved in the process of technical evaluation, conditioning or designing SuDS for developments or those who have a vested interest in urban flooding and are required to take account of the application of climate change within design.

This factsheet considers Climate Change guidance figures which were released by the Environment Agency in February 2016. Specifically it and considers how projections for changes in rainfall and catchment responses might be applied in the process of SuDS design.

The author

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His work experience to date includes analysis and design of drainage systems using various hydraulic modelling packages and development of guidance for local authorities. As a leading specialist in the field of sustainable drainage, Anthony has been a key tutor for the (CIRIA) national SUDS training workshops since 2006, was a member of the Project Steering Group for the 2015 SuDS Manual and co-authored a SuDS Design & Evaluation Guide on behalf of 16 local authorities across England.

Introduction

Future predictions suggest that more extreme rainfall events will occur with greater regularity. To make allowance for this within SuDS calculations the current industry approach is to increase the depth / intensity of rainfall which is applied within calculations. This is generally referred to as the Climate Change Allowance.

Defra provided projections for the impact of climate change in February 2016 which includes figures for both river flow and rainfall. There is no certainty as to the exact amount of additional rainfall or the increased storminess that we can expect on a more regular basis in the future. Therefore, a range of predictions have been provided, referred to as “Upper End” projection and “Central” projection for surface water with guidance tables.

Flood risk assessments and strategic flood risk assessments assess both the central and upper end allowances to understand the range of impact from the climate change allowances. However, for the purposes of undertaking SuDS calculations a volume of storage needs to be defined, which requires guidance on how guidance figures should be applied to sizing of SuDS storage and conveyance structures.

This fact sheet has been developed based on dialogue with Environment Agency and local authorities and considers how climate change figures are likely used and applied in industry by regulators and practitioners. In many cases there is insufficient timeframes within the project to undertake detailed analysis and therefore a simple (low risk strategy) approach to identifying appropriate figures to use in SuDS calculations is considered useful. This fact sheet considers both simple and more detailed approaches.

Information provided by Defra

Table 2 from the Defra guidance on climate change which shows anticipated changes in extreme rainfall intensity in small and urban catchments is reproduced in Table 1 below

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Table 1 – Defra's table 2 peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline) (see here for information)

Peak river flow climate change allowance projections (Table 1 of Defra's guidance on flood risk assessments and climate change allowances) are generally not considered for SuDS design as they consider river catchments rather than runoff from a development site. However, Defra's Table 1 can still be relevant when LLFA's are considering sites where there is potential for both Fluvial and Pluvial risks and the potential of combined risk. Table 1 above provides projections for changes in extreme rainfall intensity in small and urban catchments and therefore are more suited to the application of SuDS calculations for proposed development. The figures from Table 1 are intended to be applied nationally.

Specific consideration may need to be given to sites where there is both fluvial and pluvial flood risk and there may be a requirement for EA and LLFAs to coordinate where main rivers are involved to avoid potential contradicting requirements.

Applying upper end projection figures (simple approach)

This approach negates the requirement to undertake detailed sensitivity analysis.

Using Table 1, a 40% increase in rainfall intensities would be applied to residential, commercial and other types of development (with exception of water compatible development) where the proposed lifespan of development exceeds 2069. In most cases residential development would be considered to have a lifespan greater than 50 years and would therefore fall into this category.

Where it can be clearly demonstrated that the lifespan of the development will not exceed 2069 (through explicit planning condition of the decommissioning / demolishment of the development for example), the use of 20% climate change applied with calculations might be considered reasonable. Any reduction in climate change allowance from '2080s' timescale should be agreed at pre-application stage with the LPA / LLFA.

Specific considerations for the calculation process include;

- Climate change allowance is applied to rainfall intensities within design calculations. For example, a 40% CCA would result in rainfall intensities being multiplied by 1.4.
- Maximum allowance discharge (flow control rate) would be retained at current day allowance as required by NSTS or Local SuDS standards where they take precedence. This will demonstrate no increase in flood risk downstream over time due to the proposed development.
- All storage would be contained within, or within immediate vicinity of, the proposed storage structure with no planned overflow routing of flows up to the 100year plus climate change allowance.

- Provision of storage for the CC Upper End projection does not negate requirement for the designer to consider exceedance where rainfall exceeds design limits or in the event of blockage of any part of the SuDS management train.

These considerations also apply to the detailed approach, with insertion of the central projection figures substituting the upper end projection figures.

