



Building on-farm resilience to water-related risks

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Cranfield Water Science Institute

20 November 2025

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Agricultural climate and water-related shocks

Shock

Acute

Chronic

Impacts

Floods and droughts

Environmental degradation, abstraction reform

Responses

Operational short-term coping strategies

Strategic long-term planning and collaboration

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Presentation outline

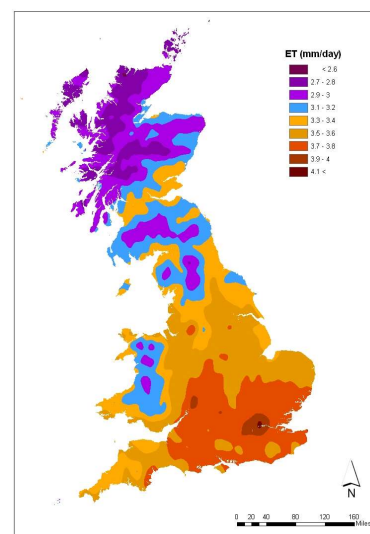
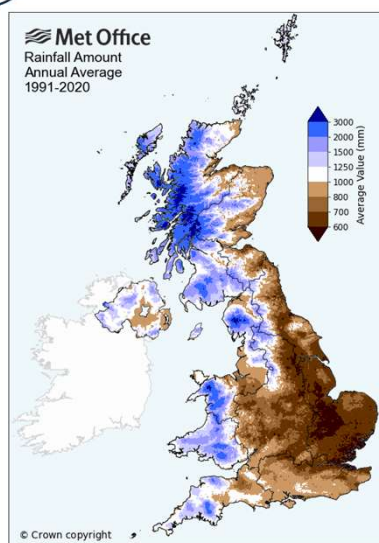
- **Understanding the key risks**
 - Agroclimate and droughts
 - Environmental destination and abstraction reform
 - Changing climate and extremes
- **Opportunities to reduce vulnerability**
 - Drought risk management
 - Rainwater harvesting
 - Water sharing
 - Smart agricultural water resources management
 - Working together (Water Abstractor Groups)

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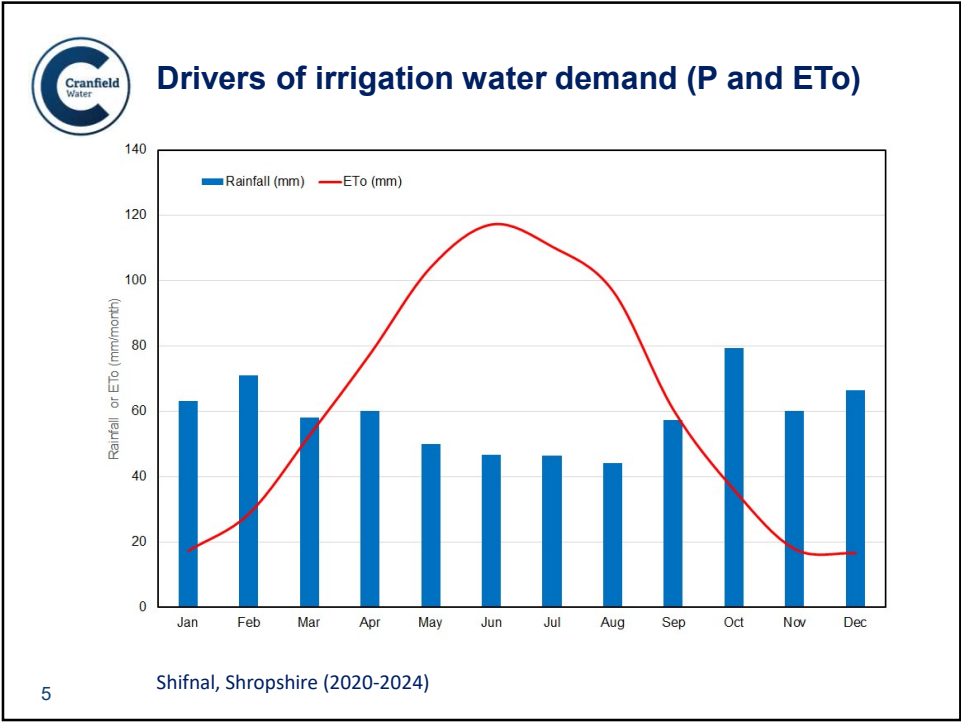


Long-term average annual rainfall and ETo (July)

