ROTHAMSTED RESEARCH

Environment Agency

CATCHMENT SCIENCE 2019

AGRICULTURAL CATCHMENTS PROGRAMME · WEXFORD, NOVEMBER 5TH – 7TH

Use of regulatory information and monitoring data to update pollutant loadings from Sewage Treatment Works across England at national scale

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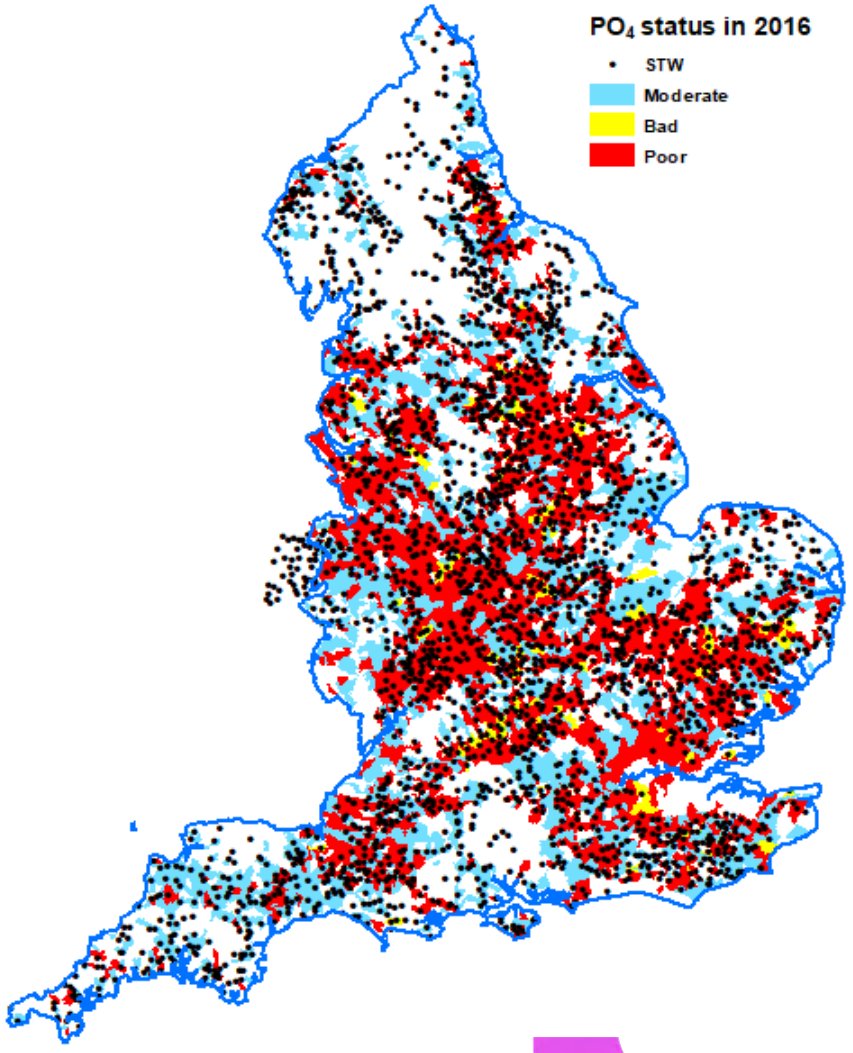
UKRI Biotechnology and Biological Sciences Research Council

Significance of STW loadings and their quantification

- > 90% of daily flows from inland STWs have freshwater rivers as their ‘receiving environment’
- Contributing to poor nutrient status at national scale
- Significant loadings during ecological sensitive periods, i.e. low flows
- Multiple and emergent pollutants: hygiene products, nutrients and chemicals
- Application of “Polluter pays” / “Fair share” principle in mitigation



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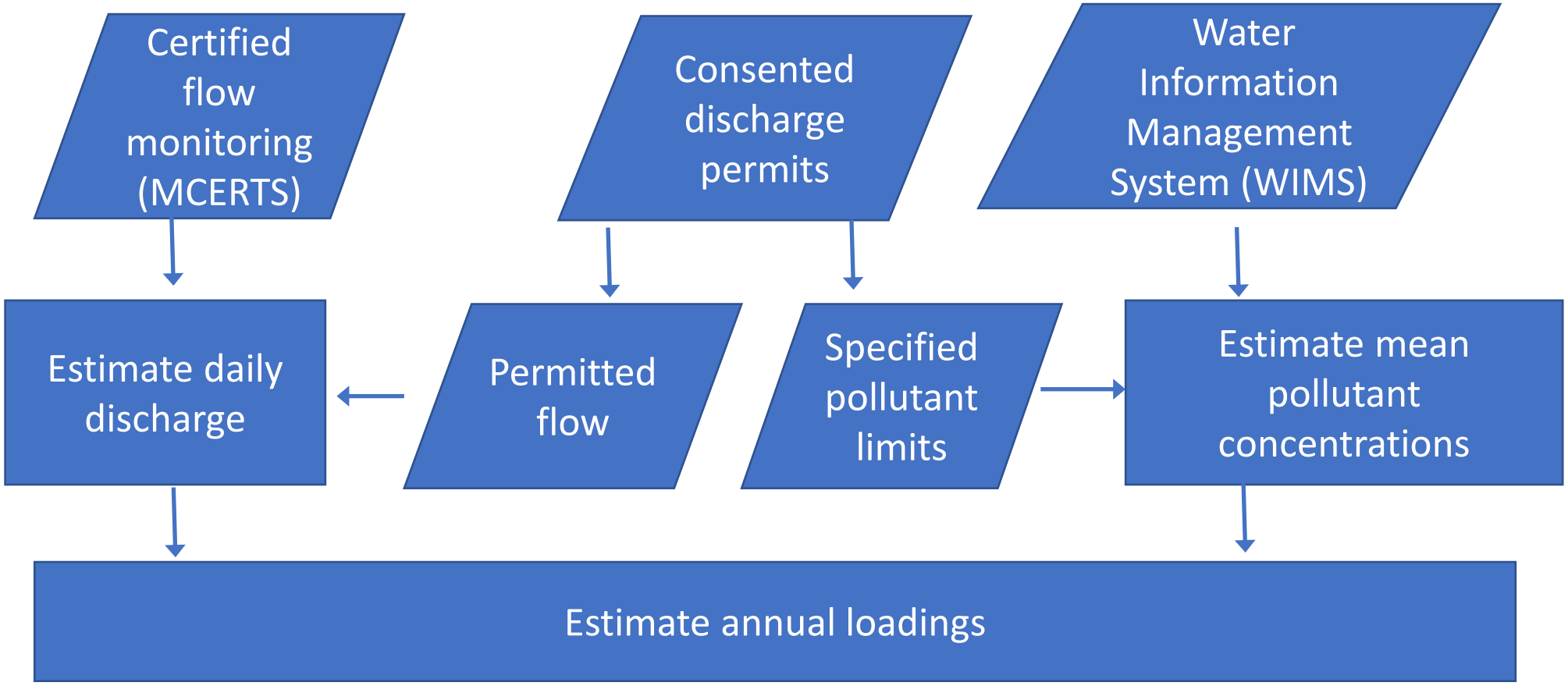
Procedure for estimating STWs loads for England



