

The winter 2015/2016 floods in the UK: A hydrological appraisal

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2. Rainfall

Early autumn 2015 was

notably dry and the

majority of rivers flows

were in the normal

range.

Dec-Jan & Nov-Jan

rainfall totals established new maxima for any 2 and 3 month periods on record.

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2nd wettest winter on

record² (in a series from 1910) at 159% of

average

February was the

driest winter month.

but still registered

above average

rainfall.

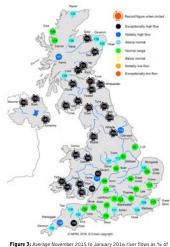
1. Introduction

• Winter 2015/2016 was defined by a procession of severe storms. bringing extreme rainfall, and widespread flooding.

entre for

- There were severe impacts on properties, infrastructure and livelihoods across northern Britain.
- This paper¹ describes the hydrological characteristics. impacts, and historical context of the event.
- Meteorological aspects and records are explored in companion papers2,3.
- The full National Hydrological Monitoring Programme report on the winter 2015/2016 will be published by November 2016.

3. River Flows



November to January mean flows (Fig. 3) show the widespread nature of peak flow maxima - with many catchments recording more than 200% of average.

New 24hr rainfall record

4th/5th Dec: 341.1mm at

Honister Pass, Cumbria

New 48hr rainfall record

4th/6th Dec: 405mm at

Thirlmere, Cumbria

Figure 1: Timeline showing major events over the winter 2015/2016 period including key rainfall red

- Great Britain outflows for winter 2015/2016 were the largest on record in a series from 1961 (Fig. 4).
- Highest recorded peak flow in the England & Wales instrumented record. The Eden, Lune & Tyne each recorded ~1700m3s-1 on 5th/6th December (Fig. 5).
- Return periods over 1-in-200 years in many catchments across northern Britain (Table 1).

River	Peak Flow (m ³ s ⁻¹)	Date	Return Period
Scottish Dee	1362.5	30 th Dec	>200
Cree	476.2	30 th Dec	150-250
Eden	1680.0	6 th Dec	>200
Tyne	1730.0	5 th Dec	100-200
Lune	1740.0	5 th Dec	100-200
Wharfe	582.0	26 th Dec	>200
Calder	276.0	26 th Dec	>200

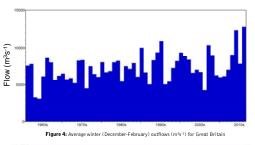


Figure 2: December 2015 to February 2016 UK Rainfall © Met Office

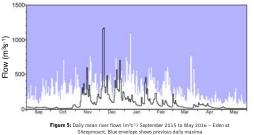


Figure 3: Average N long term average. ovember 2015 to January 2016 river flows as % of New period of record maxima circled with arrows

4. Impacts

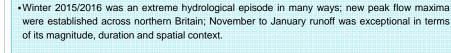
- •Flooding: Widespread flooding across northern Britain, in rural areas as well as cities (e.g. Carlisle, Leeds, Manchester, York).
- Property: Approximately 16,000 properties flooded in England in December alone more than double that of winter 2013/2014 (7,000 properties flooded4).
- Transport infrastructure: Heavily affected with numerous roads, bridges, canals and sections of railway damaged and closed.
- Business: Nearly 5.000 affected businesses across Cumbria. Lancashire, Yorkshire, Greater Manchester & Northumberland.
- Agriculture: Extensive flood plain inundation, cattle swept downstream, 2.000 sheep were lost in Cumbria.
- ·Cost: At the time of writing, £200million additional investment pledged to aid recovery. Figures suggest pay-outs will be more than £1.3billion⁵.



Figure 6: L: An RAF Chinook airlifts supplies needed to repair the Foss Barrier on the River Foss in York © Environment Agency R: Debris caught on metal fence at Ython at Ellon Gauging Station © Scottish Environment Protection Agency

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 As with previous events there was intense media coverage, some of it highly politicised; a particular focus on land use management and natural flood protection.

naford, J., Much K., Turner, S. & Parry, S. (2016) The winter 2015/2016 floods in the UK: A hydrological appraisal. Weather, (In Billens, S., Walah, S. & Kendon, M. (2017). The meteorology of the exceptional winter UC: Angenological appraisal. Weather, (in review) Billens, S., Walah, S. & Kendon, M. (2017). The meteorology of the exceptional winter of 201516 encous K and telland. Weather, (in review) New externe monthy rainfall tolais for the United Kingdom and lealand. December 2015. Weather, (in review) with M., Havandou J. & Parry, S. (2017). The winter source of 2013201 in in the United Kingdom are approaches and impacts. Weather, 70(2): 55-61 ²Barket, L., Hannalord, J., Muchan, K., Turni ²McCarthy, M., Spillane, S., Walsh, S & Keni ³Burt, S.(2016) New extreme monthly rainfal ⁴Muchan, K. Lewis, M. Hannaford, J. & Par reveal scale of

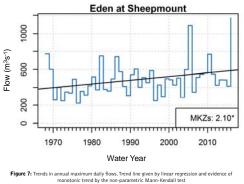


& Yany, S. (2015). The winter storms of 2013/2014 in the Ur: hydrological responses and impacts. Weath of insurance response after recent flocks, *wwakilo* cogu k. changes in UK river flows: A review of the evidence. *Prog. Phys.* Geog. 39: 29–48 , K. & Cullen, H. (2015) Climate change increases the probability of heavy rains like those of storm Desm. *en. Aydrol. Earth Syst. Sci. Discuss.* 21: 31197-13216

• Events came only two years after winter 2013/2014

flooding, making these two winters the wettest on record for the UK (in records from 1910).

5. Historical Context & Trends



- As well as further demonstrating the exceptional nature of winter 2015/2016, Fig. 7 shows a statistically significant increase in high flows on the Eden in Cumbria (since records began in 1967).
- · Currently little compelling evidence for any upward trend in long instrumented records of flood magnitude or frequency6.
- A 'real time' attribution study published in December 2015, claimed that the Storm Desmond rainfall was made 40% more likely as a result of anthropogenic warming7.

6. Summary