

Drought Plan 2027

Annex 4: Drought triggers and indicators

May 2026



from
**Southern
Water** 

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Abbreviations

ABH	Abstraction borehole
ADO	Average Deployable Output
BFI	Baseflow Index
BFIHOST	Baseflow Index Hydrology of Soil Types
BGS	British Geological Survey
CSMG	Common Standards Monitoring Guidance
DI	Distribution Input
DO	Deployable Output
DP13	Drought Plan 2013
DP19	Drought Plan 2019
DP22	Drought Plan 2022
DRS	Drought Response Surface
DVF	Drought Vulnerability Framework
DYAA	Dry Year Annual Average
DYCP	Dry Year Critical Period
EA	Environment Agency
EFI	Environmental Flow Indicator
ESoR	Exceptional Shortage of Rain
HAZ	Hampshire Andover
HKZ	Hampshire Kingsclere
HoF	Hands-off Flow
HRZ	Hampshire Rural
HSE	Hampshire Southampton East
HSW	Hampshire Southampton West
HWZ	Hampshire Winchester
IOW	Isle of Wight
KME	Kent Medway East
KMW	Kent Medway West
KTZ	Kent Thanet
LoS	Level of Service
MDO	Minimum Deployable Output
MRF	Minimum Residual Flow
NEUB	Non-Essential Use Ban
PET	Potential Evapotranspiration
RMS	River Medway Scheme
RSA	Restoring Sustainable Abstractions
SBZ	Sussex Brighton
SGI	Standardised Groundwater Indices
SHZ	Sussex Hastings
SNZ	Sussex North
SPEI	Standard Precipitation and Evapotranspiration Index
SPI	Standard Precipitation Index
SWS	Southern Water
SWZ	Sussex Worthing
TUB	Temporary Use Ban
WFD	Water Framework Directive
WINEP	Water Industry National Environment Programme
WRSE	Water Resources South East
WRZ	Water Resource Zone

IMPORTANT NOTE:

This Annex is incomplete and the table below describes progress, along with work still to be completed.

Drought Triggers	Description
Annex % Complete	30%
Work Completed	<ul style="list-style-type: none"> • Scope of works for the river flow trigger development was issued • Atkins contracted to do the river flow trigger development modelling work and should complete the task at the end of October 2026 • Groundwater trigger development was done in-house, and draft groundwater triggers have been developed. • Drought Vulnerability Framework <p><i>This Annex is in draft form only. As indicated below, the content remains subject to further analysis, regulatory input and evidence and may be amended prior to finalisation of the Drought Plan. Southern Water does not invite reliance on this section in its current form.</i></p>
Work Remaining	<p>In progress:</p> <ul style="list-style-type: none"> • Final internal review of rainfall (SPI and SPEI) triggers • Updates to reservoir triggers are being completed internally and are expected to be finalised by the end of May 2025 • Atkins is progressing with the trigger development work and have completed their phase 1 report. <p>Pending:</p> <ul style="list-style-type: none"> • Internal review of environmental triggers pending
External Deliverables	<p>Consultancy support</p> <ul style="list-style-type: none"> • Modelling of streamflow triggers is being undertaken by Atkins
	<p>Regulatory support</p> <ul style="list-style-type: none"> • Review of updated groundwater triggers by July 2026 • Review of draft reservoir triggers in July 2026 • Review of draft streamflow triggers by September 2026

Drought Triggers	Description
<p>Dependencies</p>	<p>Development and finalization of drought triggers depend on the following ongoing work streams:</p> <ul style="list-style-type: none"> • With regulatory support, revision of the Section 20 Agreement so that it covers the full planning horizon of Drought 2027. This has a great impact on the modelling work. • Regulatory agreement on the Hampshire Drought Order sequencing based on River Itchen licence renewal discussions and outcomes. • Completion of the Itchen proposed licence change discussions through which the EA has stated its intention to raise the HoF, which will have consequences on the frequency of use of drought orders, TUBs and NEUBs and the evidencing of ESoR. • Final decision on our WRMP24 • Testwood April 2027 licence changes
<p>Critical Path</p>	<p>The critical path for finalising Hampshire river flow triggers is the resolution of the outstanding dependencies.</p> <p>If a conditional or phased drought plan approval is possible, all dependencies except the Section 20 agreement must be resolved, as the current agreement remains in place until 2030. Following conditional or phased approval, we will progress the Section 20 work and update the modelling to extend coverage to the period 2030–2032</p>
<p>Timeline</p>	<ul style="list-style-type: none"> • Draft updated reservoir triggers expected by end of May 2026 • Regulatory review of draft updated groundwater triggers by end of May 2026 • Atkins streamflow drought trigger development work will be completed in draft by October 2026.
<p>Decision points, meetings and workshops</p>	<p>Scheduled progress meetings are being held regularly with the consultants and internal teams working on trigger work for Drought Plan 27 (DP27).</p> <p>Meetings with regulators will be arranged to review the drought triggers for DP27.</p>

1. Introduction

This annex describes our assessment of vulnerability to drought of different durations and severity and the drought triggers we use to identify the development and progression of a drought. Since our consultation in 2021, we have had to make a number of changes to the drought plan and annexes such as this in response to regulatory feedback. We have re-submitted our draft plan to regulators in May 2022, September 2022 and February 2024. Following a letter received from Defra on 21 August 2024 we have made further changes to our draft plan and the annexes. We have also made minor changes to the appendices of this document in response to the letter received from Defra on 9 July 2025.

2. Drought vulnerability assessment

2.1 Introduction

Our 2019 Water Resources Management Plan (WRMP19) included an assessment of the drought vulnerability of our water resource zones (WRZs) under Annex 3, Section 4.5¹. In our WRMP19 assessment we considered the rainfall deficits, probabilities and impacts upon our Deployable Output (DO) of droughts of varying severity (in terms of rainfall deficit) and duration.

We based our WRMP19 drought vulnerability assessment on methods developed under the Environment Agency (EA) 'Understanding the Performance of Water Supply System during Mild to Extreme Droughts' study². We completed our assessment as part of our WRMP19 technical work prior to the publication of the Drought Vulnerability Framework (DVF)³ in late 2017. Our assessment included development of Drought Response Surface (DRS) for each of our sensitive WRZs that compares rainfall deficits to DOs across vulnerable WRZs.

Since the publication of our WRMP19, we have updated our drought vulnerability assessment in line with the updated guidance and methods set out in the DVF (UKWIR, 2017)⁴ and the results are presented herein.

2.2 Methodology

2.2.1 Data sources

The input data for our assessment are based on our supply and demand modelling from WRMP19 and are summarised in Table 1.

¹ Southern Water, 2020. Water Resources Management Plan, Annex 3: Supply Forecast

² Anderton, S., Ledbetter, R., and Prudhomme, C., 2015. Understanding the performance of water supply systems during mild to extreme droughts, Report SC120048/R Environment Agency, Bristol.

³ Counsell, C., Hunt, D., and Ledbetter, R., 2017. Drought Vulnerability Framework, UK Water Industry Research Limited, London.

⁴ *ibid*

Table 1: Summary of input data used for our drought vulnerability assessment.

Data	Description	Source
Rainfall	Stochastic rainfall for key rain gauge inputs to our water resource models	WRMP19 stochastic climate model
DO	DO of our sources	Time series of DO from our WRMP19 stochastic modelling
Demand	Distribution Input (DI) for WRMP19	Modelled DI for 2022 as set out for each WRZ in our WRMP19 water resource planning tables
Demand saving	Estimated impact (in %) of demand restrictions (Temporary Use Bans and Non-Essential Use Bans) on WRZ demand	WRMP19 Demand Savings Study ⁵ and WRMP19 water resource planning tables
WRZ imports and exports	Volume of transfers both internal and external between a WRZ and neighbouring WRZs, including that of other water companies	WRMP19 water resource planning tables
Headroom	Target headroom to account for uncertainty in our supply-demand balance	WRMP19 water resource planning tables
Outage allowance	Allowance for the volume of sites water which might not be available due to planned or unplanned outages	WRMP19 Water Resource Planning tables

2.2.2 High level screening

The first step in our assessment was to conduct a high-level screening to evaluate and evidence the WRZs that could be subject to a lower level of analysis due to their apparent drought resilience.⁶

The vulnerability of our supply system to drought varies across our supply area. This reflects differences in rainfall patterns and the nature of water resources and the varying proportions of groundwater, rivers and reservoirs that make up our supplies

The amount of water that we can supply to some WRZs is limited either by our abstraction licences or by the amount we can safely treat. These WRZs tend to show a high degree of resilience to drought. A full drought vulnerability assessment of these WRZs would provide only limited benefit.

We have applied the high-level screening process set out in the DVF⁷ to all of our WRZs. Any WRZs that could meet either, or both, criteria below are screened out from detailed assessment:

1. For run-of-river and groundwater dominated WRZs, the amount of DO that is at risk from drought is smaller in percentage terms than the following calculation:

$$[Available\ headroom\ net\ of\ outage\ (DO - demand - target\ headroom)] / DO$$

⁵ Atkins, 2017. Effectiveness of Restrictions Technical Note, Southern Water Drought Plan.

⁶ Counsell, C., Hunt, D., and Ledbetter, R., 2017. Drought Vulnerability Framework, UK Water Industry Research Limited, London.

⁷ Ibid

2. For more complex WRZs, the combined impact of the extreme drought risk (as outlined in Table 10 of the WRMP19) and climate change is less than 5% of DO, and available headroom is more than twice the target headroom.

In either case, a supply-demand deficit due to drought is implausible.⁸

The majority of our WRZs are assessed under the first category. 11 of our 14 WRZs are groundwater or run-of-river dominated with only minor or no reservoir storage. The remainder are more complex WRZs with some reservoir storage, and large inter-zonal transfers. This includes the Kent Medway East (KME) WRZ, which although is 100% groundwater, is closely interconnected with the Kent Medway West (KMW) WRZ and our reservoir system in Kent - The River Medway Scheme (RMS). The key supply characteristics of each of our WRZs are summarised in Table 2.

Table 2: Key supply characteristics by DO proportion of each of our WRZs⁹.

WRZ	Screening Criteria	Groundwater	Run of River	Reservoirs	Transfers
Hampshire Kingsclere (HKZ)	1	100%	0%	0%	0%
Hampshire Andover (HAZ)	1	100%	0%	0%	0%
Hampshire Winchester (HWZ)	1	100%	0%	0%	0%
Hampshire Rural (HRZ)	1	100%	0%	0%	0%
Hampshire Southampton East (HSE)	1	48%	52%	0%	0%
Hampshire Southampton West (HSW)	1	0	100%	0%	0%
Isle of Wight (IOW)	1	47%	23%	0%	30%
Sussex North (SNZ)	1	35%	51%	8%	6%
Sussex Worthing (SWZ)	1	100%	0%	0%	0%
Sussex Brighton (SBZ)	1	100%	0%	0%	0%
Kent Medway West (KMW)	2	44%	56% (Run of river and reservoirs)		0%
Kent Medway East (KME)	2	100%	0%	0%	0%
Sussex Hastings (SHZ)	2	5%	0%	79%	16%
Kent Thanet	1	77%	0%	0%	23%

To carry out the screening criteria for the groundwater and run-of-river dominated WRZ the available headroom net of outage was calculated according to the screening criteria equation where:

DO = DO at a given drought probability. The amount of DO at risk from drought was determined as the difference for a given drought against the calculated normal year DO.

Demand = Taken to be the forecast 2022-23 WRZ DI as set out in our WRMP19 planning tables.

Target headroom = Taken to be the WRZ target headroom for 2022-23 as set out in our WRMP19 planning tables.

⁸ Southern Water, 2019. Securing a resilient future for water in the South East: Our Water Resources Management Plan for 2020–70.

⁹ Ibid

The results of the high-level screening are presented in Table 3.

Table 3: Results by WRZ of High-level drought vulnerability screening against criteria 1. Y = WRZ is potentially drought vulnerable; N = WRZ may be screened out from detailed analysis.

	Drought return period	IOW*	HWZ*	HSW*	HSE*	HRZ*	HKZ*	HAZ*	SNZ*	SBZ*	SWZ*	KTZ*	KME*	KMW*	SHZ*
Minimum or Dry Year Annual Average	1-in-2 years	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N
	1-in-20 years	Y	N	N	Y	N	N	N	Y	N	N	N	N	N	N
	1-in-100 years	Y	N	Y	Y	N	N	N	Y	Y	N	Y	N	N	Y
	1-in-200 years	Y	N	Y	Y	N	N	N	Y	Y	N	Y	N	N	Y
	1-in-500 years	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	N	N	Y
	1-in-1000 years	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	N	N	Y
Dry Year Critical Period	1-in-2 years	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	1-in-20 years	Y	N	N	Y	N	N	N	N	N	N	Y	N	N	N
	1-in-100 years	Y	N	N	Y	N	N	N	Y	N	N	Y	N	N	N
	1-in-200 years	Y	N	Y	Y	N	N	N	Y	N	N	Y	N	N	N
	1-in-500 years	Y	N	Y	Y	N	N	N	Y	Y	N	Y	N	N	N
	1-in-1000 years	Y	N	Y	Y	N	N	N	Y	Y	N	Y	N	N	N

*see Table 1 for WRZ names.

The results of high-level screening against the first criteria show there are five ‘simple’ WRZs that are screened out from detailed assessment. These are HWZ, HRZ, HAZ, HKZ (northern Hampshire, Western area) and KME (Eastern area). The four northern Hampshire WRZs were also not considered in our WRMP19 drought vulnerability assessment.¹⁰ These WRZs are 100% dependant on groundwater and our water resource modelling for WRMP19 indicated that the yield of these groundwater sources is either licence or infrastructure constrained and is not sensitive to drought or climate change. In addition, the DO of each of these WRZs exceeds forecast demand and target headroom.

¹⁰ Southern Water, 2020. Water Resources Management Plan, Annex 3: Supply Forecast.



KME is dominated by groundwater but receives some water through internal transfers from the neighbouring KMW WRZ. KME is relatively drought resilient, whilst there are some drought sensitive sources, the WRZ demand is low compared to the DO available. There are also a number of non-drought sensitive infrastructure or licence constrained sources which are able to maintain supplies.

The high-level screening ignores the effect of transfers considering only the native WRZ DO. This affects some WRZs which are dependent upon transfers from neighbouring WRZs such as the IOW and KTZ. If these transfers were included in the baseline DO, then these WRZs would be more resilient.

Of the more 'complex' WRZs that include or are closely linked to a degree of WRZ storage; KMW and SHZ pass the first screening assessment for Dry Year Critical Period (DYCP), but SHZ fails for the Dry Year Annual Average (DYAA) period. When considered against the second screening criteria for WRZs that are more complex only KMW has sufficient headroom to pass by itself. However, if considered collectively, given the interlinked nature of the WRZs, then both fail.

2.2.3 Characterisation of supply system and calculation approach

Following the high-level screening, the DVF must next consider the most appropriate modelling approach based on the available water resource assessments (from WRMP19) and the availability of data and models which can be applied.

All of our drought rainfall data and hydrological and hydrogeological water resource modelling for WRMP19 was undertaken using stochastic water resource models. Rainfall and Potential Evapotranspiration (PET) data were undertaken using an enhanced weather generator developed at Newcastle University¹¹. We have 2,000 years of modelled coherent rainfall, runoff, groundwater, and DO data across our WRZs.

For our 'simple' groundwater and run-of-river dominated WRZs, DO was based on additive assessment of source-by-source DOs at a range of drought severities. System simulator or behaviour models were only used to assess DO where there were conjunctive use benefits from supply system storage.

Our WRZs are therefore classified under the DVF as being consistent with DVF approach 1a or 1b.¹² For the WRZs being assessed full rainfall deficit/flow analysis is carried out.

Our assessment considered rainfall deficits and accumulations from 3 to 60 months and droughts ending in the calendar months from July to December. The inclusion of shorter period rainfall deficits (3-month intervals) was considered following recent drought permit experience for the River Test.

2.2.4 Selection of 'month ending' attribute

The 'month ending' attribute relates to the period up to which rainfall deficits are calculated and the period at which 'failures' occur, or periods when abnormal restrictions might occur.

¹¹ Serinaldi, F. and Kilsby, C., 2012. A modular class of multisite monthly rainfall generators for water resources management and impact studies. *Journal of Hydrology* 464-465, pp. 528-540.

¹² Counsell, C., Hunt, D., and Ledbetter, R., 2017. *Drought Vulnerability Framework*, UK Water Industry Research Limited, London.

For the majority of our WRZs, key deficits and failures are driven by supply-demand deficits for the Average Deployable Output (ADO) or Minimum Deployable Output (MDO) period. This reflects the run-of-river and groundwater dominance of such WRZs where supplies become most constrained during the time of minimum flow or low groundwater level typically in the autumn or early winter.

We have characterised each of our WRZs according to our understanding of their historical drought response and the composition of their supplies Table 2. Our characterisation is presented in Table 4.

Table 4: Selection of the two ‘month ending’ response surfaces for our WRZs.

Timing	Summer Critical Period (peak week) driven	ADO/MDO driven; small storage, flashy	ADO/MDO driven; medium storage, normal (groundwater recession)	ADO/MDO driven; high storage, slow (groundwater) recession
WRZs in category		IOW, SBZ, SWZ	HSW, HSE, SNZ, KTZ	KMW, SHZ, KME
Early ‘Month Ending’ DRS	Ending July	Ending July	Ending August	Ending September or October
Late ‘Month Ending’ DRS	Ending August	Ending October	Ending November	Ending November or December

Irrespective of the recommended response surface, our DVF assessment has been carried out in a semi-automated way such that it is straightforward to calculate a DRS for any given month ending and rainfall accumulation period. We have therefore considered all the data for droughts ending from July through to December and present the most appropriate data that best characterises each WRZs drought vulnerability.

2.2.5 Selection of demand level

The DRS is required to be generated for a single, specified level of demand to be used within the behavioural model or other assessment of WRZ failure (e.g. for comparison to DO). Four possibilities are presented under the DVF¹³:

1. Total WRZ demand (DI)
2. Total WRZ demand plus target headroom
3. Total WRZ demand plus target headroom and outage
4. Demand equivalent to DO

The framework recommends that the primary assessment of drought vulnerability should be against demand Level 2 (Demand plus target headroom) and this corresponds to our main assessment. We have also produced DRS plots for demand Level 3 (Demand plus target headroom and outage).

¹³ Counsell, C., Hunt, D., and Ledbetter, R., 2017. Drought Vulnerability Framework, UK Water Industry Research Limited, London.

Although we have not directly assessed against Level 4 (Demand equivalent to DO), we have generated response surface plots for scenarios equivalent to that under the ‘Mild to Extreme Droughts Study’¹⁴ which examines the relationship between rainfall deficits, drought duration and decline in DO. We have also plotted additional DRS plots that relate rainfall deficit and drought duration to hydrological variables that characterise each WRZ, such as key flow time series or groundwater levels at indicator boreholes. Although not required by the DVF or for the vulnerability assessment, these analyses provide useful additional context that can more readily be related to drought trigger levels.

We have not considered an assessment at demand Level 1.

The data for our demand levels are based on that presented in our water resource planning (WRP) tables for the period 2022-23 which represents the first year of this Drought Plan (DP22). Our forecast demand profiles typically decline due to our planned water efficiency and leakage reduction programme and hence this represents a worst-case demand scenario for the period covered by this plan.

- The value for demand is the DI - line 11FP in the WRP tables
- The value for target headroom is the target headroom allowance - line 16FP in WRP tables
- The value for outage is the WRZ outage allowance - line 10BL in WRP tables

All of these data are based on the DYAA/MDO WRP tables.

2.2.6 Demand management and drought permits/orders

We have included the benefits demand side effect of demand restrictions for Temporary Use Bans (TUBs) and Non-Essential Use bans (NEUBs) in our drought vulnerability assessment. This is consistent with our approach to completing Table 10 of the WRP tables. The magnitude of demand saving benefits are based on those assumed for WRMP19¹⁵ and are summarised in Table 5.

Table 5: Summary of demand side benefits of restrictions applied to DI for failure assessment based on our MDO period.¹⁶

Supply area	WRZs	Effectiveness of TUBs and NEUBs (MDO period)
Western	HKZ, HAZ, HRZ, HWZ, HSE, HSW, IOW	3%
Central	SNZ, SBZ, SWZ	3%
Eastern	KMW, KME, KTZ, SHZ	2%

We have excluded the supply-side benefits of demand savings and the benefits associated with any drought permits/orders. This reflects that the benefits are uncertain and that they do not provide long-term resilience. For example, our target level of service (LoS) and reliance on drought permits/orders is expected to reduce as other planned water resource schemes provide a greater degree of resilience.

¹⁴ Anderton, S., Ledbetter, R., and Prudhomme, C, 2015. Understanding the performance of water supply systems during mild to extreme droughts, Report SC120048/R Environment Agency, Bristol.

¹⁵ Atkins, 2017. Effectiveness of Restrictions Technical Note, Southern Water Drought Plan.

¹⁶ Ibid

Where our drought vulnerability assessment has been applied outside of a behavioural model then we have made simplifying assumption that the benefits are always on. Whilst this is inconsistent with our stated LoS for TUBs and NEUBs, we would generally not expect significant supply failures to occur in normal to mild droughts (<1-in-20 years return period) except for HSW where we recognise the significant risk to the WRZ and its reliance on drought permits/orders.

2.2.7 Other supply and demand assumptions and failure calculations

In applying our vulnerability assessment, we have applied a consistent set of assumptions around other elements of our supply-demand balance. These elements are not covered in detail by the DVF and our assumptions are set out in Table 6.

