

Compelling evidence plus ambition threatened by uncertainty and denial

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“No satisfactory way has been devised of measuring risk to the natural environment, even in principle, let alone defining what scale of risk should be regarded as tolerable”

Royal Commission on Environmental Pollution (1998).

DASPASM (Stages in Managing Uncertainty)

- . **D** denial
- . **A** acknowledgement
- . **SP** specification of sources and types of uncertainty
- . **A** assessment (i) Qualitative (“pedigree”)
(ii) Quantitative
- . **S** specification of policy or project relevance
- . **M** management

Compelling Evidence

To know one's ignorance is the best part of knowledge
(Lao Tzu, The Tao, No. 71)“

- EA Evidence strategy
 - Short-term, reactive
 - Summaries of available science and data
 - Best available science
 - Modelling strategy
 - Every decision is based on a model – a synthesis of empirical data, process understanding and analysis.
- Some examples
 - Source apportionment of P and WFD risks assessments
 - Nitrate Trends
- WF classification - ecology

Ten commandments for good policy analysis



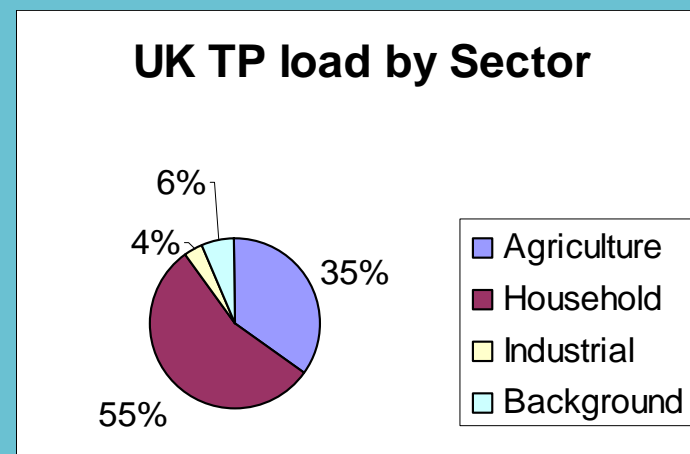
- 1) Do your homework (literature, experts, users)
- 2) Let the problem drive the analysis
- 3) Make the analysis as simple as possible (but no simpler)
- 4) Identify all significant assumptions
- 5) Be explicit about decision criteria and policy strategies
- 6) Be explicit about uncertainties
- 7) Perform systematic sensitivity and uncertainty analysis
- 8) Iteratively refine the problem statement and the analysis
- 9) Document clearly and completely
- 10) Expose the work to peer review

Ref: Morgan & Henrion (1990). *Uncertainty. A guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. CUP, Cambridge
e.g. Willows & Connell (2003). *Climate adaptation: Risk, Uncertainty and Decision making*. UKCIP technical report, Oxford

Source Apportionment - Background

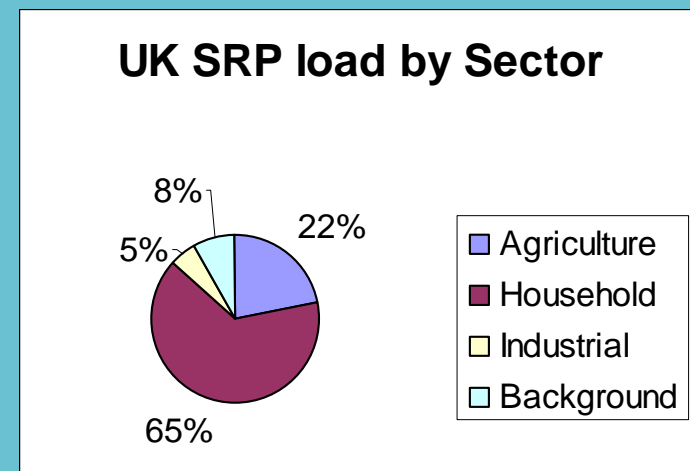


1993 43% of Annual load of P to surface waters from Agriculture (Morse et al 1993)



2006 Warwick/NRI study for DEFRA

Agriculture contributes 36% of TP load in England (57% in Wales)



Agriculture contributes 22% of SRP load across UK

Source Apportionment

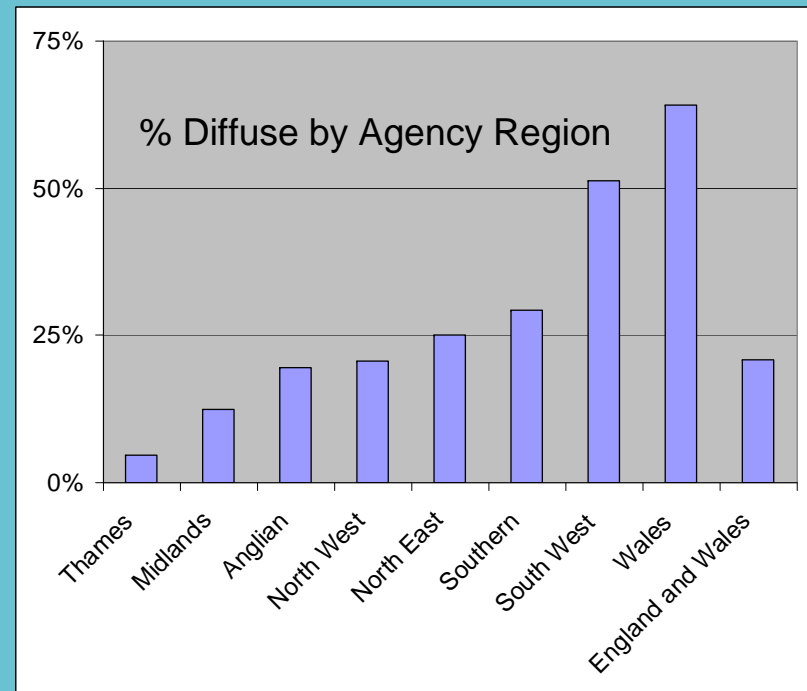


2006

ADAS study for DEFRA

Agriculture contributes 18% of total phosphorus input to rivers over England and Wales

(24-28% after allowing for treatment under UUWTD*)



* Nb ADAS report quotes 24%, but figures in Table 2.4 of report indicate the figure is 28%

Phosphorus Risk Assessment Objectives

1. Develop an assessment of the risk posed to Rivers from Agricultural Diffuse and Population Point Sources of Phosphorus
 - that meets the needs of WFD RBC2
 - that allows identification of hydrological catchments at greatest risk from diffuse sources
 - That provides a potential basis for identifying WPZ's
 - That can be used to assess the potential effectiveness of possible controls on sources of phosphorus (diffuse and (?) point sources)
2. Compare and evaluate against ADAS methodology and results
3. Make recommendations for WPZ methodology

Point sources

1. Large number of potential predictors

1. Proportion of catchment that is classified as urban
2. Number of upstream sewage treatment works
3. Population equivalents served
4. Consented dry weather flows
5. Water Co Flow estimates+
6. Total effluent flow as proportion of predicted river flow (Low-flows 2000)

CFD (EA) WC Data

-	-
√	√
X	√
√	X
X	√
√	√

Also

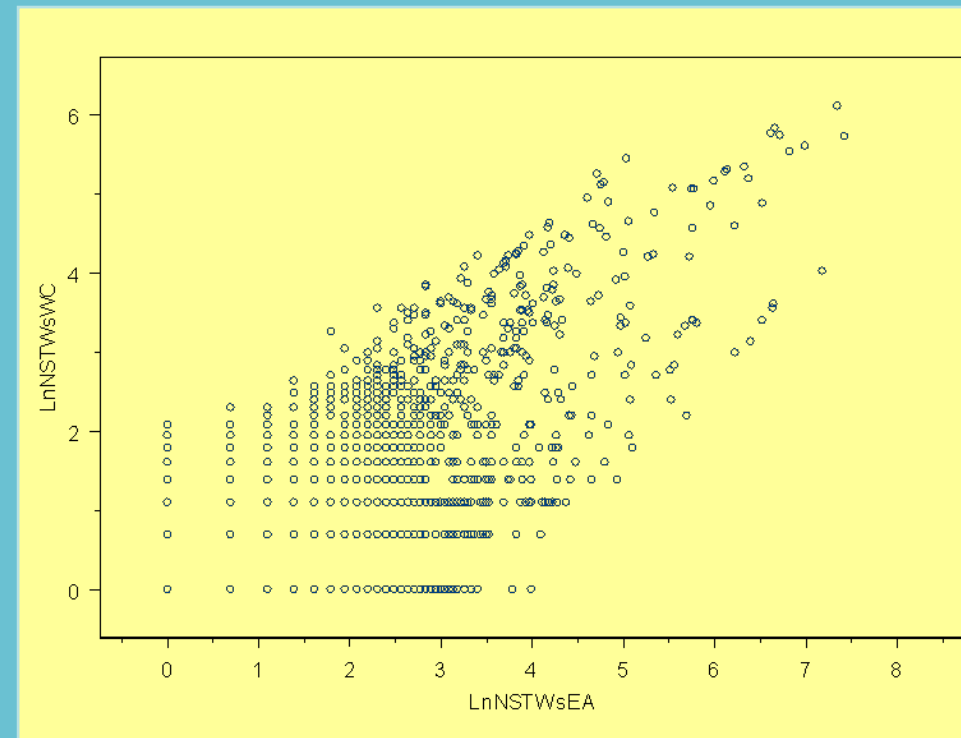
7. Psychic estimates of Point source P

Comparison of Ea and Water Company data on numbers of upstream discharges



“Errors using inadequate data are less than using no data at all” Charles Babbage

