Adapting to Climate Change

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Overview of Talk

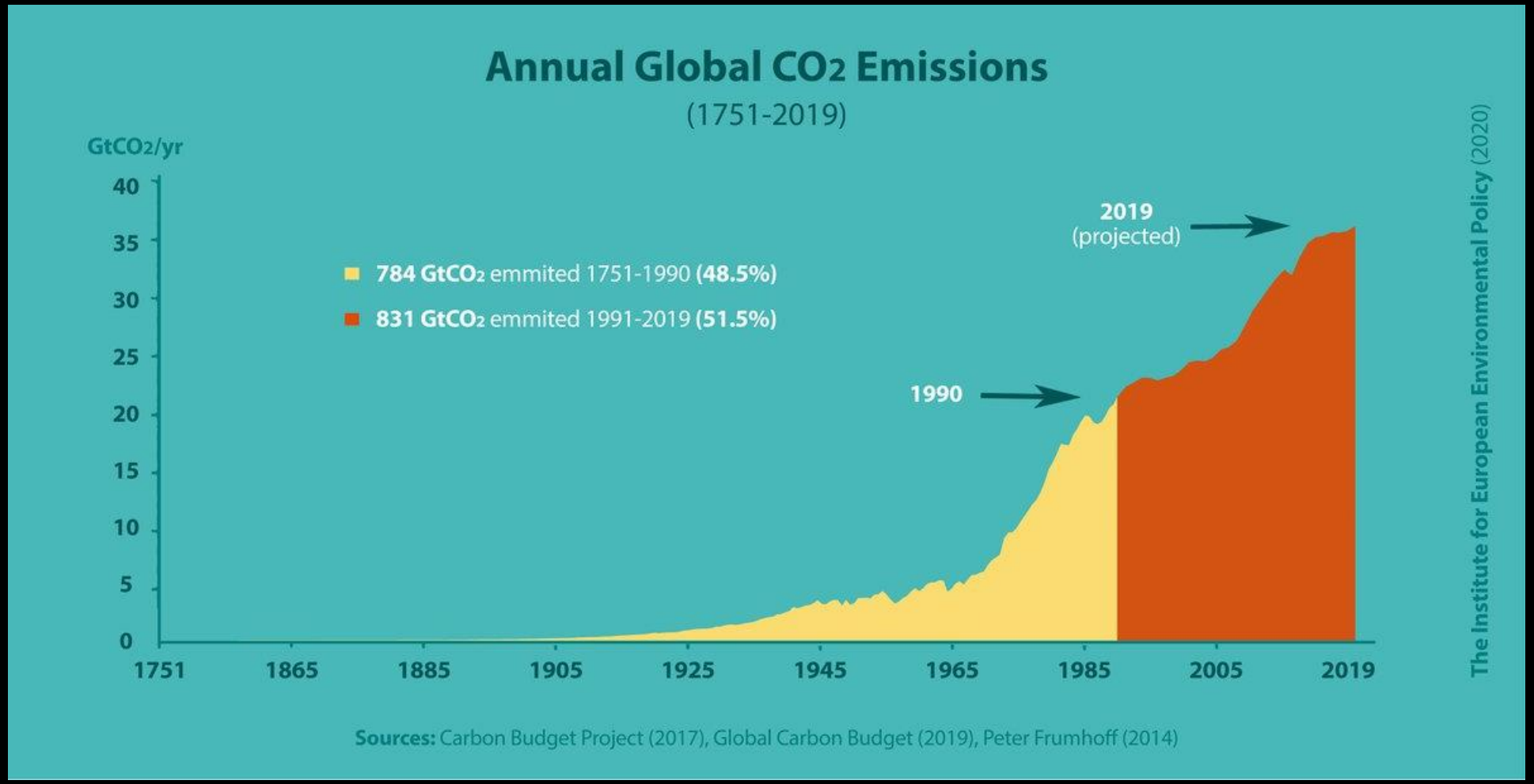
1. Why increased priority needs to be given to adaptation
2. Changing paradigms in approaches to adaptation
3. The importance of place in understanding impacts and adaptation
4. What are the impacts of adaptation actions?

Defining Adaptation

An adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. (Adger et al., 2009)

Why increased priority needs to be given to adaptation

Adaptation needs to be given added priority



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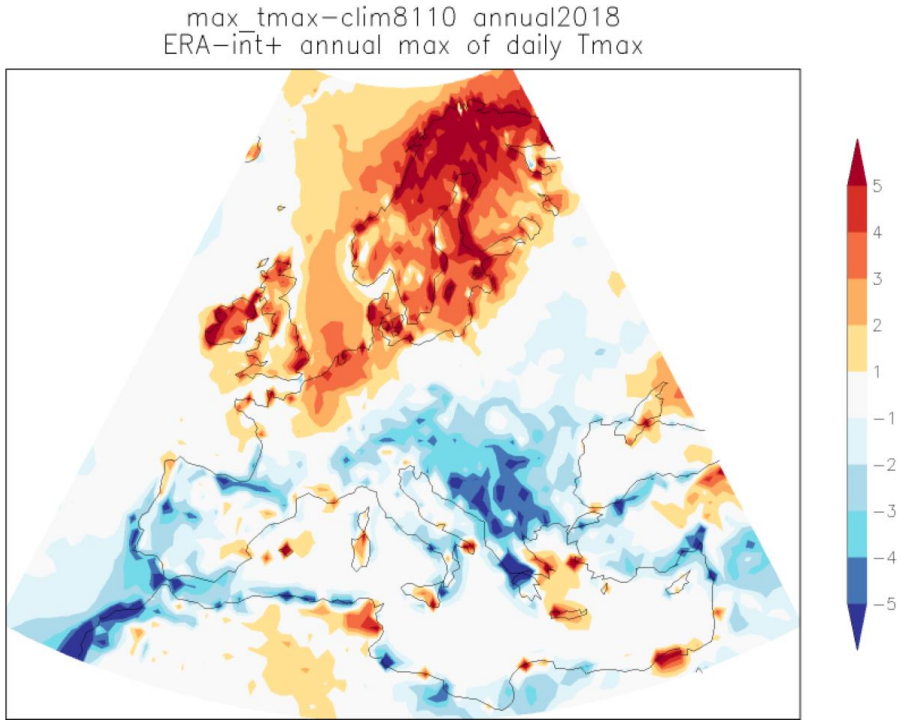
Adaptation needs to be given added priority