Focus on suspended solids and total phosphorus

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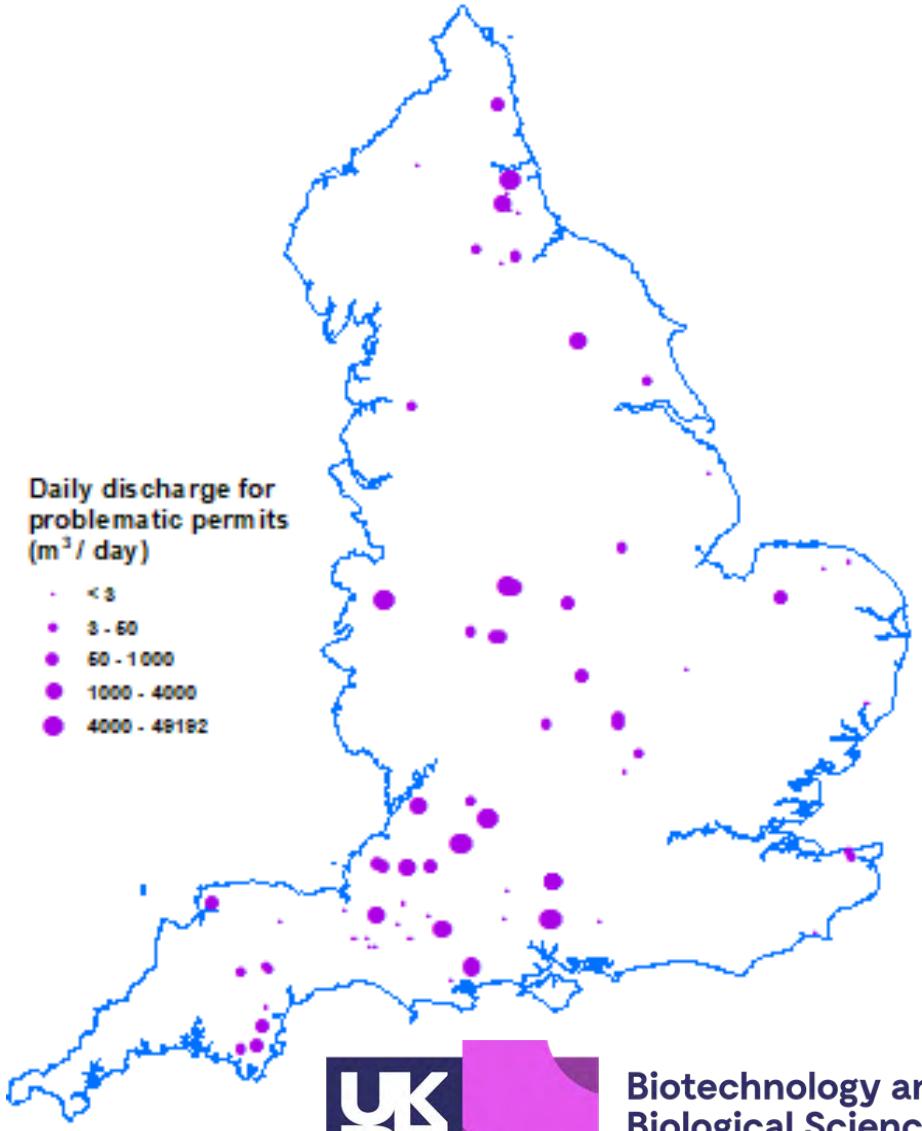
Filtering of STWs for data processing

- Considered both water company and non-water company managed STWs
- With valid specified permitted flows
- With outlets inside WFD Cycle II surface waterbodies
- With no ambiguity concerning flow permits for multiple outlets
- With ‘freshwater river’ as the ‘receiving environment’

In total, 4732 STWs were identified for further data processing



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Filtering of WIMS data by sampling purposes