1. National data on catchment point sources (available to this project) show low correlation
2. Lack of consistency in data suggest high uncertainty in estimates of point source pressure
3. This is a problem when
 - major determinant of surface water P quality is point source discharges
 - Monitoring data is targeted towards discharge points
4. Likely to adversely affect model calibration and predictive skill



Predictive skill based on r^2



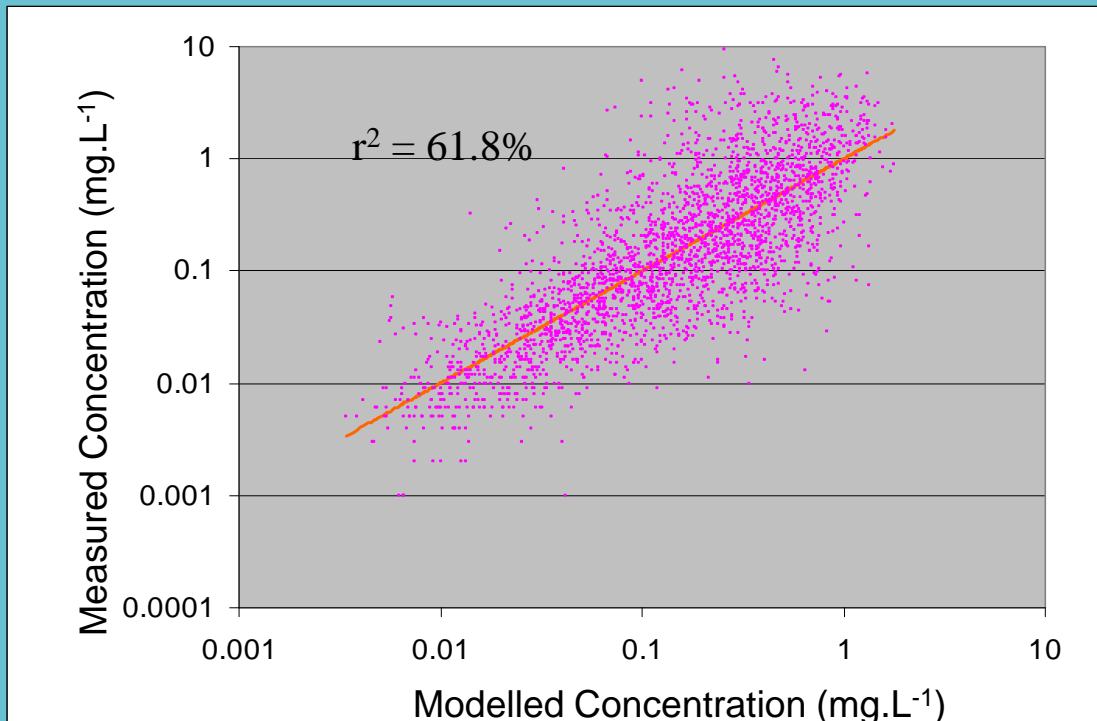
Variables	Number of discharges		Flow estimates		Population equivalents	Proportion of River Flow		% Urban Area	Psychic Point Estimate
	EA	WC	EA	WC	WC	EA	WC		
No Diffuse Predictor	17.9	13.3	23.8	12.8	30.1	30.2	30.2	32.4	47.8
Psychic Dissolved P	26.4	23.6	33.9	24.1	40.2	39.9	38.2	42.8	53.7
Psychic Total P	27.9	25.4	35.6	26.0	40.3	40.9	39.0	44.3	54.3

Selected model

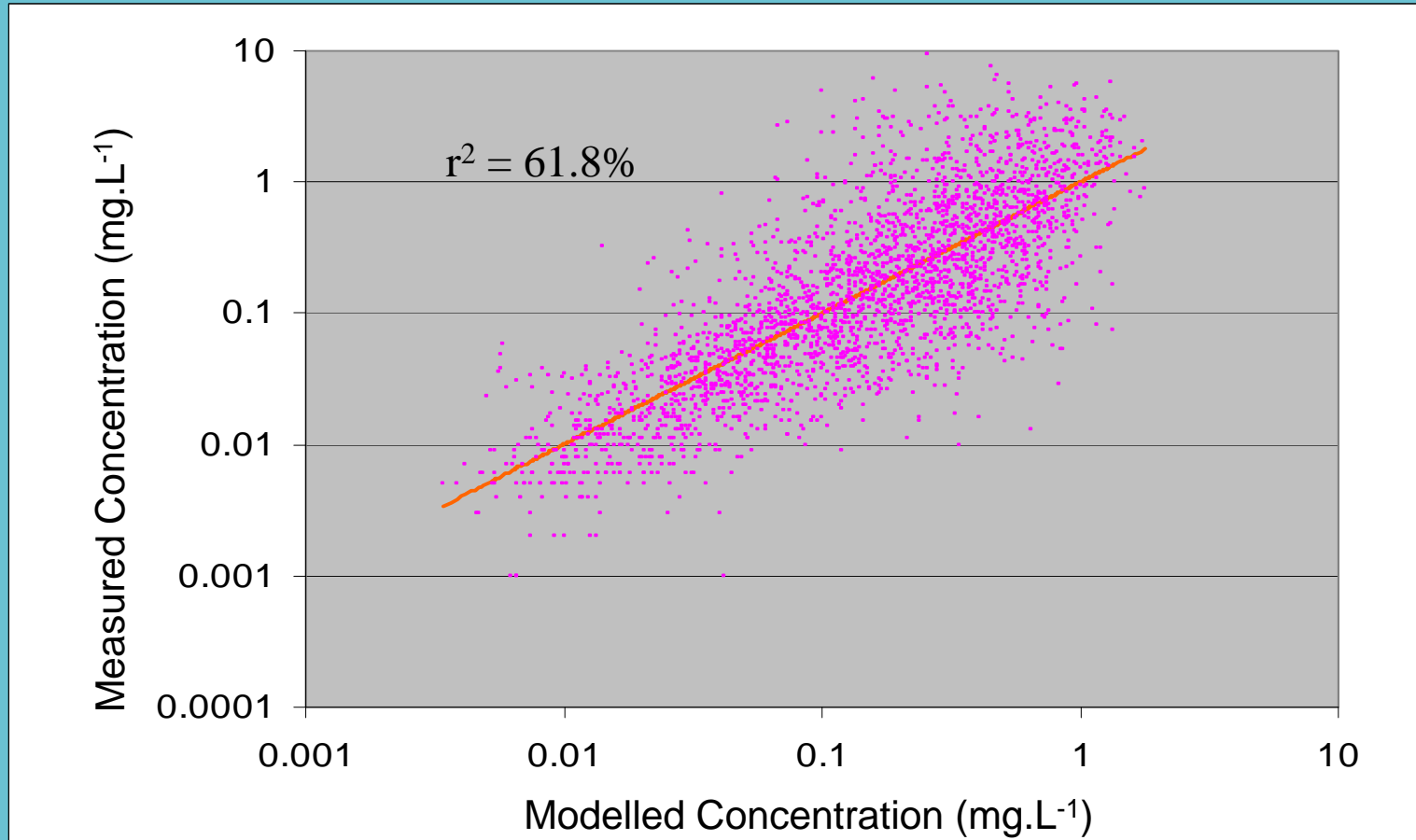


1. Diffuse Pressure variables
2. Point Source pressures

- Psychic Total Phosphorus
- EA CFD flows as proportion of estimated RBC water body river flow-
- % urban area
- Psychic Point source P estimate



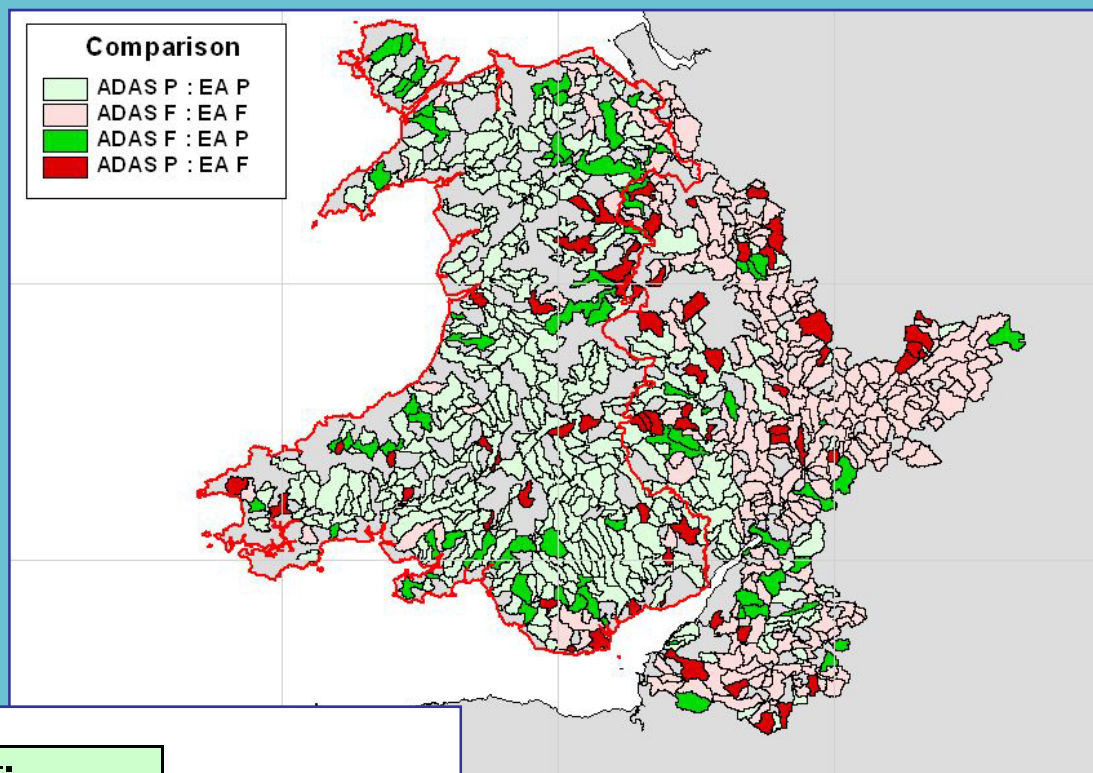
Fitted Model (all catchments)