The hottest 3-day average of Tmax in 2018 (ECMWF analyses up to 24 July, forecasts up to 31 July) compared to the highest 3-day maximum temperature in the period 1981-2010 that is currently the “normal” period (ERA-interim). Along coasts there are artefacts from comparing the high-resolution analyses with the lower-resolution ERA-interim reanalysis. Source: Worldweatherattribution.org

In Ireland, there are clear trends towards more heat waves in the observations. Attribution study on this summer’s extreme temperatures using climate models give a very similar increase in probabilities to the observations — roughly a factor two more likely in Dublin

Summer 2018

Adaptation needs to be given added priority

Environmental Research Letters

CrossMark

OPEN ACCESS

RECEIVED
28 June 2017

REVISED
28 October 2017

ACCEPTED FOR PUBLICATION
7 November 2017

PUBLISHED
18 January 2018

LETTER

Super Storm Desmond: a process-based assessment

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Keywords: atmospheric river, climate change attribution, extratopical cyclones, North Atlantic warming

Supplementary material for this article is available online

Abstract

'Super' Storm Desmond broke meteorological and hydrological records during a record warm year in the British–Irish Isles (BI). The severity of the storm may be a harbinger of expected changes to regional hydroclimate as global temperatures continue to rise. Here, we adopt a process-based approach to investigate the potency of Desmond, and explore the extent to which climate change may have been a contributory factor. Through an Eulerian assessment of water vapour flux we determine that Desmond was accompanied by an atmospheric river (AR) of severity unprecedented since at least 1979, on account of both high atmospheric humidity and high wind speeds. Lagrangian air-parcel tracking and moisture attribution techniques show that long-term warming of North Atlantic sea surface temperatures has significantly increased the chance of such high humidity in ARs in the vicinity of the BI. We conclude that, given exactly the same dynamical conditions associated with Desmond, the likelihood of such an intense AR has already increased by 25% due to long-term climate change. However, our analysis represents a first-order assessment, and further research is needed into the controls influencing AR dynamics.

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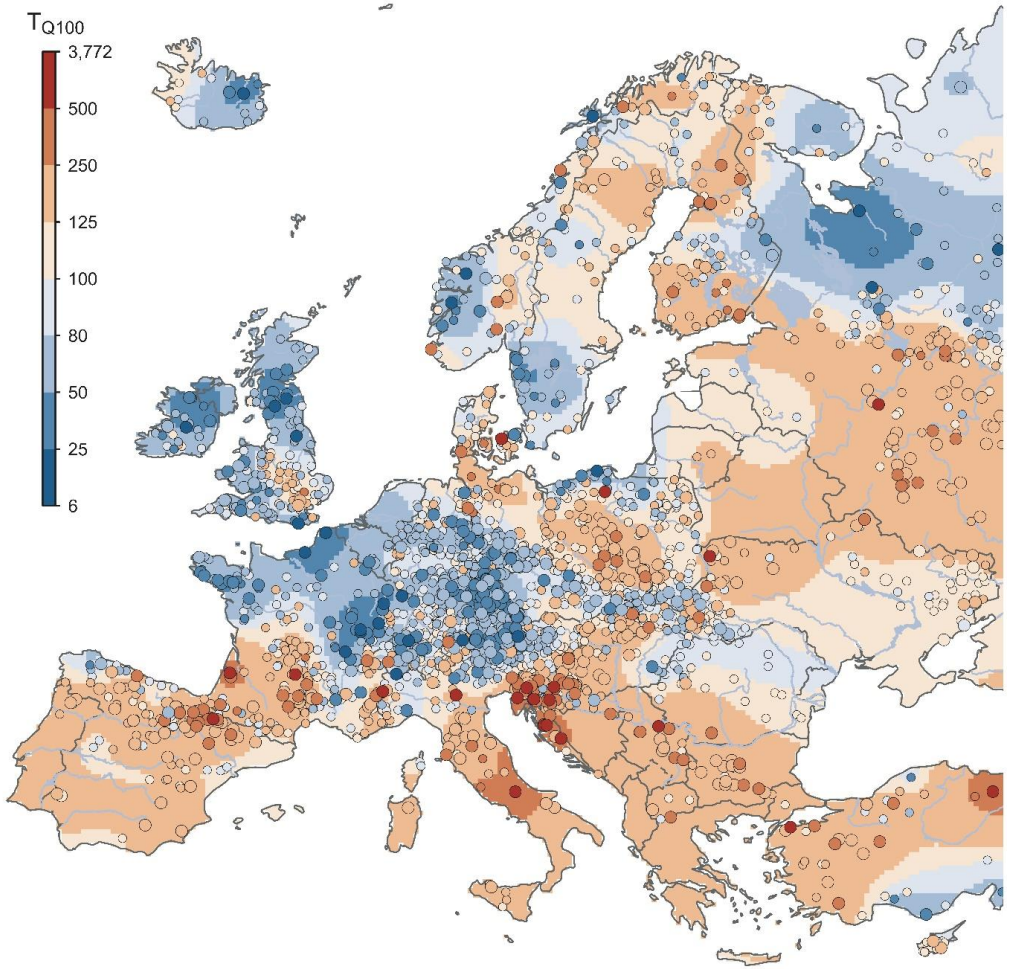
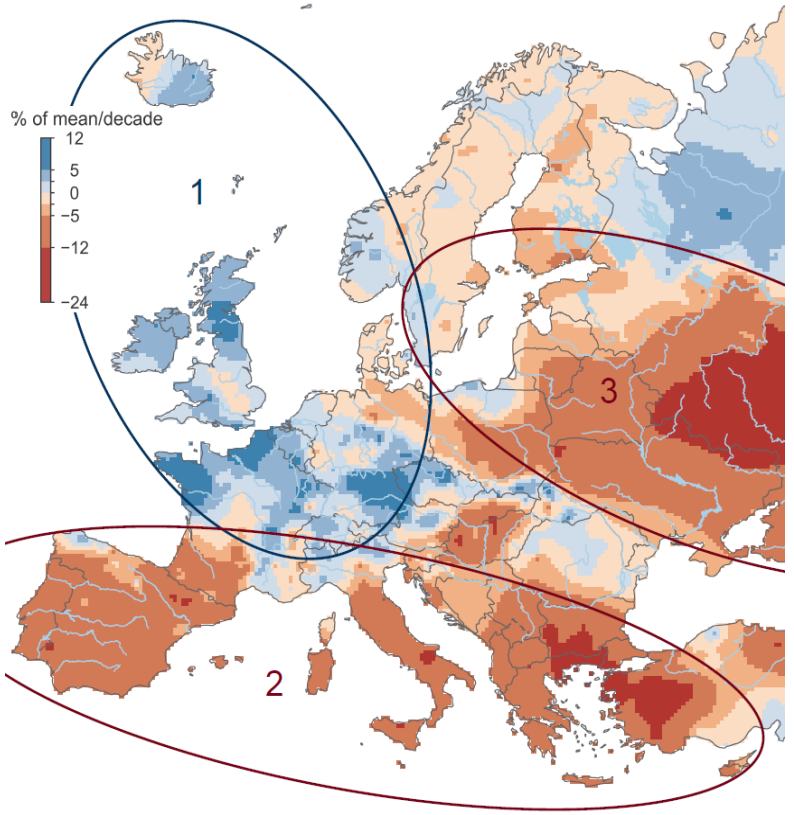


