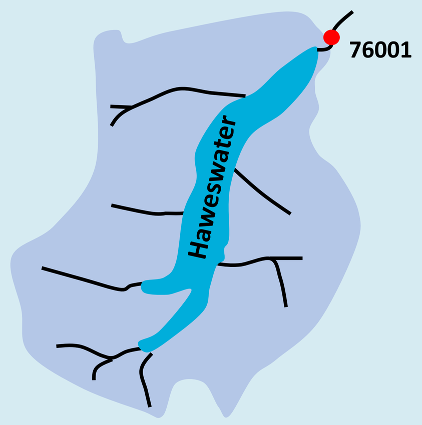
Developing generic reservoir operating rules for inclusion in the national-scale hydrological modelling of Great Britain



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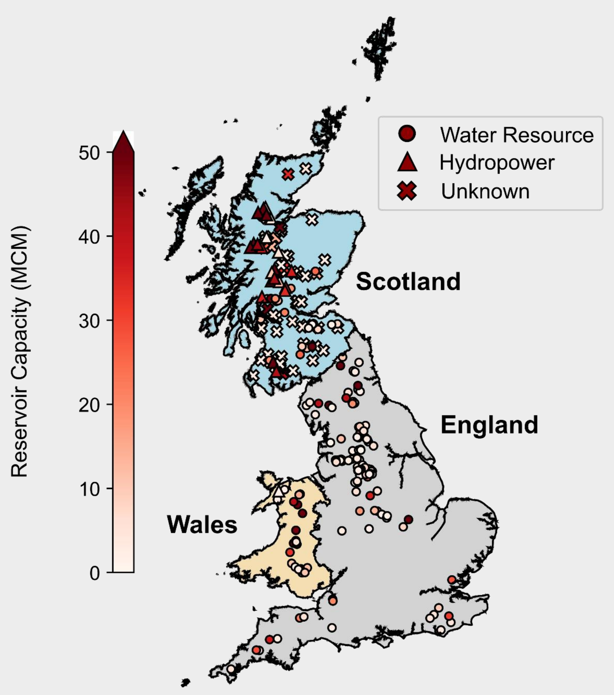
National-Scale Detection of Reservoir Impacts Through Hydrological Signatures

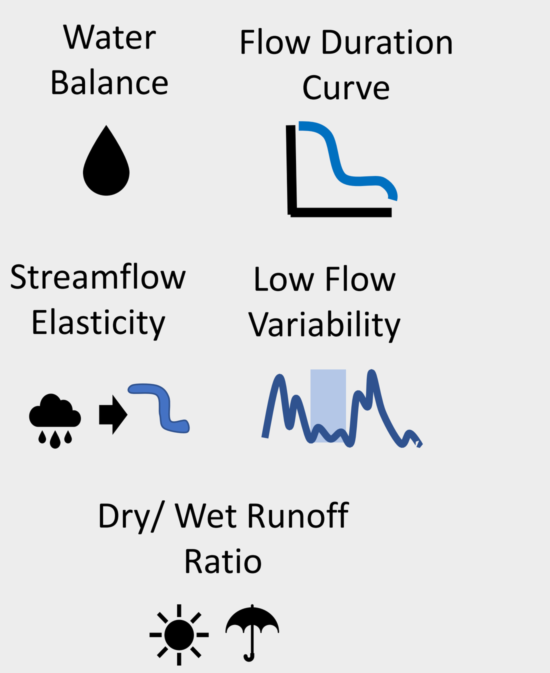
Salwey et al. (2023) [in review, WRR]



The UK Reservoir Inventory contains 273 reservoirs, of these:

- 76% are designed for water resource management
- 90% of reservoirs were constructed by 1975
- The average reservoir capacity is 24 Million Cubic Metres (MCM)