Comparison of modelled and measured Pass (P) and Fail (F) WFD status for monitored river catchments

False Positive Rate: 15%
(i.e. predict fail, measure pass)

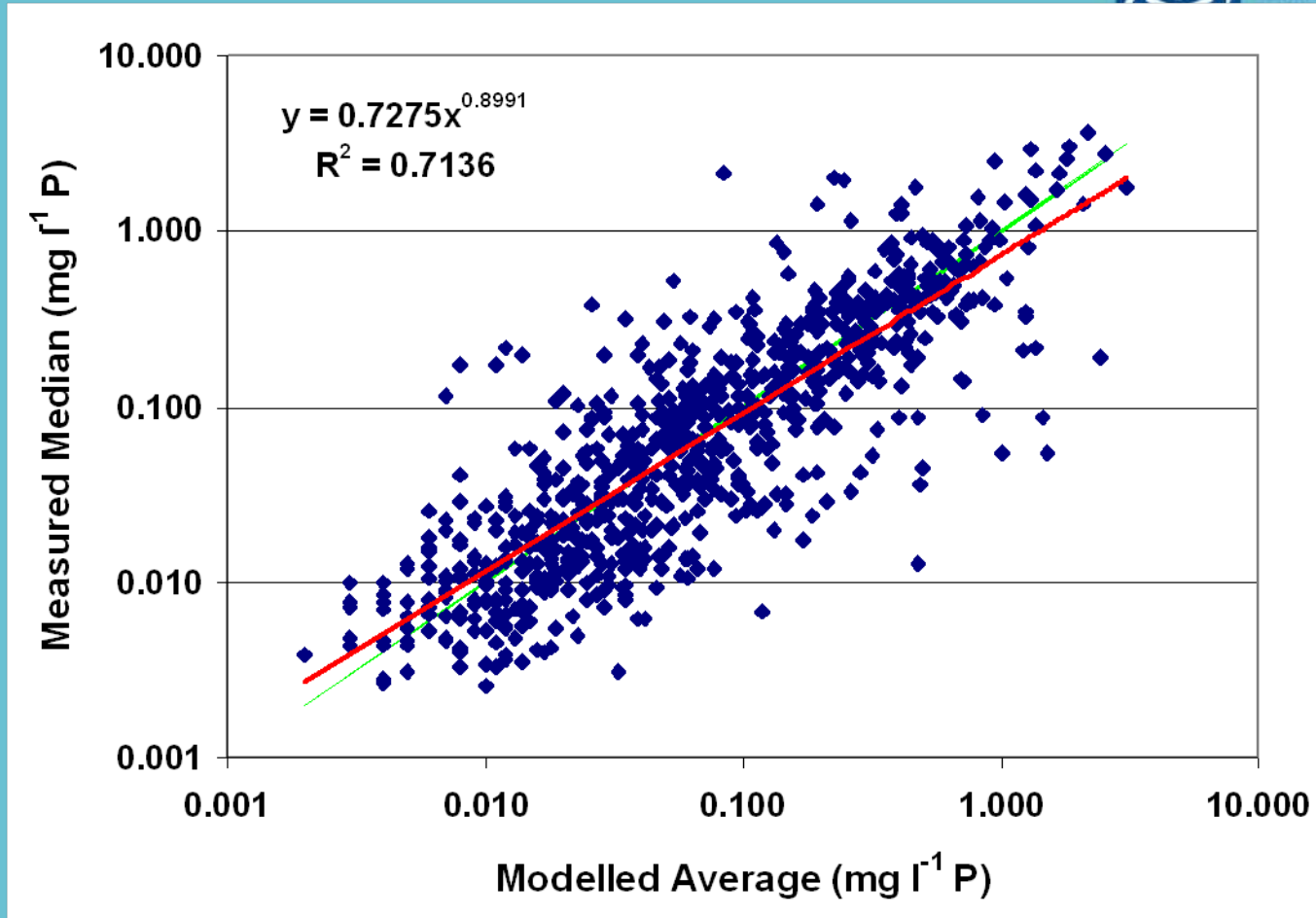
False Negative Rate 21%
(i.e predict pass, measure fail)



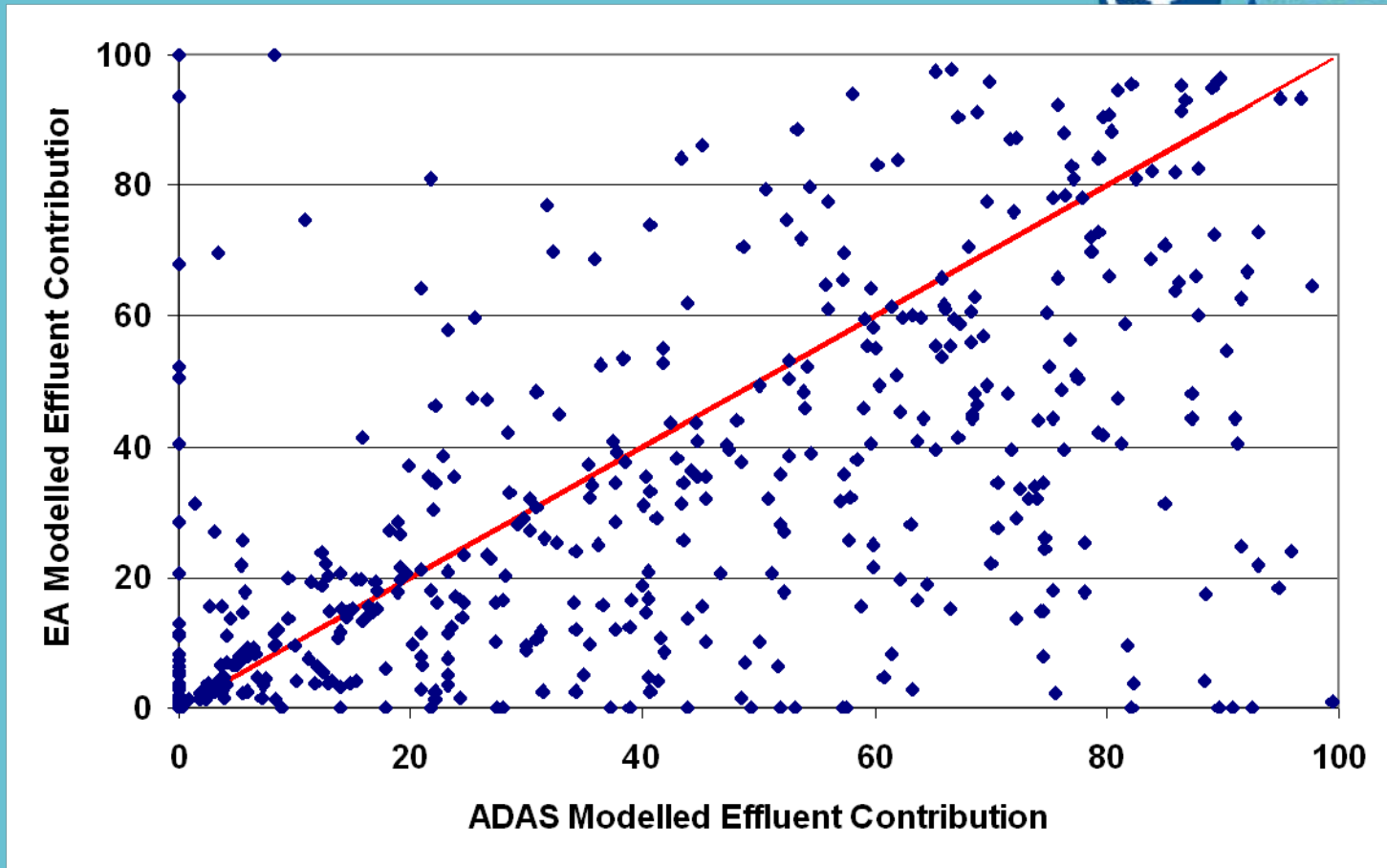
ADAS Model:	EA Measurement:		Total:
	Pass	Fail	
Pass	394	64	458
Fail	70	240	310
Total:	464	304	768

Model Baseline for 2004 and Monitoring Data for 2004 to 2006 ?

Source : ADAS



Comparison of modelled and measured concentrations in monitored river catchments.



Comparison of ADAS and EA modelled effluent contribution to annual total phosphorus loads at monitored catchments.