As the majority of our WRZs are dominated by supplies from run-of-river or groundwater supplies we have assessed system failures. For systems where there is no storage, failures are calculated to occur where:

$$WRZ\ DO + Imports - Exports < WRZ\ DI + Target\ headroom\ (for\ demand\ Level\ 2)$$

Where

WRZ DO is input as time series outputs from our water resource modelling.

Imports and Exports are fixed values from our WRP tables.

DI is the fixed WRZ DI for 2022-23 from our WRP tables.

Target headroom is the fixed target headroom for 2022-23 from our WRP tables.

For assessment against demand Level 3, outage is included as an additional demand (DI) volume.

Table 6: Other assumptions in our drought vulnerability assessment.

Supply-demand element	Assumption
Process losses	Excluded from our assessment, generally these are small and vary with DO. Process losses are not considered in WRMP19 Table 10.
Imports and exports	Net effect on WRZ DO included in our assessment. Although we have generally excluded transfers from WRMP Table 10, these volumes are important for maintaining supplies in some WRZs and may increase drought vulnerability in others.
Residual calculation to account for integrated risk model/scenario generator model approach - includes allowance for uncertain sustainability reductions	We have excluded this additional volume, which accounts for our risk-based planning approach rather than target headroom. Uncertain sustainability reductions have also been excluded but they are important drivers of supply demand deficits and increasing drought vulnerability in some WRZs.
Climate change	As our climate change modelling approach is probabilistic, it is inappropriate to apply a single climate change factor to our DO. Climate change may either increase or decrease DO and therefore we have excluded its effects in our assessment that is based on our baseline DO. Use of the baseline DO is consistent with how we have completed WRMP Table 10.
Other supply demand schemes	Where other supply-demand schemes (e.g. increased water efficiency) are expected to be in place by 2022, we have included the impact of these schemes in our baseline DO. Note that this excluded the supply-side benefits of any drought permits/orders.

For the more complex WRZs where storage in surface water reservoirs is a major component of supply, the full 2000-years stochastic flow sequence has been modelled in our behavioural Aquator model of our

Eastern area. These WRZs (KMW, KME and SHZ) have been combined into a single vulnerability assessment due to the conjunctive use for these WRZs and the transfers between them.

The underlying calculation and generation of our DRS plots has been produced in Python code. This allows semi-automated construction of DRS plots, rainfall deficits and probability plots for each WRZ.

2.3 Results

2.3.1 Evaluation of rainfall deficit/probability bands

Our DO assessments for WRMP19 were based on calculations using stochastically generated rainfall time series in combination with hydrological and groundwater models. These models were used to produce output time series of flows and groundwater levels from which DO could be estimated.

Following our recent drought permit experience for the River Test we wanted to examine the relationship of shorter drought durations (<3 months). Because the calculations have been automated, we are able to assess the full range of rainfall deficits from 3 to 60 months inclusive.

Rainfall probability/deficit curves have been generated automatically from our stochastic rainfall data for each WRZ. Rainfall deficits for accumulations were compared to the long-term (1961-90) average. Rainfall probability and return period was determined by inverse ranking. An example pair of deficit versus return period plots are presented in Figure 1.

All of the rainfall deficit plots across our region show similar trends. Rainfall accumulations show that variance increases with return period and that rainfall deficit, as a proportion of long-term average rainfall, shows a higher variation for shorter drought durations and accumulation periods. Regression to the mean causes deficits to trend towards smaller deficits as the accumulation periods increase. Autumn and winter months also tend to show slightly larger deficits from the mean over short accumulation periods (>6 months) than summer months (July and August) which are typically drier anyway.

All years were allocated into rainfall deficit bands according to their annual rainfall totals by WRZ. The average number of days failure was calculated for each DRS cell by adding the number of days failure in each cell and dividing by the total number of years that fall within that cell. We have excluded short duration failures of less than 4 days.

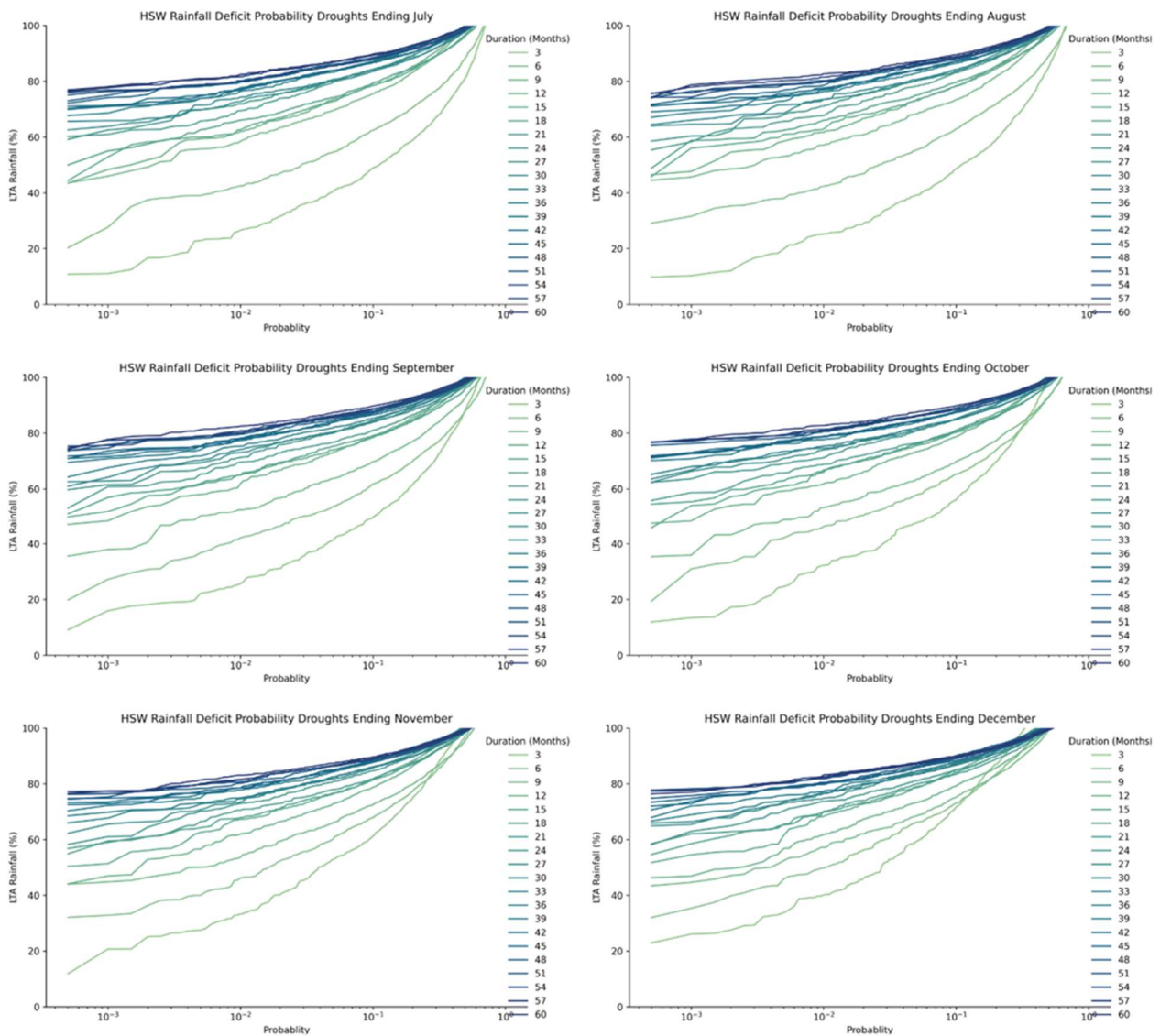


Figure 1: Example rainfall deficit versus return period plots for HSW WRZ.

2.3.2 Drought vulnerability - HSW

A summary of the key DRS plots for this WRZ are presented in Figure 2. The full set of DRS plots for each calendar month is included in Appendix A.

Summary plots like Figure 2 have been produced for each WRZ or group if WRZ comprises four sub plots that show the following:

- Top left, a DRS that relates the decline in DO relative to the normal year maximum to rainfall deficits. Although not required as part of the formal drought vulnerability assessment that focuses on supply failures, this analysis is still useful to understand the hydrology and hydrogeology of the WRZ supplies. It also provides an indication of WRZ resilience as even though the system may not fail, reduced supplies during drought can restrict operational flexibility redundancy and make a WRZ more prone to shocks such as large unplanned outages or other external factors.

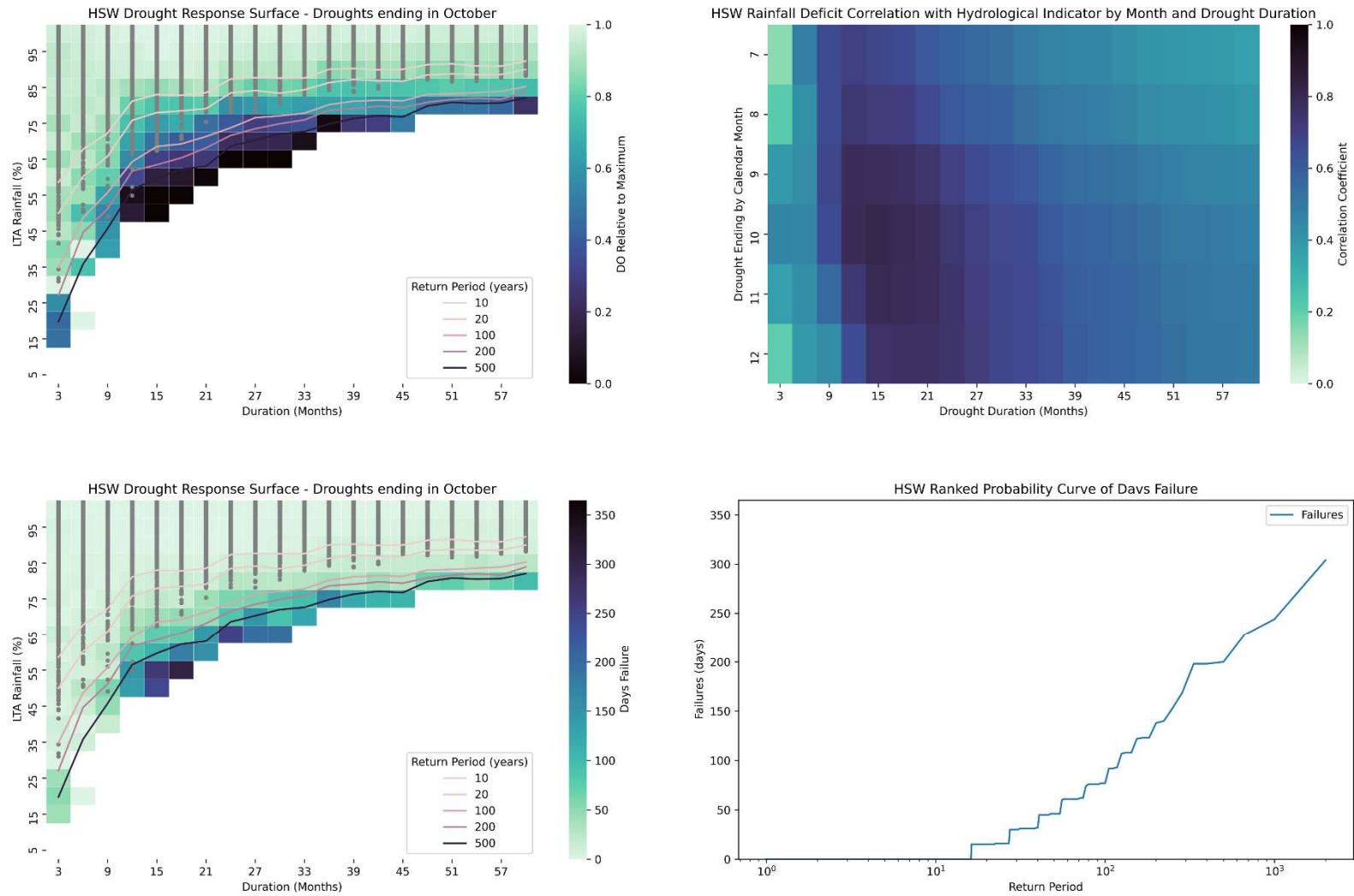


Figure 2: Drought response surfaces for HSW WRZ.

- The top right chart is a correlation heat map between the time series of a key hydrological indicator for a given WRZ and the rainfall deficits for different drought durations and drought ending months. This plot shows how the hydrological and hydrogeological systems of a WRZ respond to drought and is helpful for identifying the critical drought duration and month ending. For HSW the hydrological indicator time series is the modelled River Test total flow.
- The lower left plot is the critical DRS for that water resource which relates rainfall deficits and drought durations to supply system failures for the most critical drought 'ending month'. For HSW, as with many of our WRZs, this critical month appears to be October. Generally, this reflects the timing of groundwater and flow minima.
- The lower right plot shows a ranked probability curve of failure days. This is provided for comparison against our LoS and for comparison of our expected failures against our target LoS. This plot is also used to consider if any LoS scaling adjustments are warranted.

The DO DRS for HSW is similar to that from our WRMP19 preliminary vulnerability assessment. This indicates that in HSW, DO starts to decline for relatively mild droughts (<1-in-10 years) and very significantly declines for droughts of greater than 1-in-20 years severity. The most critical drought durations are for rainfall deficits for droughts between 9 and 30 months with the greatest impacts for droughts ending in October between 15-21 months' duration. There is also some sensitivity to short-term rainfall deficits that arises from dry autumn and summer periods leading to extended recession in river flows.

The rainfall deficit – hydrological indicator plot shows similar results, with the greatest correlations between low flows occurring due to rainfall deficits between 12-18 months' duration ending in the autumn month between September and November when minimum annual flows typically occur.

The DO response surface showing failures indicates that failures start to occur for relatively mild droughts (<1-in-20 years). This is consistent with the WRMP19 water resource modelling which showed this WRZ faces significant supply-demand deficits following sustainability reductions that occurred in 2019. We are reliant on drought permits/orders to maintain supplies even in moderate droughts until a long-term water resource solution is in place for Hampshire. Failures can occur for all drought durations and even minor rainfall deficits but are most significant for rainfall deficits greater than 1-in-20 years and for drought durations between 12-24 months. This reflects that single dry winter events combined with dry summer and autumn conditions, similar to the 1976 historical drought, have the most significant impact on this WRZ.

As we recognised in WRMP19, the failure probability curve illustrates that we cannot meet our target LoS in this WRZ whilst we are reliant on drought permits/orders to close our supply-demand balance. We expect that we will need to implement drought permits/orders on average 1-in-10 to 1-in-20 years and will need to apply for drought permits/orders much more frequently.

2.3.3 Drought vulnerability - HSE

The summary DO response surfaces and associated plots for HSE are presented in Figure 3. These follow a similar format to those presented for HSW.

Overall, the response surfaces for HSE are very similar to that for HSW as the River Itchen shares many similar characteristics to the River Test. Both are baseflow dominated chalk rivers and hence the hydrological response to rainfall deficits is very similar.

As with HSW, DO response, failures and hydrological indicators suggest the critical drought periods are for rainfall deficits between 9-24 months' duration ending in October with the largest DO deficits and failures for droughts between 15 and 18 months. Failure probabilities are similar to HSW and below our target LoS,

reflecting that this WRZ is somewhat reliant on water transferred from HSW. The WRZ was subject to large sustainability reductions in 2019, which have placed the WRZ in significant drought deficit.

For both HSE and HSW the sensitivity to some short-term rainfall accumulations suggest that autumn drought effects are very important, this reflects that dry autumns lead to delayed onset of groundwater recharge and recovery of flow which can lead to Hands-off Flow (HoF) conditions being approached or crossed. This would favour development of triggers that reflect river baseflow and evapotranspiration (e.g. Standard Potential Evapotranspiration Indices).

DO falls rapidly when rainfall levels fall below 80% of long-term average rainfall over periods of more than 12-18 months DO. For more severe drought events of <1% annual probability, DO effectively falls to zero. The groundwater contribution to HSE maintains DO for longer but ultimately yield from both WRZs is curtailed entirely by the imposed HoF conditions under severe droughts (<0.5% annual probability).

2.3.4 Drought vulnerability - IOW

The drought response plots for the IOW (Figure 4) show a much greater degree of resilience than the adjacent HSW and HSE WRZs. The full set of plots is in Appendix A. DO varies by only minor amounts with rainfall deficits and this reflects that in our assessment approach the DOs are set for severe droughts that maintain HoF conditions. Our larger groundwater abstractions and surface water abstractions are also relatively drought resilient to low groundwater levels and being sustained by a flow augmentation scheme.

However, the apparent drought resilience most dominantly reflects that the WRZ is supported by transfer from the mainland and can maintain supplies whilst the transfer is active. This transfer, and by proxy, the WRZ is subject to the same vulnerability as the rest of HSW and hence actual failures are likely to be much more frequent than illustrated by this analysis.

Figure 5 shows a DRS for the IOW which relates rainfall deficit and drought duration to decline in groundwater levels at our indicator borehole. As with the Hampshire WRZs, critical drought durations for the IOW are between 12 and 18 months for single dry winter and dry summer but ending earlier in the year, between August and September, as shown by the Hydrological Indicator correlation plot. This reflects that the Chalk aquifer of the IOW shows characteristically very flashy rapid responses to groundwater recharge and dry periods with large groundwater fluctuations. Typically, recharge starts earlier than in the mainland chalk aquifers, but groundwater levels are more sensitive to shorter periods of dry weather, especially in the autumn, but also recover faster.

Figure 3: Drought response surfaces for HSE WRZ.

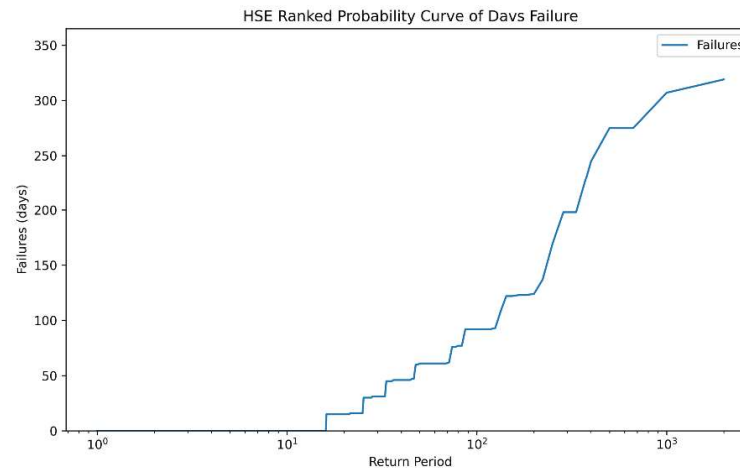
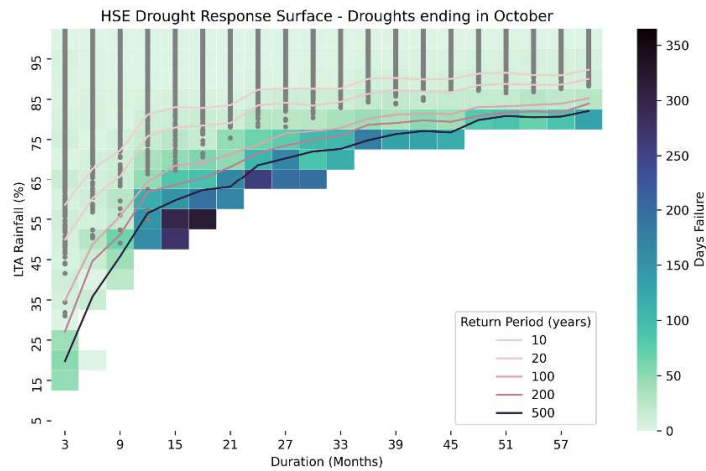
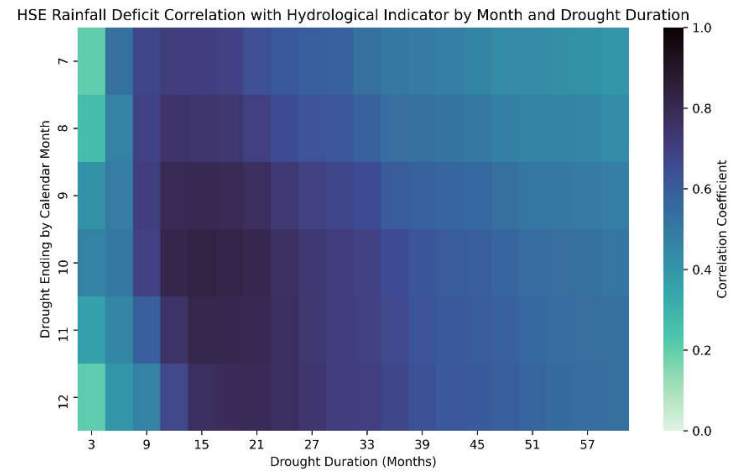
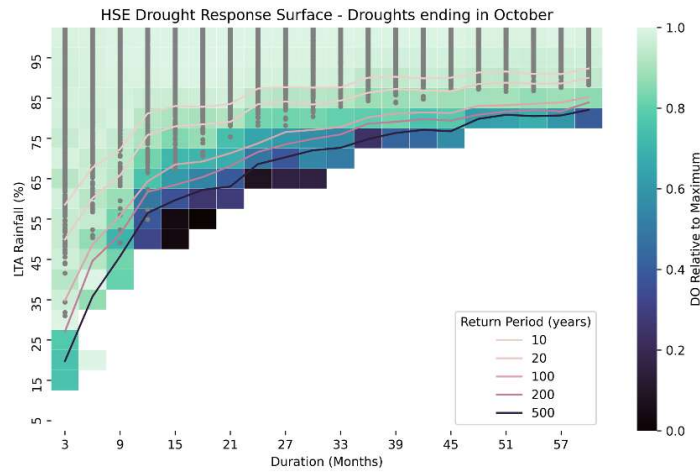
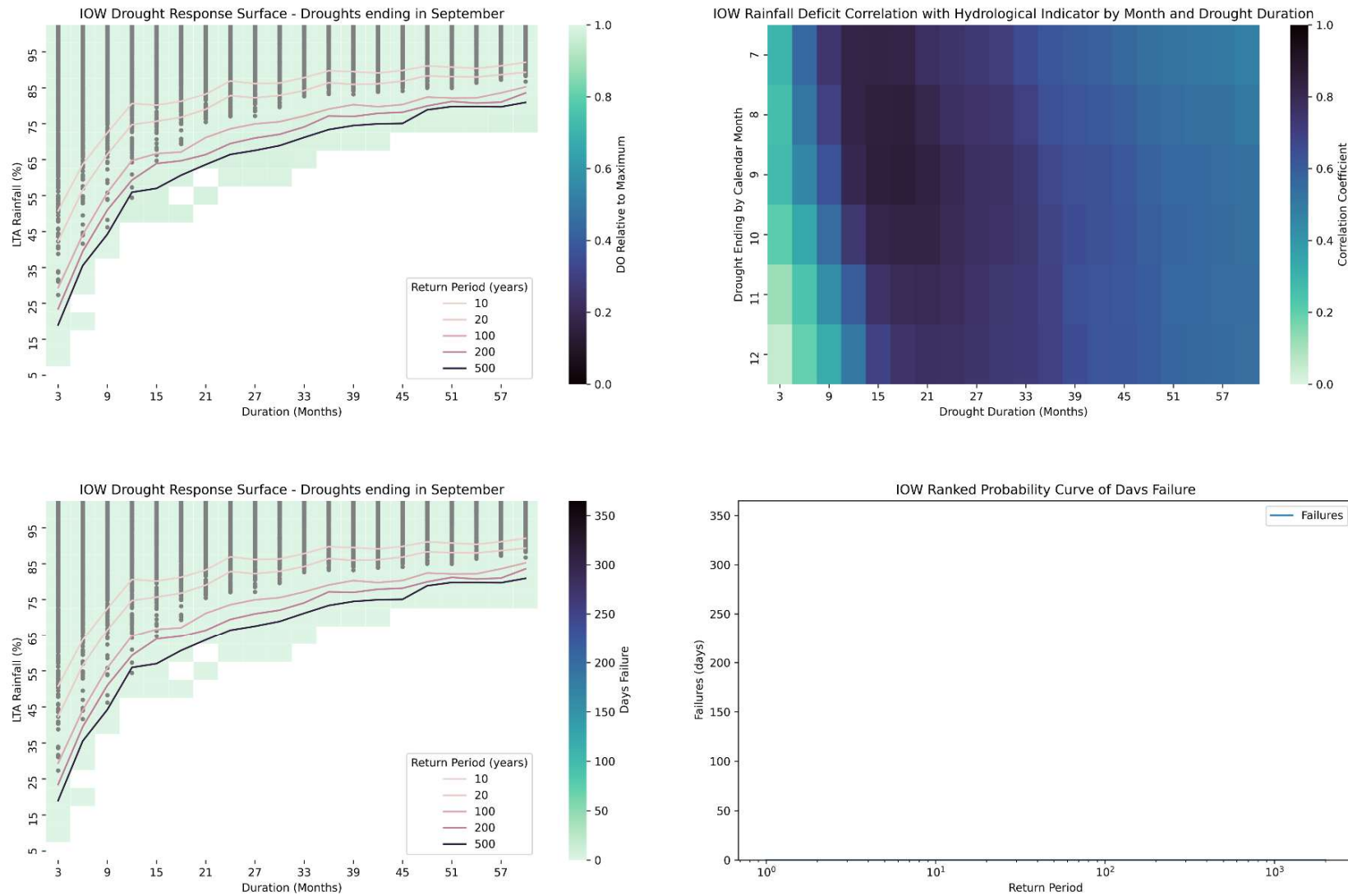


