SuDS design criteria for catchment flood protection

Are current criteria appropriate?

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Drainage design for catchment flood protection

- All countries of UK (roughly) in alignment, BUT
  - Is it best practice?
  - Does it effectively protect against flooding?
  - Is it cost-effective?

What about river morphology and pollution?

- Is the environment protected from urban pollution?
- Are we minimising water abstraction?
Current practice

Aligned (largely) with the SuDS Manual

- SuDS Non-statutory technical Standards LASOO (2015) - England
- Water Assessment and Drainage Assessment Guide (2015) - Scotland
- Interim standards for sustainable drainage systems (SuDS) (2016) – Wales

Surface water attenuation volume

- Peak flow control:
  - Option A) 1:1yr, 1:100yr greenfield peak flow rate with
    - Volume control for 1:100yr 6hr Greenfield volume,
  - Option B) Qbar (minimum 2l/s/ha)
- Volume control (morphology / pollution):
  - Interception (no runoff for 5mm rainfall)
- Climate change: 20% to 40%
  - Critical storm duration ~24+ hours (100 – 150mm)
Cost overview

Current national cost of storage

- Large developments
  - 10 – 15m³ / house
- Small developments
- ~ 5m³ / house
  - (due to minimum flow rate / throttle size)
- COST
  - @£500 / m³ / house @ 200,000 houses / yr = £1000M / yr!!

Is this cost effective in protecting others from flooding?

- 40% uplift on rainfall due to climate change doubles the storage volume.
So what’s wrong?

But if we are all agreed as to what we should do, why rock the boat?

- Are there inconsistencies in current design practice?
- What are the opportunities for improvement to this procedure?
- What obstacles are in the way of change?

Our challenge is to exist in harmony with the natural environment by:

- Minimise eco-system impact
- Minimise resource consumption

But we must also focus on:

- Effective flood risk mitigation
- At minimum cost
Greenfield runoff measurements

FSR / FEH / ReFH
- River-based analysis

ReFH2 current research
- Plot scale and urbanised catchments
  - Limited details available

ADAS 345 (MAFF 5) / Prudhoe and Young (LR565) and others
- Field drainage / Small catchments
  - Event duration based on site Gradient, Soil and Area

Rodda & Hawkins
- Testing greenfield runoff estimation techniques using high resolution field observations

3 Approved methods for planning
ReFH2 - 2D study on Greenfield runoff linked to site gradient

2D ICM model of 8km² catchment
- Calibrated to ReFH2 on the catchment
- Then used for predicting 1ha plot scale runoff of different site gradients

8km² steep catchment
5.5hr critical duration

1ha site
15 mins and 1 hour events
Rowden drainage experiment

- Fourteen 1 ha plots monitored 9/2006 – 12/2008
- 5 – 10% gradient
- Clayey catchment
  - IH124 predicted 1:100 yr peak flow of 18.9l/s
    - exceeded by 6 of the largest 10 peak flow events
  - ADAS 345 predicted 1:100 yr peak flow of 69.2l/s
    - exceeded by 2 of the largest 10 peak flow events

Conclusion

- Greenfield runoff rates used for planning are all (probably) wrong
- HOWEVER - using a much faster greenfield runoff rate is not necessarily appropriate for protecting downstream areas.
Reducing benefit of controlling runoff

95% of all rainfall events

Paved runoff

Interception storage design

Zone of maximum benefit for hydraulic control

Zone of diminishing benefit for hydraulic control

Attenuation storage design

+40% for climate change

Runoff proportion

Rainfall depth

0mm 20mm 60mm 100mm 250mm

5yr 1hr 100yr 6hr 100yr 24hr 100,000yr 24hr

0% 10% 50% 80% 100%

S. England July 2007 90mm 8hr

Lynmouth Aug’ 1952 229mm 12hr

Boscastle Aug’ 2004 200mm 5hr

Honister pass Dec’ 2015 340mm 24hr

Boscastle Aug’ 2004 200mm 5hr

Honister pass Dec’ 2015 340mm 24hr

90mm 8hr

229mm 12hr

340mm 24hr

100mm 24hr

100,000yr 24hr

100yr 6hr

1000yr 1hr

100yr 24hr

10,000yr 1hr

1000yr 1hr

10,000yr 1hr
Receiving river control rule strategy?

Flow rate (l/s/ha)

River flow dominated by rural runoff.

Minimal influence of runoff control on small or large catchments.

How much extra storage does 40% uplift create?

100% increase.

River not at risk of flooding - less than 10 year event

Local river flood protection

Large river flood protection

Morphology / Erosion

Interception

Rainfall intensity (mm/hr)

Rainfall depth (mm)

0mm 20mm 40mm

1hr 3hr 6hr 9hr 24hr 48hr

1:100yr + 40%

1:100yr

1:1yr

10 x Qbar / 20l/s/ha min'

~5 x QBAR / 20l/s/ha min'

QBAR / 2l/s/ha min'

100mm

150mm

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Weaknesses of current approach

- There are three “approved” methods for setting limiting discharge rates
  - FSR, FEH and ReFH2
- Discharges are not focused at catchment specific requirements.
  - Perhaps 90% of developments will be discharging to small streams / rivers
- No account is taken of diminishing proportion of additional runoff for extreme long duration events and catchments in flood from rural runoff
- There is little interest (yet) in applying volumetric rules on runoff
  - Flooding
  - Morphology
  - Pollution prevention
- Technology has yet to be used to obtain efficiencies in reducing storage volumes.