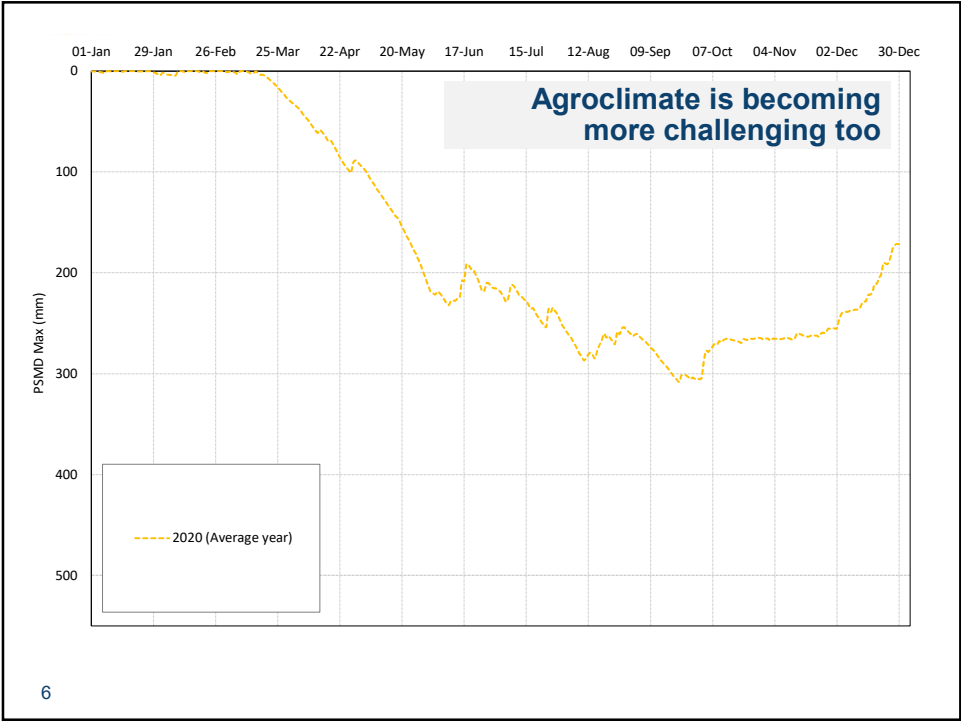


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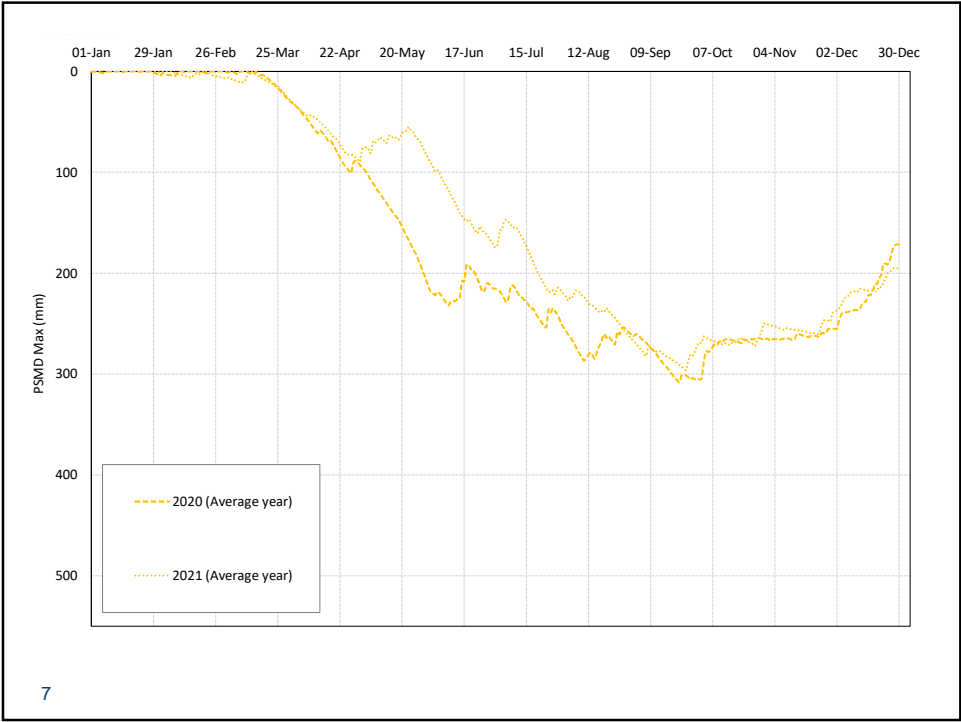
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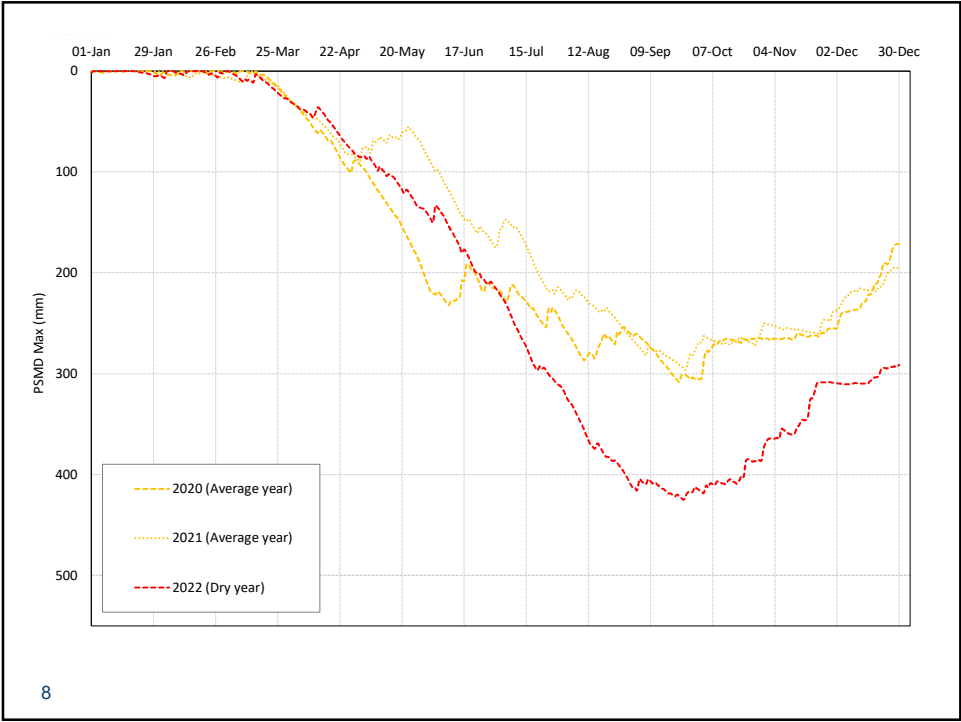
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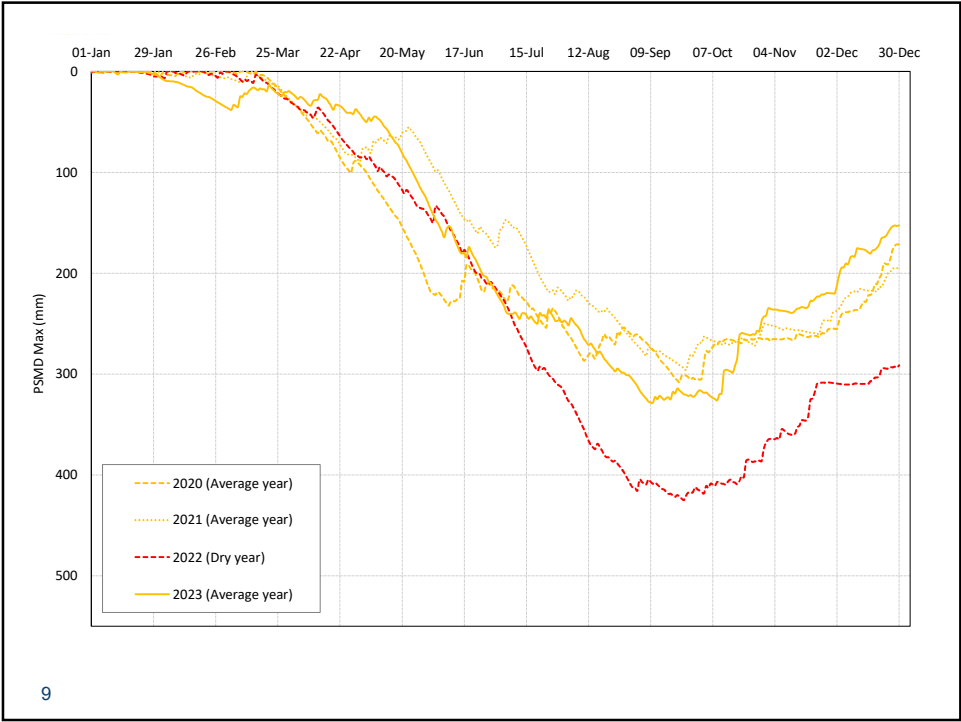
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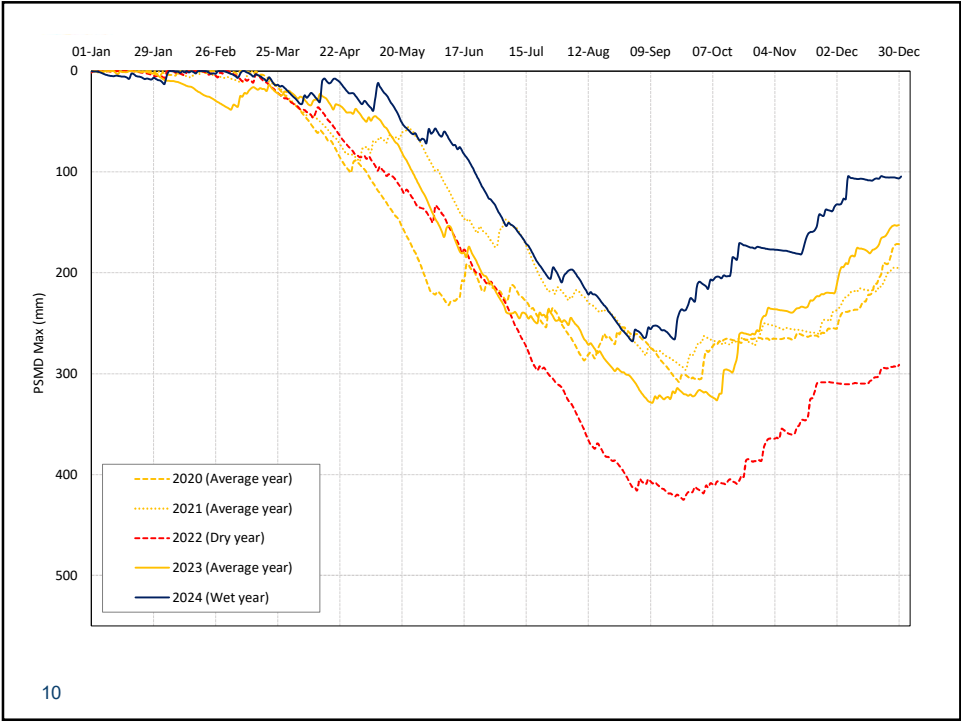
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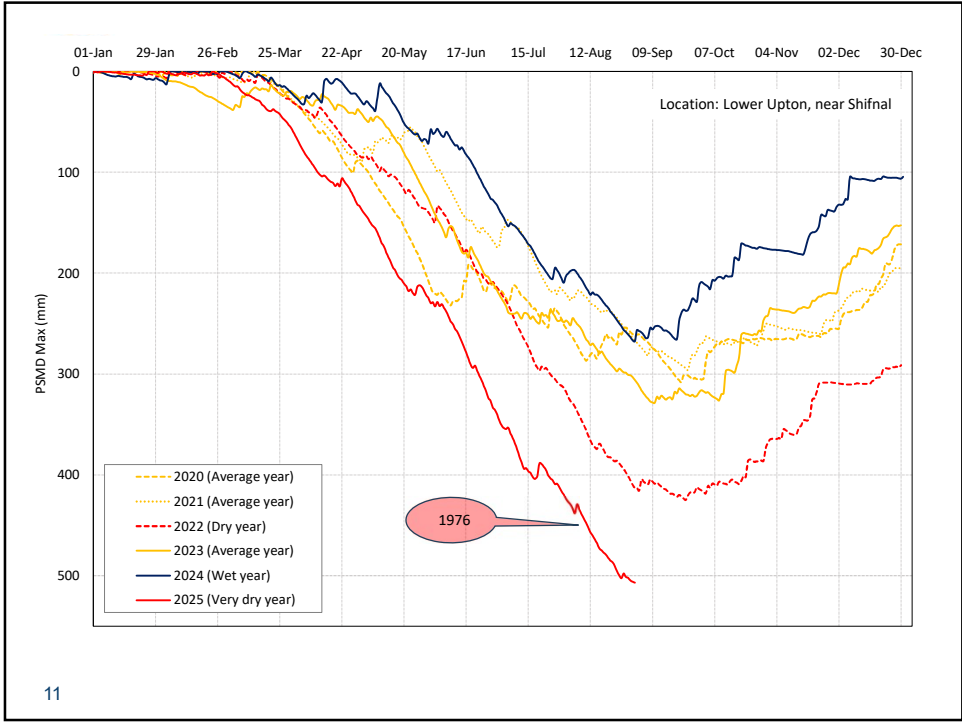
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2018, 2022 and 2025 stark reminders of drought risk