Floods getting bigger



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Bloschl et al., 2019; Nature

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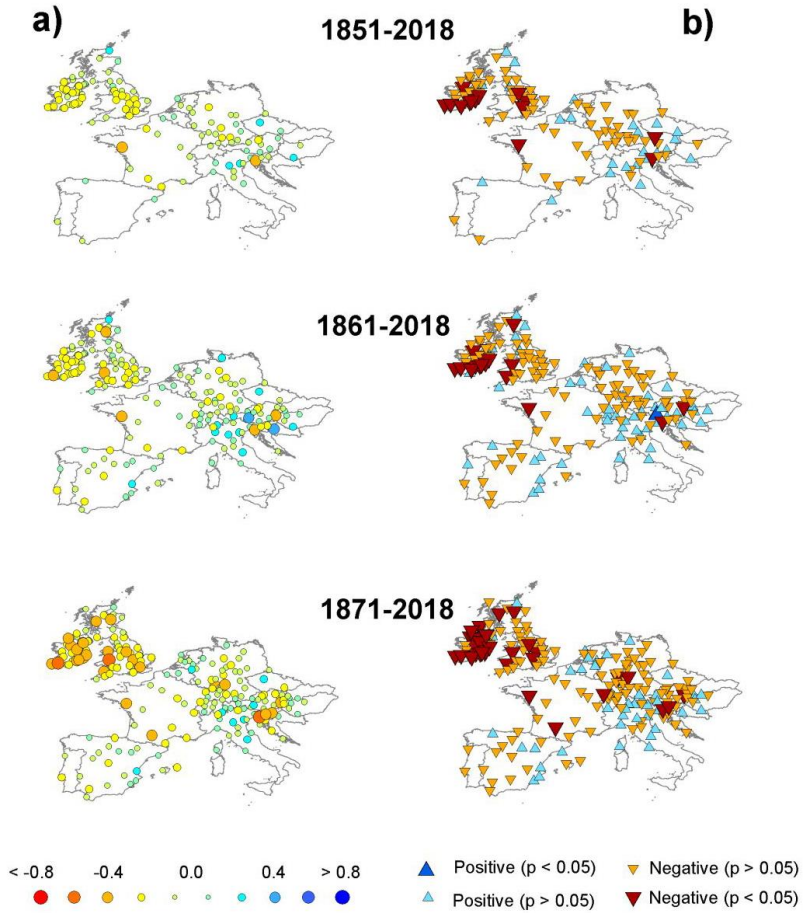

International Journal of Climatology

RMetS

RESEARCH ARTICLE

Long-term variability and trends in meteorological droughts in Western Europe (1851–2018)

Sergio M. Vicente-Serrano, Fernando Domínguez-Castro, Conor Murphy, Jamie Hannaford, Fergus Reig, Dhais Peña-Angulo, Yves Tramblay, Ricardo M. Trigo, Neil Mac Donald ... See all authors

First published: 22 June 2020 | https://doi.org/10.1002/joc.6719 | Citations: 1

Funding information: AXIS (Assessment of Cross(X) - sectorial climate Impacts and pathways for Sustainable transformation) JPI-Climate, Grant/Award Number: CROSSDRO; ERA4CS, an ERA-NET initiated by JPI Climate, Grant/Award Number: 690462; Irish Research Council for Science, Engineering and Technology, Grant/Award Number: COALESCE/2019/43; Spanish Commission of Science and Technology and FEDER, Grant/Award Numbers: CGL2017-82216-R, PCIN-2015-220; Spanish Ministry of Economy and Competitiveness, Grant/Award Number: FJCI-2017-33652; Spanish Ministry of Science, Innovation and Universities, Grant/Award Number: RTI2018-099711-J-I00; WaterWorks 2014 co-funded call of the European Commission, Grant/Award Number: IMDROFLOOD

