Cranfield UNIVERSITY
Silsoe

INSTITUTE OF WATER AND ENVIRONMENT

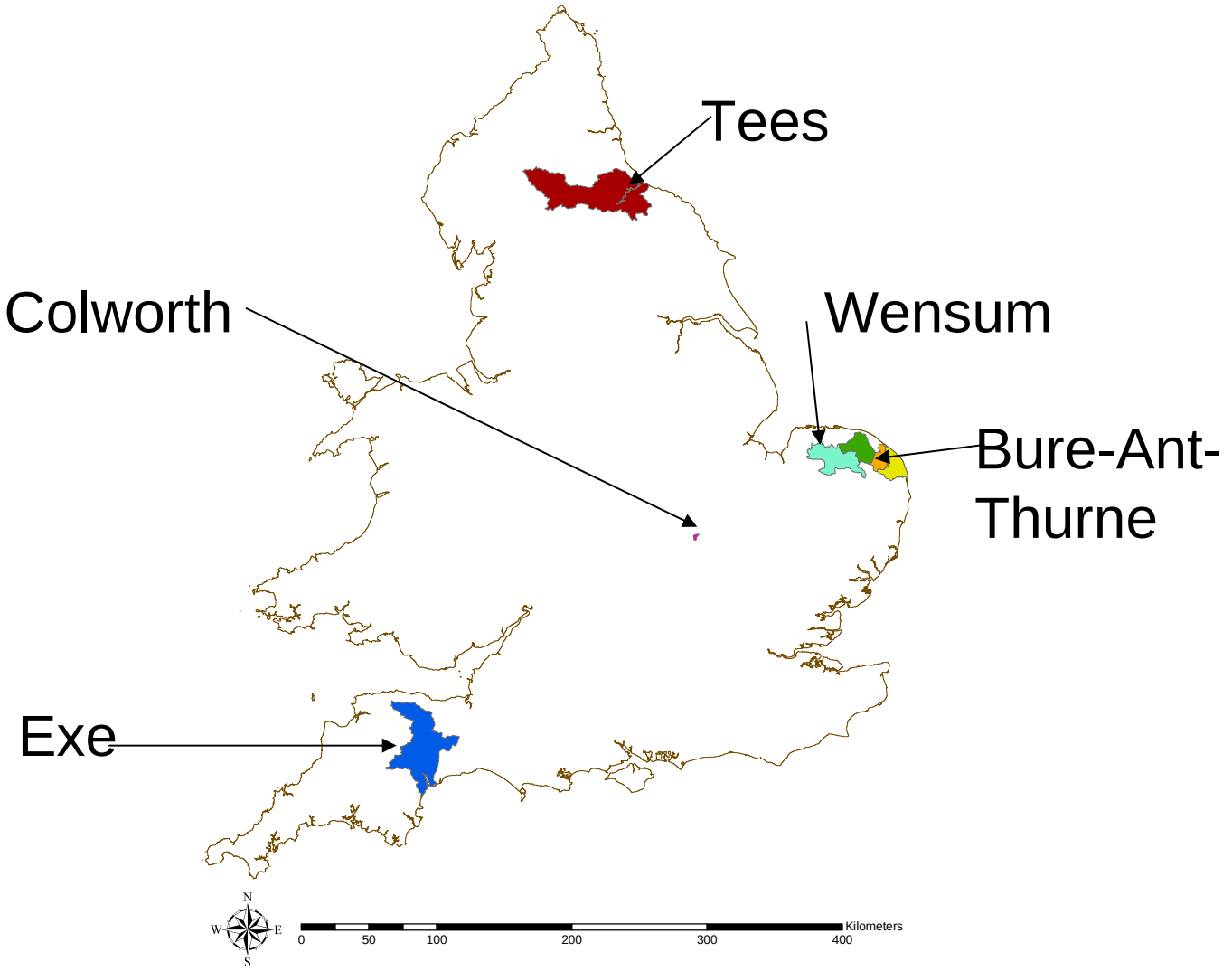
Using SWAT in English catchments: experience and lessons