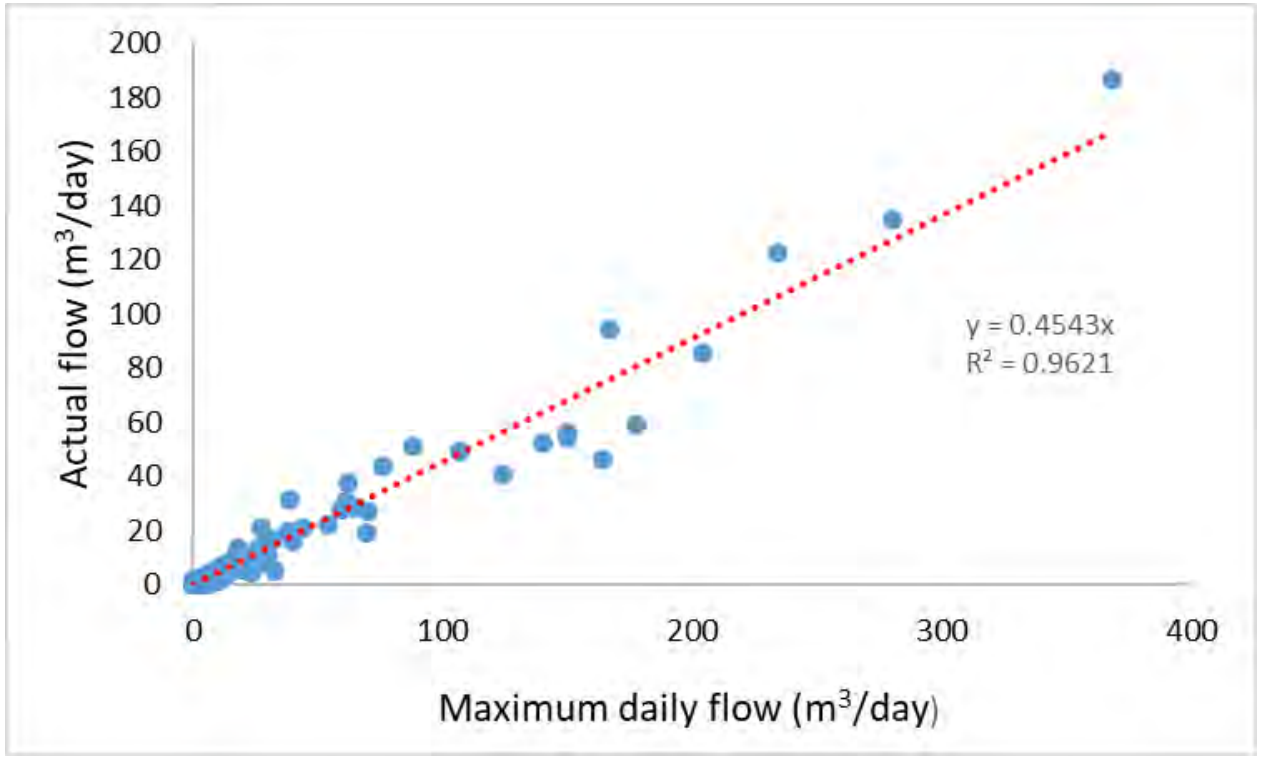
ENVIRONMENTAL MONITORING STATUTORY (EU DIRECTIVES)	996782
WATER QUALITY OPERATOR SELF MONITORING COMPLIANCE DATA	155956
PLANNED INVESTIGATION (LOCAL MONITORING)	126047
MONITORING (UK GOVT POLICY - NOT GQA OR RE)	104154
STATUTORY FAILURES (FOLLOW UPS AT NON-DESIGNATED POINTS)	99212
WATER QUALITY UWWTD MONITORING DATA	77752
COMPLIANCE AUDIT (PERMIT)	58753
UNPLANNED REACTIVE MONITORING (POLLUTION INCIDENTS)	37593
STATUTORY FAILURES (FOLLOW UPS AT DESIGNATED POINTS)	22206
WASTE MONITORING (AGENCY INVESTIGATION)	16369
UNPLANNED REACTIVE MONITORING FORMAL (POLLUTION INCIDENTS)	13248
WASTE MONITORING (FORMAL SAMPLE)	8806
PLANNED INVESTIGATION (NATIONAL AGENCY POLICY)	7519
MONITORING (NATIONAL AGENCY POLICY)	6352
PLANNED FORMAL NON-STATUTORY (PERMIT/ENV MON)	1475