Applying central projection figures (detailed approach)
Table 1 central projection figures represent the minimum climate change allowances that can be adopted in terms of calculating storage volumes. However, sensitivity tests **must** demonstrate that no unacceptable flood risks by not allowing for Upper End Projections. Sensitivity testing must demonstrate;

- no unacceptable risk to people, i.e. significant flood depths or velocities on site for sensitivity test rainfall that could present a danger to people;
- no unacceptable risk to property on site;
- no additional flood risk generated elsewhere off site.

Selection of appropriate design life is as per the advice set out in the simple approach, with substitution of central projection figures for storage calculations. Where an unacceptable flood risk is demonstrated the Upper End Projection allowances must be incorporated into design calculations for storage / conveyance.

Sensitivity testing

The extent of sensitivity testing should be proportionate to the scale of development, sensitivity of receptor and the severity of risk likely to be experienced in the event of the central projection figures being exceeded. When attenuation storage fills to capacity any additional flows generated are either likely to pond at the storage location or be conveyed elsewhere.

1. location Localised Ponding of flow at storage

Using modelling or hand calculations it is possible to calculate the depth of excess ponding water by determining the differences in rainfall runoff between central and upper end projections and where levels on site have been reasonably well defined and depth of ponding / flooding can be estimated.

Consideration should be given to:

- Selection of an appropriate rainfall duration when preforming these calculations. Modelling will allow for simulating a range of rainfall durations to be tested.
- Increasing the depth of water at the storage locations is likely to increase the outflow rate through the flow control. The design of the flow control may need to be adapted to take this into consideration.

2. Conveyance of exceedance flow to another location.

When the sensitivity test indicates potential for flows to exceed the proposed storage capacity and for runoff to flow across the surface, the designer should evaluate likely flow volumes, depths and velocities to ensure there is no significant risk to the development or people; which will therefore demonstrate that the risks can be suitably managed. Generally, depths less than 0.25m will not present a risk, but steep parts of sites may generate high velocities which may still present a hazard even at shallow depths of flow.

The guidance stated in the *Framework and Guidance for Assessing and Managing Flood Risk for New Development' (FD2320/TR2)* provides a guide establishing the hazard rating from combined flow velocity and depth. That guidance is reproduced below.

Velocity Coefficient C **0.5**

(V+C) * D

Velocity	Depth 0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25
0.50	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
1.00	0.38	0.75	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75
1.50	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
2.00	0.63	1.25	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6.25
2.50	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
3.00	0.88	1.75	2.63	3.50	4.38	5.25	6.13	7.00	7.88	8.75
3.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
4.00	1.13	2.25	3.38	4.50	5.63	6.75	7.88	9.00	10.13	11.25
4.50	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50
5.00	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38	13.75

d x (v + 0.5)	Degree of Flood Hazard	Description
<0.75	Low	Caution *"Flood zone with shallow flowing water or deep standing water"*
0.75 - 1.25	Moderate	Dangerous for some (i.e. children) *"Danger: Flood zone with deep or fast flowing water"*
1.25 - 2.5	Significant	Dangerous for most people *"Danger: flood zone with deep fast flowing water"*
>2.5	Extreme	Dangerous for all *"Extreme danger: flood zone with deep fast flowing water"*

There are various methods for evaluating overland flow velocities and depths which can range from hand calculations to detailed linked 1D/2D flood modelling as follows;

- Manning's equation can be used to estimate the likely depth and velocity of flow along anticipated (modified) flow routes.
- Hydraulic models which can simulate 2D surface runoff can be used and are likely to provide more confidence of estimated flow velocity, depth and direction across the site.

The level of complexity required for assessment will be influenced by the sensitivity of the receptors to flood risk and the complexity of the scheme in terms of layout and levels. Selection of suitable methodology is subjective and relies upon professional judgement of a suitably qualified individual.

References

Guidance – Flood risk assessments: climate change allowances.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [last accessed 22/05/2018]

Flood Risks to People Phase 2 FD2321/TR2 Guidance Document

http://randd.defra.gov.uk/Document.aspx?Document=FD2321_3437_TRP.pdf [last accessed 22/05/2018]

Framework and Guidance for Assessing and Managing Flood Risk for New Development' (FD2320/TR2) *http://evidence.environment-agency.gov.uk/FCERM/en/Default/FCRM/Project.aspx?ProjectID=b82d7708-574d-4ee2-8f02-60d91761ead5&PageID=25ed1548-e755-452a-9d94-f2fc7d984e56* [last accessed 22/05/2018]

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