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Abstract

We analysed long-term variability and trends in meteorological droughts across Western Europe using the Standardized Precipitation Index (SPI). Precipitation data from 199 stations spanning the period 1851–2018 were employed, following homogenisation, to derive SPI-3 and SPI-12 series for each station, together with indices on drought duration and severity. Results reveal a general absence of statistically significant long-term trends in the study domain, with the exception of significant trends at some stations, generally covering short periods. The largest decreasing trends in SPI-3 (i.e., increasing drought conditions) were found for summer in the British and Irish Isles. In general, drought episodes experienced in the last two or three decades have precedents during the last 170-years, emphasizing the importance of long records for assessing change. The main characteristic of drought variability in Western Europe is its strong spatial diversity, with regions exhibiting a homogeneous temporal evolution. Notably, the temporal variability of drought in Western Europe is more dominant than long-term trends. This suggests that long-term drought trends cannot be confirmed in Western Europe using precipitation records alone. This study provides a long-term regional assessment of drought variability in Western Europe, which can contribute to better understanding of regional climate change during the past two centuries.

Citing Literature

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Online Version of Record before inclusion in an issue

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Related Information

Metrics
Citations: 1
Am score 106

Details
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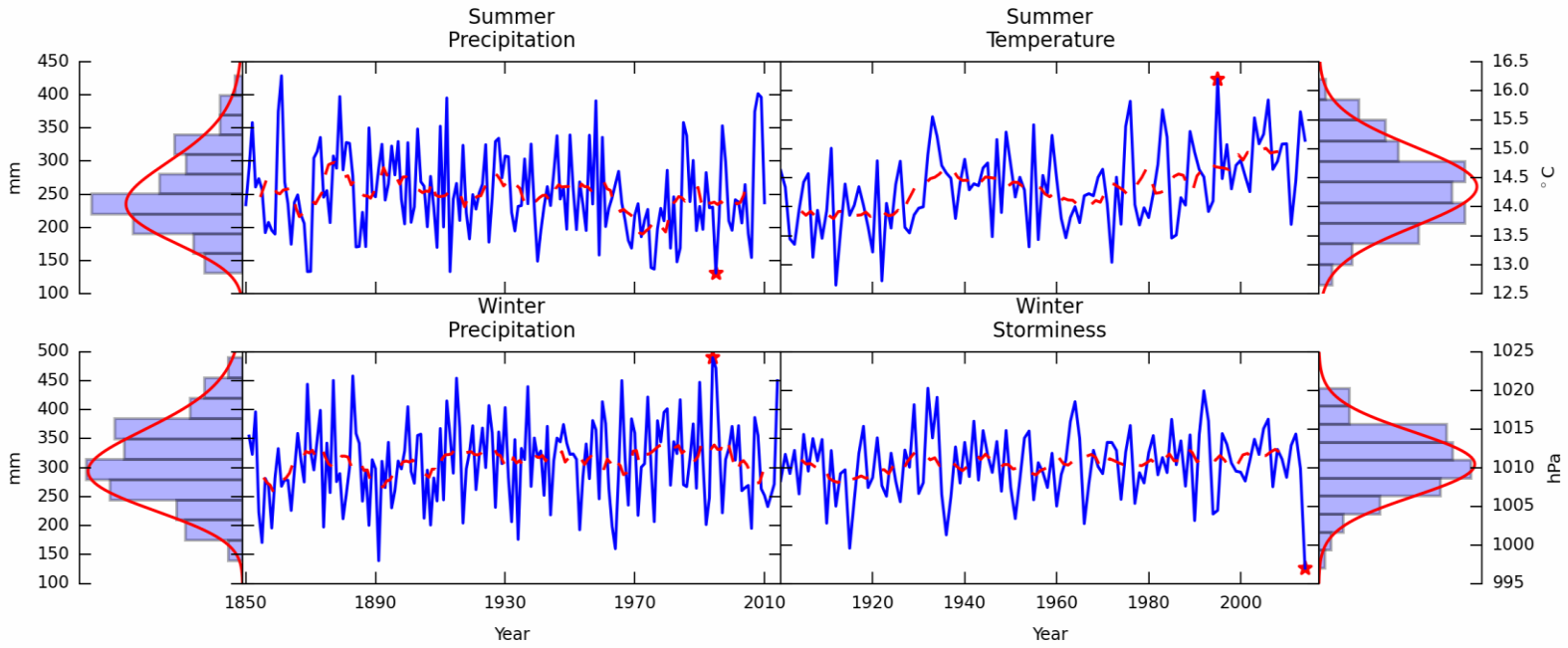
Keywords
drought instrumental period Mediterranean precipitation Standardized Precipitation Index trends Western Europe

Funding Information
• AXIS (Assessment of Cross(X) - sectorial

Spatial distribution of the magnitude of change in summer SPI (Aug SPI3) (left) and their statistical significance

Adaptation needs to be given added priority



- Over the period (1900–2014) records suggest a greater than 50-fold increase in the likelihood of the warmest recorded summer (1995), whilst the likelihood of the wettest winter (1994/95) and driest summer (1995) has respectively doubled since 1850.

