How will climate change affect spatial coherence of streamflow and groundwater droughts in Great Britain?

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INTRODUCTION

Streamflow (SF) droughts: different regions simultaneously in drought

How will drought coherence change in future?

SF and Groundwater (GW) simultaneously in drought within same region

How climate change will affect spatial coherence of droughts is a key question that water managers must answer, in order to adopt strategies to mitigate impacts on water resources. For example water transfers between regions have long been considered as a possible water management option. Conjunctive use of streamflow (SF) and groundwater (GW) is another common water management practice. However, in both cases, these solutions are only viable if both regions or stores are not in drought simultaneously. These relationships might change under the influence of climate change.

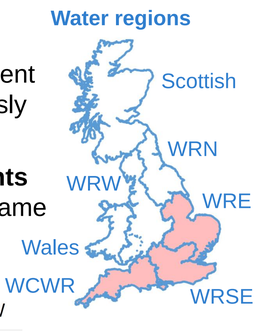
METHODS

DATA: Future droughts projections using eFLaG dataset

Baseline 1989-2018 | Near Future 2020-2049 | Far Future 2050-2079

Conditional and Joint **probabilities**

- **SF droughts** in different regions simultaneously
- **SF and GW droughts** simultaneous within same region



Future projections: 'enhanced Future Flows and Groundwater' (*eFLaG*, Hannaford et al., 2022) dataset, which are the nationally consistent transient hydrological (streamflow and groundwater) projections for the UK, based on the latest UK Climate Projections (UKCP18):

Link to eFLaG data paper

- 4 hydrological models
- 1 groundwater model
- 12 ensemble climate projections

Drought event extraction: variable (monthly) threshold method using 30th percentile (Q70) for 'moderate droughts'.

Joint and conditional probabilities: to study simultaneous SF droughts in pairs of regions, and conjunctive droughts in SF and GW within each region.

RESULTS

SPATIAL COHERENCE OF SF DROUGHTS

Figure 1 shows the joint probability of two regions being in SF drought simultaneously:

- Expected to increase everywhere in summer and autumn in future.
- Expected to remain low in winter and spring, except in South-East (regions WRE and WRSE).

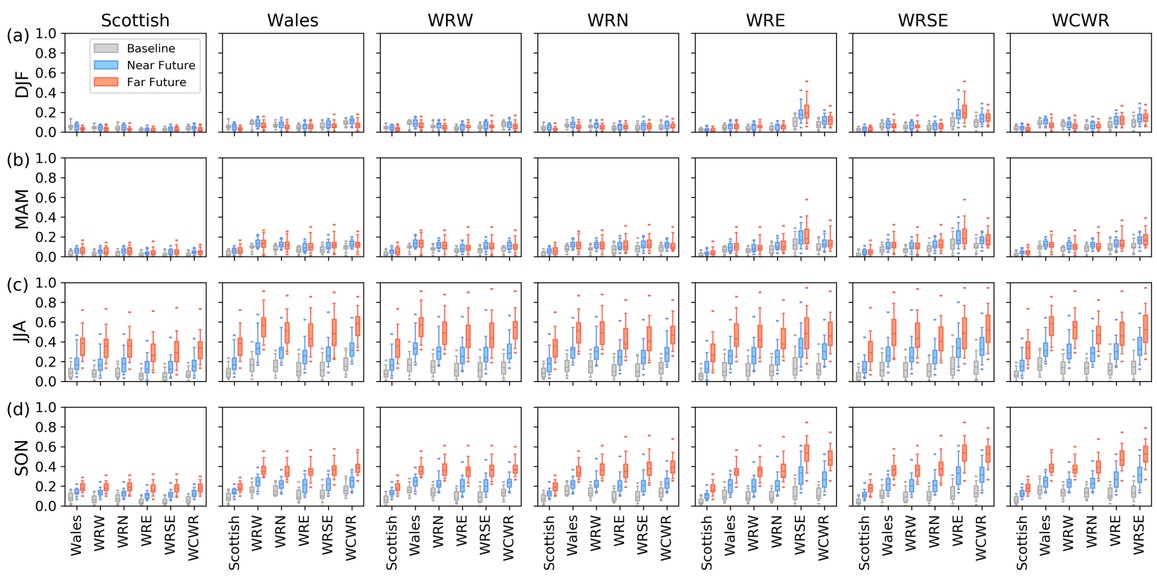


Figure 1: *Joint probabilities of each region (columns) being in drought simultaneously with every other region, for (a) DJF: winter, (b) MAM: spring, (c) JJA: summer, and (d) SON: autumn.*

SIMULTANEOUS SF AND GW DROUGHTS

Figure 2 shows that the probability of having a GW drought given that we have a SF drought in summer (Fig. 2a, JJA) is likely to decrease slightly in the far future, whereas the probability of having a SF drought given that we have a GW drought is likely to increase (Fig. 2b, JJA).