Consequences



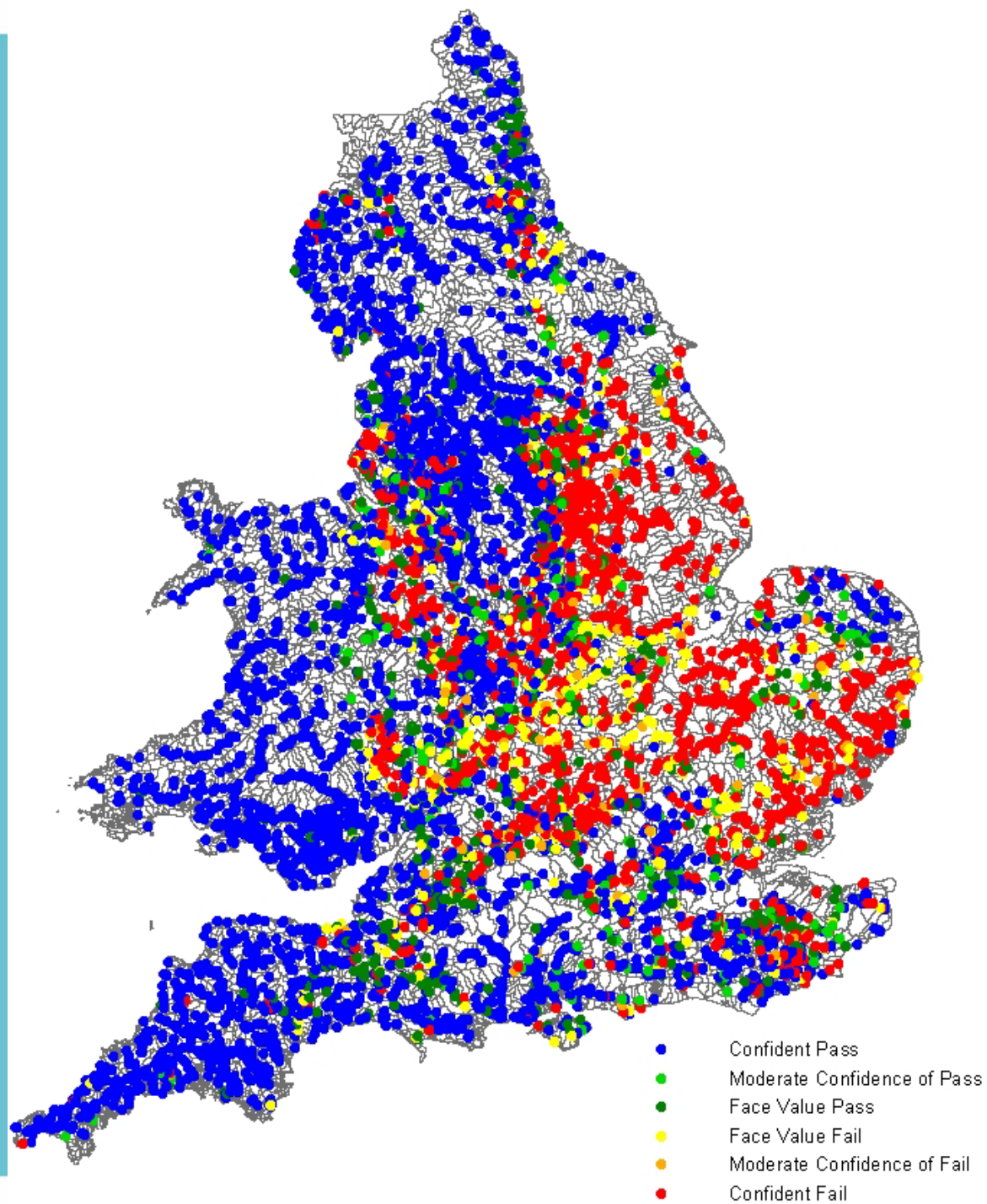
- National source apportionment project (EA-UKWIR)
 - Multiple pollutants
 - Nutrient P, Cu, BOD/DO, NH₃, PAH's, DEHP (diethylhexyl phthalate)
 - Emphasis on data and methods for estimating spatially resolved inventory
- Scale dependence of source apportionment estimates (EA R&D project)
- WFD (DEFRA) funding available (???) for further model based analysis of P
 - STW and agricultural sources
 - Better treatment of chemical forms of P
 - and In-stream dynamics
-

Surface water NVZ method

EA Monitoring data

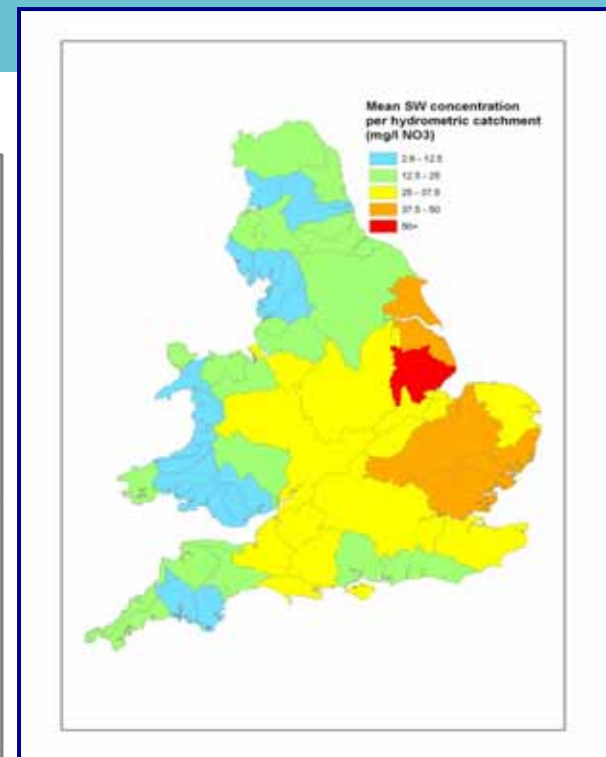
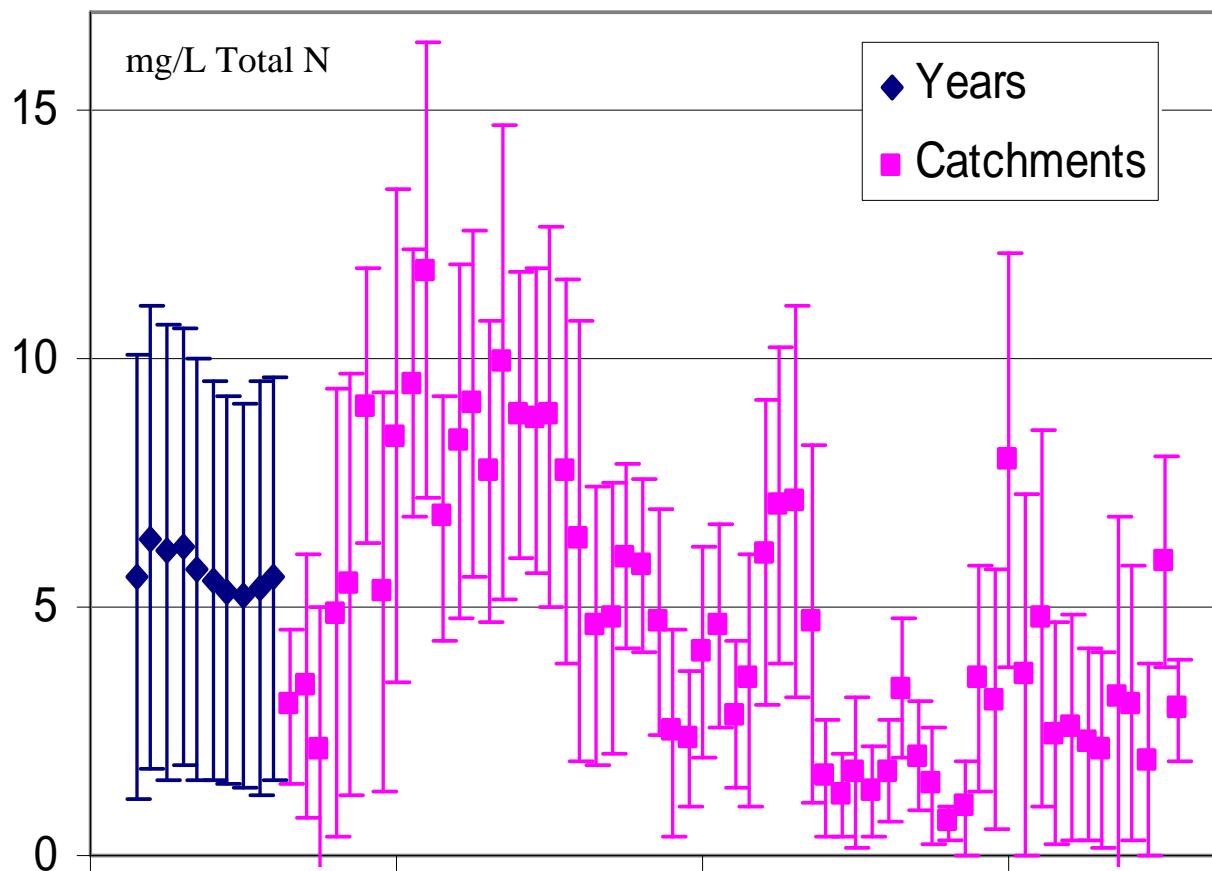
95%ile Observed Total N ($\text{mg}\cdot\text{L}^{-1}$)

Classified by confidence of achieving target (“drinking water standard”)