Figure 4: Drought response surfaces for IOW WRZ.



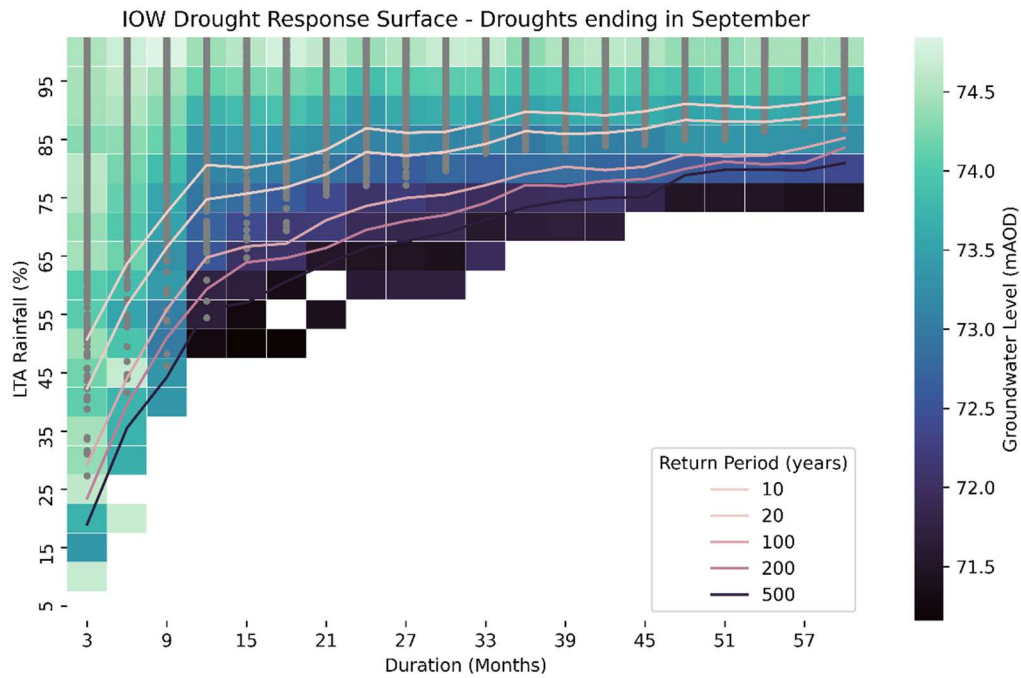


Figure 5: DRS for indicator borehole groundwater levels - IOW

2.3.5 Drought vulnerability – SNZ

Figure 6 shows the summary DRS plots for the SNZ WRZ. The full set of DRS plots is in Appendix A.

Total DO in this WRZ is closely related to available flow above a Minimum Residual Flow (MRF) condition on the Western Rother. At low flows, abstraction from the river and associated groundwater which are subject to the MRF condition must reduce or cease to maintain the MRF condition. The DO drought response reflects this by showing declines in DO in line with increasing rainfall deficit with the largest declines occurring at long return periods for rainfall deficits of 12-21 months between 50% and 75% of long-term average rainfall. This is equivalent to a drought event worse than around a 1-in-20 years rainfall deficit.

As with the Hampshire WRZs, the correlation plot indicates that low flows are most closely associated with droughts ending in September to November of 15-21 months duration, encompassing a single dry winter and dry autumn such as 1976 historical drought event.

Due to the link between DO and flow, failures start to accumulate as flows recede in this WRZ even for relatively mild droughts. This reflects the WRZ’s reliance on drought permits/orders to maintain supplies in drought due to delays and potential environmental impacts associated with planned water resource schemes. Failures are most significant for 15-18 months duration droughts ending October.

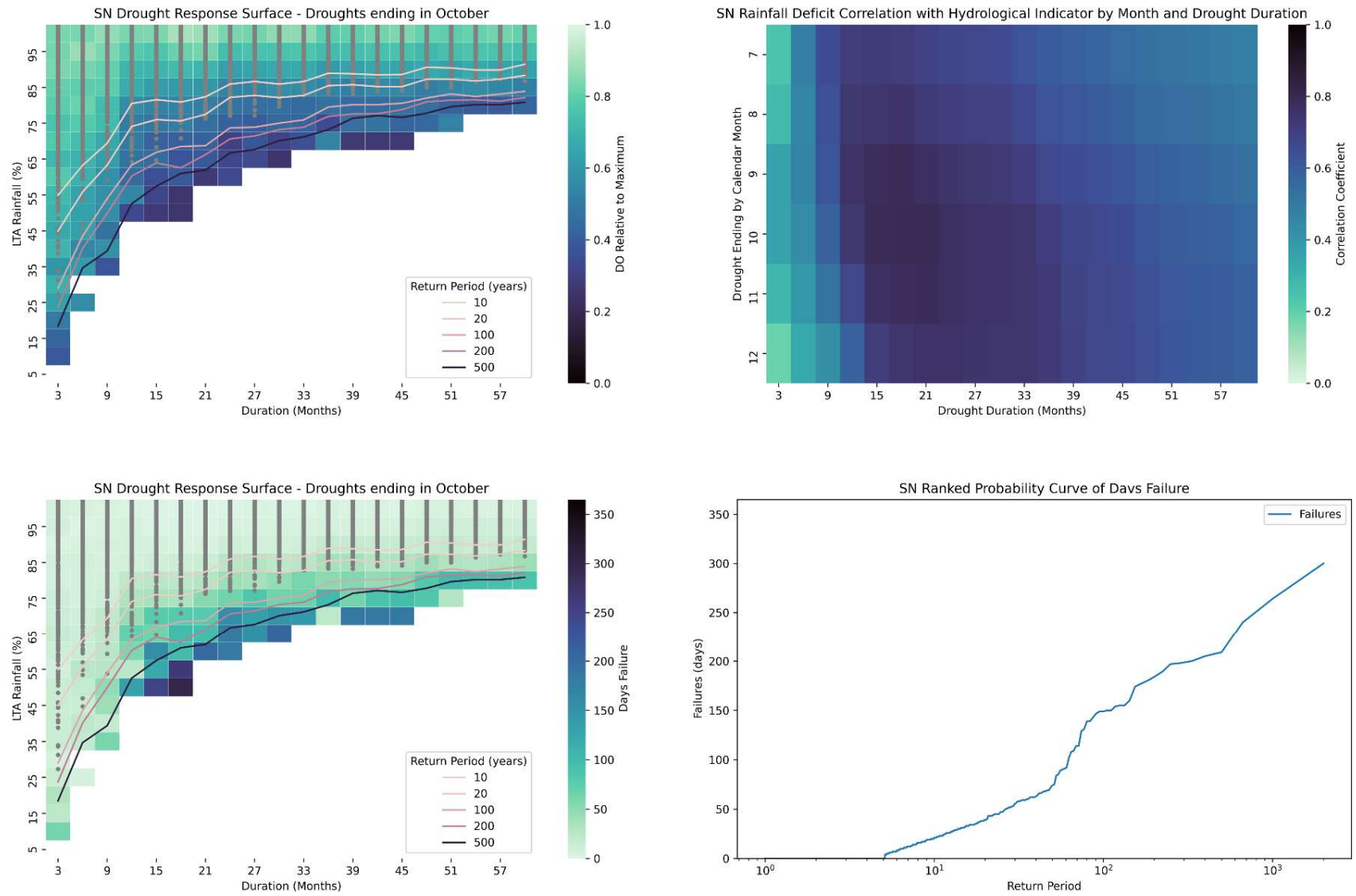


Figure 6: DRS plots for SNZ WRZ.

2.3.6 Drought vulnerability – SBZ and SWZ

These two WRZs are considered together here as they share many similarities. Both WRZs are supplied from the Sussex Chalk aquifer that shows similar drought and recharge responses and hence their drought vulnerability and responses are similar.

Drought-related decline in DO in these WRZs is directly related to groundwater levels (Figure 7) with a common indicator borehole used to determine DO. SBZ has a greater number of drought sensitive sources but as a proportion of lost DO due to rainfall deficits, SWZ is more sensitive. The summary DRS plots for SWZ and SBZ are presented in Figure 8 and Figure 9 respectively and the full set is provided in Appendix A.

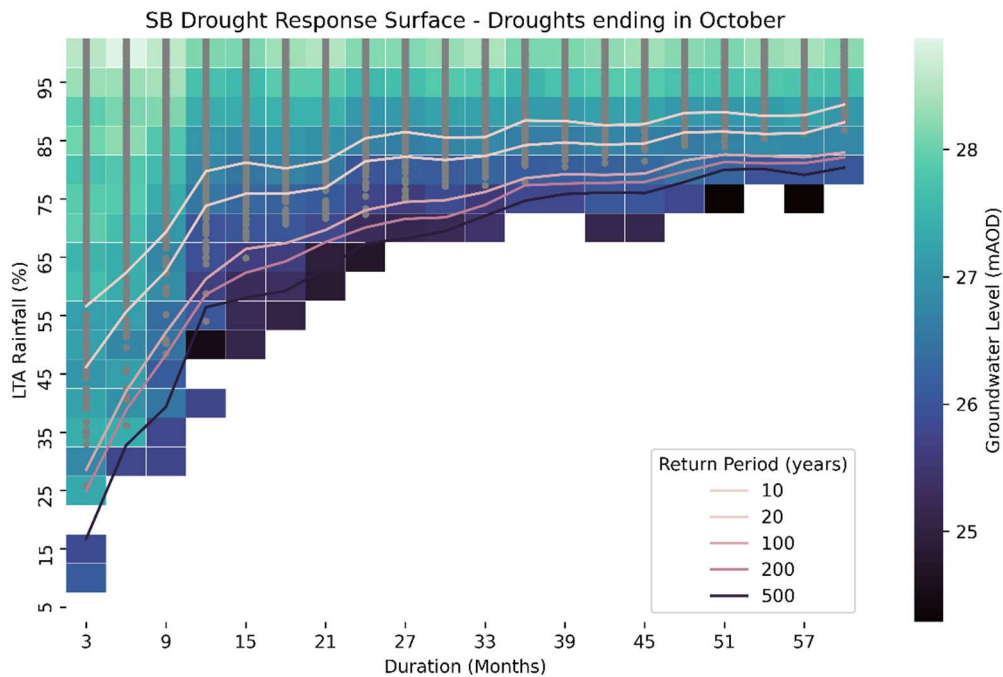


Figure 7: DRS for groundwater level decline, SBZ indicator borehole.

DO starts to reduce when rainfall levels fall below 90% of long-term average rainfall for periods of 12 months or more. The greatest DO impacts appear to occur for accumulations of 12 to 24 months rainfall deficits of 50-75% of long-term average. These events would be equivalent to around the 1% to 0.2% annual probability drought (1-in-100 years to 1-in-500 years). Despite some drought sensitive sources, high yields, the large number of treatment works and interconnected networks provide a degree of drought resilience in these WRZs with failures only occurring in SBZ for extreme droughts. This is consistent with our finding from WRMP19, which indicated that the supply-demand deficits in these WRZs were driven by uncertain future abstraction licence changes.

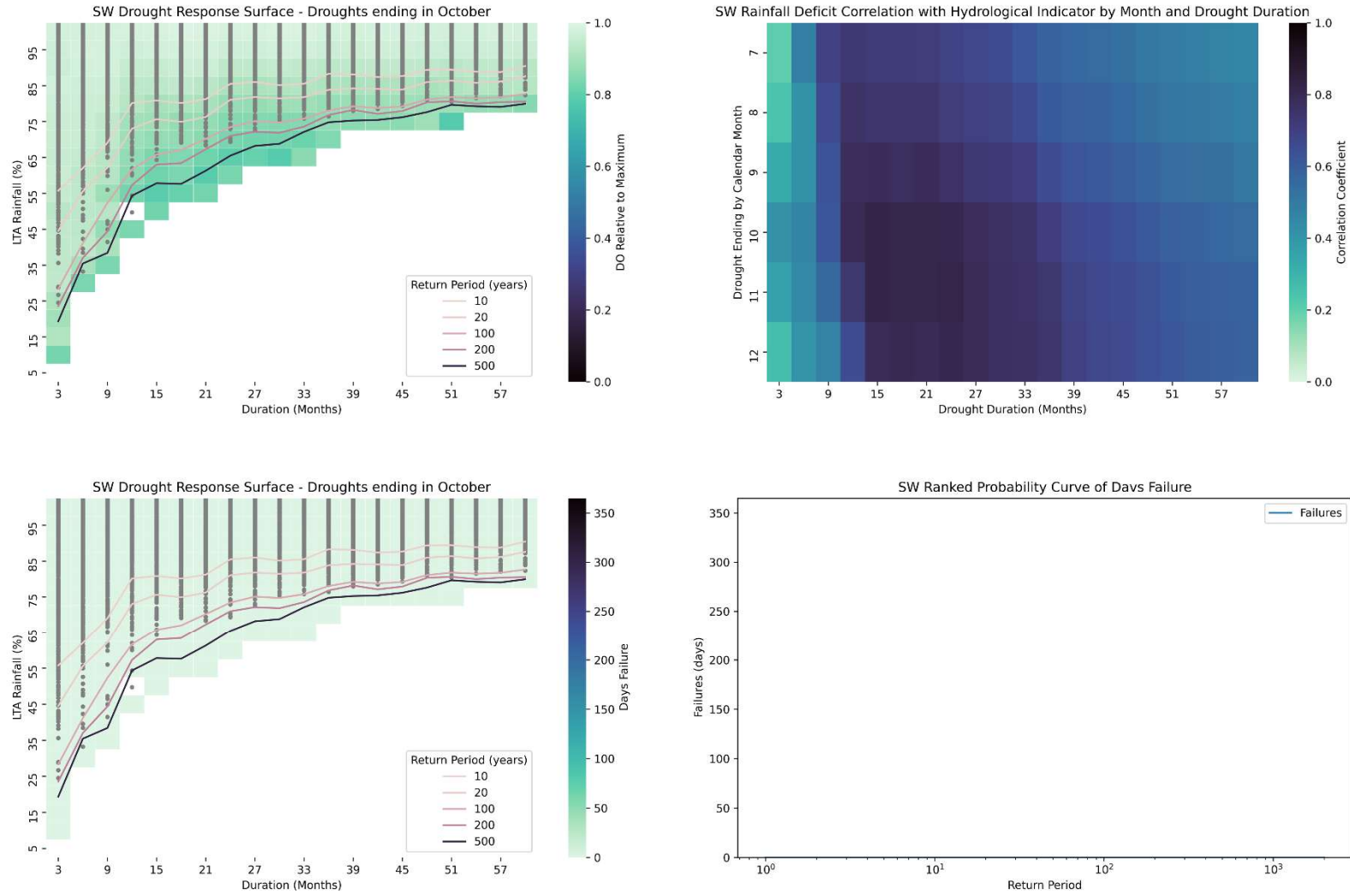


Figure 8: DRS plots for SWZ WRZ.

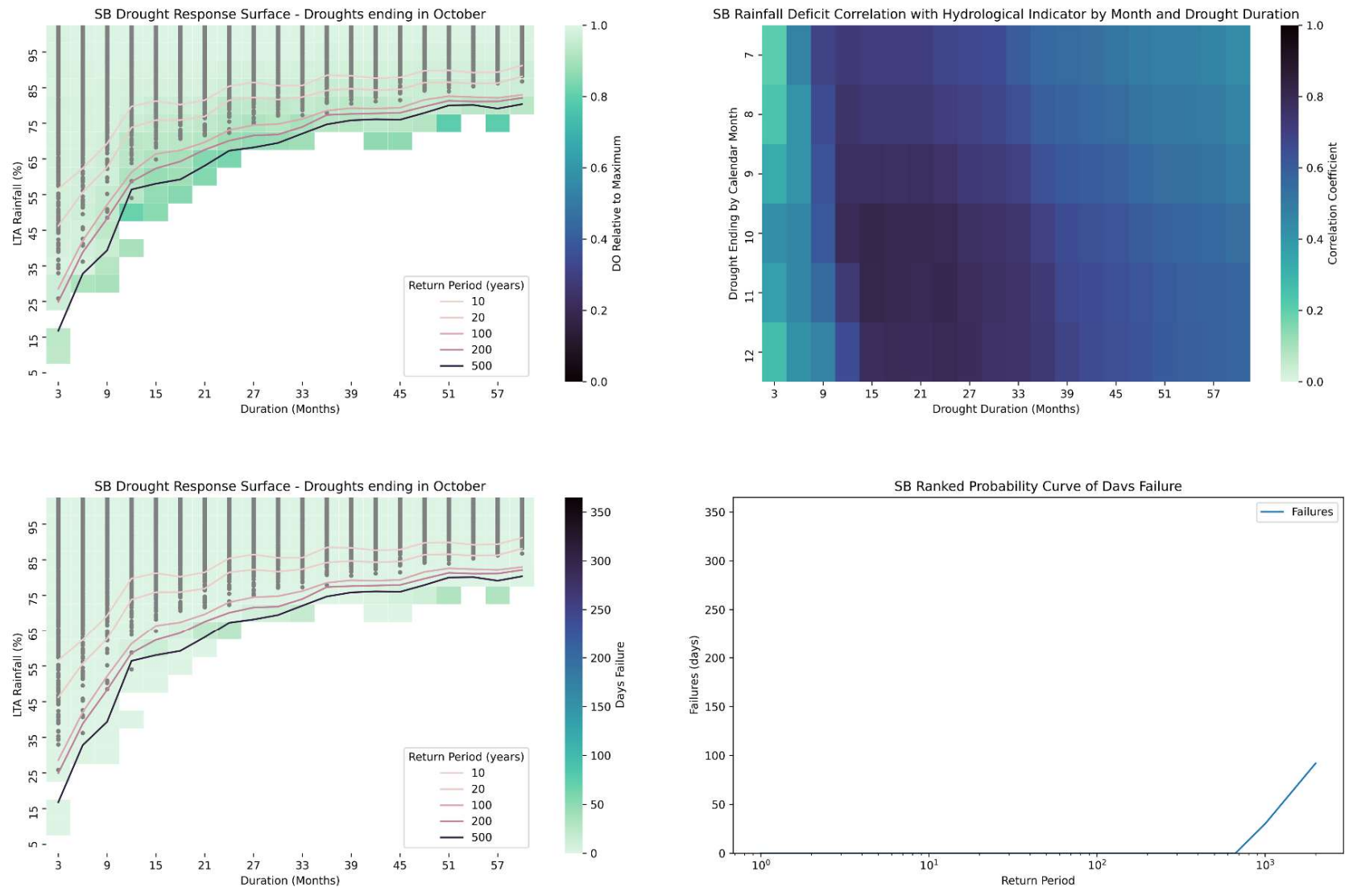


Figure 9: DRS plots for SBZ WRZ.