- Impacts on rainfed and irrigated cropping systems and livestock
- Widespread abstraction restrictions (HoFs)
- Delays in reservoir refilling (2022-23 and 2025) due to low winter rainfall
- Changing planting programmes – reduced cropped areas
- Profound concerns regarding future licensed allocations and planned reductions to meet environmental destination targets

Photo courtesy Andrew Francis, Elveden Farms

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Droughts are a slow onset creeping phenomenon



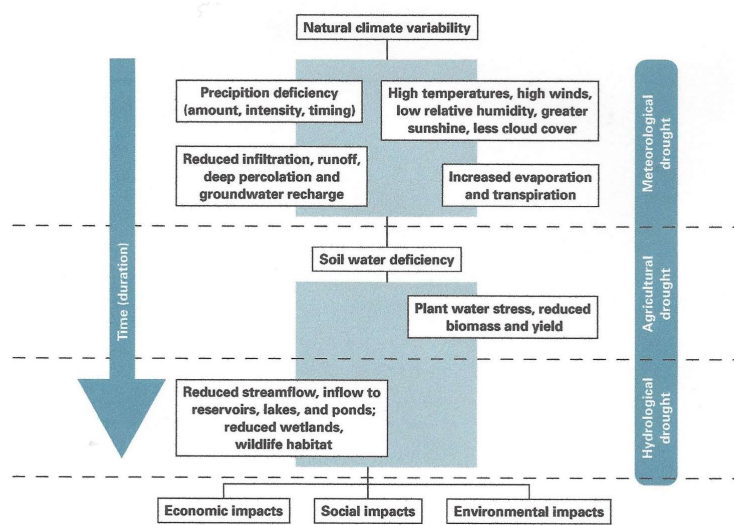
Drought indicators or indices often used to **track droughts**

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Drought types and dependencies

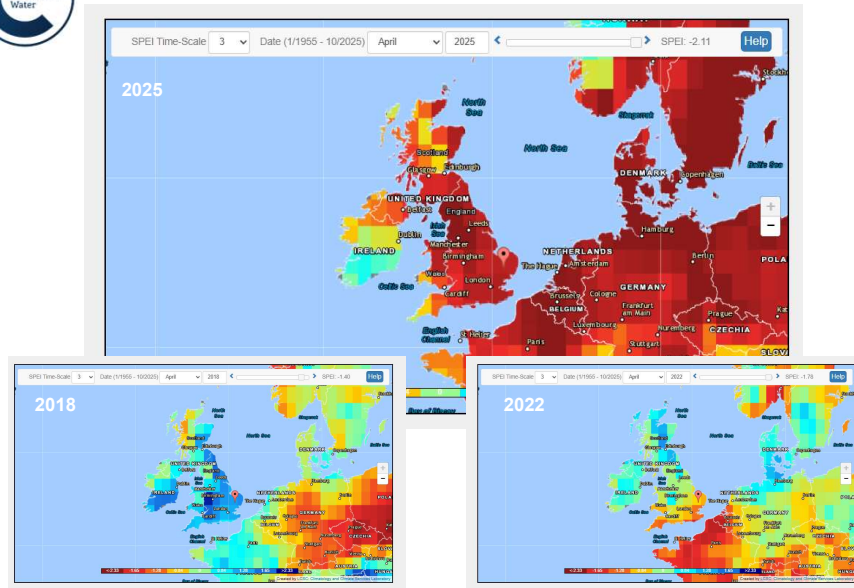


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Frequency of drought risks increasing



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SPEI Global drought monitor <https://spei.csic.es>

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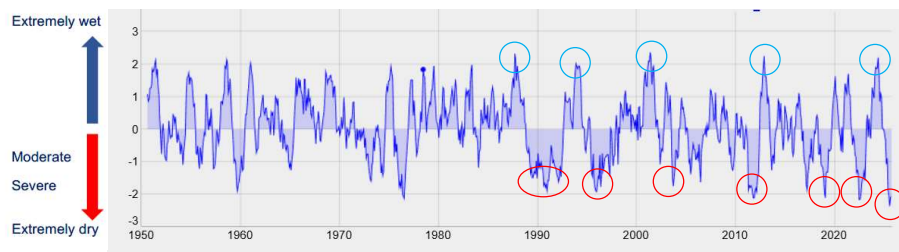