ELSEVIER

Climate Risk Management

Volume 11, 2016, Pages 37-52

Past and future climate change in the context of memorable seasonal extremes

T. Matthews [a], D. Mullan [b], R.L. Wilby [c], C. Broderick [d], C. Murphy [d]

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https://doi.org/10.1016/j.crm.2016.01.004

Abstract

It is thought that direct personal experience of extreme weather events could result in greater public engagement and policy response to climate change. Based on this premise, we present a set of future climate scenarios for Ireland communicated in the context of recent, observed extremes. Specifically, we examine the changing likelihood of extreme seasonal conditions in the long-term observational record, and explore how frequently such extremes might occur in a changed Irish climate according to the latest model projections. Over the period (1900–2014) records suggest a greater than 50-fold increase in the likelihood of the warmest recorded summer (1995), whilst the likelihood of the wettest winter (1994/95) and driest summer (1995) has respectively doubled since 1850. The most severe end-of-century climate model projections suggest that summers as *cool* as 1995 may only occur once every ~7 years, whilst winters as wet as 1994/95 and summers as dry as 1995 may increase by factors of ~8 and ~10 respectively. Contrary to previous research, we find no evidence for increased wintertime storminess as the Irish climate warms, but caution that this conclusion may be an artefact of the metric employed. It is

Changing paradigms in approaches to adaptation

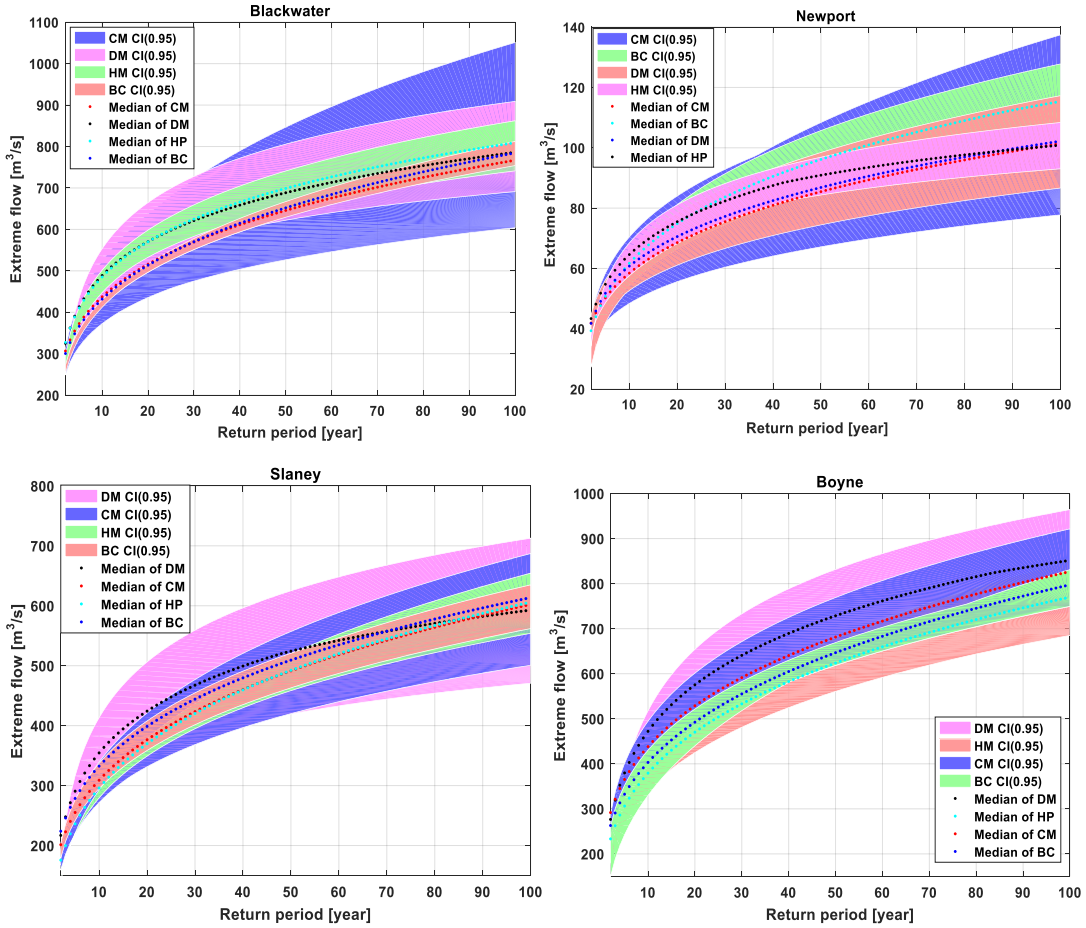
TABLE 1 | Two Paradigms

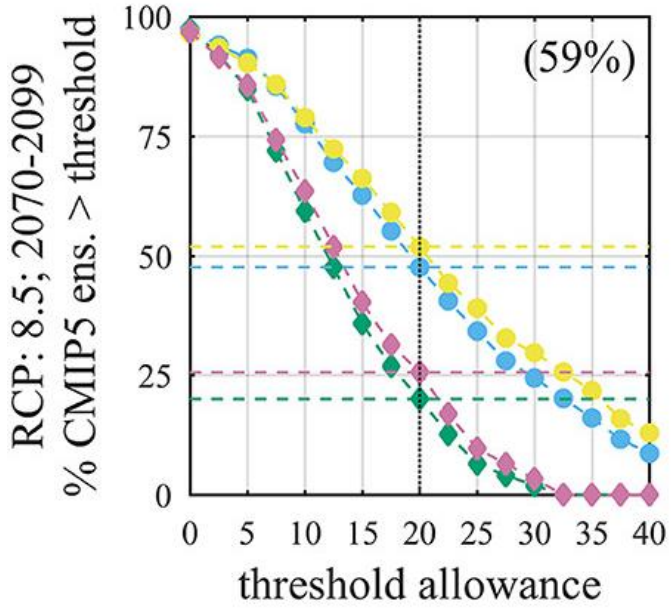
Paradigm 1: 'Predict-then-Act'
Figure out your best-guess future and design the best policy you can for that future
Conceptual framework: Maximize expected utility
Question: 'What is most likely to happen?'
Paradigm 2: 'Seek Robust Solutions'
Identify greatest vulnerabilities across full range of futures and identify the suite of policies that perform reasonably well across this range
Conceptual framework: Minimize regret
Question: 'How does my system work and when might my policies fail?'