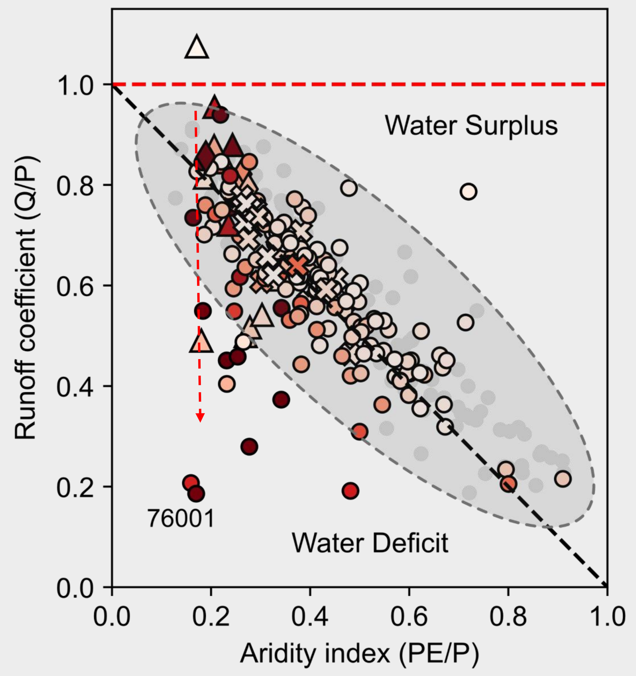
5 hydrological signatures:



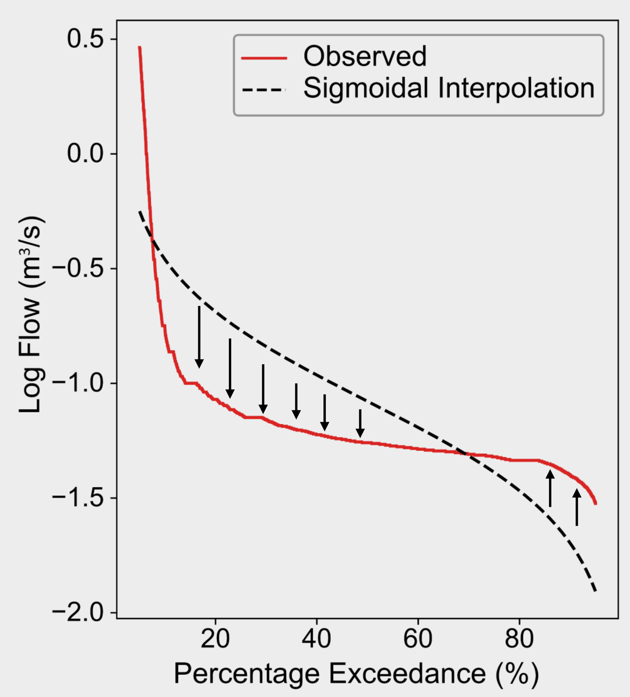
Hydrological signatures can be used to identify reservoir-induced flow alteration across Great Britain

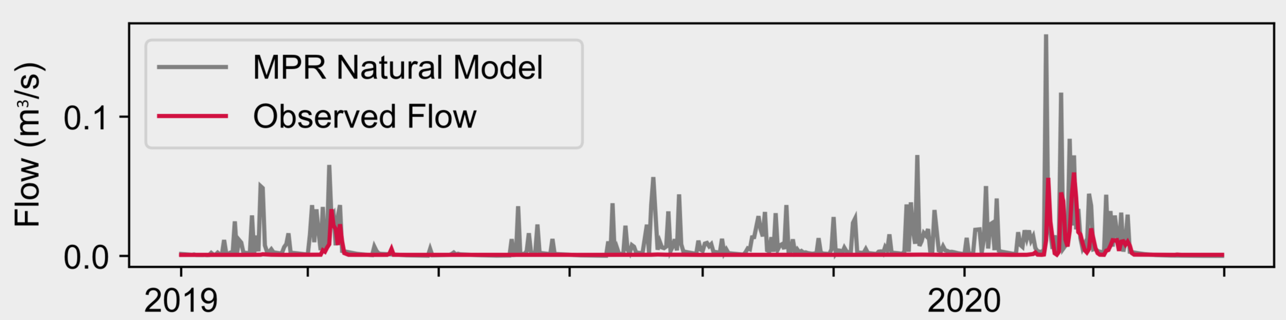
- The degree of alteration depends on a catchments contributing area and normalised upstream capacity
- Application to 186 catchments across Great Britain finds that reservoirs often induce loses in the water balance and reduce flow variability