Frequency of drought (and flood) risks increasing

SPEI drought indicator provides a measure of the deviation from the average

Cambridge

Flood risk years 1987, 1993, 2001, 2012, 2024

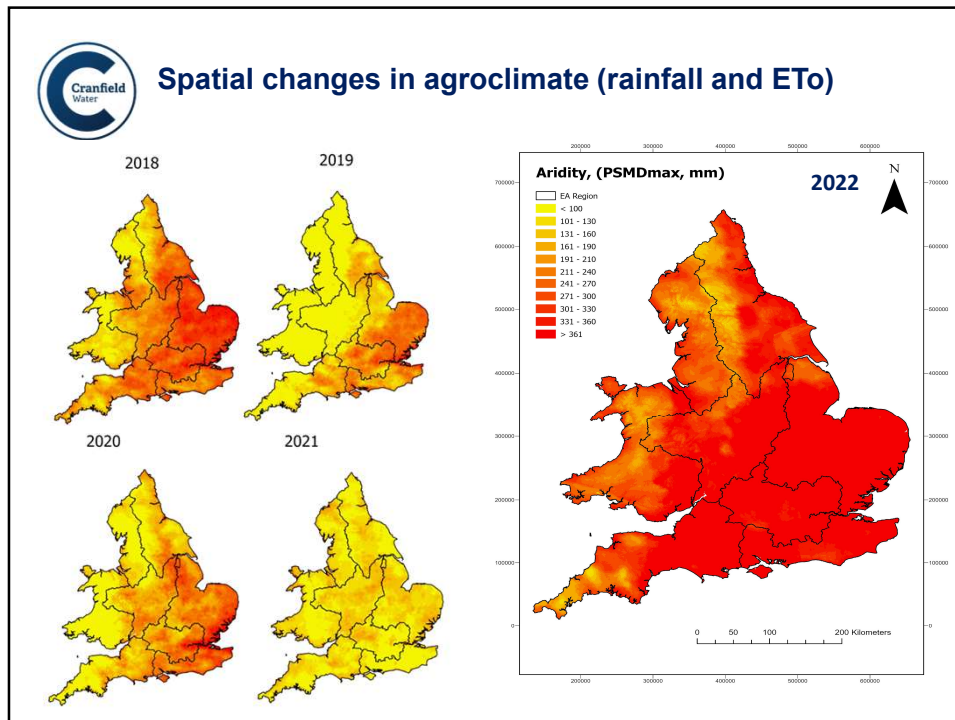


Drought risk years 1988-92, 1995, 2003, 2011, 2018, 2022, 2025

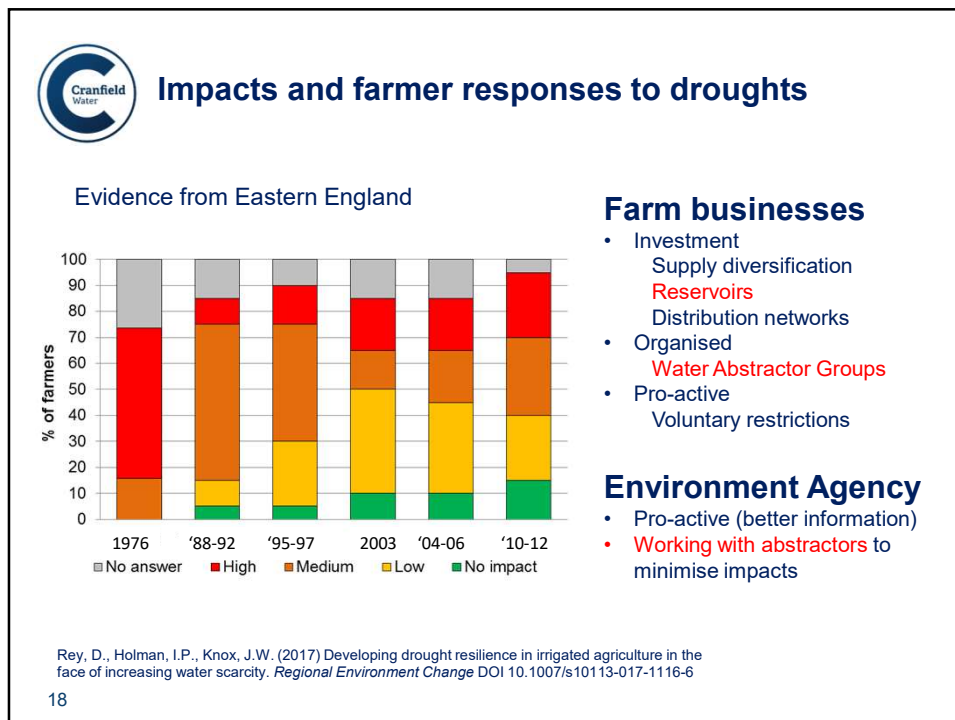
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SPEI Global drought monitor <https://spei.csic.es>

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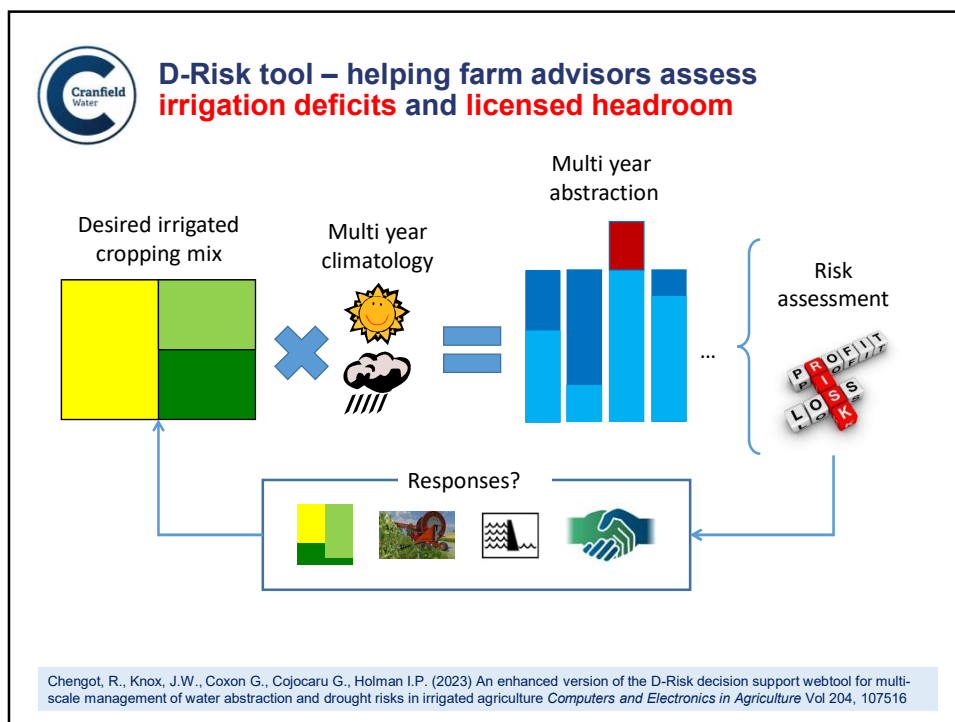


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 **D-Risk webtool**
<https://www.d-risk.eu>



DRisk inputs

- Country and county (England, Scotland and Wales)
- Location (postcode)
- Gauging station and catchment (if you want to include HoFs)
- Period – baseline or future
- Individual farm or groups of farms
- Crop and soil information
- Abstraction licences (direct and storage)

