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Anthropogenic greenhouse gas contribution to UK autumn flood risk

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Interest in attributing the risk of damaging weather-related events to anthropogenic climate change is increasing[1]. Yet climate models typically used for studying the attribution problem do not resolve weather at scales causing damage[2]. Here we present the first multi-step study that attributes increasing risk of a damaging regional weather-related event to global anthropogenic greenhouse gas emissions.

The event was the UK flooding of October and November 2000, occurring during the wettest autumn in England & Wales since records began in 1766[3] and inundating several river catchments[4]. Nearly 10,000 properties were flooded and transport services and power supplies severely disrupted, with insured losses estimated at £1.3bn[5,6].

Though the floods were deemed a 'wake up call' to the impacts of climate change[7], anthropogenic drivers cannot be blamed for this individual event: but they could be blamed for changing its risk[8,9]. Indeed, typically quoted thermodynamic arguments do suggest increased probability of precipitation extremes under anthropogenic warming[10]. But these arguments are too simple[11,12,13] to fully account for the complex weather[4,14] associated with the flooding.

Instead we use a Probabilistic Event Attribution framework, to rigorously estimate the contribution of anthropogenic greenhouse gas emissions to England & Wales Autumn 2000 flood risk. This involves comparing an unprecedented number of daily river runoff realisations for the region, under Autumn 2000 scenarios both with and without the emissions. These realisations are produced using publicly volunteered distributed computing power to generate several thousand seasonal forecast resolution climate model simulations[15,16] that are then fed into a precipitation-runoff model[17,18]. Autumn 2000 flooding is characterised by realisations exceeding the highest daily river runoff for that period, derived from the observational-based ERA-40 re-anaylsis[19].

We find that our climate model adequately represents autumn synoptic conditions, and that our precipitation-runoff model adequately represents England & Wales runoff variability. Moreover, our model results indicate 20th century anthropogenic greenhouse gas emissions significantly (at the 10% level) increased England & Wales flood risk in Autumn 2000 and most probably about trebled it.

This pilot demonstration of the Probabilistic Event Attribution framework forms the foundation for an ongoing long-term project to provide operational attribution statements for extreme weather-related events worldwide.

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