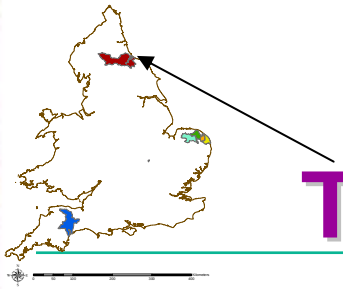
Sue White, Narayanan Kannan, Ian Holman, Jodie Whitehead, Isabelle Beaudin, Julie Carter, John Hollis, Bruna Grizzetti, Ed Fredenham and Nathalie Bertrand

Cranfield UNIVERSITY
Silsoe

INSTITUTE OF WATER AND ENVIRONMENT

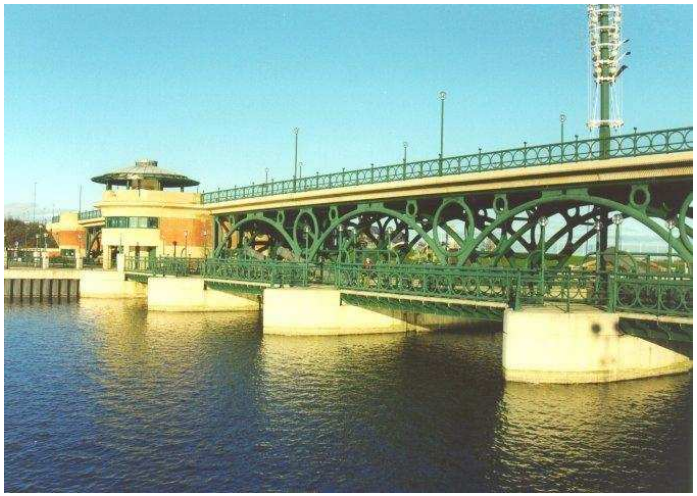
Where SWAT has been used





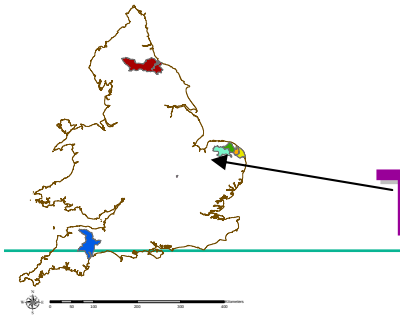
The River Tees

- Dominantly moorland with some grazing
- Limited arable land near the east coast
- Strong rainfall gradient west-east
- Peat soils over large areas of the headwaters
- Used to look at likely future inflows of water, sediment and nutrients to an estuarine barrage



Cranfield UNIVERSITY Silsoe

INSTITUTE OF WATER AND ENVIRONMENT



The Wensum

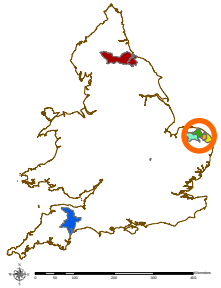
- Largely arable land
  - this is under pressure
- Driest part of the UK
- Irrigation required for some crops
- Serious erosion problems
- Study carried out for the local water company – who wanted to look at the possible impacts of land use change on nutrient levels as compared with increased waste-water or water treatment
- Also used to model pesticide losses

Cranfield UNIVERSITY Silsoe

INSTITUTE OF WATER AND ENVIRONMENT

The Ant-Bure system and upper Thurne

Cranfield UNIVERSITY Silsoe

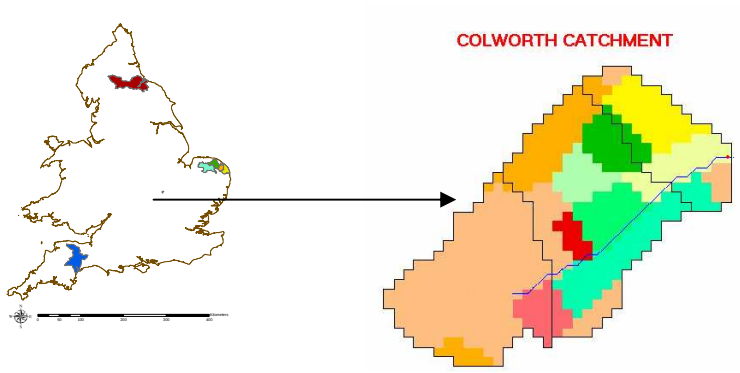


- Largely arable land
  - this is under pressure
- Driest part of the UK
- Irrigation required for some crops
- Drainage prevalent in upper Thurne
- Of strategic importance for low-lying shallow lakes of the Norfolk Broads
- Being used to look at future land-use and climate scenarios (poster – Jodie Whitehead *et al*)