Weaver et al., 2013

Adaptation as impacts led Vs Solutions led

Adaptation as impacts led Vs solutions led





Water Resources Research

Research Article | Open Access

Using a Scenario-Neutral Framework to Avoid Potential Maladaptation to Future Flood Risk

Ciaran Broderick, Conor Murphy, Robert L. Wilby, Tom Matthews, Christel Prudhomme, Mark Adamson

First published: 17 January 2019 | https://doi.org/10.1029/2018WR023623 | Citations: 7

SECTIONS PDF TOOLS SHARE

Abstract

This study develops a coherent framework to detect those catchment types associated with a high risk of maladaptation to future flood risk. Using the "scenario-neutral" approach to impact assessment the sensitivity of Irish catchments to fluvial flooding is examined in the context of national climate change allowances. A predefined sensitivity domain is used to quantify flood responses to +2 °C mean annual temperature with incremental changes in the seasonality and mean of the annual precipitation cycle. The magnitude of the 20-year flood is simulated at each increment using two rainfall-runoff models (GR4J, NAM), then concatenated as response surfaces for 35 sample catchments. A typology of catchment sensitivity is developed using clustering and discriminant analysis of physical attributes. The same attributes are used to classify 215 ungauged/data-sparse catchments. To address possible redundancies, the exposure of different catchment types to projected climate is established using an objectively selected subset of the Coupled Model Intercomparison Project Phase 5 ensemble. Hydrological model uncertainty is shown to significantly influence sensitivity and have a greater effect than ensemble bias. A national flood risk allowance of 20%, considering all 215 catchments is shown to afford protection against ~48% to 98% of the uncertainty in the Coupled Model Intercomparison Project Phase 5 subset (Representative Concentration Pathway 8.5; 2070–2099), irrespective of hydrological model and catchment type. However, results indicate that assuming a standard national or regional allowance could lead to local over/under adaptation. Herein, catchments with relatively less storage are sensitive to seasonal amplification in the annual cycle of precipitation and warrant special attention.

Plain Language Summary

Climate change presents a significant challenge for flood managers. Their decisions regarding the designation of vulnerable areas and investment in large-scale flood

Figure 12 Total uncertainty in flood frequency curve using 12 CMIP6 GCMs (CM), 5 bias correction methods (BC), 30,000 behavioural parameter sets (HM) and 3 extreme value distribution (DM). Shaded areas represent the 95 percent confidence interval for each component in the modelling chain while the dotted line stands for their respective median values.

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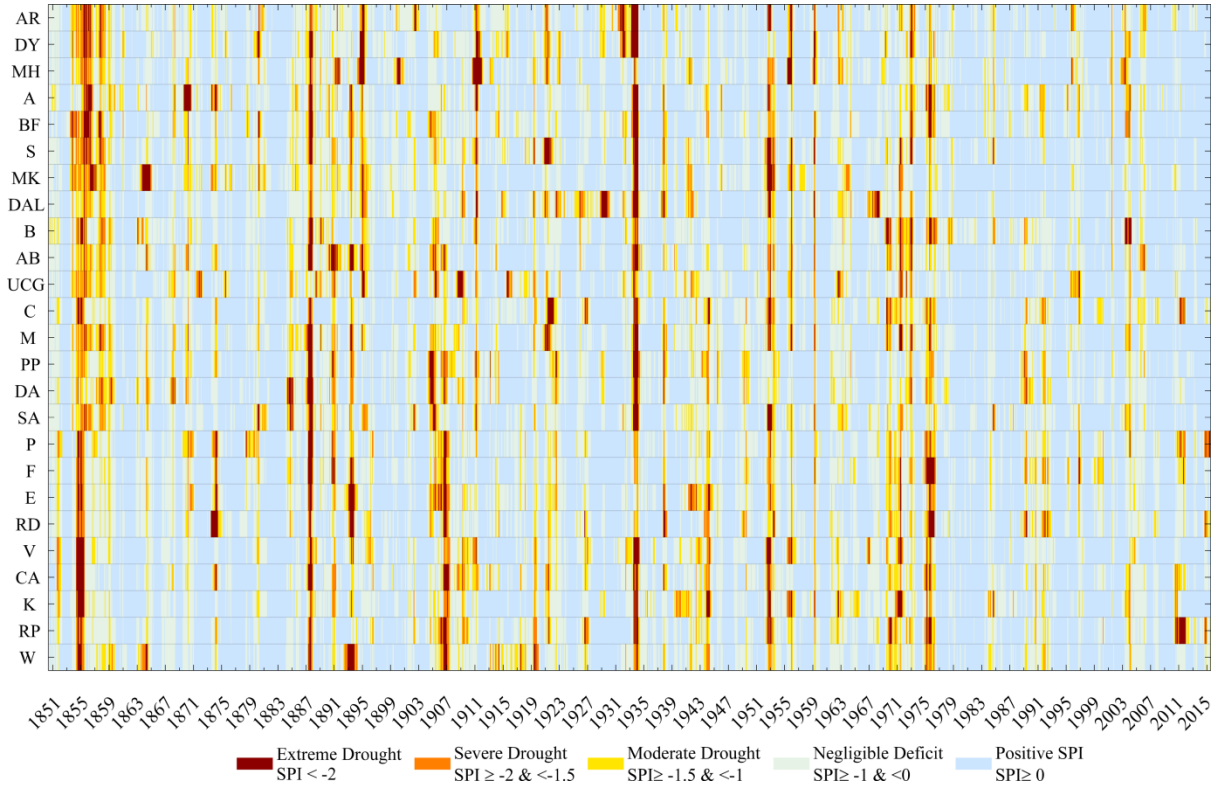
Meresa, Murphy, Fealy (2020)