2.3.7 Drought vulnerability – KMW and SHZ

We have grouped our KMW and SHZ WRZs together for this assessment as they are coupled by the conjunctive use of the reservoirs associated with the RMS. A summary set of drought vulnerability plots are shown in Figure 10 and the full set is presented in Appendix A.

Failure in these conjunctive WRZs were assessed when reservoir volumes fell to emergency storage. When considered conjunctively between KMW and SHZ, failures are driven by the smaller SHZ reservoirs reaching their emergency storage levels, primarily Powdermill reservoir, though to a degree it is possible for the WRZ to be supplied from KMW via transfer from Bewl reservoir to Darwell reservoir.

Reservoir yields begin to decline around a 1-in-50 years drought and the critical drought duration appears to be for extreme droughts (>1-in-500 years) 12-18 months in duration months ending in October. There is also a degree of sensitivity to longer duration droughts, >24 months in length.

The key resource in these WRZs is Bewl reservoir. This supplies water to both KME and KMW and can be used to transfer water to Darwell reservoir in SHZ. When KMW/Bewl Reservoir is considered in isolation, it shows a much greater resilience than SHZ with failures in KMW being much less frequent and only for droughts greater than 1-in-200 years in severity (Figure 11). This possibly suggests that use of Powdermill emergency storage may not be appropriate.

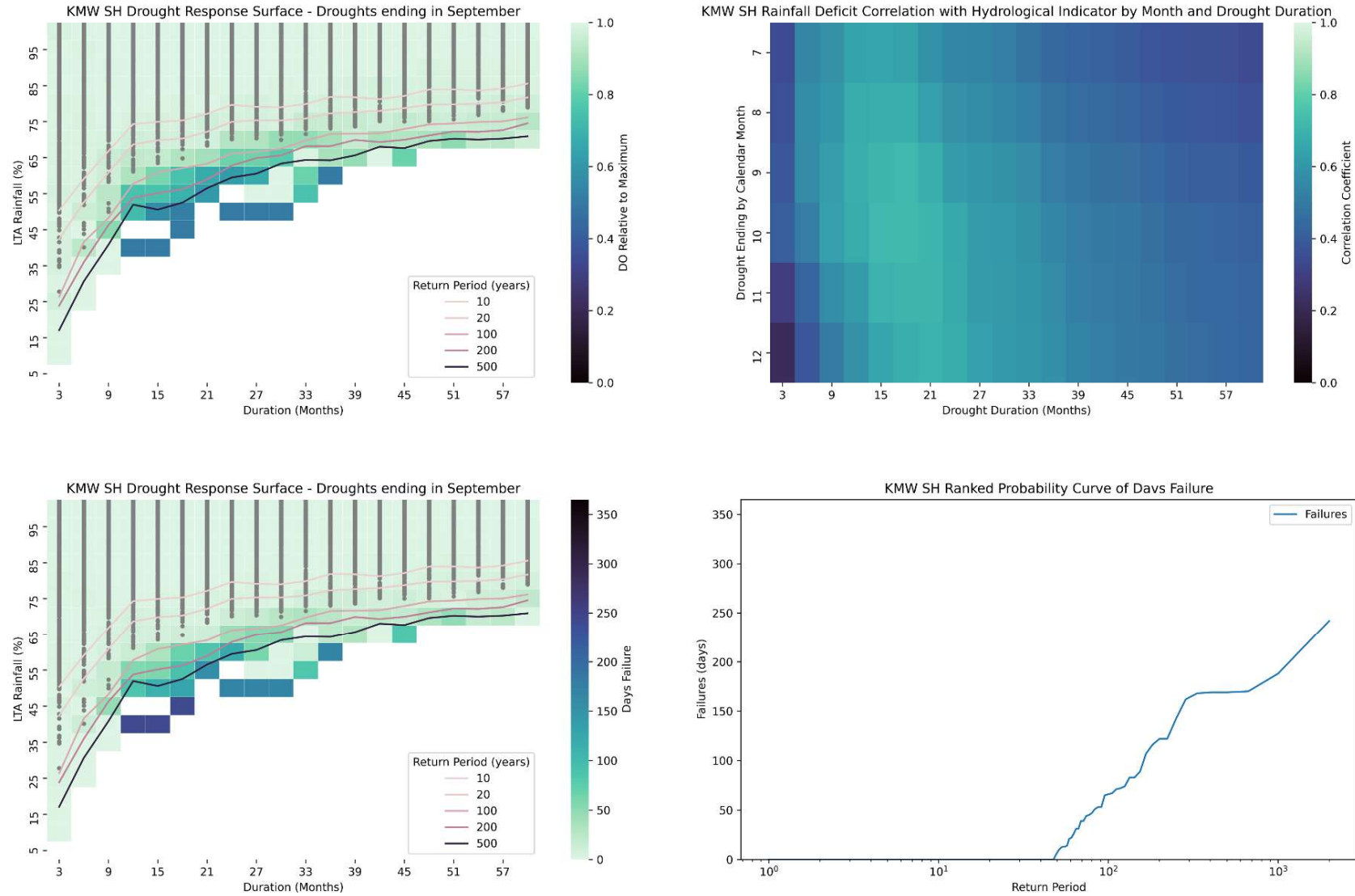


Figure 10: DRS plots for KMW and SHZ WRZs.

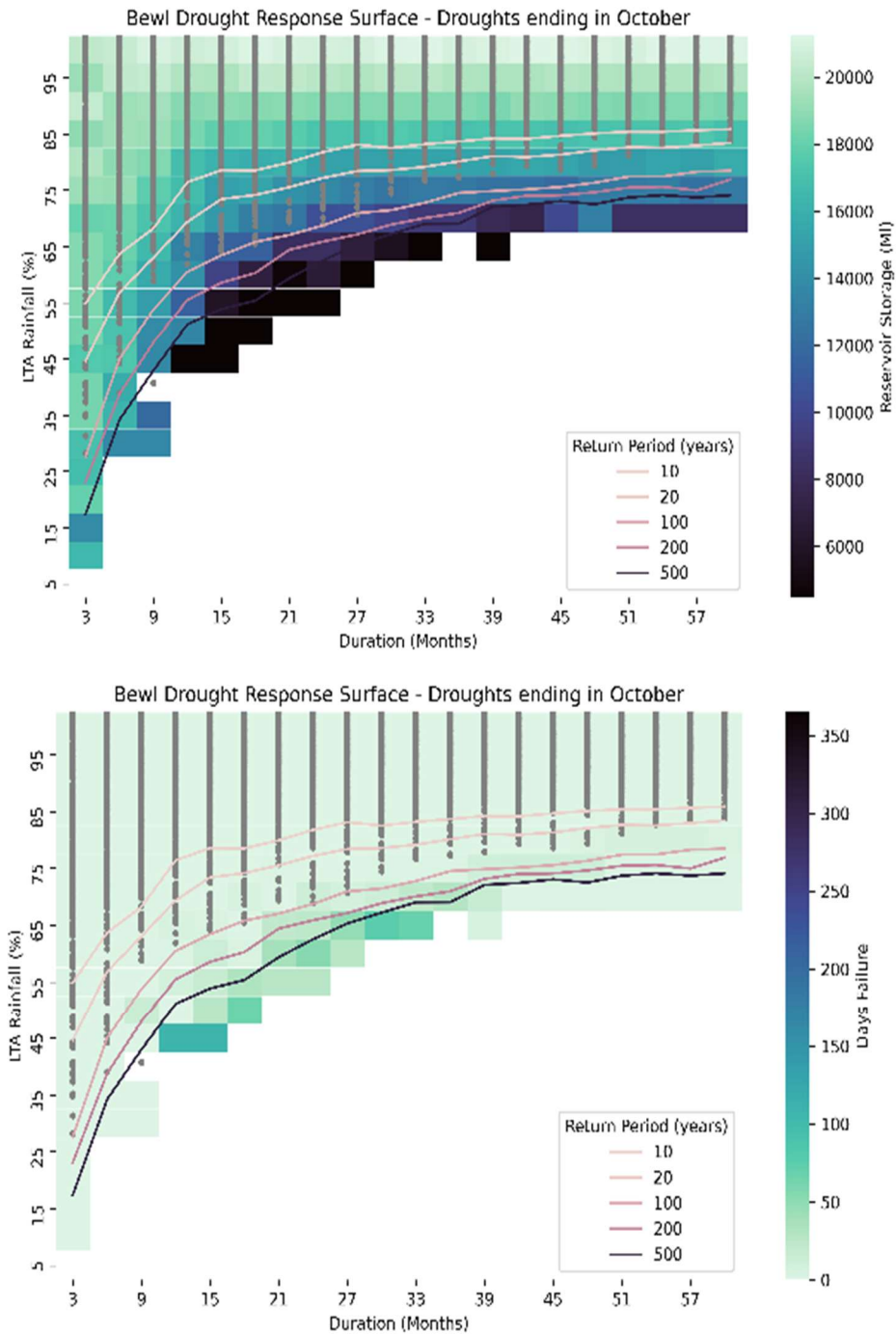


Figure 11: DRS plots for reservoir storage and failures associated with Bewl reservoir – KMW WRZ.

2.3.8 Drought vulnerability – KME

Although KME was flagged in the high-level screening as not requiring a full assessment, we have still developed summary DRS plots as the groundwater sources in this WRZ do show some drought sensitivity, which is not significant from a failure point of view but is useful to consider in terms of overall resilience and operational flexibility.

As expected from the high-level screening, this WRZ shows only a limited sensitivity of DO to rainfall deficits and no failures. This is consistent with a limited number of sources being groundwater level constrained. The majority of DO in the WRZ is supplied by licence or infrastructure constrained groundwater abstractions and their outputs are not drought sensitive.

The hydrological correlation plot shows that Kent Chalk aquifer shows a stronger response to longer duration droughts than in many of our other WRZs at about 33-36 months reflecting a vulnerability to sustained droughts over multiple years and dry winters.

This is better illustrated by a groundwater level DRS (Figure 12) which indicates that the lower groundwater levels are associated with severe to extreme (> 1-in-200 years return period) long duration droughts greater than 21 months in duration ending in the late autumn.

This is consistent with our general understanding of the Kent Chalk aquifer. Typically, the aquifer responds more slowly to groundwater recharge and periods of dry weather, especially when contrasted with the relatively flashy and fast responding chalk aquifers in Sussex and the IOW.

A suite of summary plots is provided in Figure 13 and the full set in Appendix A.

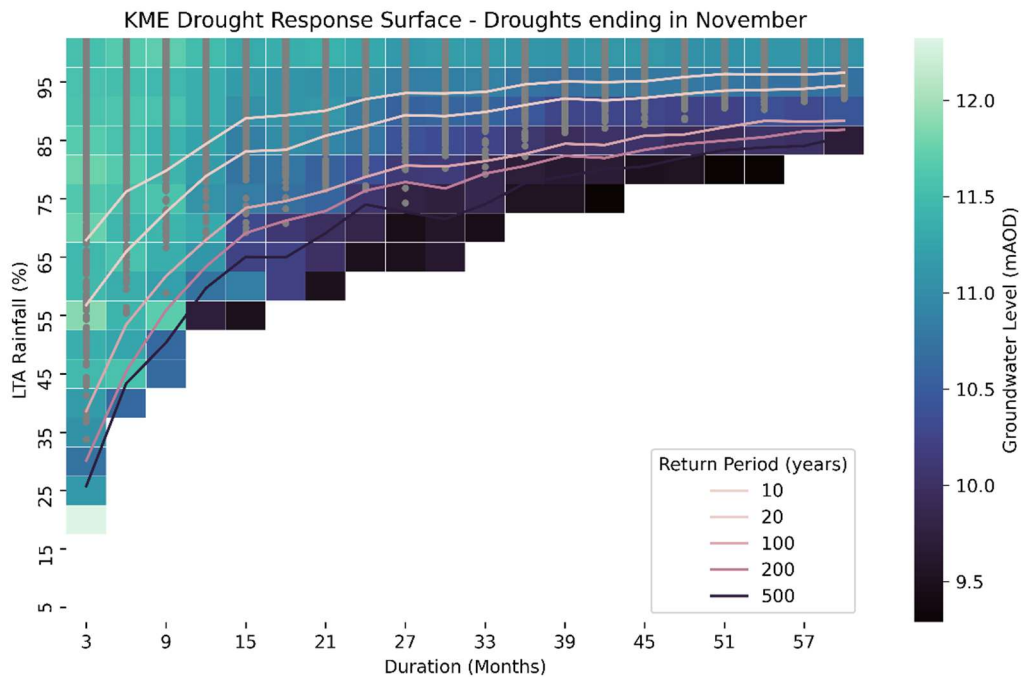


Figure 12: DRS for groundwater level decline in indicator borehole – KME WRZ.

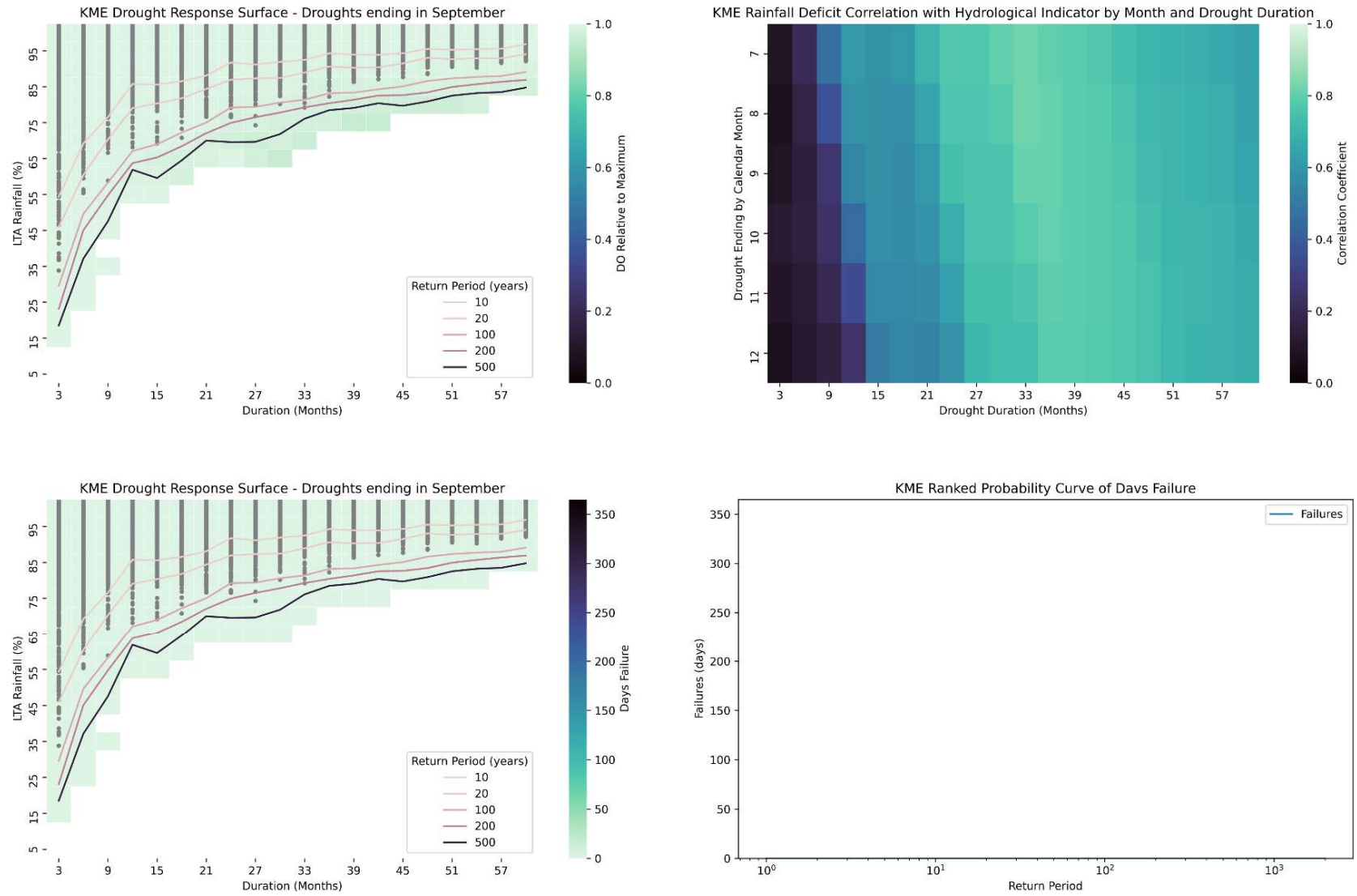


Figure 13: DRS plots for KME WRZ.

2.3.9 Drought vulnerability – KTZ

Summary DRS plots for our KTZ are shown in Figure 14 and the full set of plots is presented in Appendix A.

This WRZ shows many similarities with the neighbouring KME WRZ as both are supplied by groundwater only and situated in adjacent chalk aquifer blocks that share some similar characteristics. A greater proportion of groundwater sources show sensitivity to drought in this WRZ and hence the proportional decline in DO with increasing drought severity is greater. Like KMW, the critical droughts in this WRZ are of longer duration than those in the Sussex and Hampshire chalk aquifers, reflecting greater storage and slower response of this aquifer to rainfall and recharge. The recharge season also often starts latest in the Kent Chalk owing to rain shadow effects and higher PET.

The critical drought duration for KTZ is from 15-33 months with the greatest DO loss and groundwater level decline for droughts of 27-30 months duration ending in September.

Although it is more drought sensitive than KME, the KTZ WRZ exhibits no failures in this assessment owing to an intra-zonal transfer between the two. This helps to sustain KTZ during dry periods when it would otherwise be in deficit and to offset outages caused by raw water quality (nitrate) challenges within the WRZ.

The inclusion of outages in the assessment (Figure 15) illustrates the water quality challenges and significantly increases the rate of failure and illustrates the principal threat to this WRZs resilience. This is presently being addressed through a major network and treatment upgrade and catchment management.

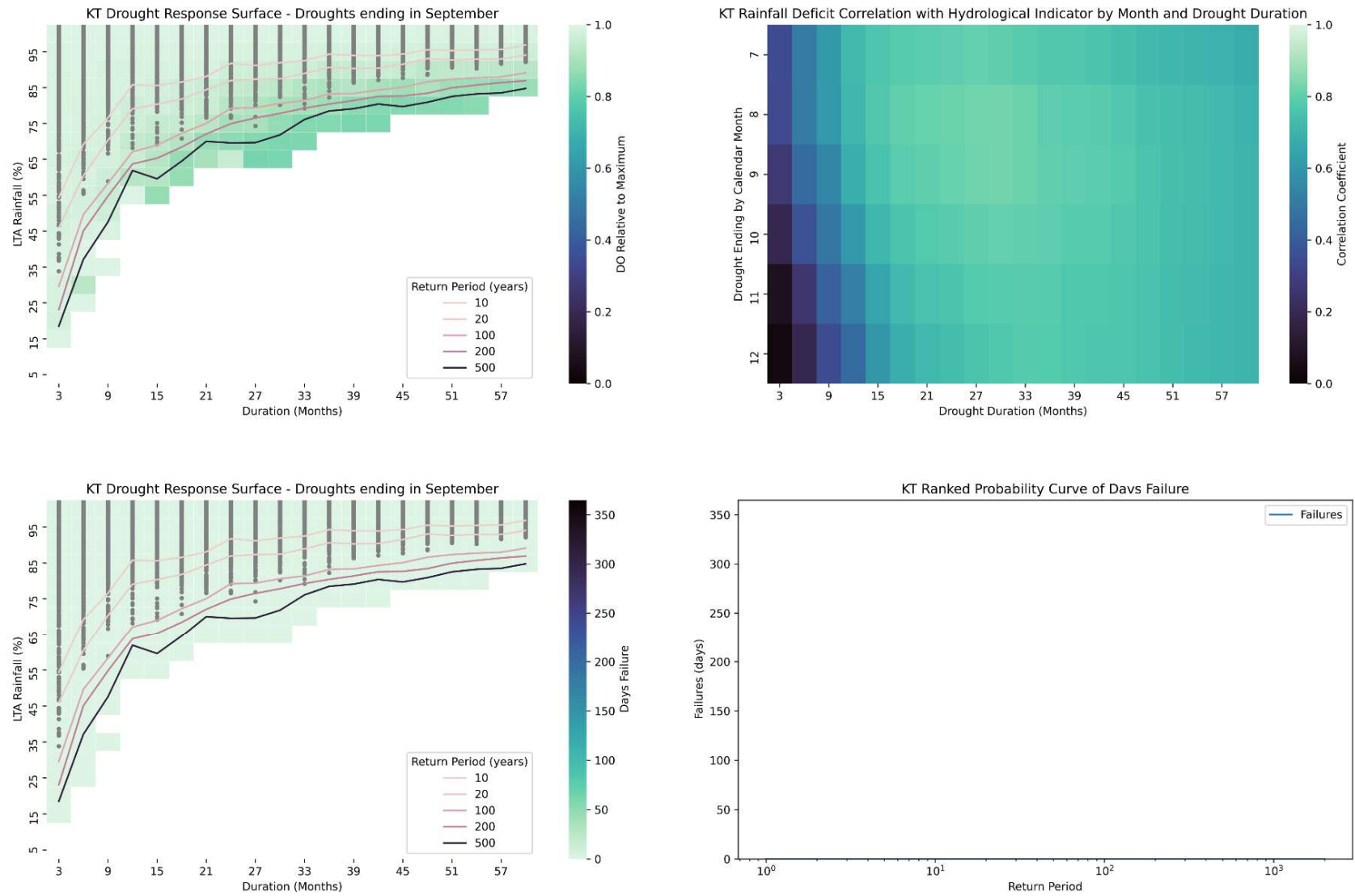


Figure 14: DRS plots for KTZ WRZ.