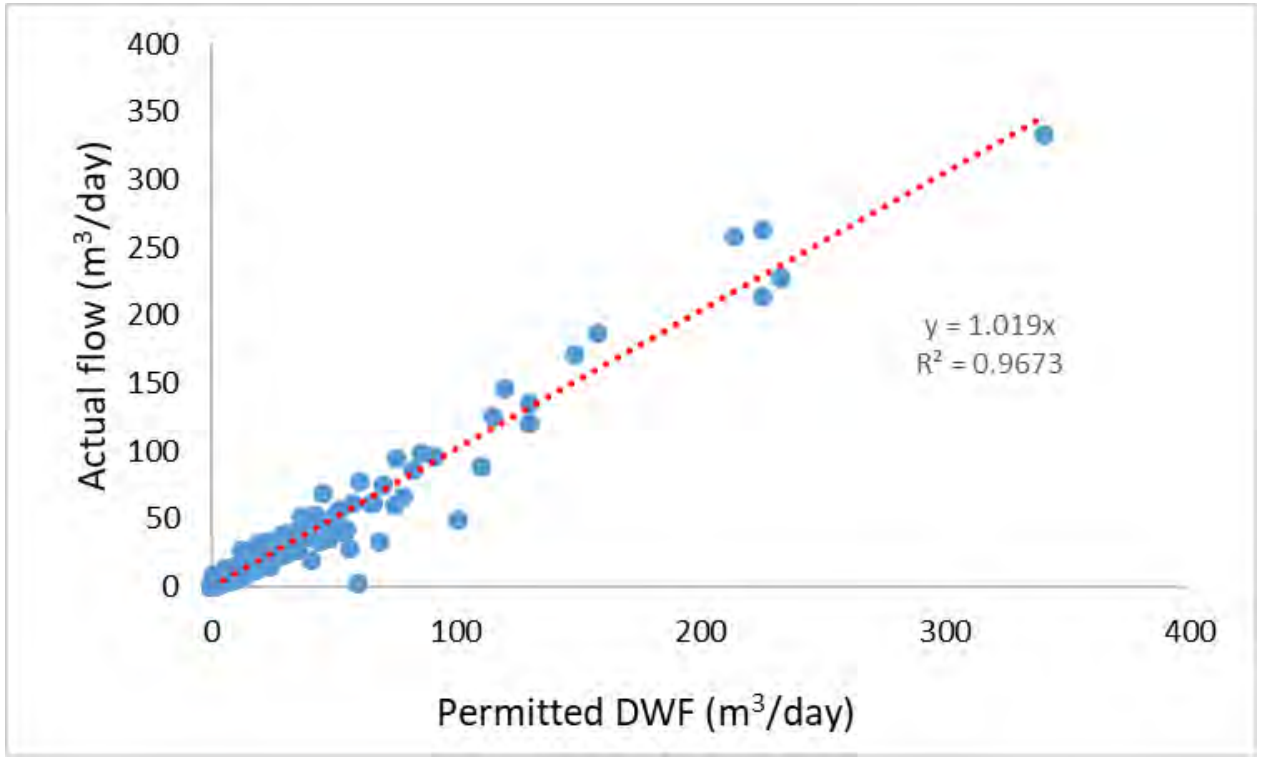
WIMS site selection

- Only samples from selected STWs
- Monitoring years: 2013 to 2016
- Minimum samples for a year: 4
- Minimum number of sampling years: 3

	Suspended solids			TP		
Year	Samples	Mean (mg/l)	STD (mg/l)	Samples	Mean (mg/l)	STD (mg/l)
2013	3509	13.2	14.3	522	1.14	0.98
2014	3508	11.9	18.1	560	1.08	1.06
2015	3531	12.2	14.4	558	1.13	1.03
2016	3494	11.5	10.0	547	1.07	0.87

Relationships between permitted flows and actual flows





Permitted maximum flow → X0.45 → Daily mean discharge

Permitted flow in DWF → X1.02 → Daily mean discharge

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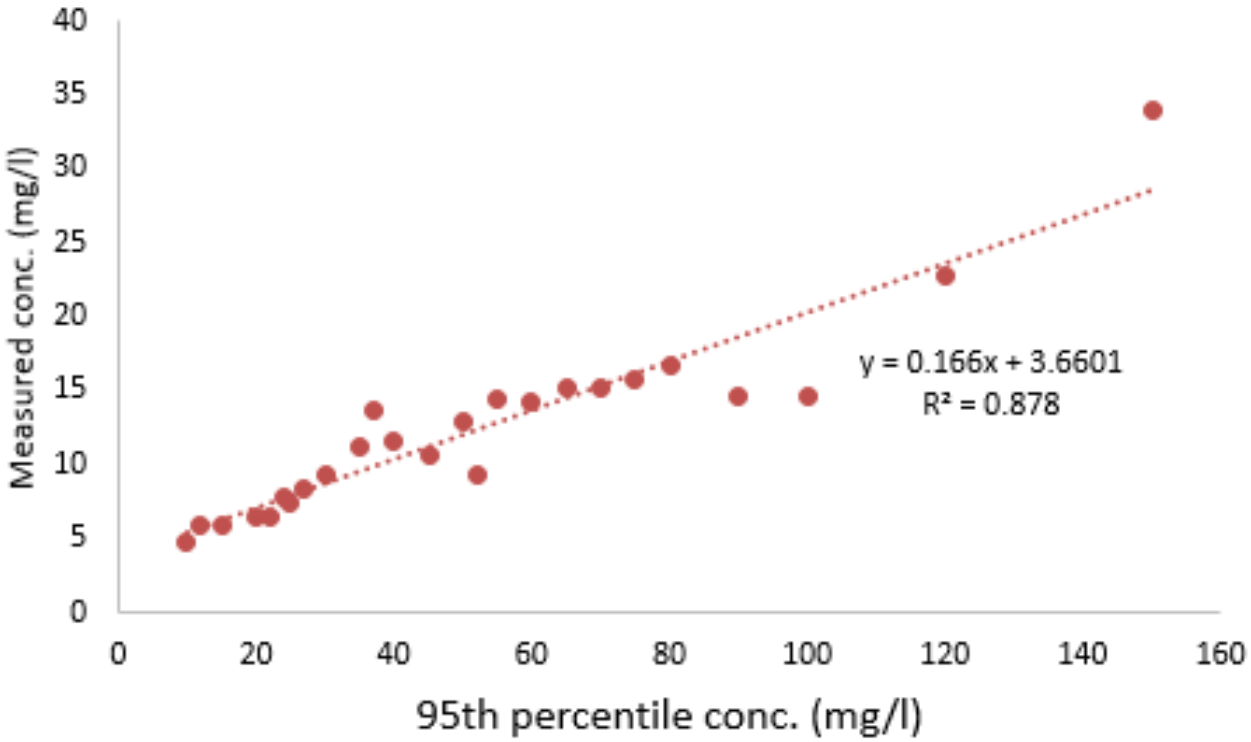
Relationship between permitted and actual SS concentrations