We should also value long observational records for their adaptation potential



DNA of Irish Drought

Received: 27 September 2019 | Revised: 18 December 2019 | Accepted: 10 February 2020
DOI: 10.1002/joc.6521

RESEARCH ARTICLE

International Journal of Climatology | RMetS

The forgotten drought of 1765–1768: Reconstructing and re-evaluating historical droughts in the British and Irish Isles

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Funding information
Irish Research Council, Grant/Award Number: COALESCE/2019/43; Natural Environment Research Council, Grant/Award Number: NE/L01061X/1; Science Foundation Ireland, Grant/Award Number: SFI/17/CDA/4783

Abstract
Historical precipitation records are fundamental for the management of water resources, yet rainfall observations typically span 100–150 years at most, with considerable uncertainties surrounding earlier records. Here, we analyse some of the longest available precipitation records globally, for England and Wales, Scotland and Ireland. To assess the credibility of these records and extend them further back in time, we statistically reconstruct (using independent predictors) monthly precipitation series representing these regions for the period 1748–2000. By applying the Standardized Precipitation Index at 12-month accumulations (SPI-12) to the observed and our reconstructed series we re-evaluate historical meteorological droughts. We find strong agreement between observed and reconstructed drought chronologies in post-1870 records, but divergence in earlier series due to biases in early precipitation observations. Hence, the 1800s decade was less drought prone in our reconstructions relative to observations. Overall, the drought of 1834–1836 was the most intense SPI-12 event in our reconstruction for England and Wales. Newspaper accounts and documentary sources confirm the extent of impacts across England in particular. We also identify a major, "forgotten" drought in 1765–1768 that affected the British-Irish Isles. This was the most intense event in our reconstructions for Ireland and Scotland,

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Noone et al. (2017)

The importance of place in understanding impacts and adaptation

Importance of place in adaptation

- Attachment to place - connection that individuals have with the people and environments in which they live.
- Identity created around a settlement or place, the sense of pride associated with belonging to a village, town or city, and the friendships and networks that exist within them.
- Contributes to individual and community well-being and quality of life, and is widely used as an element in assessing community sustainability.
- Place attachment may also shape adaptive responses
- May inspire citizens to develop or participate in climate adaptation planning processes
- May inspire citizens to resist adaptation actions if importance of place is not appreciated

ELSEVIER

Journal of Environmental Psychology
Volume 55, February 2018, Pages 81-89

Place attachment, disruption and transformative adaptation

Darren Clarke [a], Conor Murphy [a], Irene Lorenzoni [b]

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https://doi.org/10.1016/j.jenvp.2017.12.006

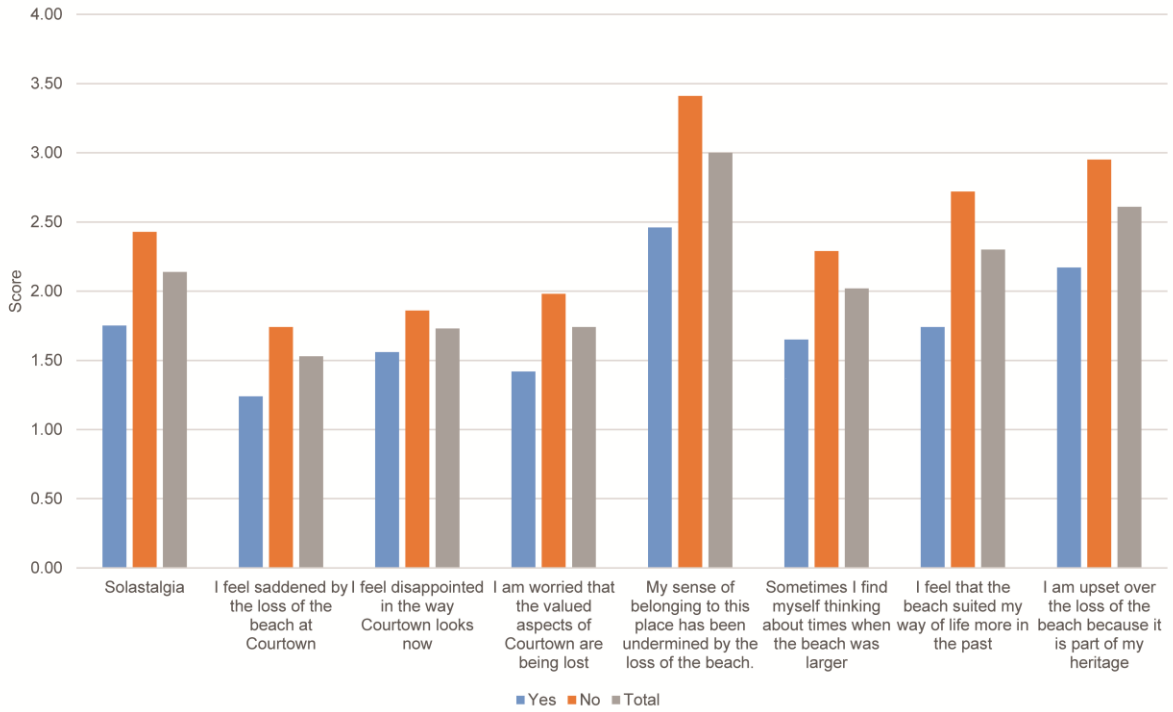
Highlights

- Transformation is likely to be resisted by individuals if it negatively disrupts place.
- Strength of place attachment is negatively correlated with perceptions of fair governance.
- Neither flood risk nor experience impact strength of place attachment or support for adaptation.
- Including the views of an entire community, not just those exposed to hazards is crucial to reduce adaptation barriers.
- Proactively managing place attachment in adaptation planning is fairer than no/delayed adaptation.