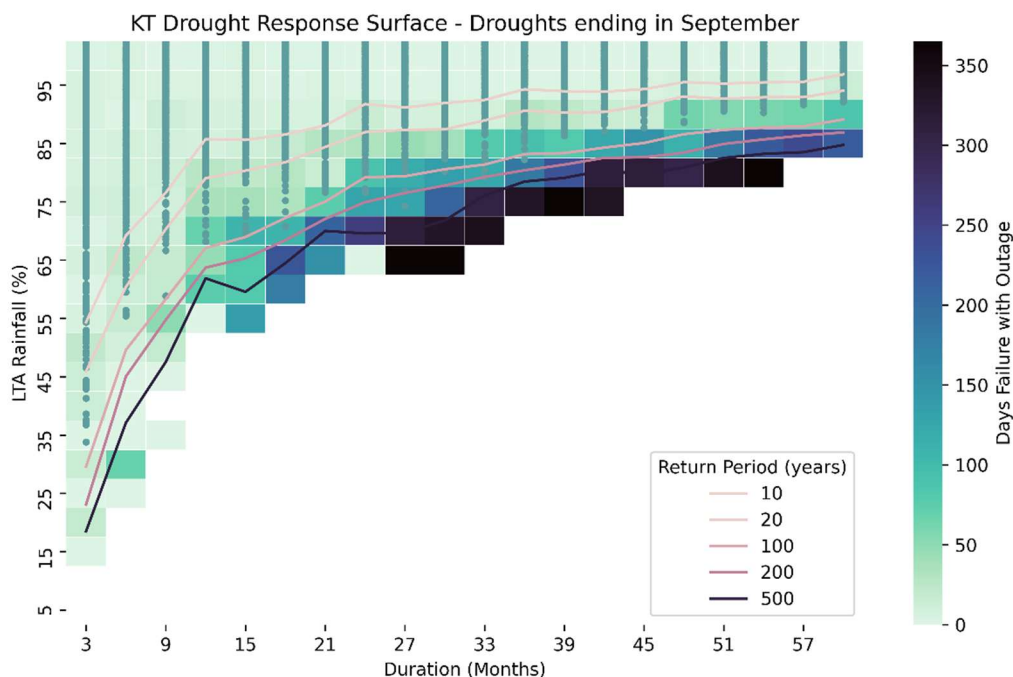


Figure 15: DRS plots for KTZ WRZ including outage.

2.4 Drought vulnerability assessment – key findings

Key findings from vulnerability assessment for each of our sensitive WRZs are as follows.

- Sussex and Hampshire show very similar critical droughts. This largely reflects the characteristics of the Chalk aquifer that dominates SBZ and SWZ and provides groundwater baseflow support to the rivers Test and Itchen. Southern Hampshire and the Sussex Chalk are most sensitive to 12-21 months events ending in October with the most critical event around 15 months in duration. These represent single dry winter events but with multiple dry summers and autumns. Dry autumns are particularly critical reflecting that delayed onset of recharge and groundwater recovery following a dry summer extends groundwater and flow recessions.
- SNZ shows a similar critical drought response to the adjacent Chalk dominated WRZs but the supply mix differs mostly comprising Lower Greensand groundwater and baseflow to the Western Rother.
- The surface water dominated WRZs (HSW, HSE and SNZ) are the most drought vulnerable. This is from a combination of existing or marginal supply-demand deficits and DO which is dominated by river flows above MRF or HoF conditions.
- Our Kent WRZs tend to be more sensitive to longer duration droughts than in Hampshire and Sussex and to an extent this reflects the storage buffering of the large reservoir systems that provide a degree of resilience to short drought events.

3. Overview of our drought triggers

Having characterised the drought vulnerability of our supply system, this section sets out the data and trigger levels that we will use to monitor the onset and severity of drought.

Given the diversity and vulnerabilities of our WRZs, we employ a range of trigger levels based on monitoring multiple hydro-meteorological variables/factors. Our decisions draw on a comprehensive set of factors, including rainfall deficits, seasonal timing, and the condition of key water resources—namely reservoir storage, river flows, and groundwater levels. This approach is formalised through our multifactorial trigger framework, which evaluates the status of several critical indicators to determine the most appropriate drought response for each WRZ. By assessing these triggers collectively rather than in isolation, we ensure that our actions are proportionate, evidence-based, and tailored to the specific circumstances of each zone.

We employ a suite of drought triggers that cover a range of hydro-meteorological characteristics and responses relevant to our water supplies:

- Rainfall
- PET
- Groundwater levels
- River flows
- Reservoir storage
- Multifactorial triggers

A drought is defined as a deficit or reduction in any of the hydro-meteorological variables we monitor relative to the long-term average or normal conditions. The drought cascade typically begins with a rainfall deficit, often referred to as a meteorological drought, which makes rainfall monitoring critical for identifying its onset. Our drought vulnerability assessment indicates that rainfall deficits lasting around 12–18 months represent critical durations that have the greatest impact on supplies. Only a few WRZs—most notably HSW and the Isle of Wight—show significant sensitivity to short-duration droughts. It worth noting that in 2025, drought conditions in our Hampshire areas were triggered by rainfall deficits of much shorter duration. We have chosen to monitor rainfall deficits through Standard Precipitation Indices (SPI), which allow easy site-to-site comparison across our supply area.

However, rainfall data alone only is not enough to fully understand the hydrological impact of drought (e.g. on groundwater levels and river flows). The timing of rainfall deficit has a significant effect on drought. To better understand and monitor the hydrological impacts of rainfall deficits, we incorporate PET data to allow us to monitor the amounts and deficits of effective rainfall. These data are captured through a Standard Precipitation and Evapotranspiration Index (SPEI), an extension of the SPI calculation.

Over 70% of our resources are groundwater abstractions from the Chalk and Lower Greensand aquifers and these comprise a large number of drought sensitive sources where yields reduce under conditions of low groundwater levels, as evidenced by our drought vulnerability assessment (e.g. for SBZ and SWZ). Through our operational practice and numerous modelling studies, we have developed a good understanding of the characteristics of each aquifer block and have selected indicator boreholes that provide a reasonable representative indication of the groundwater status of each aquifer block. These boreholes have long observation records, are regularly monitored, and often are reported upon in the EA water situation reporting.

Similar to groundwater levels where we have surface water supplies, we have set triggers on river flow levels to inform the need to take drought actions to maintain supplies, protect the environment and to meet our HoF

or MRF licence conditions. In some cases, our river flow triggers are directly linked to our drought actions, for example under the Section 20 Agreement with the EA for the River Test and River Itchen Catchment Drought Permits and Orders.

Similarly, we have set triggers and actions linked to the storage volumes in our reservoirs. These are critical to the supplies in some of our WRZs, particularly in our Eastern area and are based on behavioural modelling of reservoir performance during severe and extreme droughts.

Overlying these individual suites of drought trigger levels, we have set out a series of multifactorial trigger levels that identify the key trigger sequences that reflect the underlying supplies of our supply areas and WRZs.

As set out in the drought plan main report, having validated and gained confidence in the skill of our predictive models we have made a refinement to our approach. We recognise that the triggers themselves are conservative and would lead to more applications than are required. We have learned from dry conditions since 2019 in particular from the River Test drought permit applications in 2019 and 2022. Furthermore, we have learnt from the 2025 drought. So, we would now only apply for a drought permit or drought order if both the triggers have been reached and our flow forecasting shows that crossing of the hands off flow is likely.

3.1 Environmental stress triggers

The Drought Plan guideline¹⁷ allows for the development of environmental triggers that would indicate when the environment might become stressed during drought due to a reduction of flows or groundwater levels, but which may not necessarily impact upon water supplies.

Many of our large abstractions have been subject to sustainability investigations under Water Industry National Environment Programme (WINEP), which aims to improve the status of abstraction-impacted water bodies in line with the objectives of the Water Framework Directive (WFD). Many of these sites have since been subject to abstraction licence changes as part of mitigations to improve water body status and prevent deterioration. These have taken the form of annual, monthly or daily quantity reductions and the imposition of HoF or MRF conditions.

In some cases, it is the loss of resource from environmentally driven licence changes that have required us to use drought permit/order options to be able to maintain public water supply in a drought. Such actions may lead to environmental impacts, but the drought permit/order process seeks to limit such impacts by only enacting these measures when necessary to maintain water supplies and through monitoring, mitigation and where necessary compensation for the impacts. Environmental stresses will be, to some extent, mitigated within the abstraction licence conditions and our preparations for drought permits/orders.

Development of environmental stress triggers may be more practical, and provide more benefits, for sites where the environmental impacts of our abstractions are less well understood. This is most likely to be the case for our groundwater sources which are being studied under our 'No Deterioration' WINEP objectives.

¹⁷ Environment Agency, 2025. Water Company Drought Plan guideline, March 2025

Limited hydroecological data presently exist for such sites and is unlikely to be comprehensive for low-flow periods.

In the absence of regular or live hydroecological monitoring, flow and/or water quality data are likely to provide the best indication of potential for environmental stress. We have continued to use the flow standards for the Environmental Flow Indicator (EFI) thresholds or use of the Common Standards Monitoring Guidance (CSMG) thresholds as an indicator for establishing environmental stress.

In Table 7 we have set out environmental stress triggers for several key surface water bodies in our supply area. The triggers are based on the low flow Q_{95} (95th percentile) EFI which provides a good indication of water body stress during drought conditions.

We have used our understanding of the specific abstraction reductions likely to be required at the relevant individual sources to meet EFI targets to set target abstraction rates based on the work we have conducted for Sustainability Reductions in WRMP19 and for our draft WRMP24 Environmental Destination.

However, our long term WRMP planning has shown that to achieve these abstraction reduction targets before 2027 would create supply - demand deficits until some of our long term strategic water supply options are available. As these abstractions are currently operating within their abstraction licences any reductions to alleviate environmental stress would have to be made on a best endeavours basis, reflecting the drought severity and supply risk at that time

These trigger locations have been selected as telemetered flow data is available at nearby gauging stations that allows near real-time monitoring of flow conditions compared to the EFI and so could act as a live indicator of environmental stress. Potential mitigations actions are indicated in Table 7; however, there are a number of limitations to this approach that must be recognised.

There are a limited number of actions that we can currently take if the EFI triggers are crossed. The most obvious is to increase water efficiency messaging and to reduce abstraction from affecting sources (e.g. those closest to surface water bodies or groundwater dependent terrestrial ecosystems) and relocate it elsewhere (e.g. from headwater catchments to downstream sources). However, this may not always be practical, particularly in a developing drought and will depend on the nature of the sources (capacity, licence, network arrangement and drought sensitivity) and levels and distribution of demand. Relocation of abstraction also risks just relocating the environmental stress elsewhere.

For sites not yet subject to environmental licence changes, or which are subject to ongoing WINEP studies, flow conditions and abstraction impacts may be such that EFI targets are not met, even under normal conditions, hence the environment may be in a degree of constant stress. This may only be fully understood and appropriate mitigation possible once these studies conclude.

There may be some physical enhancement or management actions we could take (e.g. sluice control) if such environmental stress triggers are crossed, but this would rely on having a good understanding of the hydroecological function of an affected water body to ensure that such actions are appropriate and would not cause damage themselves.

Our current WINEP studies cover a number of our groundwater abstractions. The investigations will require a significant amount of monitoring, modelling and will improve our understanding of abstraction impacts on surface water bodies and groundwater dependent terrestrial ecosystems. This is likely to lead to future licence changes and mitigations which will provide enhanced protection against deterioration of water body status but will also provide us with the data and understanding that we could use to develop more refined

environmental stress triggers, and where needed, additional drought actions to provide increased environmental protection.

Table 7: Proposed environmental stress triggers based on Q₉₅ EFI.

River name	Q ₉₅ EFI (MI/d)	Associated gauging station	Associated source(s)	Best Endeavors Abstraction Target rate	WRZ	Action
Anton	76.42	Fullerton	Andover	5MI/d	HAZ	Increase water efficiency communications, reduce abstraction at Andover as much as possible to target rate, increase abstraction at near Whitchurch to compensate
Test, conf Dever to conf Anton	223.27	Chilbolton	Whitchurch, Overton	1.55MI/d 1.6MI/d	HAZ	Increase water efficiency communications, no other action presently possible, no relocation option
Test, conf Dun to Tadburn Lake	339.26	Timsbury	Romsey	5.4MI/d	HRZ	Increase water efficiency communications No other action presently possible, no relocation option
Test total flow	450.74	Testwood, Conager Bridge, Ower, M27TV1	Test Surface Water	55MI/d	HSE	Flow already below River Itchen flow triggers, drought actions including monitoring and mitigation set out under our Section 20 Agreement
Candover Brook	17.69	Borough Bridge, Candover Stream	Alresford	0MI/d	HWZ	Increase water efficiency communications, reduce abstraction at Alresford (relocate to Winchester) but only shifts impacts downstream
Itchen at Easton	195.28	Easton	Winchester	13.3MI/d	HWZ	Increase water efficiency communications, reduce abstraction at Winchester (relocate to Itchen Surface Water or the Section 20 Agreement measures), shifts impacts downstream
Itchen at Allbrook and Highbridge	283.02	Allbrook and Highbridge	Itchen Surface Water, Itchen Groundwater, Twyford	30MI/d	HSE	Flow already below River Itchen flow triggers, drought actions including monitoring and mitigation set out under our Section 20 Agreement
Lukely Brook	24.67	Carisbrooke	Newport, Lukely Brook	3.42MI/d 0.79MI/d	IOW	Increase water efficiency communications, reduce abstraction at Lukely Brook and, if possible, Newport
Chillerton	12.93	River Medina at Chillerton	Rookley	0.7MI/d	IOW	Increase water efficiency communications, relocate abstraction to Newport or Sandown (if possible)
Caul Bourne	2.82	Caul Bourne	Caul Bourne	0.8MI/d	IOW	Increase water efficiency communications, abstraction already limited to protect HoF, no other actions possible
Eastern Yar	13.34	Burnt House	Sandown	8MI/d	IOW	Increase water efficiency communications, Use Flow Augmentation Scheme, relocate abstraction to Newport if possible, use Cross-Solent main
Upper Rother at Durford	19.86	River Rother at Iping Mill	Rogate	0MI/d	SNZ	Increase water efficiency communications, associated source is out of service until 2024, no other actions possible
River Lod	4.29	River Lod at Halfway Bridge	Petworth South	1.33MI/d	SNZ	Increase water efficiency communications, relocate abstraction downstream (to Pulborough)
Western Rother	121.85	Pulborough	Pulborough Surface	40MI/d	SNZ	Increase water efficiency communications, no other action presently possible, no relocation option
Nailbourne and Little Stour	40.19	Little Stour at Littlebourne	Near Canterbury	5MI/d	KTZ	Increase water efficiency communications, relocate abstraction from Canterbury to other sources where possible (but may not be due to wider groundwater abstraction impacts)

3.2 Rainfall

As illustrated by our drought vulnerability assessment, rainfall deficit is fundamental to the definition of a drought, which is characterised as a period with lower-than-average precipitation. Prolonged periods of low rainfall can also drive other drought characteristics such as low groundwater levels and low river flows.

Our rainfall triggers are based on SPI. The SPI¹⁸ is an internationally recognised approach to categorising rainfall deficit, which is essentially a comparison of rainfall deviation from average values, normalised according to the natural variability (expressed as a standard deviation) of rainfall at a given site. SPI gives a good indication of the status of rainfall variation from the norm over a given period (e.g. 6, 12, 24 months) and can be assessed probabilistically.

The ability to calculate SPI metrics of different length readily allows comparison with hydrological variables such as flow which respond over similar timescales and which can be identified from our drought vulnerability assessment.

Our rainfall drought triggers are based on the Met Office 'Had UK' monthly rainfall data which provided to us under licence by the EA and which are copyright of the EA and the Met Office¹⁹.

We have developed the following rainfall triggers.

- A Level 1 trigger based on a 20% annual probability (1-in-5 years). This trigger is useful for establishing the start of a drought and is more critically applied in our HSW and HSE WRZs where river flows and recession towards HoF conditions that restrict DO is sensitive to very mild rainfall deficits.
- A Level 2 trigger based on a 10% annual probability (1-in-10 years) consistent with our target LoS for TUBs.
- A Level 3 trigger based on a 5% annual probability (1-in-20 years) consistent with our target LoS for NEUBs and drought permit application (outside of Hampshire).

SPI based trigger thresholds are calculated for accumulation periods covering 3, 6, 12, 18, 24, 30, 36, 42 and 48 months durations for fourteen EA hydrological catchments which are relevant to our WRZs (Table 8).

To derive our rainfall triggers SPI values were calculated for the monthly rainfall time series across a range of accumulations. Trigger levels for SPI were then calculated by applying percentiles of the required probability (0.1 = 1-in-10 years and 0.05 = 1-in-20 years) to the annual minimum SPI values.

The derived trigger levels were then cross-checked against historical rainfall time series to ensure that the frequency at which the trigger curves are crossed is approximately correct based on the historical rainfall record.

¹⁸ McKee, T.B., Doesken, N.J., Kleist, J., 1993. The Relationship of Drought Frequency and Duration to Time Scales, Eight Conference on Applied Climatology, 17-22 January 1993, Anaheim, California.

¹⁹ Dataset name, Monthly Rainfall data for Hydrological Areas used within Water Situation Reports from the Environment Agency Daily Rainfall Tool (DRT)– 3rd Party IP: NRW, SEPA and Met Office.

Table 8: Relation of EA hydrological catchments used for rainfall monitoring to our WRZs.

EA hydrological catchment	Relevant WRZs
River Test (TPD_SE_H23)	HSW, HAZ, HKZ, HRZ
East Hampshire Chalk (TPD_SE_H24)	HSE, HWZ
IOW (TPD_SE_H27)	IOW
Western Rother Greensand (TPD_SE_H33)	SNZ
West Sussex Chalk (TPD_SE_H25)	SWZ
River Adur (TPD_SE_H38)	SNZ
East Sussex Chalk (TPD_SE_H26)	SBZ
River Medway (TPD_SE_H42)	KMW, KME
Eastern Rother (TPD_SE_H43)	SHZ
North West Grain (TPD_SE_H45)	KME, KMW
North Kent Chalk (TPD_SE_H29)	KME, KMW
Stour (TPD_SE_H30)	KTZ
Dover Chalk (TPD_SE_H31)	KTZ
Thanet Chalk (TPD_SE_H32)	KTZ

The duration of the SPI indicator has been analysed and tailored to reflect the vulnerability of resources that are present within each area or WRZ. We may consider the use of alternative duration SPI metrics as necessary to support our Exceptional Shortage of Rain (ESoR) case for any drought permit/order applications. This follows our lessons learned review following the mock River Test Drought Permit in autumn 2018.

The calculated SPI thresholds for each catchment are shown in Table 9 and Table 10. The SPI thresholds can be related to the drought responses and most critical drought periods identified from the drought vulnerability assessment.

Table 9: Summary of SPI trigger thresholds for rainfall (3 - 24 months accumulations).