Nitrate Trends

Variation in Surface Water Concentration



Sums-of-Squares Partition

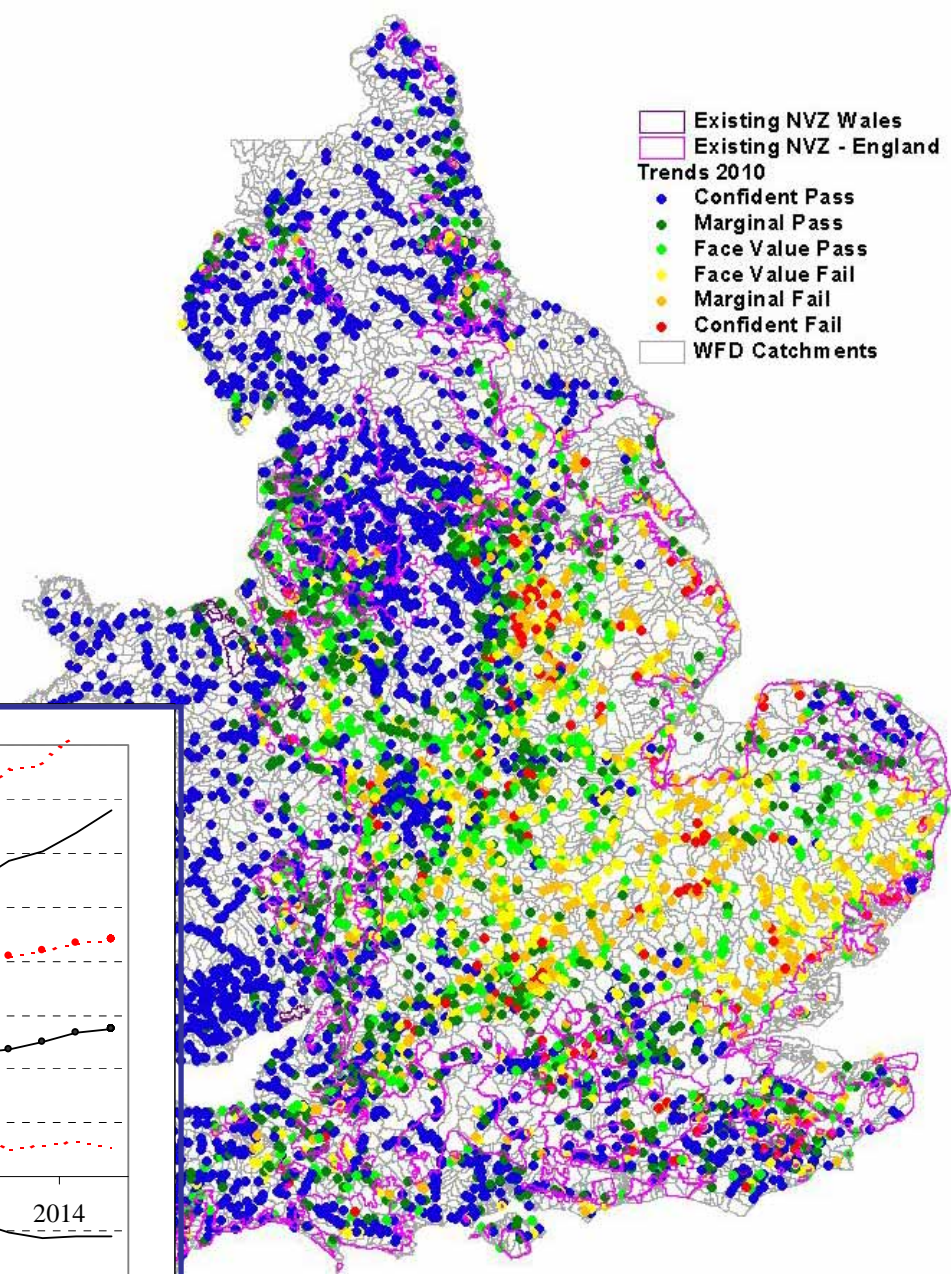
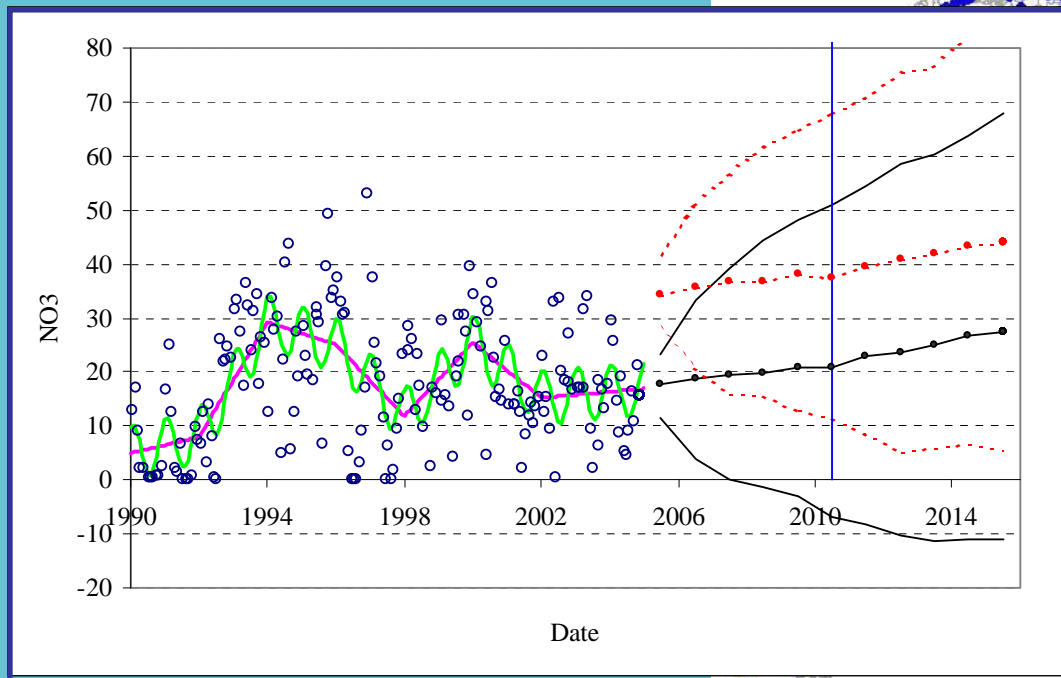
Between catchments	40.6
Within catchments	48.0
Total annual	9.3
Residual	2.1

Trends - point data

EA Monitoring data

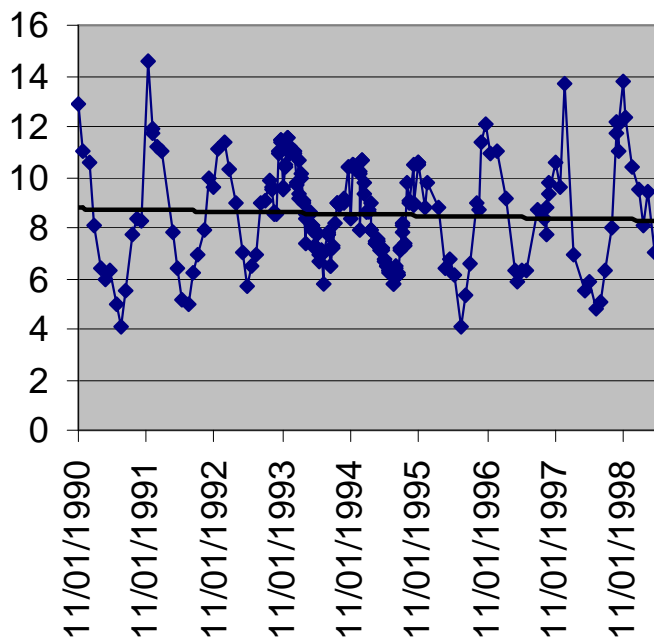
Trend Analysis results

Confidence of achieving nitrate target
in 2010



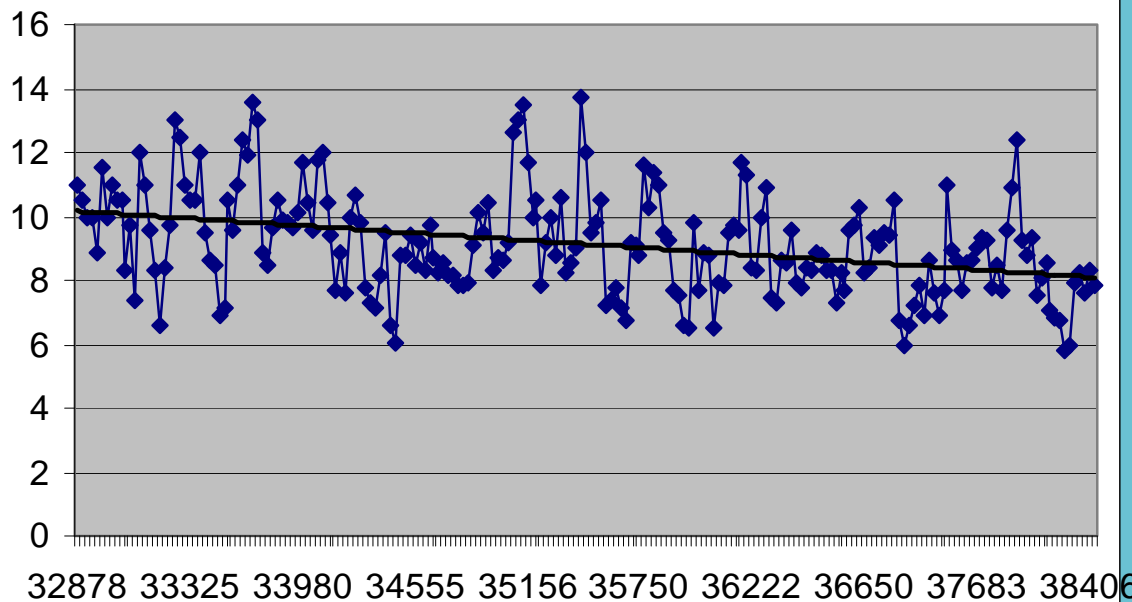
Long term declining trends ...