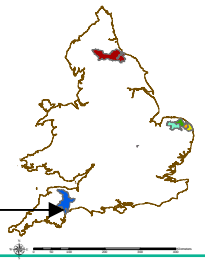
INSTITUTE OF WATER AND ENVIRONMENT

The Colworth catchment

- Small agricultural area (1.415 km^2) where all field operations, crop yields etc were known
- Outflows of water, pesticides and sediment recorded
- Fields under-drained
- Used as a test case of SWAT application to a small catchment alongside the TERRACE study (poster – White *et al*)
- Pesticide modelling and impacts of pesticide management were focus
- Also used in a hypothetical study to model LAS losses from sewage sludge (presentation – Kannan *et al*)

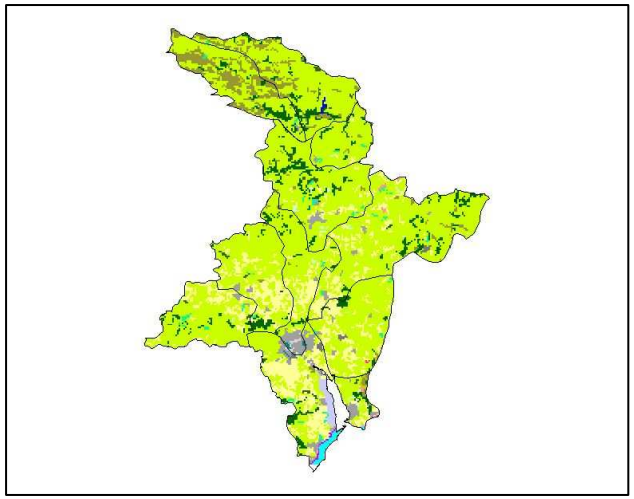


The Exe catchment



Cranfield UNIVERSITY
Silsoe

- Wetter part of the UK
- Largely moorland, peat soils in the north, intensive grazing in the central region, arable land to the south
- Used as a demonstration catchment for the TERRACE project (poster – White *et al*) where Mecoprop losses were modelled
- Modelled with two catchment discretizations
- Also used to investigate ways of using poorly defined pesticide inputs (poster – White, Grizzetti & Hollis)
- Used as a focus for modelling E.Coli inputs from diffuse sources to the estuary