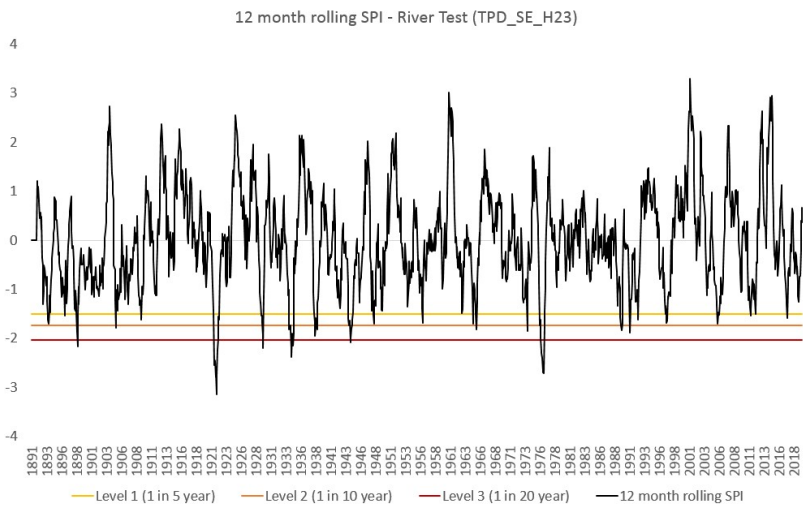
SPI accumulation period (months)	Exceedance*	River Test (TPD_SE_H23)	EHamp Chalk (TPD_SE_H24)	SW IOW (TPD_SE_H27)	WRother Greensand (TPD_SE_H33)	WSussex Chalk (TPD_SE_H25)	River Adur (TPD_SE_H38)	ESussex Chalk (TPD_SE_H26)	River Medway (TPD_SE_H42)	Eastern Rother (TPD_SE_H43)	North West Grain (TPD_SE_H45)	North Kent Chalk (TPD_SE_H29)	Stour (TPD_SE_H30)	Dover Chalk (TPD_SE_H31)	Thanet Chalk (TPD_SE_H32)
3	Level 1	-1.78	-1.82	-1.89	-1.88	-1.95	-1.95	-1.95	-1.97	-2.03	-1.97	-1.94	-1.94	-1.99	-1.84
	Level 2	-1.96	-1.95	-2.01	-2.01	-2.05	-2.01	-2.01	-2.00	-2.08	-2.00	-2.01	-2.02	-2.03	-1.89
	Level 3	-2.04	-2.02	-2.06	-2.03	-2.06	-2.03	-2.02	-2.02	-2.13	-2.06	-2.02	-2.03	-2.07	-1.94
6	Level 1	-1.76	-1.73	-1.72	-1.68	-1.66	-1.65	-1.64	-1.64	-1.65	-1.66	-1.69	-1.65	-1.64	-1.51
	Level 2	-1.96	-1.96	-1.88	-1.91	-1.91	-1.89	-1.81	-2.03	-1.86	-1.95	-1.98	-1.85	-1.87	-1.74
	Level 3	-2.22	-2.19	-2.14	-2.11	-2.06	-2.04	-1.98	-2.20	-2.08	-2.18	-2.14	-2.03	-2.03	-1.94
12	Level 1	-1.50	-1.40	-1.45	-1.34	-1.36	-1.40	-1.41	-1.46	-1.41	-1.42	-1.46	-1.32	-1.39	-1.35
	Level 2	-1.73	-1.70	-1.72	-1.57	-1.63	-1.76	-1.71	-1.73	-1.83	-1.78	-1.79	-1.81	-1.75	-1.67
	Level 3	-2.04	-2.02	-2.02	-2.02	-2.07	-1.96	-1.97	-2.00	-1.97	-1.98	-1.94	-1.95	-1.97	-1.80
18	Level 1	-1.40	-1.40	-1.35	-1.34	-1.43	-1.39	-1.40	-1.44	-1.41	-1.35	-1.42	-1.34	-1.30	-1.24
	Level 2	-1.73	-1.78	-1.67	-1.68	-1.67	-1.75	-1.78	-1.75	-1.82	-1.83	-1.83	-1.75	-1.76	-1.65
	Level 3	-1.97	-1.96	-2.06	-2.03	-2.05	-2.03	-2.01	-1.99	-2.04	-2.00	-1.99	-2.02	-2.01	-1.85
24	Level 1	-1.38	-1.39	-1.34	-1.30	-1.35	-1.40	-1.28	-1.33	-1.35	-1.34	-1.28	-1.28	-1.33	-1.19
	Level 2	-1.66	-1.71	-1.73	-1.66	-1.76	-1.69	-1.67	-1.73	-1.71	-1.68	-1.69	-1.57	-1.71	-1.63
	Level 3	-1.89	-1.77	-1.92	-1.96	-1.96	-2.01	-2.14	-2.00	-2.13	-2.06	-2.02	-2.18	-1.99	-2.03

* Level = 1-in-5 years; Level 2 = 1-in-10 years; Level 3 = 1-in-20 years

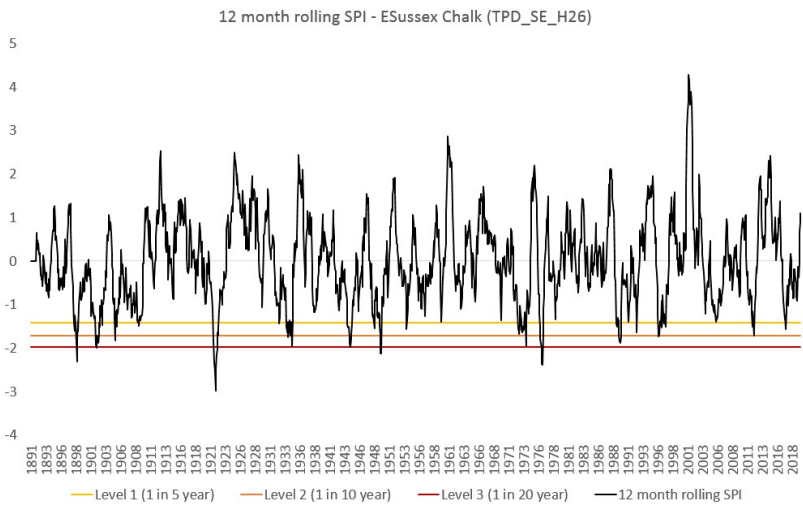
Table 10: Summary of SPI trigger thresholds for rainfall (30 - 48 months accumulations).

SPI accumulation period (months)	Exceedance*	River Test (TPD_SE_H23)	EHamp Chalk (TPD_SE_H24)	SW IOW (TPD_SE_H27)	WRother Greensand (TPD_SE_H33)	WSussex Chalk (TPD_SE_H25)	River Adur (TPD_SE_H38)	ESussex Chalk (TPD_SE_H26)	River Medway (TPD_SE_H42)	Eastern Rother (TPD_SE_H43)	North West Grain (TPD_SE_H45)	North Kent Chalk (TPD_SE_H29)	Stour (TPD_SE_H30)	Dover Chalk (TPD_SE_H31)	Thanet Chalk (TPD_SE_H32)
30	Level 1	-1.37	-1.36	-1.30	-1.28	-1.38	-1.43	-1.39	-1.44	-1.35	-1.25	-1.31	-1.26	-1.16	-1.23
	Level 2	-1.63	-1.73	-1.78	-1.70	-1.80	-1.78	-1.80	-1.76	-1.82	-1.79	-1.80	-1.69	-1.85	-1.58
	Level 3	-1.79	-1.85	-1.90	-1.89	-2.03	-1.96	-2.02	-2.02	-2.15	-1.96	-2.01	-2.02	-2.09	-1.89
36	Level 1	-1.33	-1.38	-1.27	-1.31	-1.38	-1.40	-1.35	-1.32	-1.32	-1.33	-1.38	-1.23	-1.25	-1.08
	Level 2	-1.56	-1.68	-1.70	-1.62	-1.71	-1.70	-1.65	-1.76	-1.67	-1.68	-1.70	-1.75	-1.74	-1.51
	Level 3	-1.71	-1.78	-1.86	-1.80	-1.89	-1.86	-1.89	-1.90	-2.06	-1.97	-1.94	-1.89	-2.07	-1.86
42	Level 1	-1.41	-1.39	-1.30	-1.37	-1.38	-1.20	-1.32	-1.30	-1.21	-1.33	-1.32	-1.23	-1.21	-1.02
	Level 2	-1.59	-1.72	-1.59	-1.61	-1.68	-1.65	-1.65	-1.68	-1.68	-1.70	-1.70	-1.73	-1.78	-1.47
	Level 3	-1.76	-1.83	-1.84	-1.84	-1.82	-1.90	-1.75	-1.87	-1.91	-1.97	-1.85	-1.84	-1.88	-1.72
48	Level 1	-1.29	-1.38	-1.22	-1.23	-1.27	-1.29	-1.23	-1.22	-1.17	-1.24	-1.23	-1.21	-1.25	-0.98
	Level 2	-1.58	-1.64	-1.55	-1.58	-1.63	-1.51	-1.59	-1.62	-1.61	-1.66	-1.61	-1.52	-1.73	-1.38
	Level 3	-1.73	-1.80	-1.68	-1.78	-1.78	-1.79	-1.77	-1.87	-1.90	-1.86	-1.79	-1.84	-1.85	-1.54

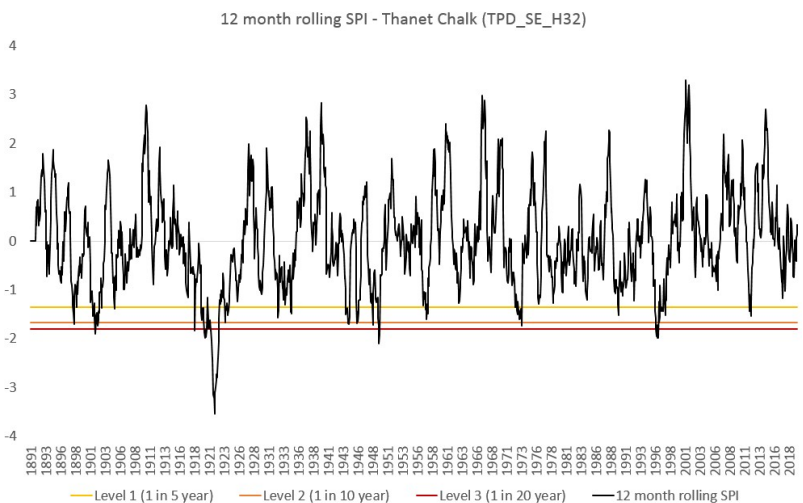
* Level = 1-in-5 years; Level 2 = 1-in-10 years; Level 3 = 1-in-20 years



	Number of annual crossings	Annual crossings frequency
Level 1	26	0.20
Level 2	13	0.10
Level 3	7	0.05



	Number of annual crossings	Annual crossings frequency
Level 1	25	0.20
Level 2	13	0.10
Level 3	7	0.05



	Number of annual crossings	Annual crossings frequency
Level 1	26	0.20
Level 2	13	0.10
Level 3	7	0.05

Figure 16: Example application of our SPI rainfall triggers to historical rainfall time series.

3.3 Standard precipitation and evapotranspiration indices

The SPI is a good measure for meteorological drought, i.e. a metric of the absence of rain. However, it provides only limited information about the how that rainfall deficit may manifest as a hydrological drought characterised by low flows or low groundwater levels.

The timing of rainfall deficits is exceptionally important to how water resources respond. For example, two 12-month drought events may have the same total rainfall and hence 12-month SPI, but in one event the rainfall deficits all accumulated over winter months and in the second the deficits all occurred over the summer months. For most of our water resource systems, the drought event with the greater winter rainfall deficits would have a much greater impact on our water resources at the end of the drought. Summer rainfall provides much less benefit than winter rainfall because higher temperatures, longer daylight hours and increased plant uptake all lead to higher evapotranspiration and reduces the amount of water available to runoff or recharge to groundwater. As illustrated by our drought vulnerability assessment, we are much more vulnerable to autumn, winter and spring drought events. In many of our groundwater dominated WRZs, summer rainfall deficits would not cause a noticeable impact on groundwater levels because we would not normally expect meaningful amounts of groundwater recharge to occur in those months.

The SPEI²⁰ is based on the same principals as the SPI but attempts to capture this seasonality by accounting for PET and hence provides a better metric of hydrological drought.

We obtained monthly PET data from the EA based on their new dataset²¹. These PET data relate to the same hydrological catchments as the rainfall series used to calculate SPI and thus are directly comparable. We have then determined SPEI triggers following a similar calculation method and the same probability thresholds (1-in-5 years, 1-in-10 years and 1-in-20 years). The corresponding suite of SPEI thresholds are presented in Table 11 and Table 12.

The effect of adopting an SPEI based trigger (compared to SPI trigger) is illustrated by Figure 17, which compares SPI and SPEI responses for the River Test Chalk catchment. Some drought events, which would not by themselves exceed SPI trigger rainfall deficits, for example 2019, do breach trigger thresholds for SPEI thresholds, indicating that the timing of the rainfall deficit led to greater hydrological impact (i.e. reduced recharge). There are also some events, where the opposite is true, for example, in 1965 where rainfall deficits were significant enough to breach the 1-in-10 years trigger, the timing of the rainfall deficit was such that this event would only just have reached the 1-in-5 years level when considered for its SPEI effects.

As it is more closely related to the hydrological water resources response, the SPEI provides a better metric overall when considering the water resource impacts of drought. However, because of the effects discussed above, and in recognition that other water users may be more significantly affected by rainfall deficits alone, for example, the environment or agriculture it is useful to consider both as complementary drought metrics.

²⁰ Vicente-Serrano S.M., Santiago Beguería, Juan I. López-Moreno, 2010. A Multi-scalar drought index sensitive to global warming: The Standardized Precipitation Evapotranspiration Index - SPEI. *Journal of Climate* 23: 1696-1718.

²¹ Environment Agency, 2020. Potential Evapotranspiration datasets, v.1.0 available under the Open Government Licence.

Table 11: Summary of SPEI trigger thresholds (3 - 24 months accumulations).

SPI accumulation period (months)	Exceedance	River Test (TPD_SE_H23)	EHamp Chalk (TPD_SE_H24)	SW IOW (TPD_SE_H27)	WRother Greensand (TPD_SE_H33)	WSussex Chalk (TPD_SE_H25)	River Adur (TPD_SE_H38)	ESussex Chalk (TPD_SE_H26)	River Medway (TPD_SE_H42)	Eastern Rother (TPD_SE_H43)	North West Grain (TPD_SE_H45)	North Kent Chalk (TPD_SE_H29)	Stour (TPD_SE_H30)	Dover Chalk (TPD_SE_H31)	Thanet Chalk (TPD_SE_H32)
3	Level 1	-1.72	-1.74	-1.61	-1.71	-1.69	-1.77	-1.74	-1.64	-1.76	-1.74	-1.79	-1.77	-1.79	-1.85
	Level 2	-1.99	-2.09	-1.80	-2.09	-1.95	-2.01	-1.98	-1.95	-2.02	-2.06	-2.02	-2.02	-2.18	-2.14
	Level 3	-2.15	-2.25	-1.90	-2.30	-2.08	-2.21	-2.11	-2.22	-2.15	-2.15	-2.19	-2.16	-2.31	-2.25
6	Level 1	-1.60	-1.64	-1.49	-1.59	-1.69	-1.74	-1.62	-1.62	-1.64	-1.60	-1.62	-1.68	-1.74	-1.79
	Level 2	-1.89	-1.97	-1.90	-1.94	-1.91	-1.85	-1.97	-1.95	-1.89	-1.88	-1.91	-1.97	-2.08	-1.95
	Level 3	-2.10	-2.21	-2.04	-2.14	-1.99	-2.20	-2.15	-2.11	-2.12	-1.98	-2.18	-2.18	-2.28	-2.26
12	Level 1	-1.48	-1.52	-1.39	-1.43	-1.45	-1.53	-1.58	-1.57	-1.48	-1.53	-1.40	-1.57	-1.61	-1.48
	Level 2	-1.77	-1.72	-1.83	-1.85	-1.65	-1.79	-1.76	-1.78	-1.70	-1.75	-1.73	-1.75	-1.82	-1.78
	Level 3	-1.92	-2.11	-1.97	-1.99	-2.08	-1.87	-2.00	-1.81	-1.93	-1.89	-2.03	-2.07	-2.00	-2.14
18	Level 1	-1.50	-1.43	-1.36	-1.46	-1.34	-1.43	-1.51	-1.33	-1.39	-1.46	-1.46	-1.51	-1.52	-1.38
	Level 2	-1.65	-1.78	-1.56	-1.78	-1.72	-1.79	-1.82	-1.76	-1.83	-1.79	-1.73	-1.81	-1.66	-1.77
	Level 3	-1.78	-1.90	-1.99	-1.93	-1.92	-1.95	-1.93	-2.03	-2.08	-1.91	-2.02	-1.89	-1.87	-1.97
24	Level 1	-1.30	-1.52	-1.18	-1.44	-1.22	-1.47	-1.46	-1.48	-1.42	-1.47	-1.55	-1.47	-1.58	-1.44
	Level 2	-1.75	-1.81	-1.61	-1.75	-1.73	-1.70	-1.70	-1.76	-1.81	-1.74	-1.72	-1.73	-1.94	-1.85
	Level 3	-2.01	-1.98	-2.23	-1.85	-1.87	-1.92	-1.85	-1.87	-1.87	-1.87	-2.09	-1.96	-2.13	-2.11

* Level = 1-in-5 years; Level 2 = 1-in-10 years; Level 3 = 1-in-20 years

Table 12: Summary of SPEI trigger thresholds for rainfall (30 - 48 months accumulations).

SPI accumulation period (months)	Exceedance*	River Test (TPD_SE_H23)	EHamp Chalk (TPD_SE_H24)	SW IOW (TPD_SE_H27)	WRother Greensand (TPD_SE_H33)	WSussex Chalk (TPD_SE_H25)	River Adur (TPD_SE_H38)	ESussex Chalk (TPD_SE_H26)	River Medway (TPD_SE_H42)	Eastern Rother (TPD_SE_H43)	North West Grain (TPD_SE_H45)	North Kent Chalk (TPD_SE_H29)	Stour (TPD_SE_H30)	Dover Chalk (TPD_SE_H31)	Thanet Chalk (TPD_SE_H32)
30	Level 1	-1.16	-1.30	-1.21	-1.32	-1.33	-1.26	-1.38	-1.22	-1.33	-1.27	-1.41	-1.47	-1.53	-1.41
	Level 2	-1.73	-1.85	-1.56	-1.90	-1.60	-1.83	-1.80	-1.80	-1.78	-1.87	-1.66	-1.85	-1.78	-1.71
	Level 3	-2.06	-2.08	-2.11	-2.01	-1.86	-1.87	-1.90	-1.98	-2.15	-2.01	-2.02	-1.97	-1.84	-1.99
36	Level 1	-1.23	-1.42	-1.29	-1.41	-1.26	-1.42	-1.35	-1.42	-1.43	-1.45	-1.48	-1.38	-1.36	-1.51
	Level 2	-1.80	-1.78	-1.54	-1.79	-1.66	-1.73	-1.65	-1.78	-1.76	-1.72	-1.72	-1.73	-1.83	-1.72
	Level 3	-2.00	-1.90	-1.96	-1.86	-1.91	-1.91	-1.85	-1.93	-1.96	-1.90	-1.79	-1.95	-1.92	-1.83
42	Level 1	-1.17	-1.32	-1.20	-1.21	-1.17	-1.19	-1.27	-1.29	-1.42	-1.26	-1.43	-1.29	-1.35	-1.40
	Level 2	-1.64	-1.68	-1.52	-1.57	-1.58	-1.71	-1.67	-1.56	-1.58	-1.65	-1.63	-1.57	-1.69	-1.62
	Level 3	-1.90	-1.77	-1.96	-1.88	-1.87	-1.88	-1.81	-1.82	-1.83	-1.76	-1.71	-1.92	-1.88	-1.80
48	Level 1	-1.22	-1.29	-1.32	-1.25	-1.31	-1.27	-1.16	-1.34	-1.26	-1.31	-1.38	-1.16	-1.27	-1.27
	Level 2	-1.68	-1.69	-1.52	-1.59	-1.57	-1.56	-1.57	-1.65	-1.67	-1.53	-1.50	-1.59	-1.76	-1.68
	Level 3	-1.78	-1.88	-2.15	-1.68	-1.71	-1.86	-1.95	-1.92	-1.89	-1.83	-1.85	-1.90	-1.84	-1.87

* Level = 1-in-5 years; Level 2 = 1-in-10 years; Level 3 = 1-in-20 years

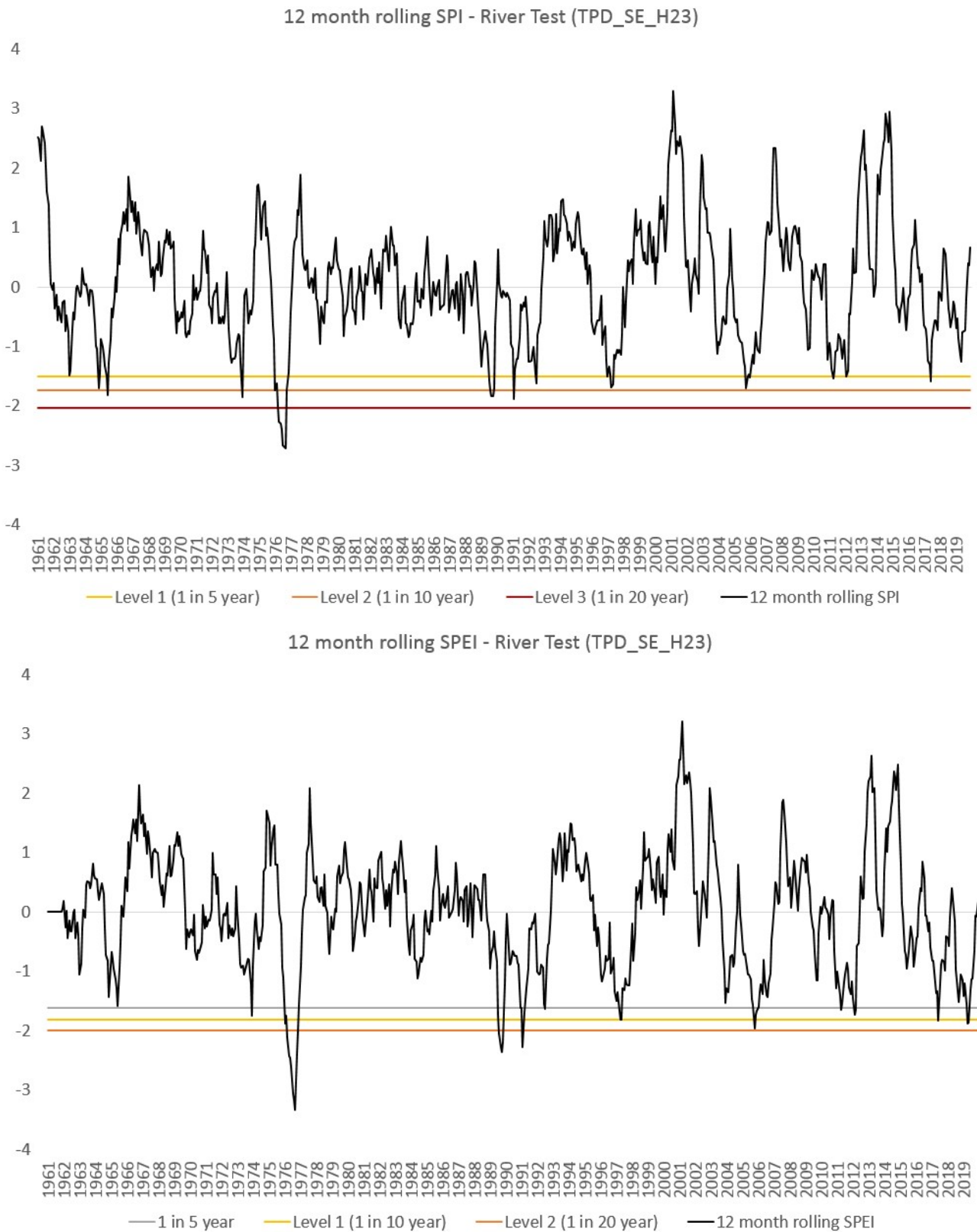


Figure 17: Comparison of historical SPI and SPEI metrics for the River Test Chalk catchment.