- Out of 4732 STWs, 2931 have explicit SS limits
- Sites without SS limits were assigned the average SS limit from the corresponding water management catchment (WMC)

Summary statistics for measured SS concentrations at STWs

Minimum	1.1
Maximum	751.1
STD	22.8
Median	10.8
Average	14.9
Q1	6.9
Q3	16.3



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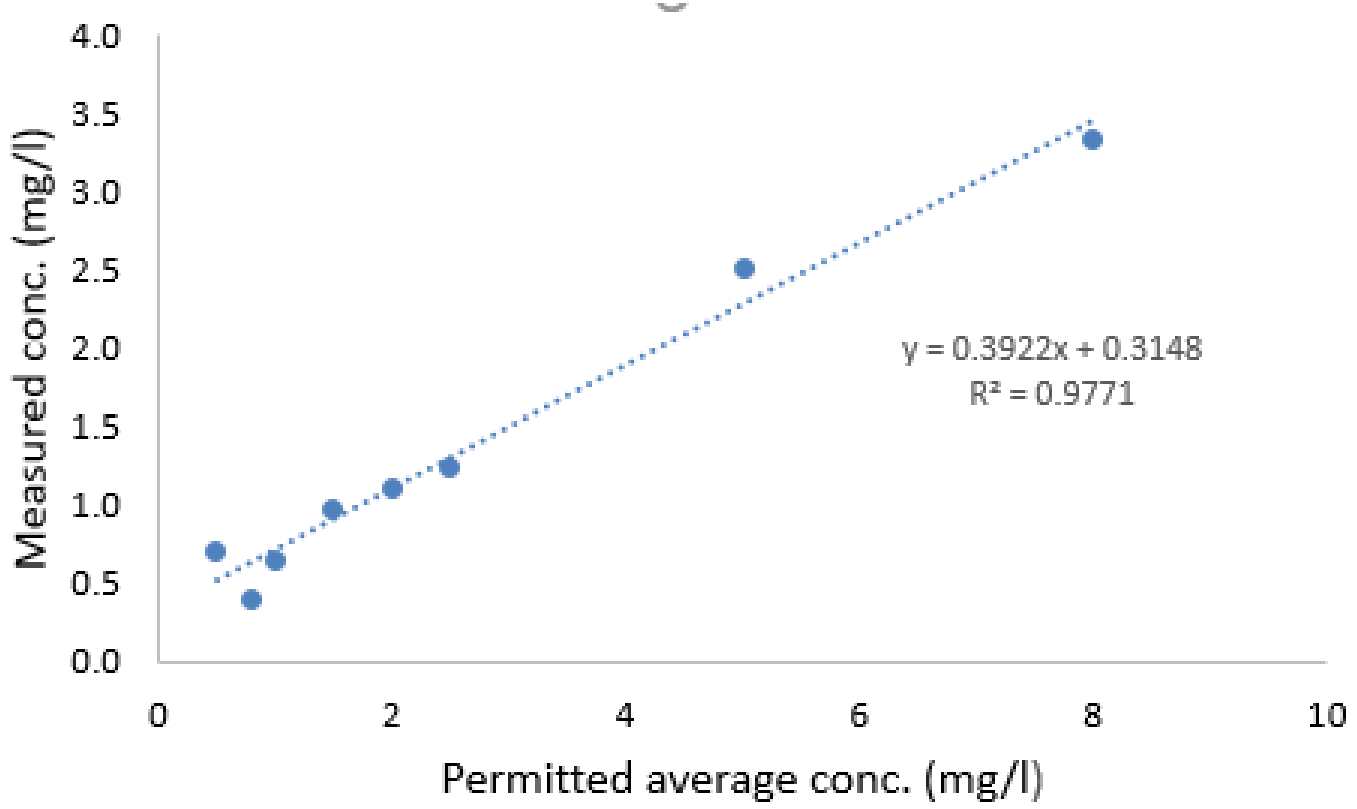
Relationship between permitted and actual TP concentrations

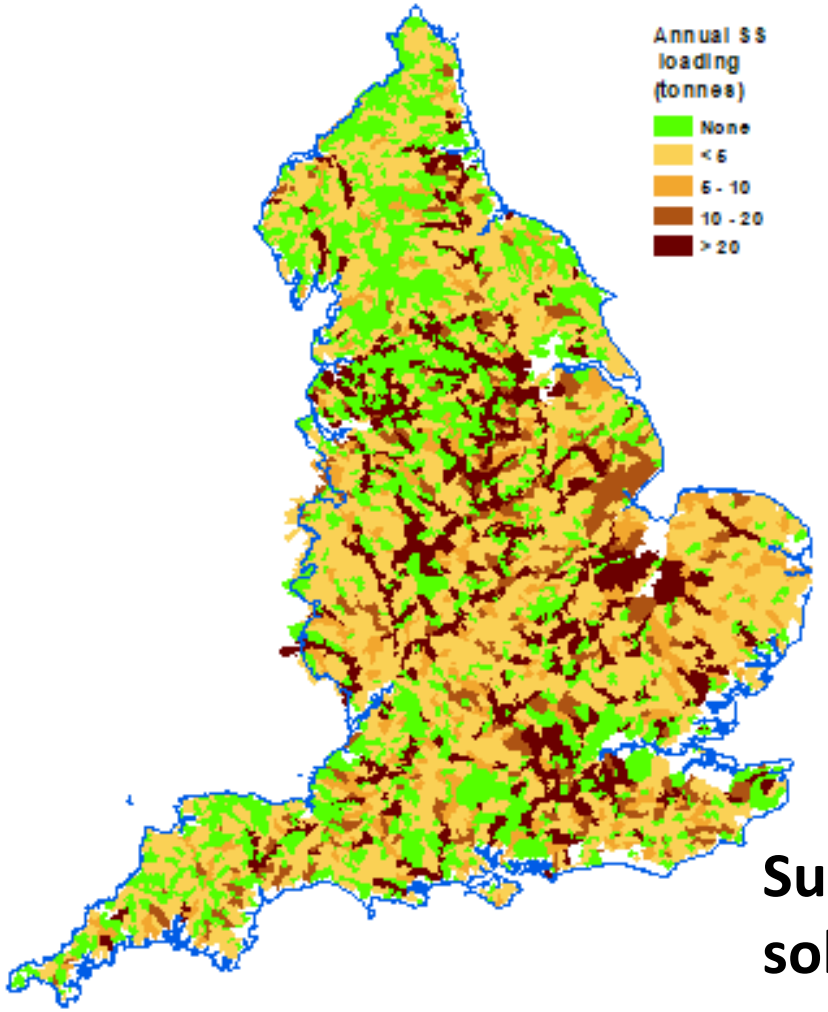
- 271 sites have explicit TP limits
- Sites without TP limits were assigned a default concentration of 5 mg/l