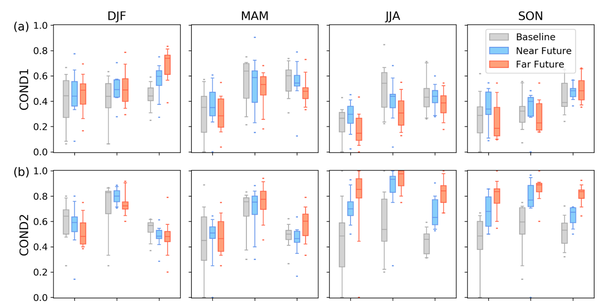
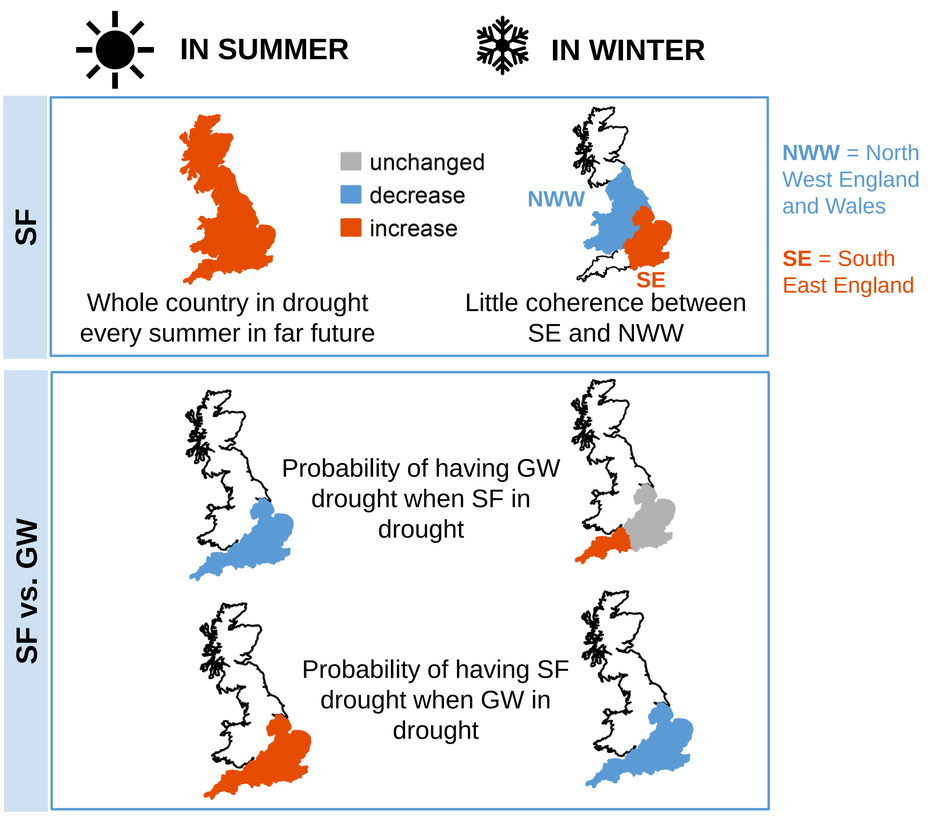


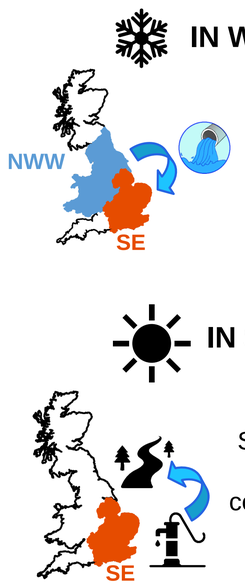
Figure 2: *Drought coherence between SF and GW within each region: (a) Conditional probability of having a GW drought given that we have a SF drought (COND1); and (b) Conditional probability of having SF drought given that we have a GW drought (COND2). The columns correspond to the seasons, with DJF=winter, MAM=spring, JJA=summer and SON=autumn.*

SUMMARY OF RESULTS



CONCLUSION

POTENTIAL SOLUTIONS for future water scarcity in South-East



The South-East of UK is the most populated and driest part of the country. It is also the part of UK where drought severity is expected to increase the most in future.

The results of our work have the potential to inform water resources planning, contributing to increase the country's future preparedness and resilience to droughts.

This flexible method, aimed at addressing drought coherence between any given regions, could be applied in any part of the world for which hydrological climate projections exist, with the potential to inform regional and national water resources management strategies.

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WHY ARE WE STUDYING FUTURE SPATIAL COHERENCE OF DROUGHTS?

BECAUSE IT CAN BE AN IMPORTANT INGREDIENT TO INFORM LONG TERM WATER RESOURCES MANAGEMENT PLANNING

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