R. Thames at Goring Weir 1990-2005



R. Trent at Keadby 1990 - 2005

Nitrate levels (nitrate-nitrogen) at NVZ designation point
Environment Agency monitoring data

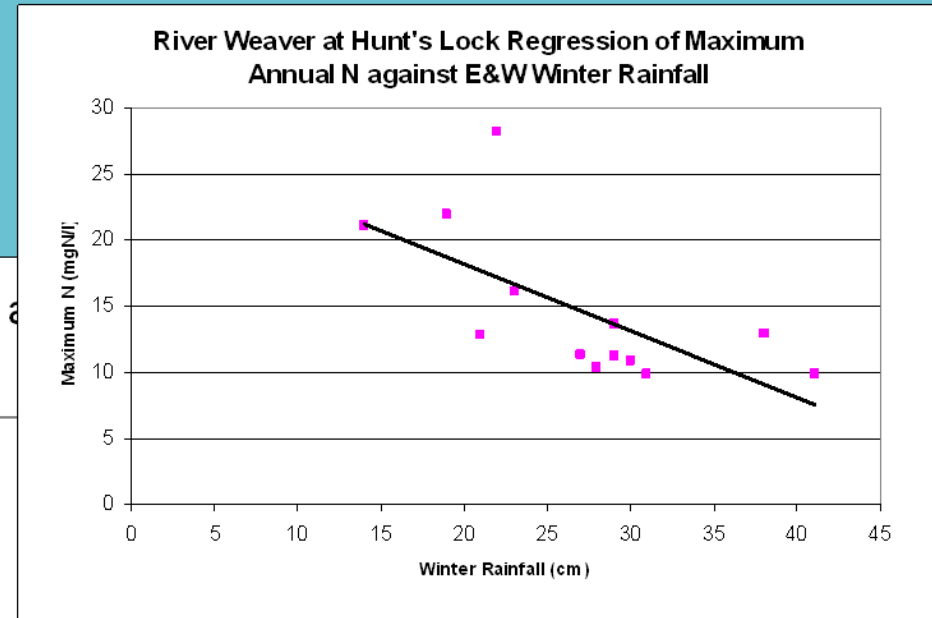
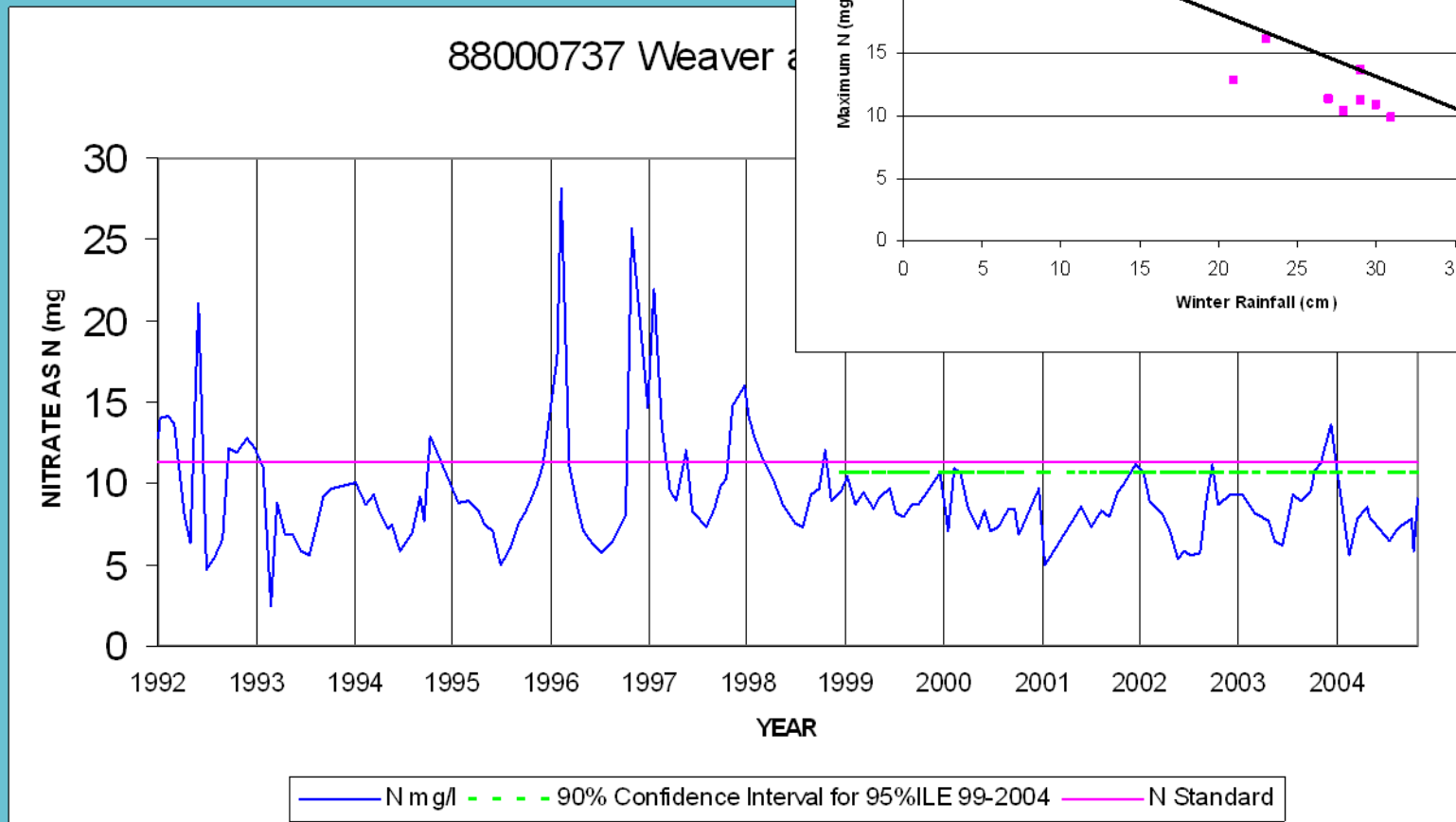


River Weaver at Hunts Lock

Confident fail (2002)

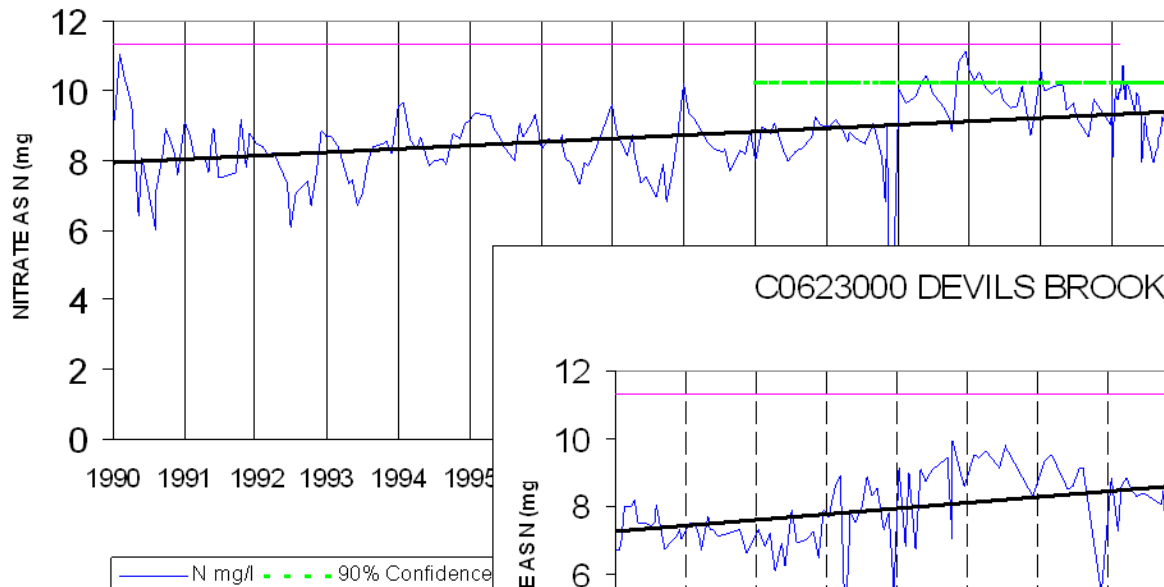
Face Value pass (1999-2004)