Water Balance



Segmentation of the Flow Duration Curve

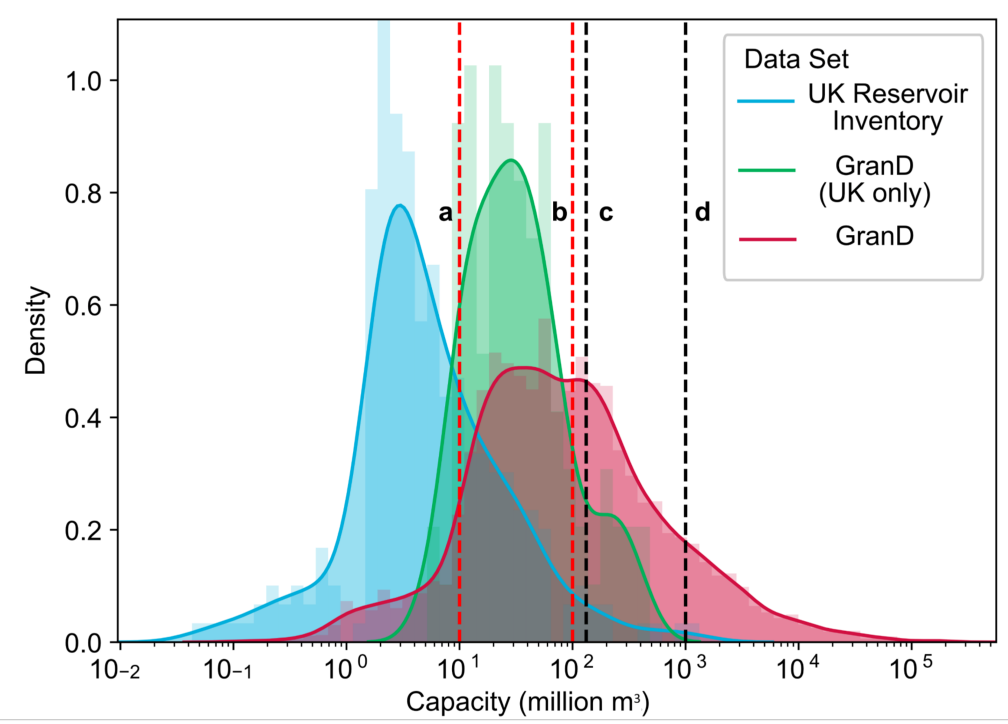


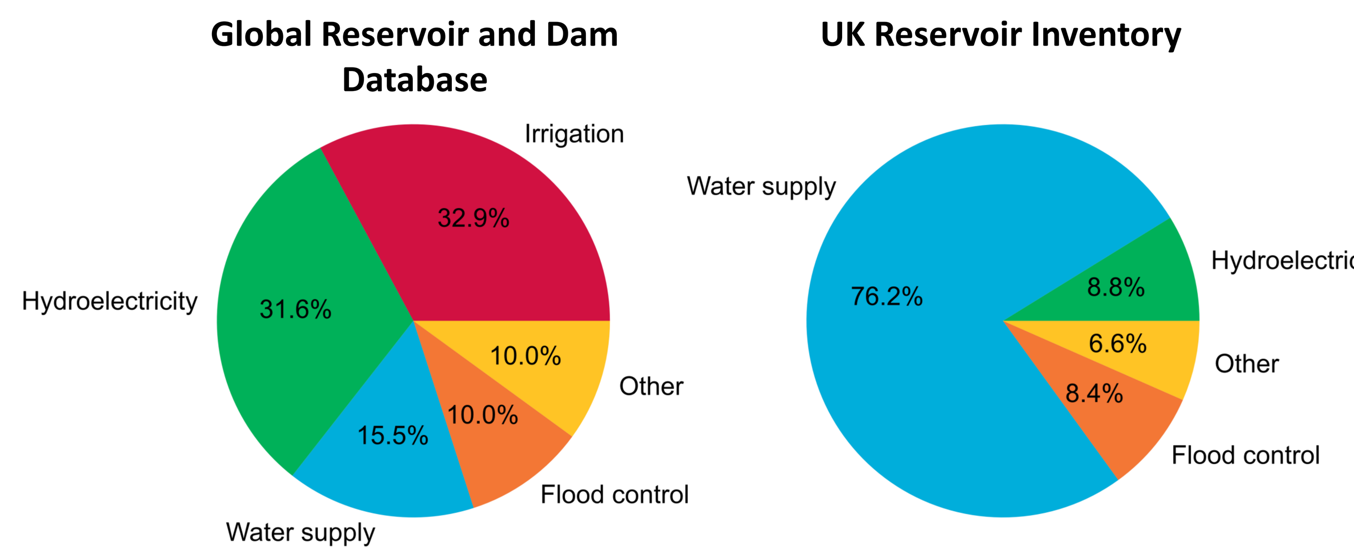


1 Motivation

Key Aim: To develop a new set of simple reservoir operating rules for integration into national-scale hydrological model simulations across Great Britain

a) Turner et al. (2020) **b)** Coerver et al. (2018)
c) Yassin et al. (2019) **d)** Hanasaki et al. (2006)