INSTITUTE OF WATER AND ENVIRONMENT

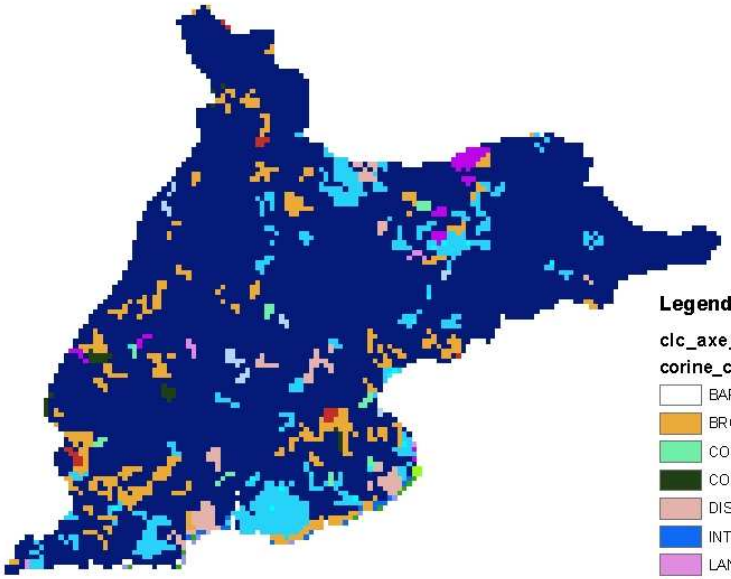
Cranfield UNIVERSITY
Silsoe

INSTITUTE OF WATER AND ENVIRONMENT

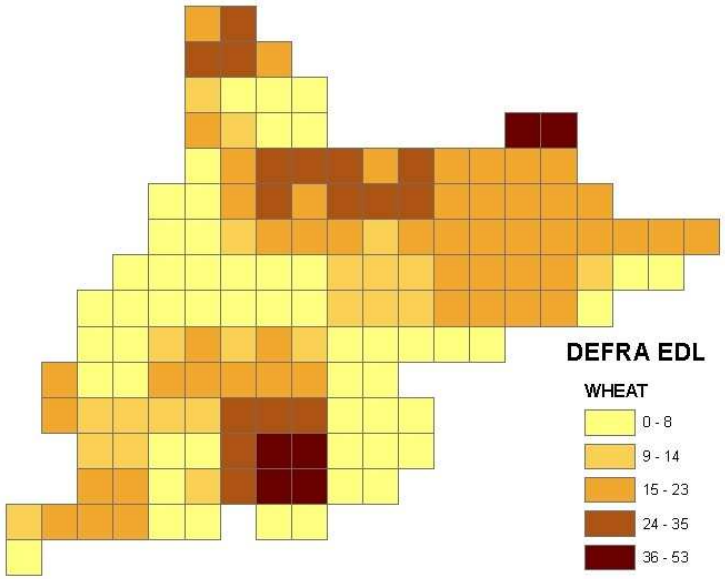
Data quality - inputs

- Land cover – national coverage is from satellite image interpretation at 250m resolution, which provides broad land use classes (e.g. arable, grassland). Data are available for 1990 and 2000
- Crop type data and animal numbers are from parish level census data (distributed to 2km grid). Data are available for 1969, 79, 81, 88, 94, 97 and 2000.
- There are national level crop rotation patterns on a regional basis, but….
- There are no definitive data on which crops grow where in which year or on stocking density for particular locations

Land Use




Legend
clc_axe_ctcht
corine_classes.LCNMEN
BARE
BROA
COMP
CONIF
DISCO
INTER
LAND
MINER
MIXED
NATUF
NON-I
PASTU
SPOR
UNCL
UNCL