DRisk outputs

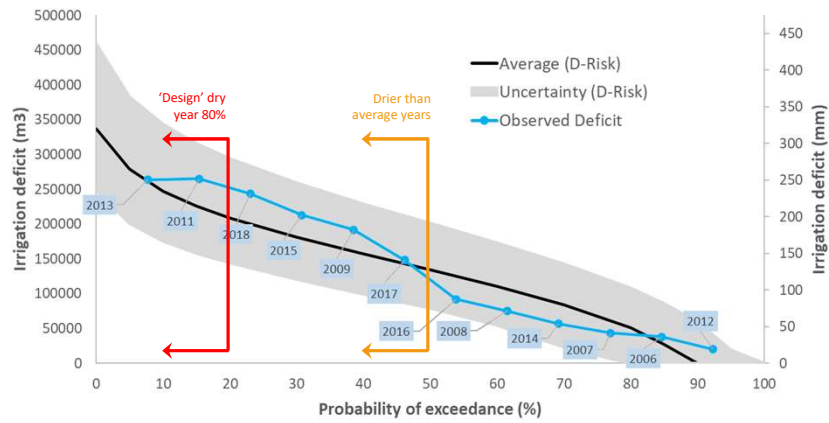
- Irrigation deficit
- Licensed headroom

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Assessing drought and abstraction risks – irrigation deficits

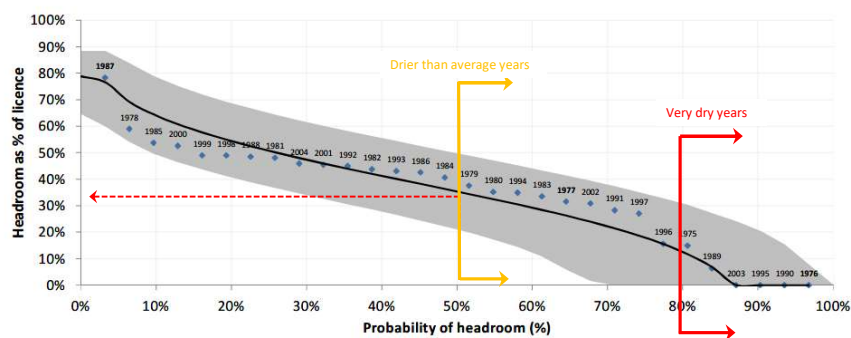


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Assessing drought and abstraction risks – licensed headroom

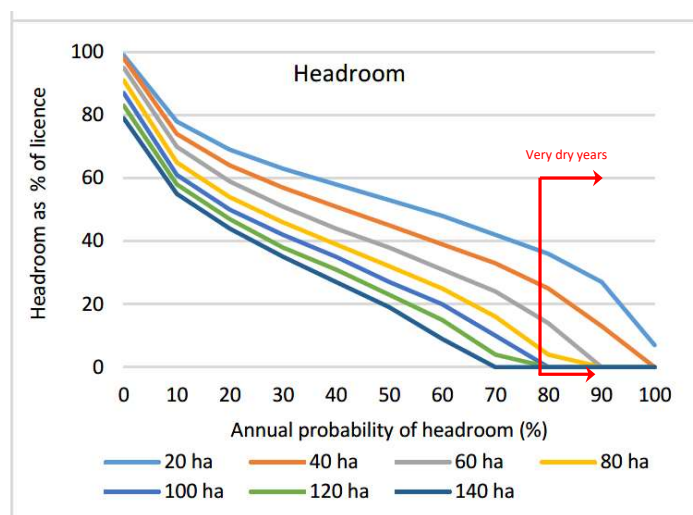


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Assessing drought and abstraction risks – licensed headroom



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D-Risk case studies

Water Abstractor Group

Using D-Risk to inform the feasibility of water sharing as a drought risk management tool in the Lark catchment (Suffolk)

https://www.d-risk.eu/Case_study_Lark_abstractor_group.pdf

Farm businesses

Using D-Risk to inform irrigation management at Frederick Hiam (Suffolk)

https://www.d-risk.eu/Case_study_Frederick_Hiam_Ltd.pdf

Using D-Risk to inform irrigation management at LF Papworth (Norfolk)

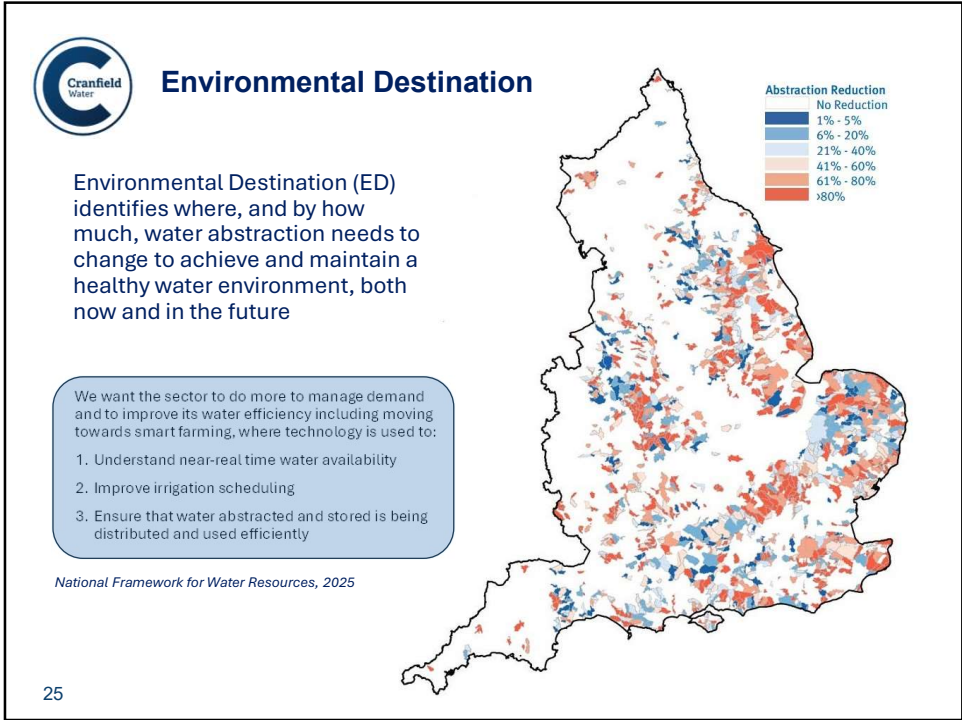
https://www.d-risk.eu/Case_study_LF%20Papworth_Ltd.pdf

Using D-Risk to inform irrigation management at WO & PO Jolly (Suffolk)