Loss of place: impacts and implications for adaptation

Place loss and well-being

- **Solastalgia** is an inability to derive solace from the present state of one's environment due to negative place disruption and has been related to a breakdown between an individual's identity and their environment.
- Solastalgia has also been associated with negative emotional responses that can influence engagement with effective coping responses and paralysis or in action towards negatively perceived environmental change.
- Our results indicate that solastalgia, resulting from loss of place is experienced by almost half of resident's, especially those who have lived in the area for >20 years.
- Seasonal variation exists for residents who experience the highest levels of solastalgia, with expression strongest in summer.
- We find that solastalgia is positively correlated with place attachment. People with higher levels of place attachment express stronger feelings of solastalgia and impacts to their lives due to loss of place.
- We also find that solastalgia is positively correlated with negative statements regarding future outlook.



Strength of solastalgia (single composite item and scale items, see Table1) for residents impacted, not impacted and total sample. The five point Likert scale responses range from: 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree. Lower scores indicate a stronger sentiment

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Phillips and Murphy (2020)

What are the impacts of adaptation actions?

Evaluating Health Impacts of Climate Change Adaptation Strategies

Neil Adger
Mumuni Abu
Catherine Butler
Sam Codjoe
Karyn Morrissey
Conor Murphy
Tara Quinn
Richard Smith

Sustainable adaptation to climate change is equitable, effective and sustainable over the long term.

Do present adaptation interventions maintain, protect and support the health and wellbeing of populations? Perhaps. But decision-making tools often use limited economic and technological metrics.

Aims

Develop an interdisciplinary evaluative tool to **incorporate the health and wellbeing impacts of interventions into sustainable adaptation**:

Develop, refine and calibrate a set of criteria for health and well-being impact evaluations of interventions, building on current knowledge of climate change adaptations.

Test sustainable adaptation by focussing on a spectrum of **flood risk adaptations**.

Sea walls enclose community resources

Living with risk has long term psycho-social impacts

Whole communities relocated with impacts on well-being

Flood adaptation strategies

Adaptation Intervention	Study Site
Planned relocation moving whole communities.	Settlements in **Volta delta** in southern Ghana.
Infrastructure interventions flood defences and levees.	Flood risk in greater **Dublin**.
Catchment resilience planning involves both building capacity to adapt to floods and remedial interventions to minimise impacts.	**Somerset** multiple interventions to enable adaptation to floods.

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University of Ghana

Conclusions

- A lot of progress has been made on adaptation in Ireland in recent years.
- A technical focus to adaptation predominates. However adaptation will happen in a complex and contested society.
- Can impacts led approaches deliver successful adaptation or do decision centric approaches that embrace uncertainty offer greater value?
- There are many sources of information beyond climate models that can be leveraged to enable adaptation.
- Understanding place and place attachment is key to adaptation.
- Impacts of climate change on well being due to place loss may be significant.
- We need to consider the impacts of adaptation strategies on health and well-being and not assume that they do no harm.

References

- Matthews, T., Murphy, C., McCarthy, G., Broderick, C. and Wilby, R.L., 2018. Super Storm Desmond: a process-based assessment. *Environmental Research Letters*, *13*(1), p.014024.
- Blöschl, G., et al. 2019. Changing climate both increases and decreases European river floods. *Nature*, *573*(7772), pp.108-111.
- Vicente-Serrano, S.M., Domínguez-Castro, F., Murphy, C., Hannaford, J., Reig, F., Peña-Angulo, D., Tramblay, Y., Trigo, R.M., Mac Donald, N., Luna, M.Y. and Mc Carthy, M., 2020. Long-term variability and trends in meteorological droughts in Western Europe (1851–2018). *International Journal of Climatology*.
- Matthews, T., Mullan, D., Wilby, R.L., Broderick, C. and Murphy, C., 2016. Past and future climate change in the context of memorable seasonal extremes. *Climate Risk Management*, *11*, pp.37-52.
- Weaver, C.P., Lempert, R.J., Brown, C., Hall, J.A., Revell, D. and Sarewitz, D., 2013. Improving the contribution of climate model information to decision making: the value and demands of robust decision frameworks. *Wiley Interdisciplinary Reviews: Climate Change*, *4*(1), pp.39-60.
- Meresa, H., Murphy, C., Fealy, R., 2020. Uncertainties and their interaction in flood risk assessment with climate change. In Prep.
- Noone, S., Broderick, C., Duffy, C., Matthews, T., Wilby, R.L. and Murphy, C., 2017. A 250-year drought catalogue for the island of Ireland (1765–2015). *International Journal of Climatology*, *37*, pp.239-254.
- Murphy, C., Wilby, R.L., Matthews, T., Horvath, C., Crampsie, A., Ludlow, F., Noone, S., Brannigan, J., Hannaford, J., McLeman, R. and Jobbova, E., 2020. The forgotten drought of 1765–1768: Reconstructing and re-evaluating historical droughts in the British and Irish Isles. *International Journal of Climatology*.
- Clarke, D., Murphy, C. and Lorenzoni, I., 2018. Place attachment, disruption and transformative adaptation. *Journal of Environmental Psychology*, *55*, pp.81-89.
- Phillips, C., Murphy, C. 2020. Solastalgia, place attachment and disruption: Insights from a coastal community on the front line. *Regional Environmental Change*, Submitted.