Concentration depends on rainfall

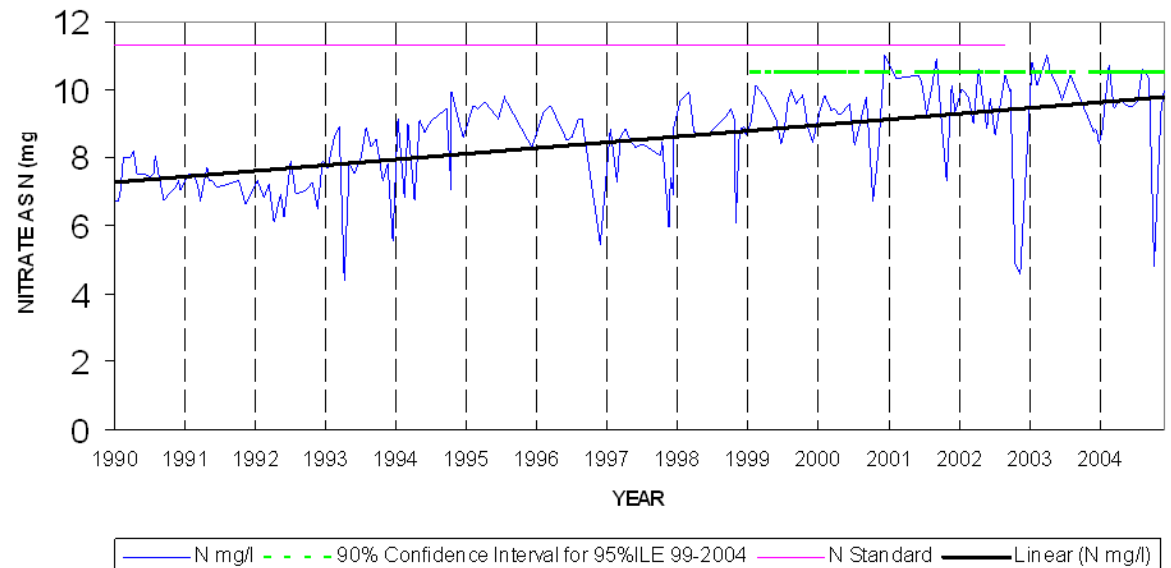


Examples of upward trends

E0001335 NORTH STREAM HACKLINGE



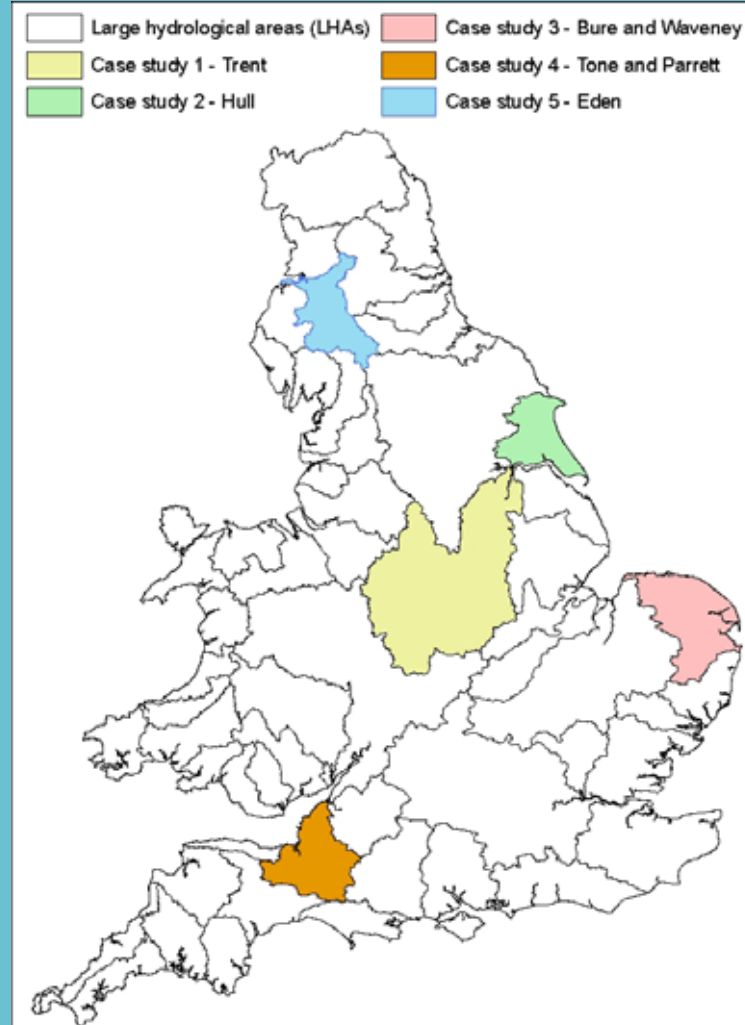
C0623000 DEVILS BROOK FRYERS BRIDGE



Spatiotemporal Modelling of Nitrate and Phosphorus in River Catchments for England and Wales

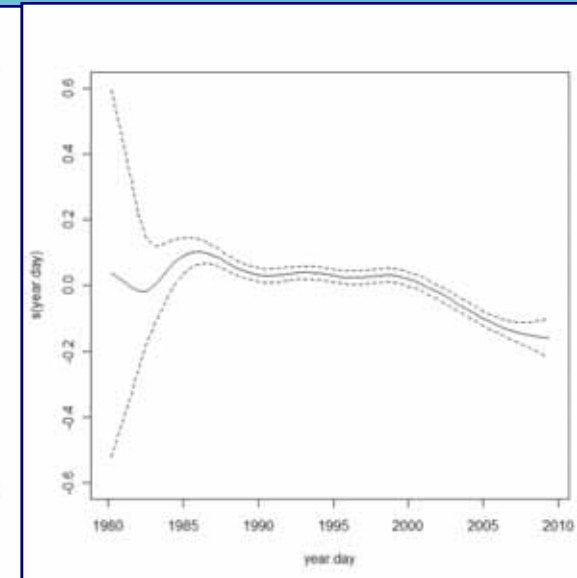
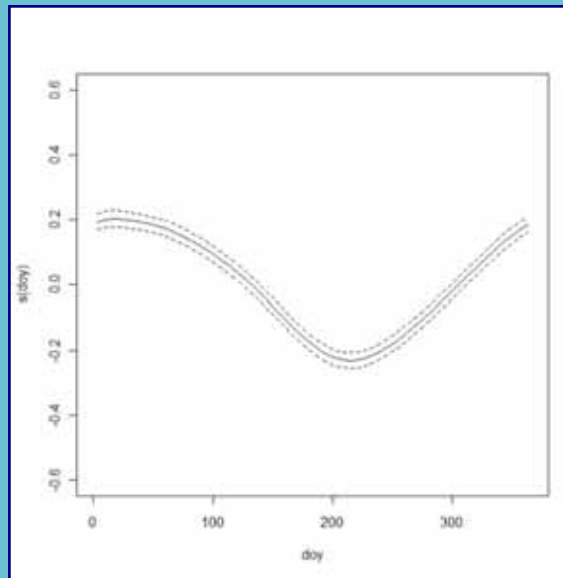
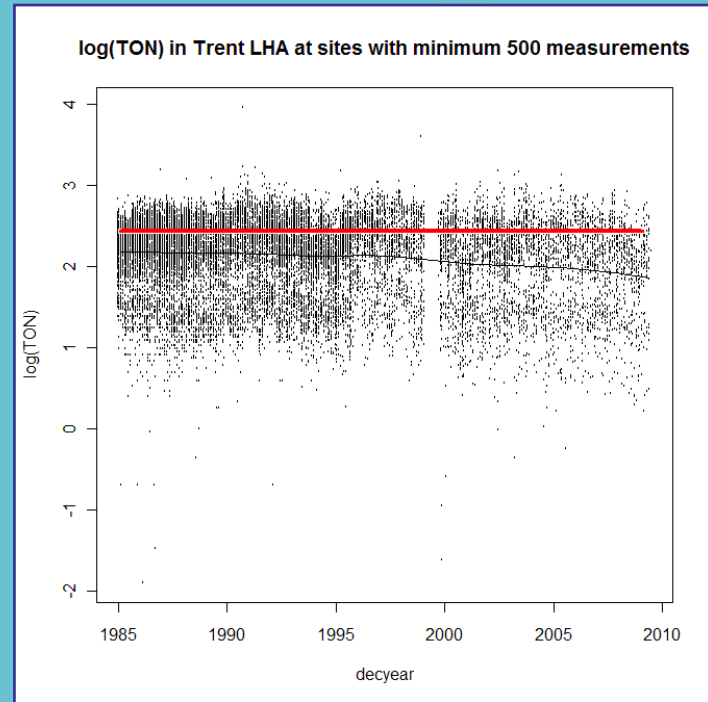
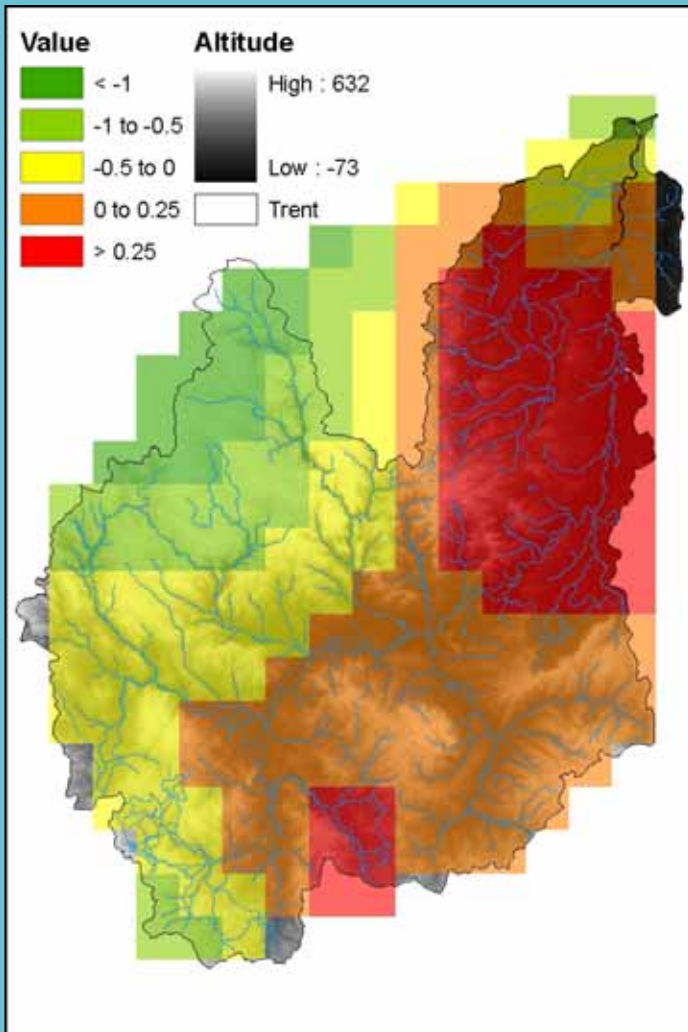
Non-parametric, additive models
fitted to all LHA's