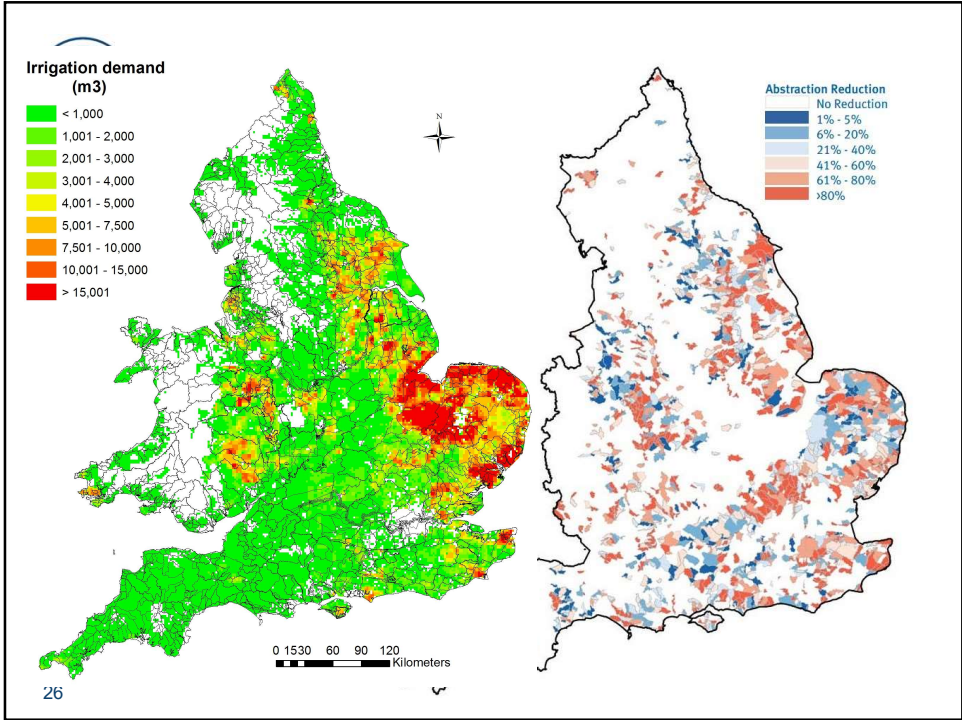
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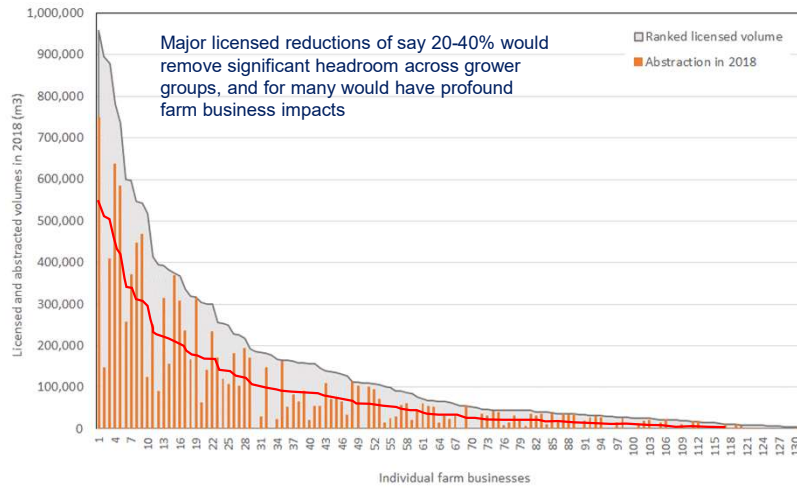
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Potential impacts of future reductions in licensed volumes?

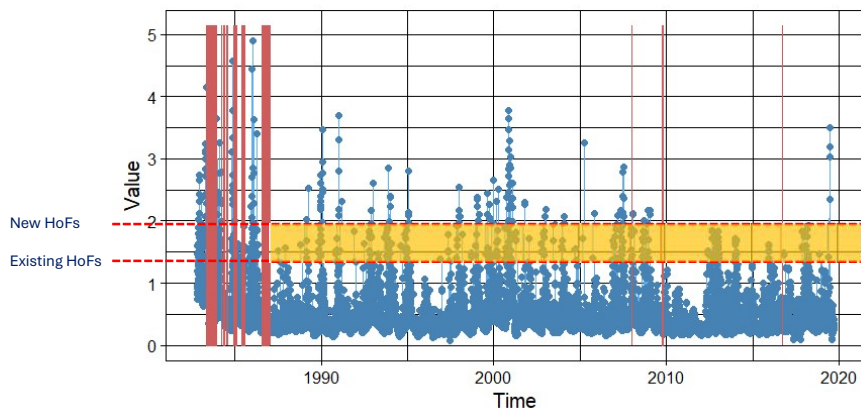


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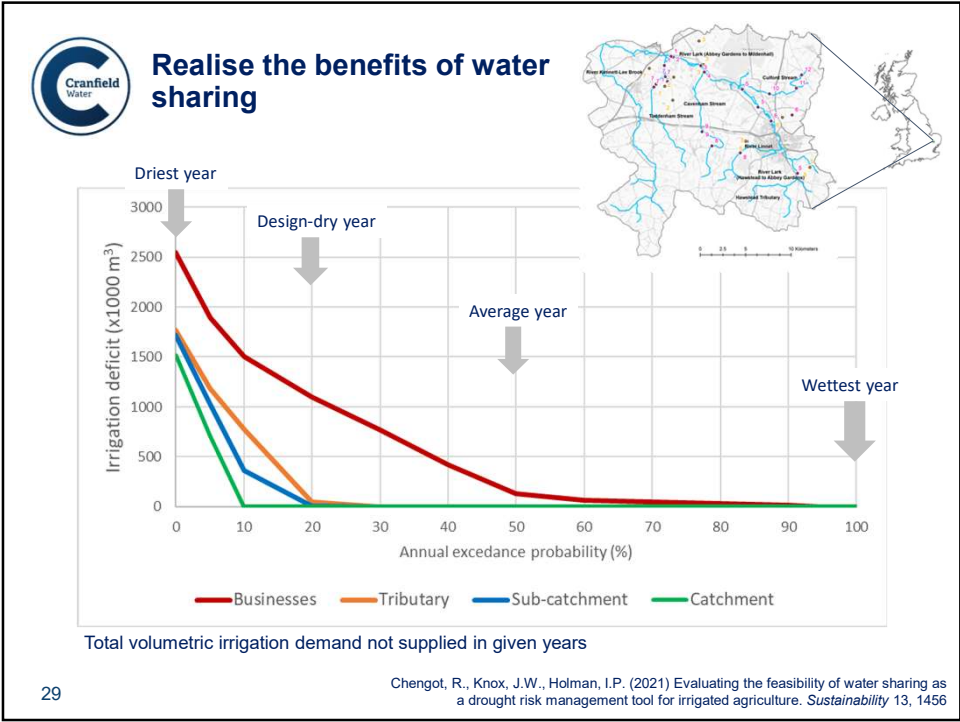