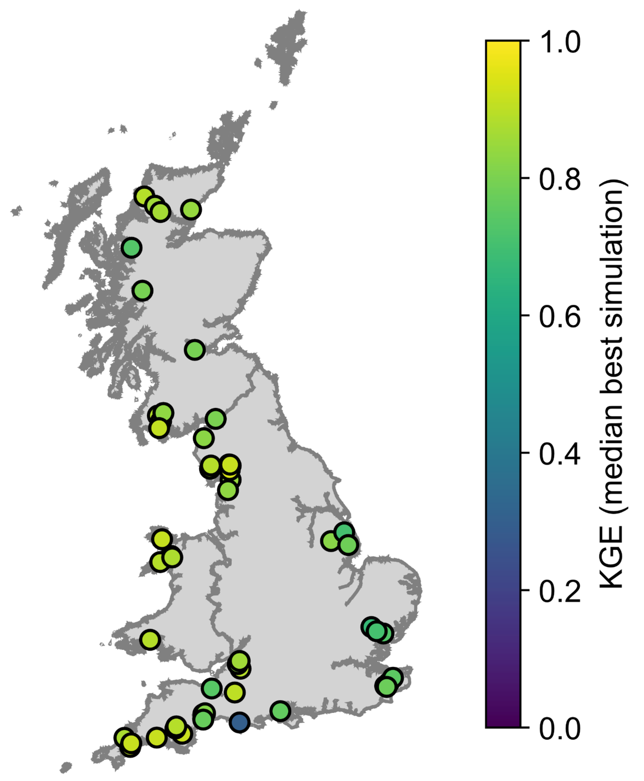




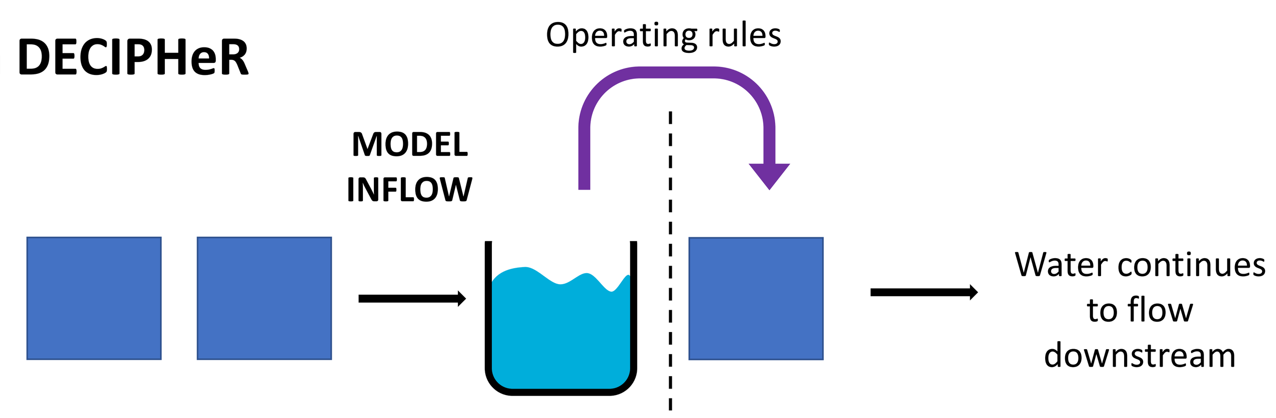
2 Model Setup (Natural Parameters)

- Multiscale Parameter Regionalisation (MPR) is used to identify nationally consistent and hydrologically meaningful values of DECIPHeR's 7 natural parameters
- Simulations are carried out across the UK Benchmark Network and evaluated with the non-parametric KGE (Pool et al. (2017)
- The top 100 global parameter combinations are then applied in the parameterisation of the reservoir catchments