3.4 Groundwater levels

Drought trigger curves for groundwater levels have been developed from EA groundwater level data across a suite of key indicator observation boreholes.

For Drought Plan 2027, we have updated our existing groundwater triggers and developed an enhanced set of new triggers to strengthen drought assessment and decision-making. The methodology and development process are fully documented, and the revised triggers are presented in **Appendix B** of this Annex.

This section will be updated following completion of the regulatory consultation process.

3.5 River flows

For Drought Plan 2027, we are reviewing and updating our river flow triggers. We have commissioned Atkins to undertake the required modelling, and this work is scheduled for completion by the end of April 2026. Atkins has produced a Phase 1 report, which is included as **Appendix C (Regulators Only)** of this Annex.

This section will be updated following the regulatory consultation process.

3.6 Drought triggers – reservoirs

We are internally reviewing reservoir drought triggers for our four main reservoirs in our supply area, namely:

- Bewl reservoir (Eastern area)
- Darwell reservoir (Eastern area)
- Powdermill reservoir (Eastern area)
- Weir Wood reservoir (Central area)

This section will be updated following the regulatory consultation process.

4. Drought Phasing

We have developed triggers based on our analysis of a wide range of drought events considering a variety of different monitoring data. The triggers are progressive in nature and therefore intended to reflect the increasing severity of a drought event so that measures that are associated with each set of triggers are only introduced when they are required.

In general, for each WRZ, the start of a drought (Level 1), which involves voluntary actions, has been defined as any SPI or SPEI trigger crossing the 1-in-5 years trigger threshold. The exception to this is in relation to the River Test and River Itchen where drought actions are defined under the Section 20 Agreement. For this, the start of drought is defined with a 60-day threshold to start preparation of drought permit and water efficiency measures. An additional 90-day trigger is also defined to provide an internal early warning. This will nearly always be a 90-day threshold triggered for the River Test and it will typically occur in advance of even moderate rainfall deficits developing.

Level 2 and Level 3 actions will tend to be defined with triggers crossing the 1-in-10 years and 1-in-20 years thresholds respectively, except for the River Test and River Itchen where drought actions are defined under the Section 20 Agreement. For each WRZ, primary and supporting triggers have been defined.

Primary triggers include the river flow, reservoir storage or groundwater levels and supporting triggers include SPI and SPEI triggers for associated durations as well as groundwater levels and triggers based on other WRZs. We have defined the associated duration for SPI and SPEI based on a comparison of historic drought occurrence between the primary trigger and different SPI and SPEI durations.

Level 2 or Level 3 actions can be initiated based on the primary trigger or based on the SPI or SPEI trigger if the primary trigger is close to its respective trigger. It is important to note that the trigger levels do not require both SPI and SPEI to initiate the next phase of drought actions.

In the case where due to data availability or recording issues a trigger is not available, actions may be initiated based on primary or supporting triggers alone. In addition to this, we may consider the use of alternative duration SPI and SPEI metrics as necessary to support an ESoR case for any drought permit/order applications. This follows our lessons learned from the Section 20 Agreement process for the River Test Drought Permit in 2019 and 2020.

A drought ends when normal conditions resume and the risk to security of supply and the environment are no greater than they would be in a normal year. Several indicators are used to determine that a drought has ended. This varies for each WRZ but in general consists of the primary trigger (river flow, reservoir storage or groundwater level) exiting the defined trigger thresholds and SPEI reaching a defined threshold. From comparisons for historic droughts (discussed in Section 5.1) we found that SPEI for the associated durations for each WRZ corresponds well to the progression of the primary triggers as it considers not just the significance of the rainfall deficit but also seasonality by accounting for PET and hence providing a better metric of hydrological drought.

Further details on the multifactorial triggers identified for each WRZ are discussed below. The phasing and combination of triggers adopted for each of the defined Level 1 to Level 3 as well as the end of drought conditions are also included specific to each WRZ.

4.1 Eastern area

This section will be updated when all triggers have undergone full review

4.2 Central Area

This section will be updated when all triggers have undergone full review

4.3 Western area

This section will be updated when all triggers have undergone full review

This section also depends on the Section 20 Agreement, Candover and stated HOF changes, all of which require regulatory support.

4.4 Flow forecasting

We use 'Catchmod' rainfall-runoff models to forecast potential river flows on both the River Itchen and the River Test. These models were parameterised and calibrated by the EA, and we have several years of experience of successfully using the models.

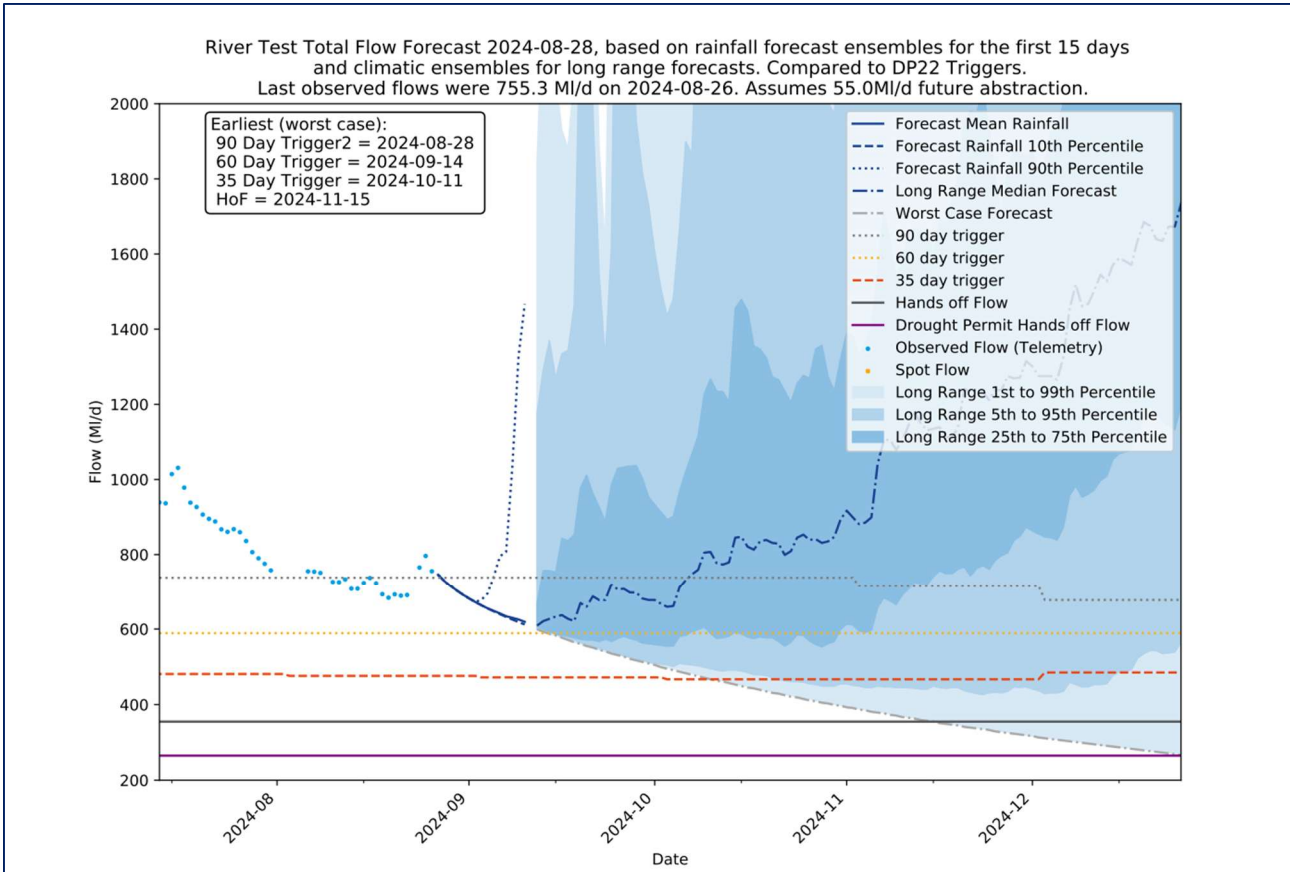
The models are configured to start at the latest observed flows and are then run into the future to provide an assessment of how flows might occur under a range of potential scenarios. The forecasts are based on actual forecast weather data for the first 15 days of the forecast. These weather forecasts take the form of outputs from ensemble weather forecasts as provided by our weather forecast provider, and comprise three outputs - the 90th percentile, 50th percentile and 10th percentile of these ensemble forecasts. The outcomes of the 15-day forecasts are then spliced with the 19,200 year synthetic climatic weather sequence as was developed for WRSE for the development of the Regional Plan and WRMP24. The outputs are then presented on charts, which present the resulting flows, separated (from the driest up) as the worst case, 1 percentile, 5 percentile, 25 percentile and average flows (see the figure below).

Whenever a forecast is run, it is straightforward to calculate the number of days until the hands off flow (HoF) may be breached. This can be done in relation to potential risk, i.e. the example in the figure below indicates that when that model was run, the chance of needing a Drought Permit (i.e. for flows to fall below the HoF) in around 65 days was >1%, but the overall risk of needing a Drought Permit was <5%.

We are of the view that using flow forecasts to assess the potential lead-in times to needing drought interventions provide a more sensitive, flexible and accurate approach than relying on trigger lines on their own. This is because the forecasts account for any potential forecast rainfall events in the near term and provide an indication of the timing and likelihood of interventions being required in the longer term. Moreover, our forecast system is ensemble based which allows us to predict a wider range of potential future streamflow realizations, which is crucial for contingency planning. The forecasts and related information can be readily shared with regulators and allow for informed decision making based on the most up-to-date understanding of the current situation and potential drought risks. As referred to in section 3.5.5, flow forecasting will provide a more flexible approach than the 35 day trigger for the River Itchen. However, as the

Section 20 Agreement specifies a 35-day trigger for the River Test Drought Permit we retain that trigger. Although, as illustrated below, it is used within the flow forecasting tool.

Figure 42 - Illustration of flow forecasting tool used for River Test



5. Testing our plan

5.1 Historical droughts

This section will be updated when all triggers have undergone full review

5.2 Severe to extreme droughts outside the historical record

This section will be updated when all triggers have undergone full review

5.2.1 Extreme 1-in-500 years drought

This section will be updated when all triggers have undergone full review

5.2.2 Severe 1-in-200 years groundwater drought

This section will be updated when all triggers have undergone full review

5.2.3 Extreme 1-in-500 years groundwater drought – SBZ and SWZ

This section will be updated when all triggers have undergone full review

5.2.4 Severe 1-in-200 years drought – Eastern area reservoirs

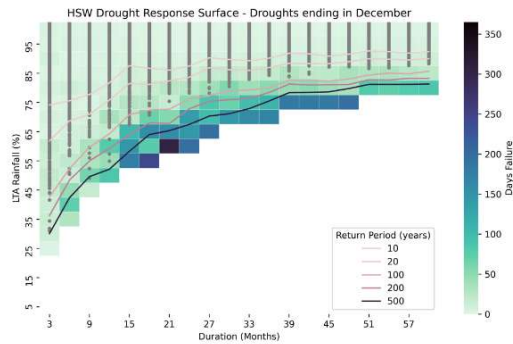
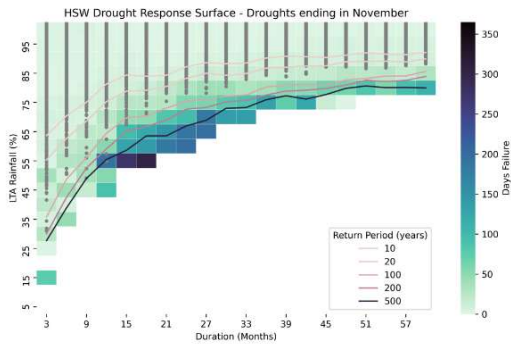
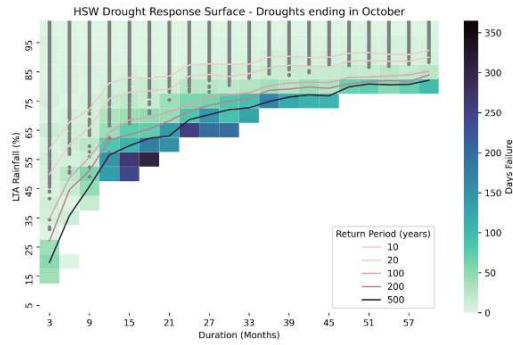
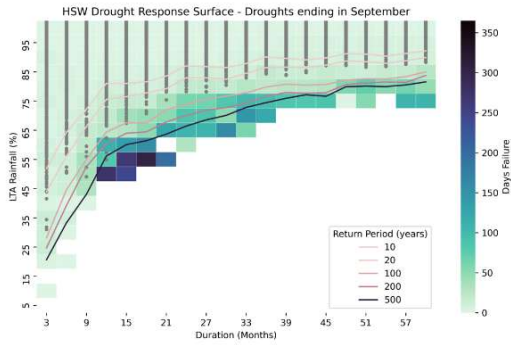
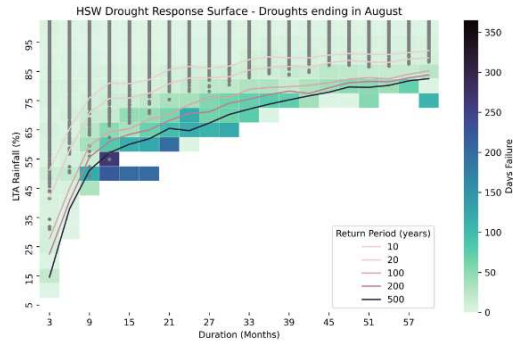
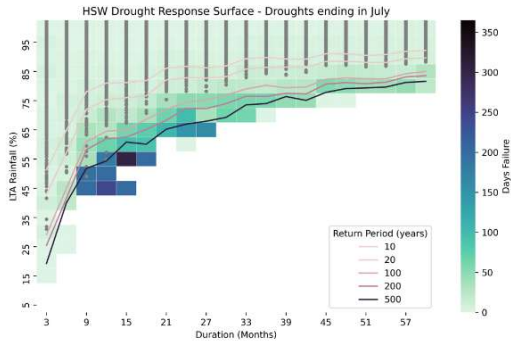
This section will be updated when all triggers have undergone full review

5.2.5 Extreme 1-in-500 years drought – Eastern area reservoirs

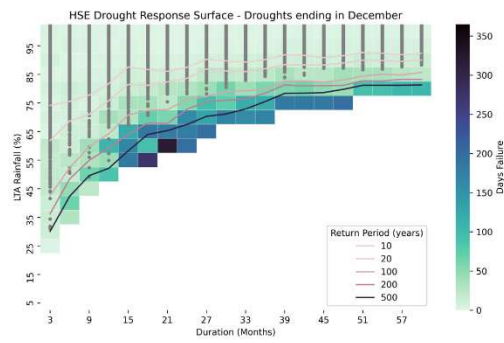
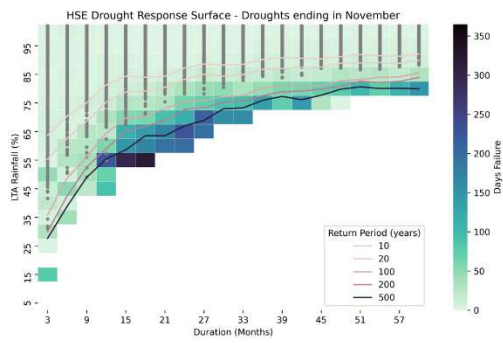
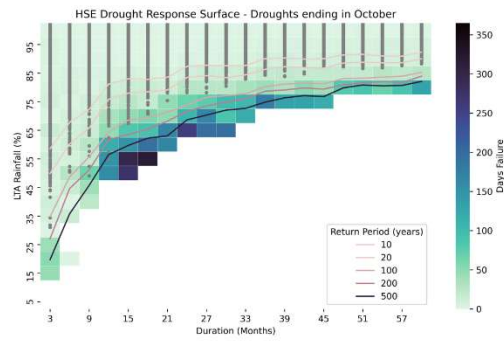
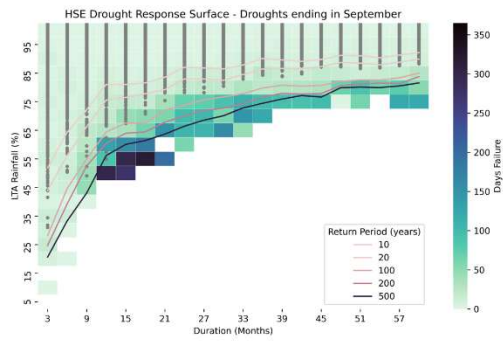
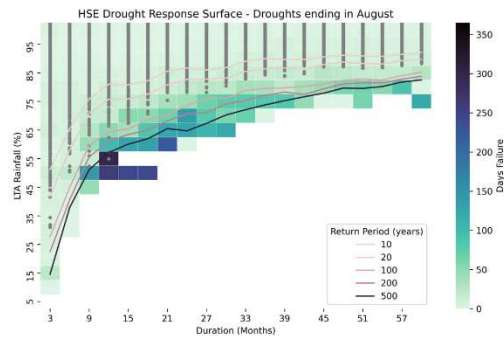
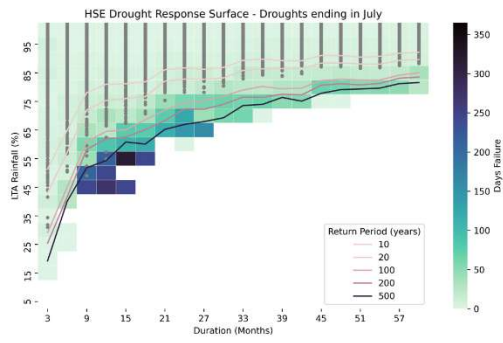
This section will be updated when all triggers have undergone full review