Examples highlighted

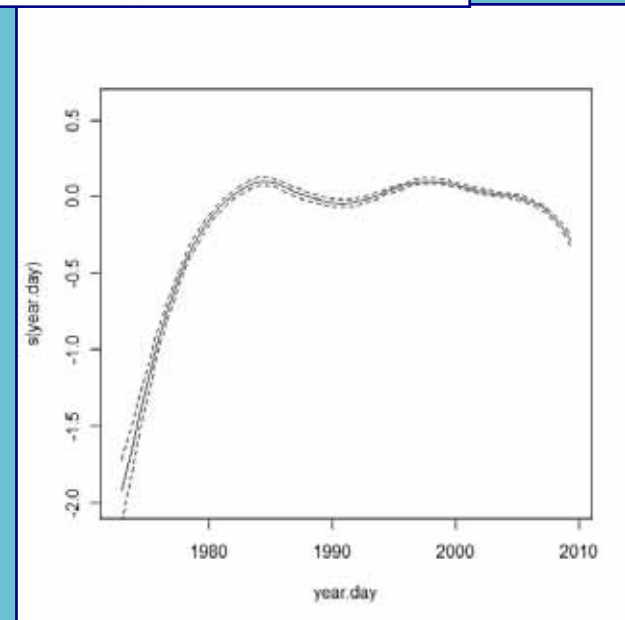
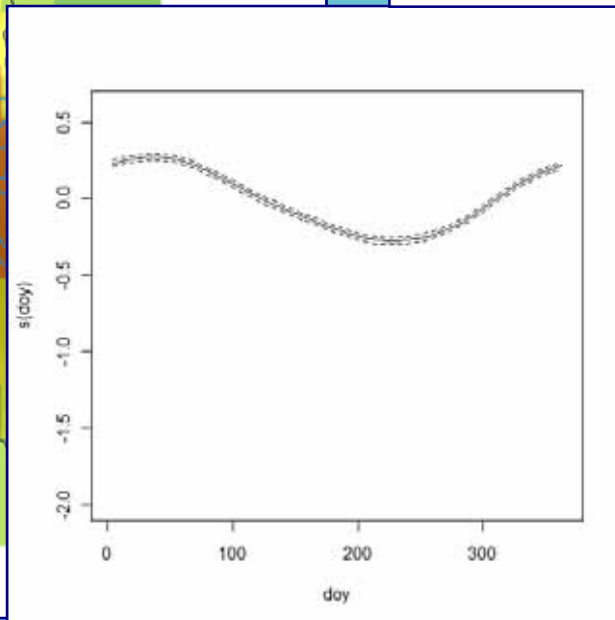
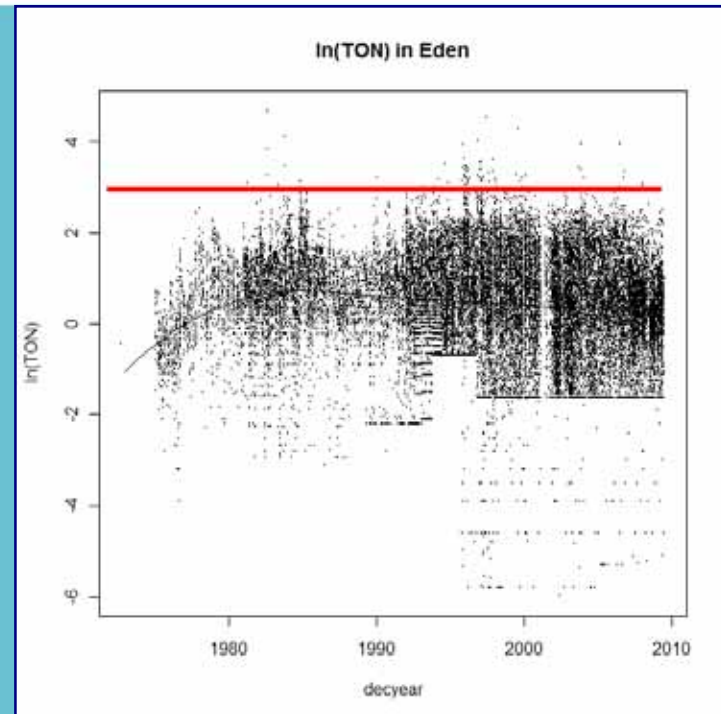
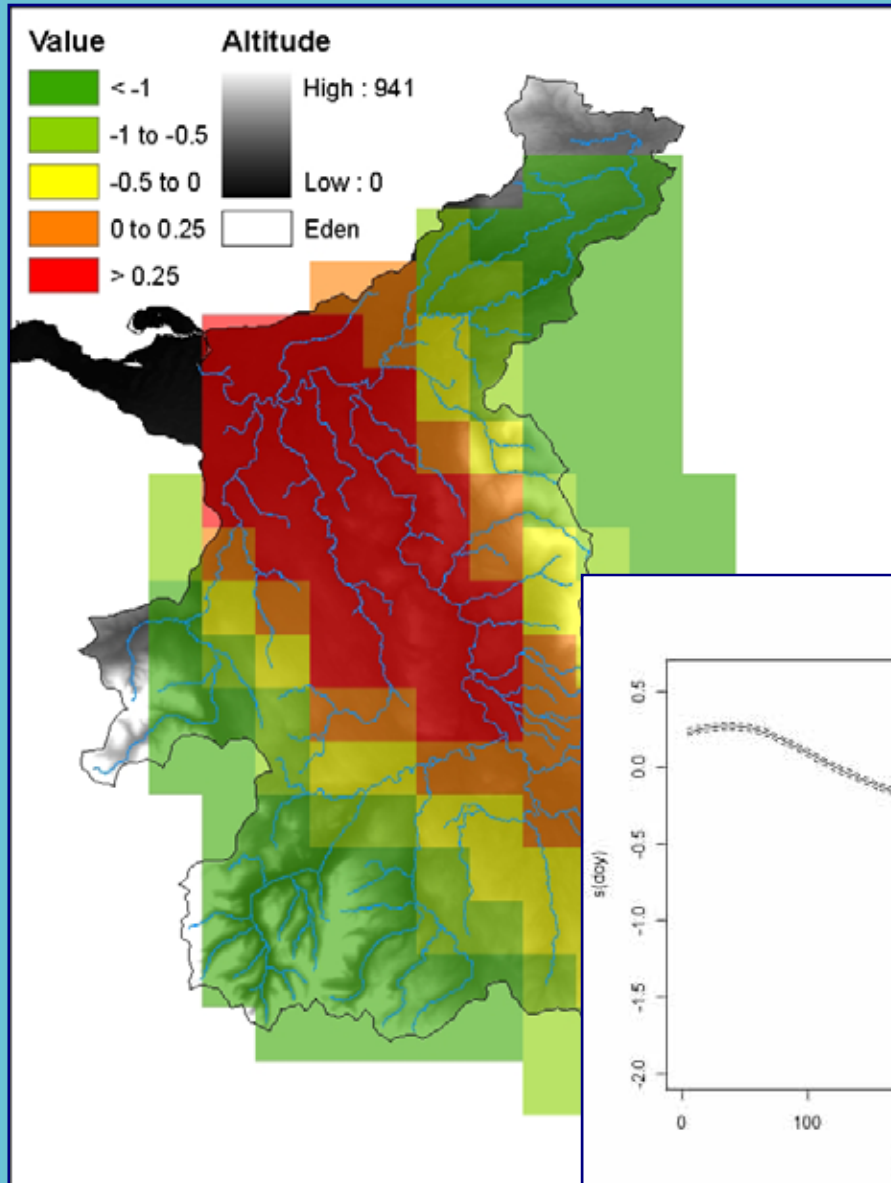


River Trent

ment



River Eden



ment

Conclusions

- Trends often increased before 2000, but mainly decreasing after.
- Trends are variable across LHAs for TON and TN.
- TN and TON seasonal pattern - generally highlights high values at the beginning and end of the year with one trough in the summer months.
- The distribution of TON and TN estimates appear to be clustered around the same locations (higher values at the bottom of the catchments).
- The seasonal effect is greater in the early years (i.e. a more pronounced dip in the summer) and smaller in the later years (interaction model).

Thank you



Thanks to

- Steven Anthony (ADAS)
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