This technique ensures that the inflow to a reservoir has not been calibrated or biased towards an impacted timeseries



3 Reservoir Module in DECIPHeR



4 Reservoir Operating Rules

a) Hanasaki et al. (2006) (non-irrigation reservoirs)

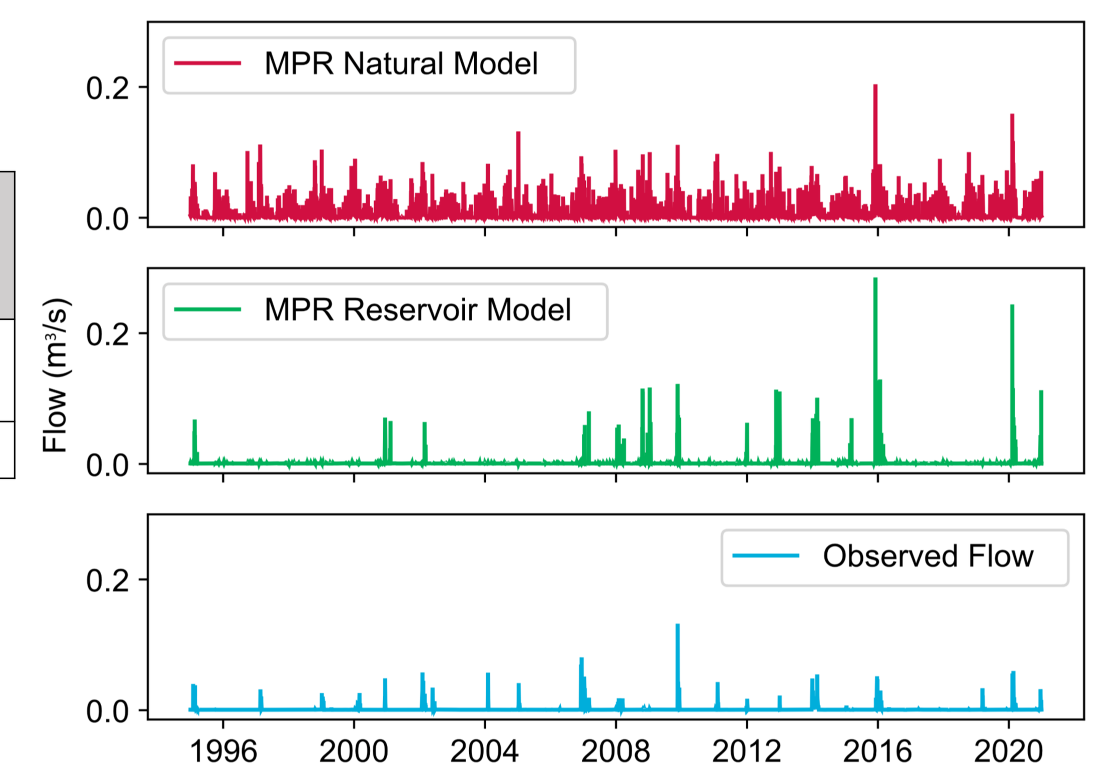
storage(t+1) = storage(t) + inflow(t) - spill(t) – release(t) *where* release(t) = mean inflow

b) New generic operating rules (designed for small water resource reservoirs)

storage(t+1) = storage(t) + inflow(t) + (***pumped_storage***(t)) – **compensation_flow**(t)– **abstractions**(t) - spill(t)

5 Initial Case Study: Haweswater Reservoir

Simulation	KGE components			
	Water Balance	Flow Duration Curve	Correlation	Non-Parametric Error (KGE)
No Reservoir	4.508	0.68	0.41	-2.57
Reservoir	1.03	0.83	0.52	0.50



6 Model Evaluation

- Non-parametric KGE
- Hydrological Signatures

Performance will also be evaluated during the onset, duration and recovery from drought and across varying flow conditions

Conclusions:

- Without reservoir representation, large-scale hydrological modelling across Great Britain misses several key processes in impacted catchments
- Most pre-existing reservoir rules are designed for reservoirs unlike those found in Great Britain
- New simple reservoir operating rules show promising results in initial hydrological model simulations downstream of reservoirs in Great Britain

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