DEFRA EDL
WHEAT
0 - 8
9 - 14
15 - 23
24 - 35
36 - 53

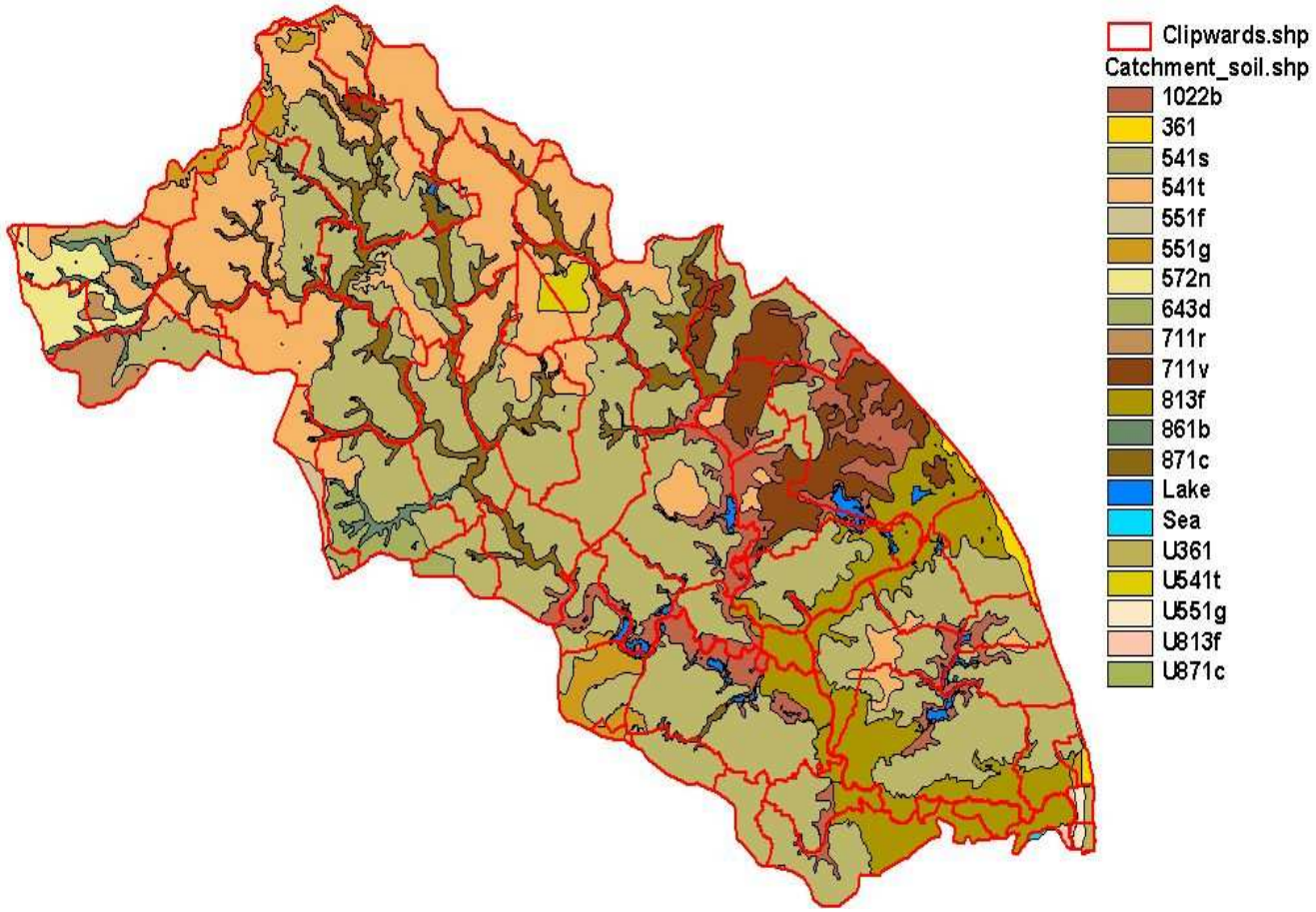
Data quality - inputs

- Land management – no detailed operational data are available. Local knowledge + best practice guidelines.
- Climate – daily rainfall data are available for research studies from the British Atmospheric Data Centre, or from the Environment Agency
- Climate – max and min temperatures, solar radiation, windspeed are available from BADC
- BADC data quality is poor
- Meteorological office data is expensive!