Raising HoFs to protect eflows - easier to implement and difficult to challenge

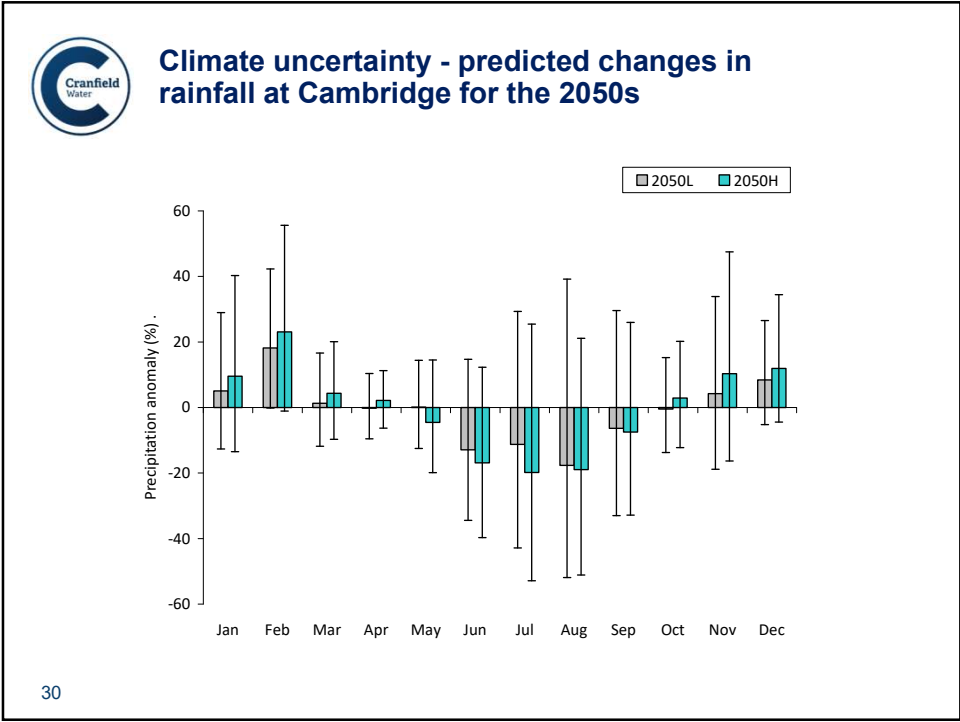


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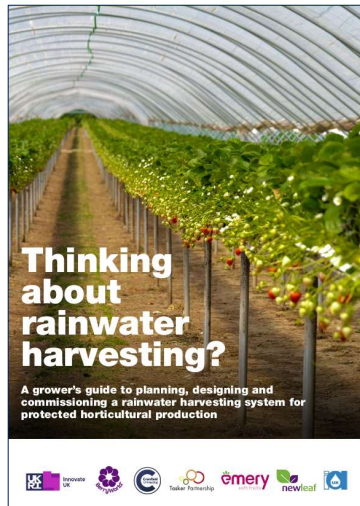
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Rainwater harvesting for protected horticulture



- Realising the business benefits
- Concept to commissioning
- Planning and permissions
- Sizing reservoir storage
- Farmer case studies

Read the booklet here:

<https://www.ukia.org/3d-flip-book/rwh-book-1/>

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Old solution for a new problem

- Rainwater is free: does not need a licence to capture, store and use
- Reduces dependency on direct abstraction (SW, GW) and PWS
- Provides insurance against abstraction restrictions (Hands-off-Flows, HoF)
- Rainwater usually better for irrigated crops, improving crop quality and yield
- Requires less pre-treatment than PWS and direct abstractions
- Reduces risks from climate variability (low summer flows, restrictions, capturing high intensity short-duration rainfall events)

RWH tool

- Enables farmers (and advisors) who do not have RWH systems to evaluate potential water resource benefits, including design options and mains water cost savings
- Assist businesses with existing RWH installations to evaluate relative performance and identify measures to improve rainwater self-sufficiency

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Key questions farmers need to consider

1. How much rainfall can you **reliably** capture on your farm site?
2. What **proportion** of harvested rainwater can you rely on to **meet your annual irrigation demand**?
3. How much **on-farm storage will you need** to make the RWH system reliable?
4. How much will it **cost**, and what water cost savings are possible?