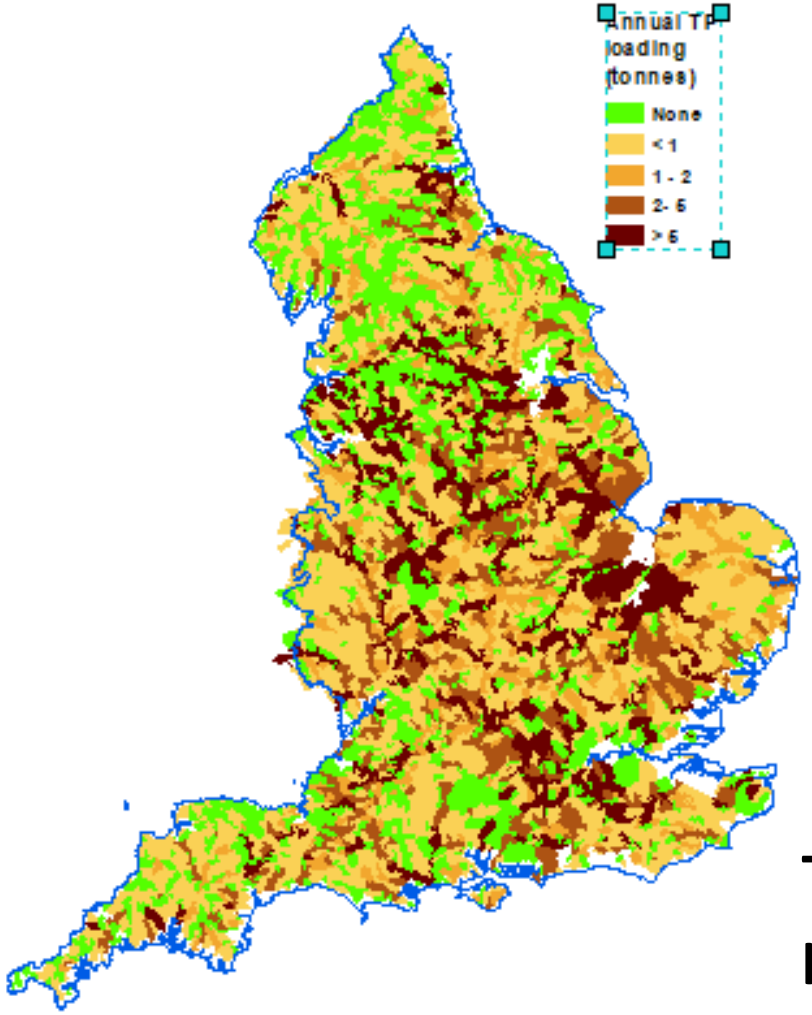
Summary statistics for measured TP concentrations at STWs