Appendix A: DRS plots by WRZ

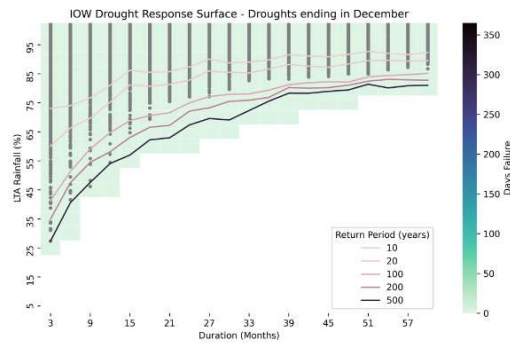
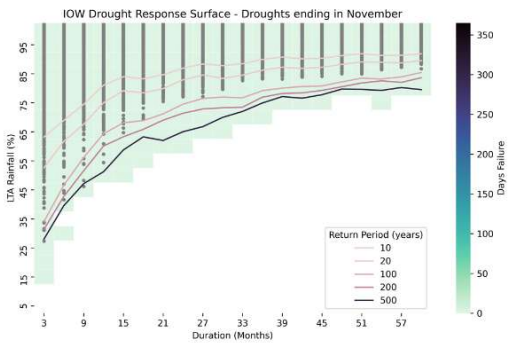
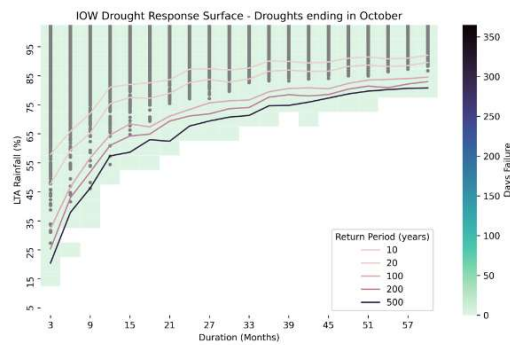
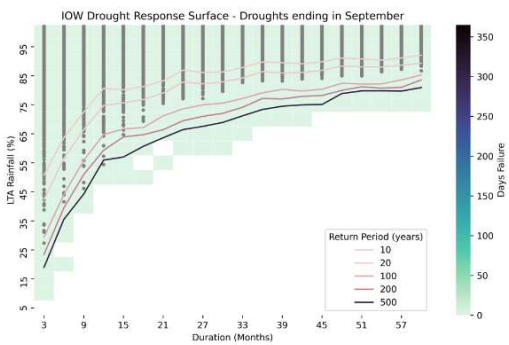
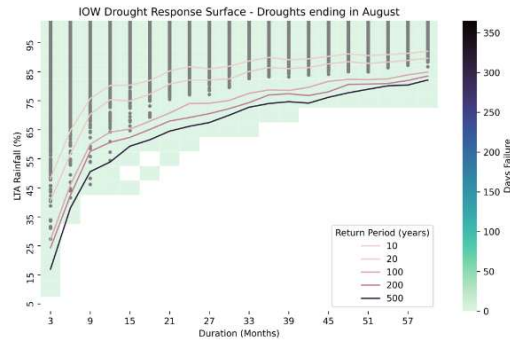
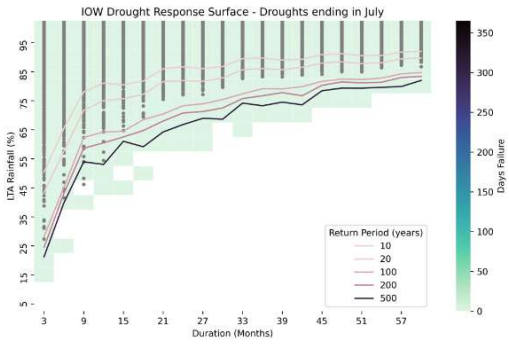
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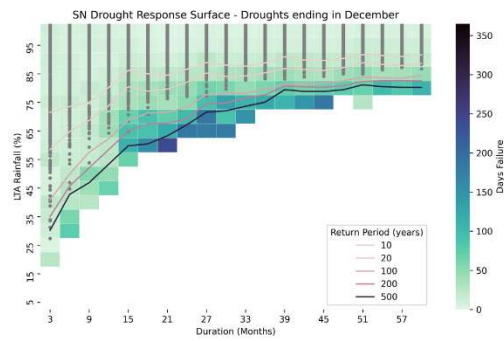
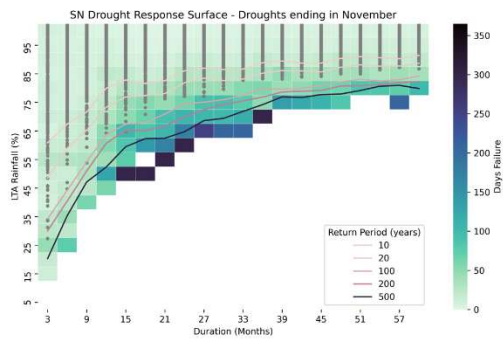
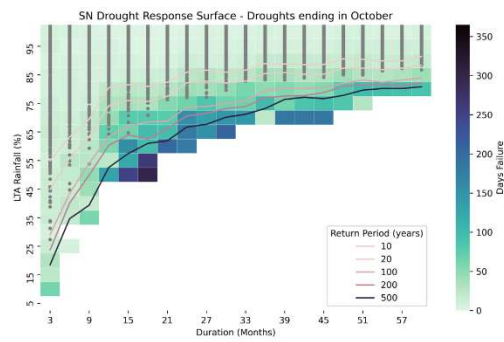
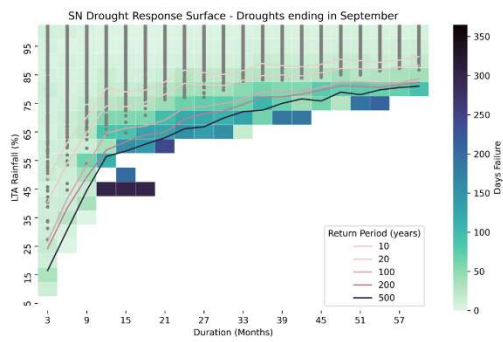
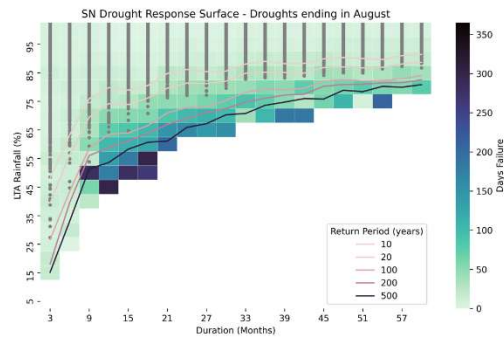
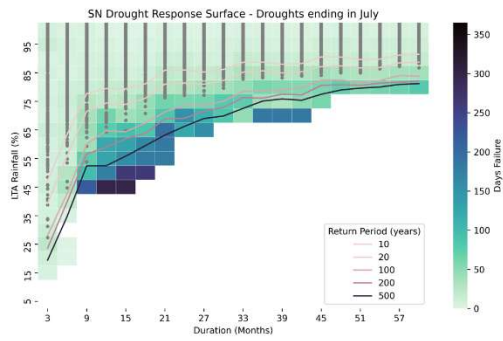
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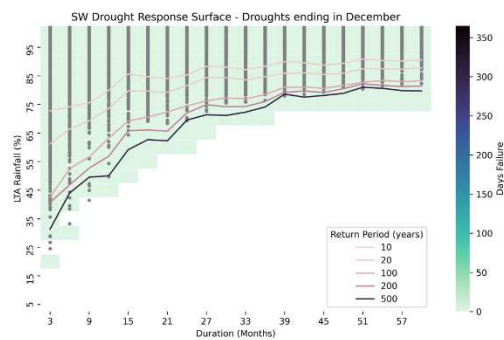
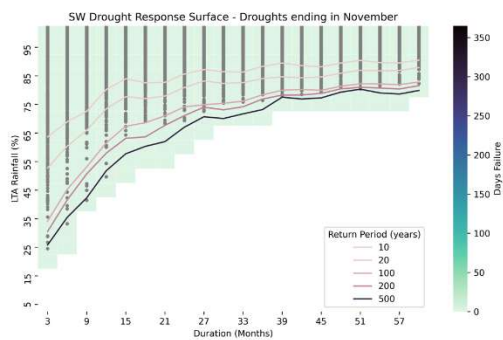
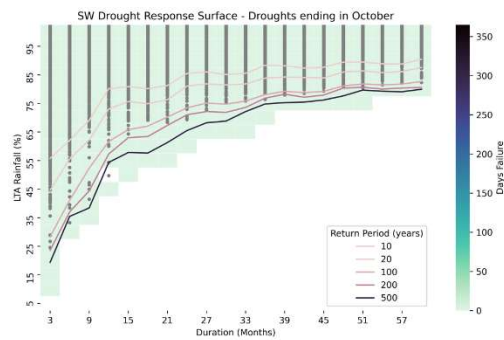
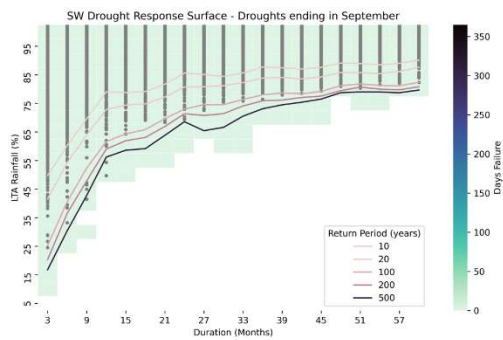
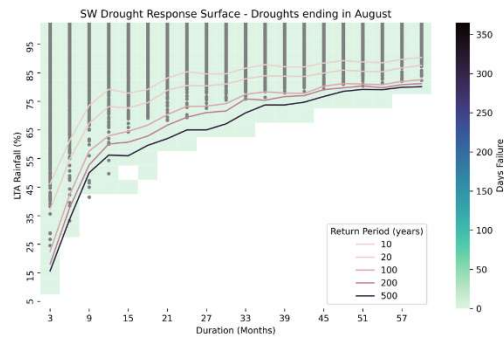
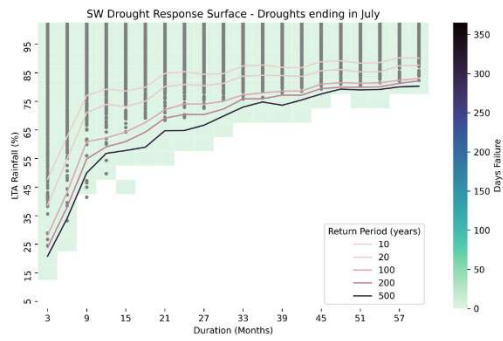
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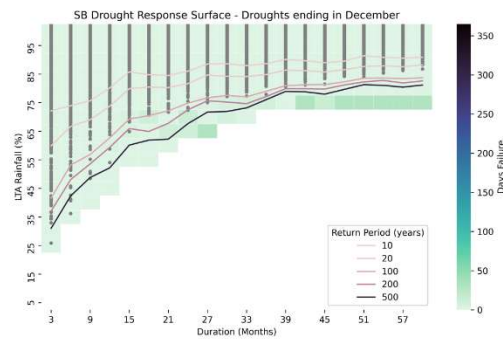
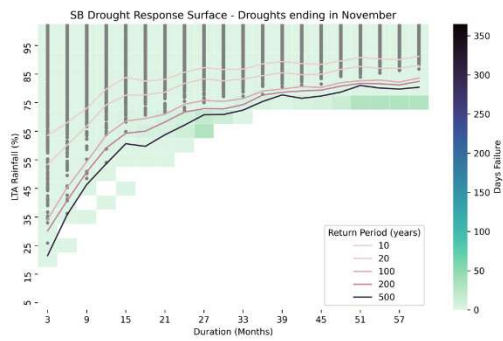
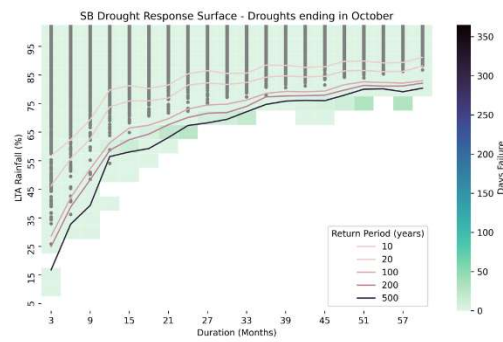
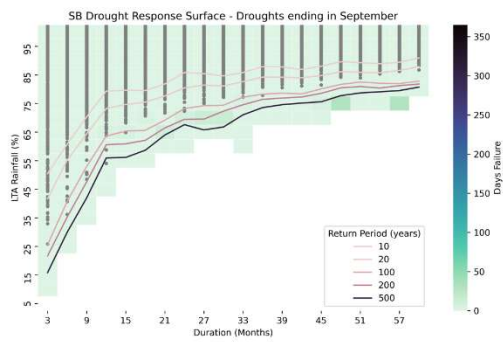
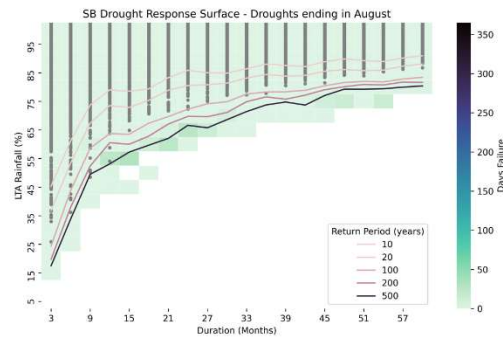
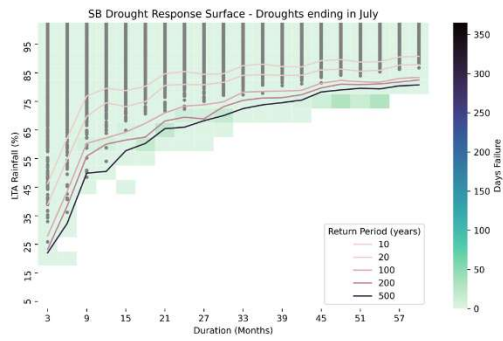
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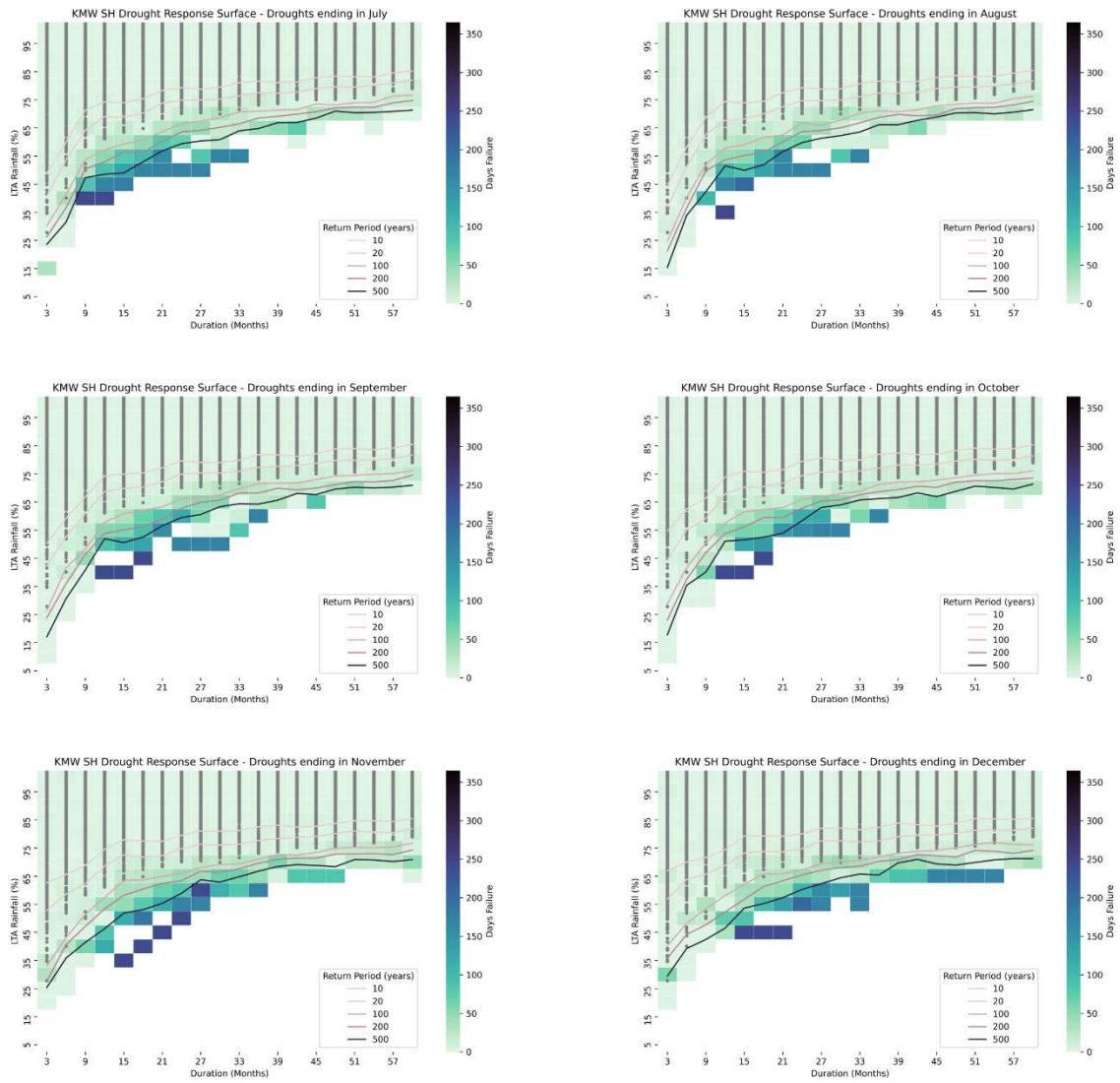
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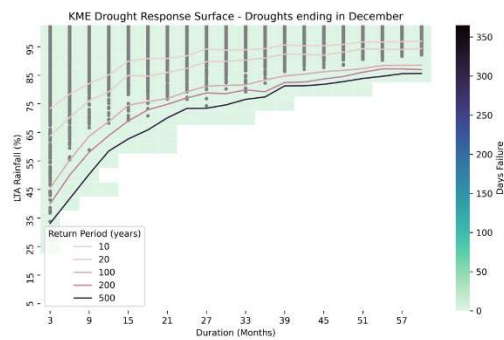
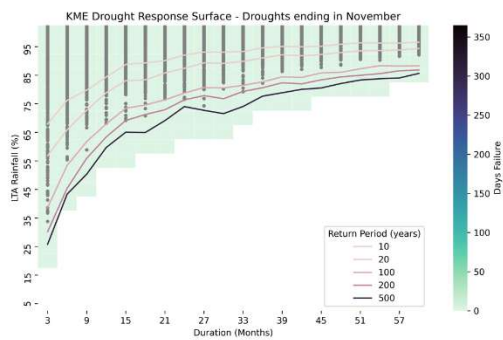
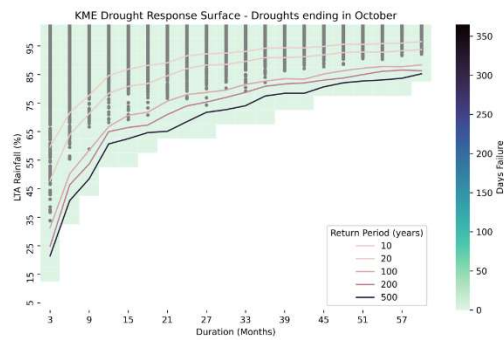
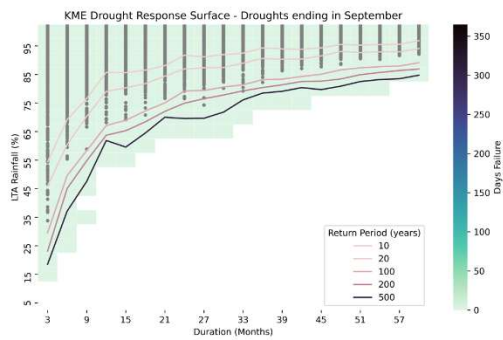
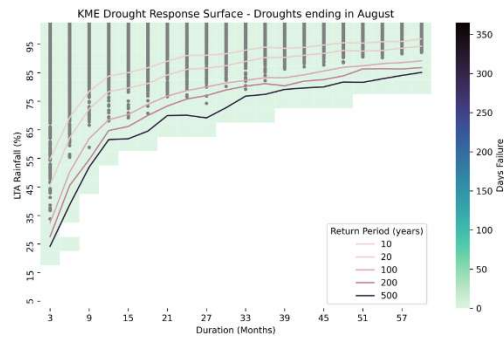
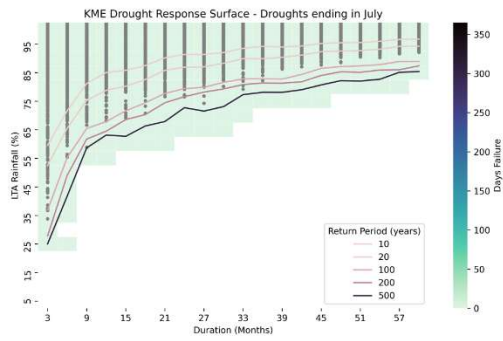
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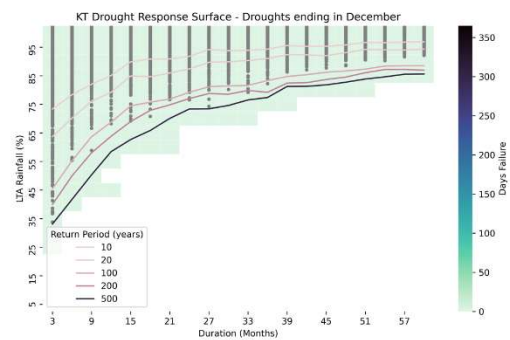
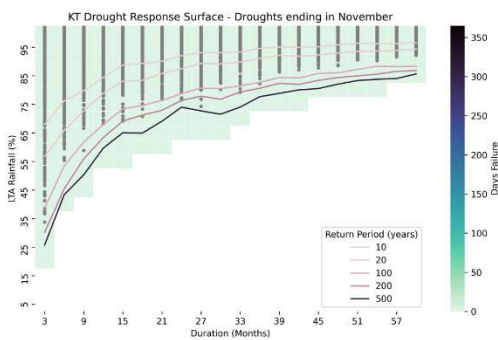
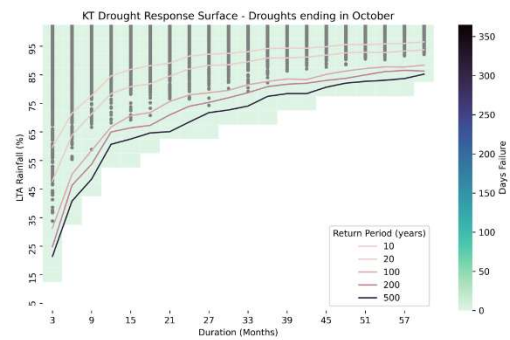
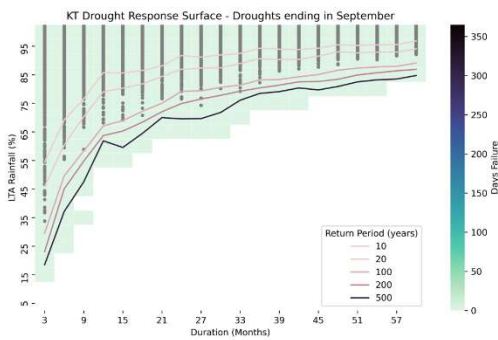
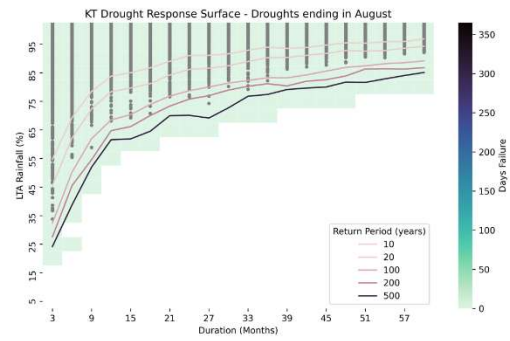
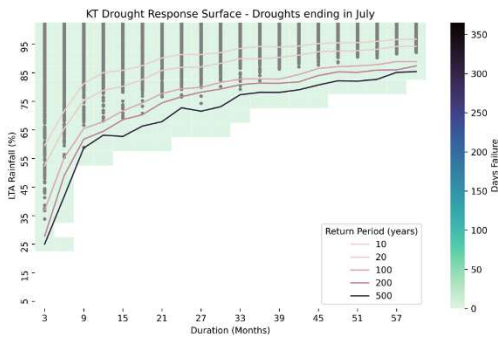
Kent Medway West and Sussex Hastings (River Medway Scheme)



Kent Medway East



Kent Thanet



Appendix B: Groundwater Triggers

See separate document.

Appendix C: Atkins River flow Drought Triggers Modelling Phase 1 Report (for regulators only)

See separate document.