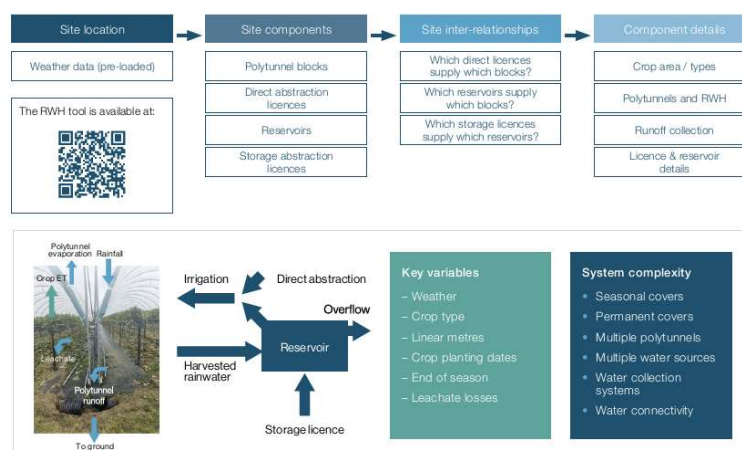


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Rainwater harvesting tool

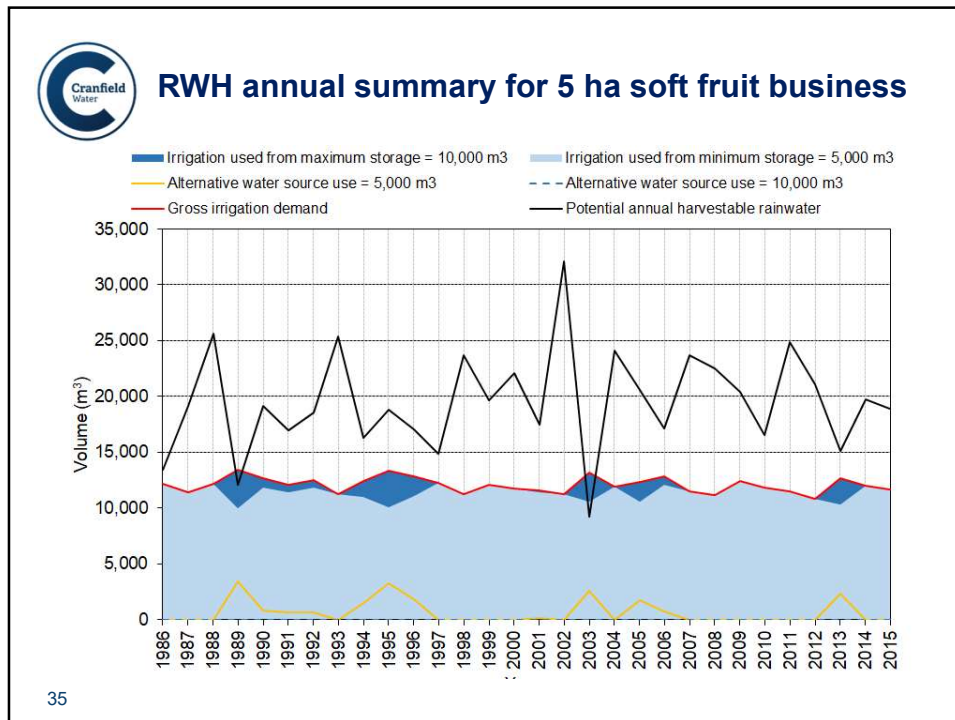


Free, interactive online tool

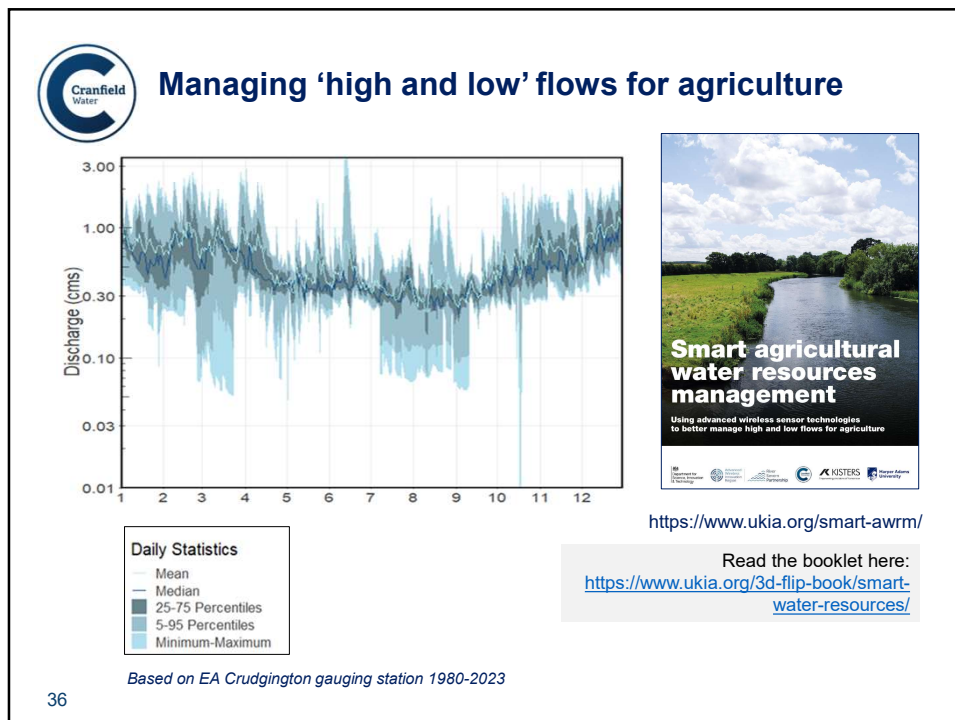
<https://www.d-risk.eu/index.php?params=rwhtool>

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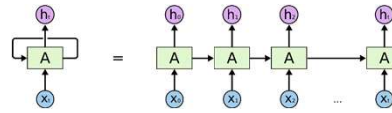


“High-flow low-flow” prototype tool

- 1 Site with long-term flow records (EA Crudgington)

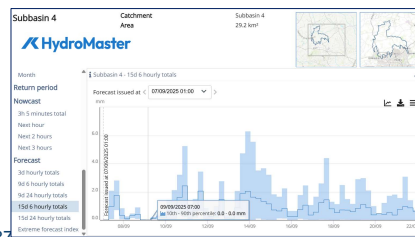


- 2 Long Short-Term Memory (LSTM) network to correlate ‘flow data’ with other datasets. Method looks for patterns and remembers long-term dependencies

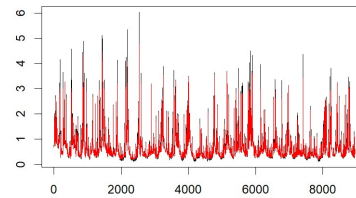


Flow data $\leftrightarrow$ Rainfall $\leftrightarrow$ Date

- 4 Integrate rainfall forecasting data so model can predict future change in levels



- 3 Train model to build confidence through calibration and validation



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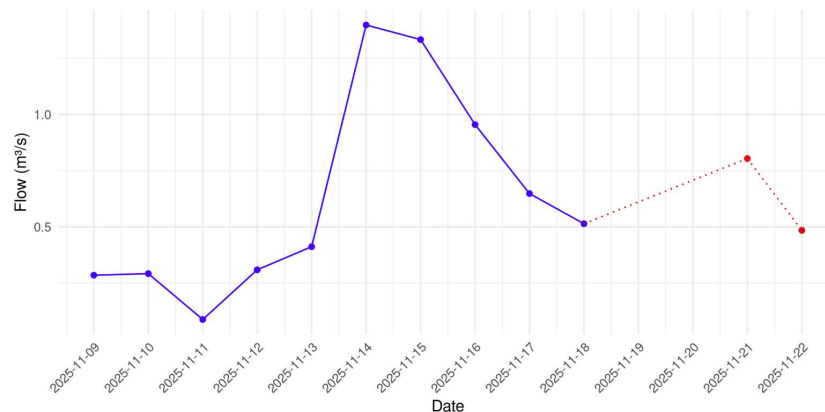


“High-low flows” prototype tool

<https://www.highlow-flows.co.uk/shropshire>



River Strine at Crudgington Green - Flow Measurement and Prediction
2025-11-09 to 2025-11-22

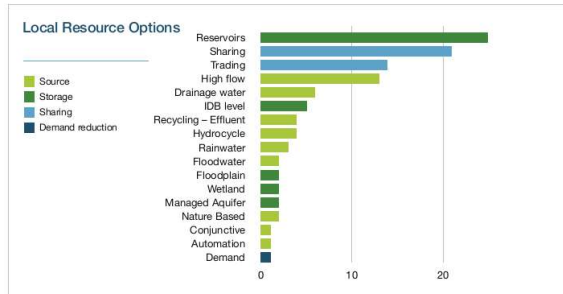


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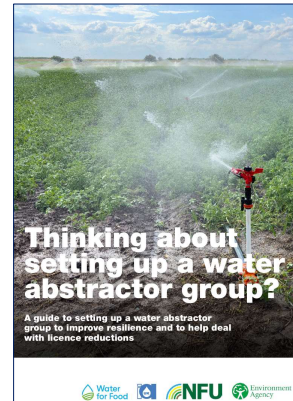


Local resource options (LROs) and water abstractor groups (WAGs)



LRO is a water resources solution that improves resilience or supply of water for a small group of abstractors in their catchment. Owned, operated and controlled by those abstractors

Options ranked using multicriteria decision process, considering cost, yield, technological advancement, ease of licensing, impact on environment and time for development



Read the booklet here:

<https://www.ukia.org/3d-flip-book/thinking-about-setting-up-a-water-abstractor-group/>

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Building resilience to water-related risks

Reduce probability

Some water-related risks may be reduced by de-coupling production from the source of the risk

Reduce dependence on direct summer abstraction (switch to high flows and increased storage)

Increase robustness to persist

Most resilience strategies focus on *robustness*, i.e. actions to enable 'system' to absorb shock and allow production to continue, as far as possible, unaffected

Improving technology, management and efficiency of irrigation

Advance warning of risk

Taking pre-emptive action to minimise financial impacts (e.g. moving stock from land that will flood, or implementing more dynamic monitoring to prepare for water restrictions)

Monitoring flows and levels to respond to changing conditions and using reservoirs to scalp floods and to share water

Re-orientate farming system

Move from a 'system' that is more, to one that is less, vulnerable to climate induced water-related risks

Move out of irrigated cropping altogether to lower risk (?) arable production. Investment costs sunk. Rainfed crops more vulnerable to drought risk

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Hess and Knox (2020)

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Embrace Fonske "Put water into the minds of all people"

Thank you



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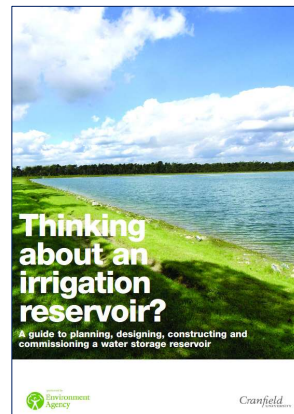


Promoting multi-use reservoirs

Current farm business models fail to exploit full opportunities
- expensive, single use and under-utilised (in most years)

Innovative opportunities for more effective storage, use and allocation

- **Scalping 'high flows'** (but you need to know when they're coming)
- **Sharing water** (but you need to know who wants water and when)
- **Generating green energy** (floatovoltaics, but what are the trade-offs)
- **Providing environmental benefits** (flood risk alleviation through NBS)
Can you get paid for it?
- Local context is critical



<https://www.pnas.org/doi/10.1073/pnas.2301355120>

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