Minimum	0.2
Maximum	10.6
STD	1.0
Median	1.0
Average	1.1
Q1	0.6
Q3	1.3

Mapped loadings for WFD waterbodies



Suspended solids



Total phosphorus

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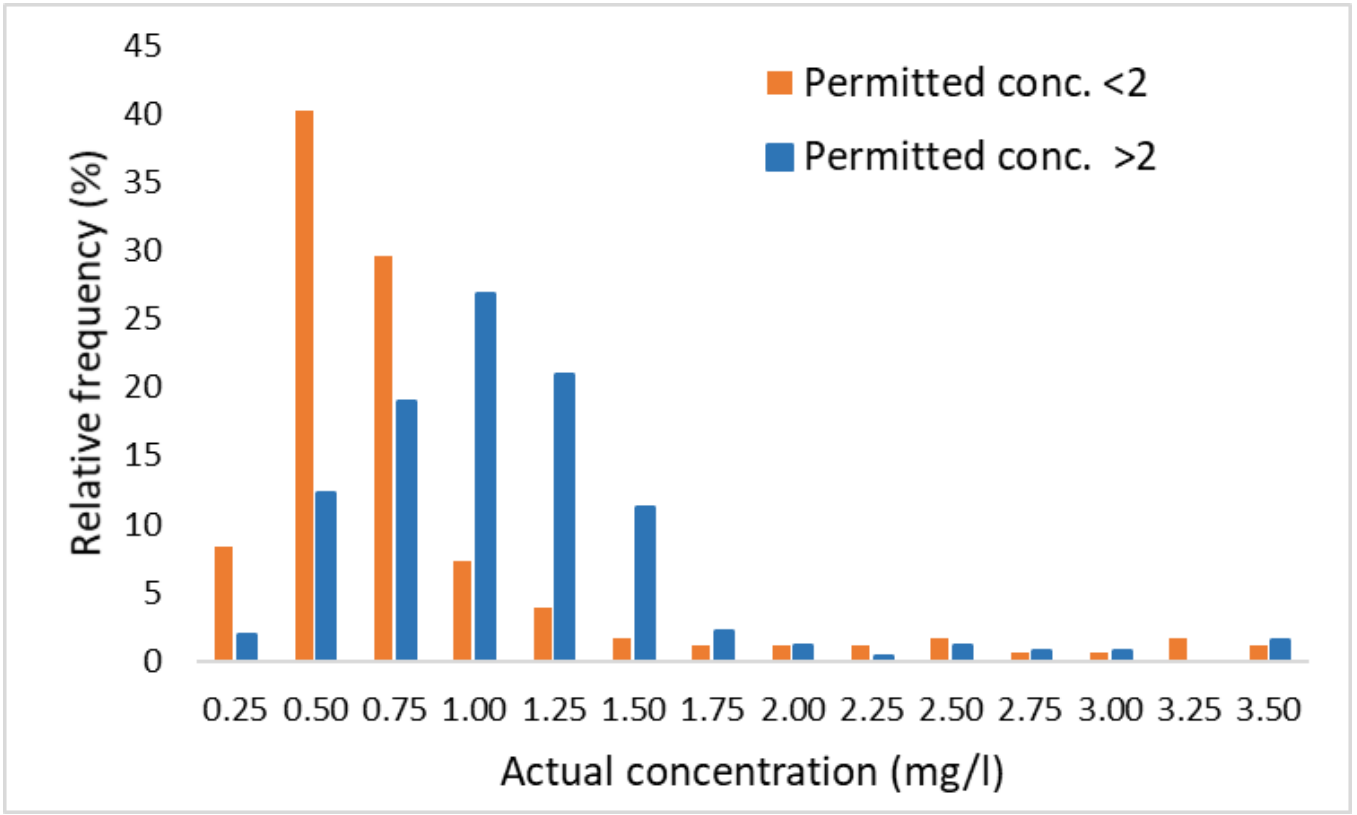
Issues with estimated loads

- Limited number of monitoring sites with good quality data, especially for TP
- Uncertainty associated with non-water company managed STWs as sparse monitored data available
- Variability of monitored concentrations for specific limits



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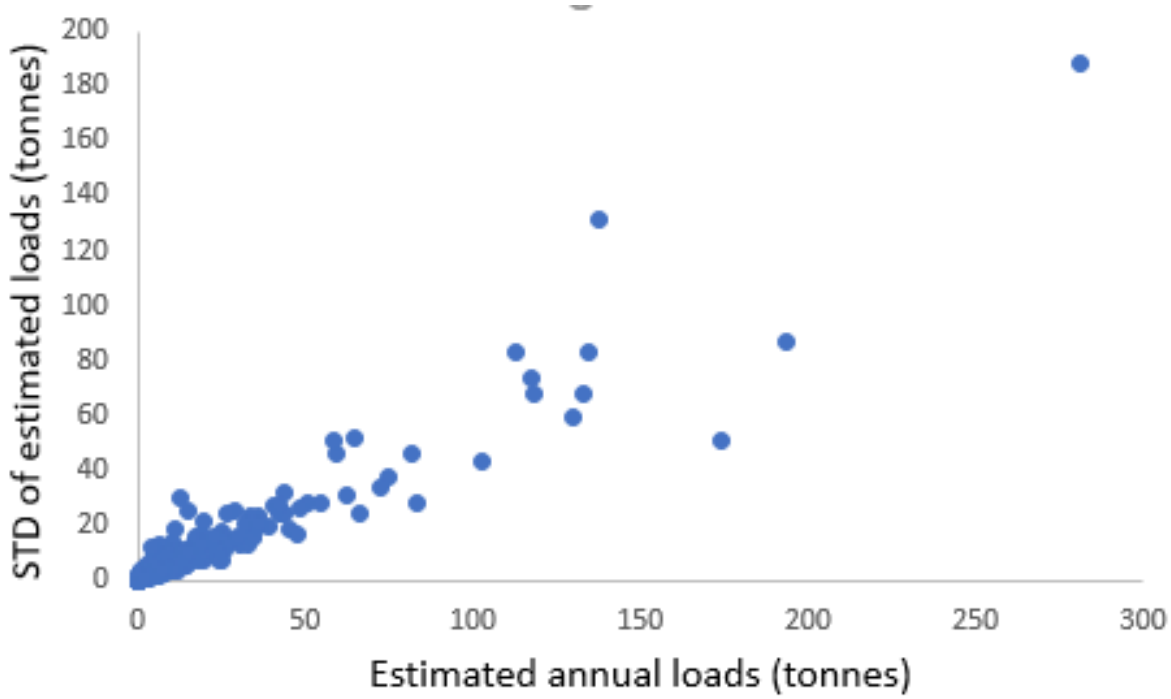
Quantifying uncertainty for the estimated loads

Observed mean and STD of flow and pollutant concentrations

Frequency distributions of observed flow and pollutant concentrations

→ @Risk software from Palisade →

Simulated STD, 5th Percentile,95th percentile of the estimates, etc.



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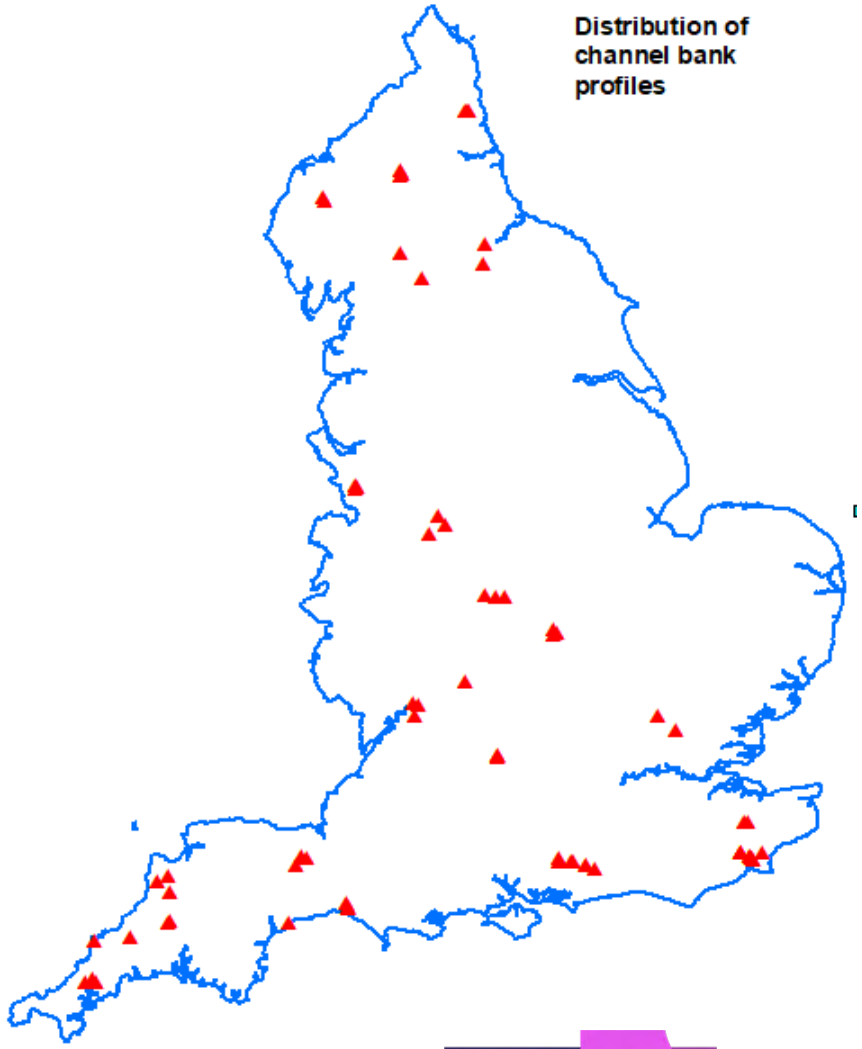
Existing treatments

Treatment	Daily discharge (m^3/day)	%
ACTIVATED SLUDGE	18831046	61.1
BIOLOGICAL FILTRATION	4572674	14.8
CHEMICAL - PHOSPHATE STRIPPING	3043887	9.9
UV DISINFECTION	1522748	4.9
CHEMICAL & BIOLOGICAL	303294	1.0
HIGH RATE BIOLOGICAL	190281	0.6
TERTIARY BIOLOGICAL	177317	0.6
CHEMICAL	120584	0.4
SAND FILTRATION	120317	0.4
SCREENING	73363	0.2
LAGOON SETTLEMENT	73026	0.2
PRIMARY SETTLEMENT	72829	0.2
OXIDATION DITCH	68677	0.2
PACKAGE TREATMENT PLANT	33772	0.1
REEDBED	19792	0.1

There is technical feasibility for further reductions, but economic costs are a major challenge

Incorporation into the Catchment Systems Model

Sector/source	Active research
Agricultural mitigated	Revised BAU using 2016 JAS data, updated priors, etc
Bank erosion	National scale sampling
Urban diffuse	Updated SAGIS load
STWs	This work
Storm tanks	Updated SAGIS load
Sceptic tanks	Updated SAGIS load
CSOs	Updated SAGIS load
Direct deposition	Updated load based on recent monitoring
Groundwater	Unchanged



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Soil to Nutrition (S2N): Institute Strategic Programme

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Mechanistic understanding

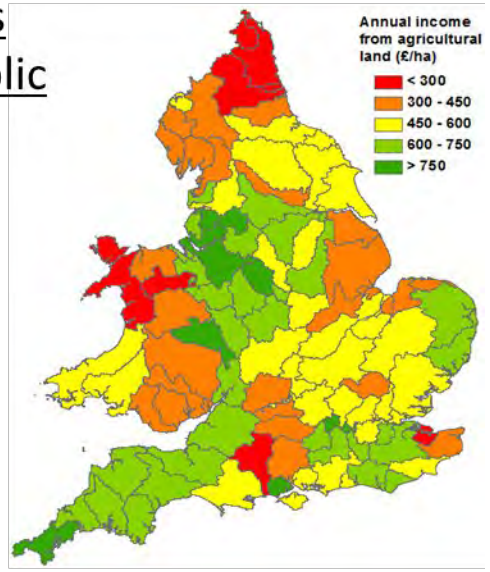
Micro-scale processes which drive nutrient use

Targeted interventions

Management impacts on nutrient use

Food Systems Private and public good

Delivering 'fit-for-purpose' metrics to benchmark and improve nutrient use



https://www.rothamsted.ac.uk/projects/soil-nutrition-s2n

S2N

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