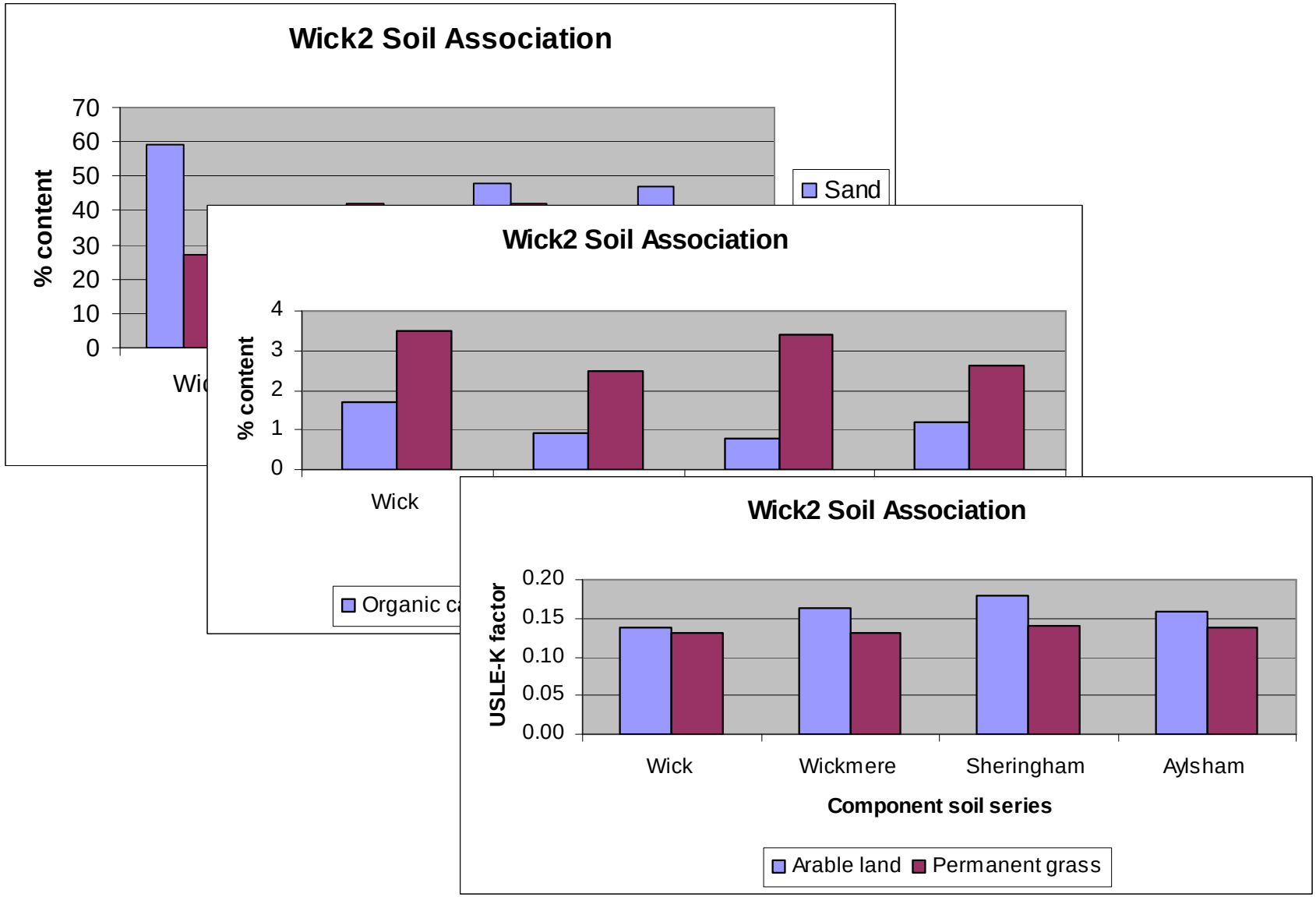
Data quality - inputs

- Soils data are mapped nationally as vector based or 1km raster based data
- The mapped data are soil associations – which can contain multiple soil series
- An associated database holds soil physical data – but this is derived from a limited number of soil samples
- Not all SWAT soil parameters are available from the database
- We have developed a number of model parameter estimation routines to provide SWAT soil parameters not included in the database

Soil data - spatial



Soil data – associated data



Peat “soil”

- Organic, black, non-structured
- Hydrology has been modelled successfully using:
  - 1% clay content
  - low bulk density
  - high porosity

Data quality - inputs

- Chemical inputs – data are not recorded at field level. Regional data are available for pesticide inputs (see poster by White, Grizzetti and Hollis)
- Nutrient inputs are assumed to follow best practice guidelines – checks are made that crops are not nutrient stressed
- Atmospheric inputs need to be assessed from point data or atmospheric models

Regional pesticide data

Region	Crop	Pesticide	Month	Dose (kg/ha)
South Western	Wheat	Mecoprop	2	0.000004
South Western	Wheat	Mecoprop	3	0.014951
South Western	Wheat	Mecoprop	4	0.078916
South Western	Wheat	Mecoprop	5	0.001695
South Western	Wheat	Mecoprop	6	0.000721

- We know these numbers are not really what farmers would use
- Mecoprop for wheat
  - recommended dosage =1.4 – 2.4 kg/ha
  - one dose per year

WINTER OILSEED RAPE		(Previous crop WBAR)			
				kg/ha	yield (t/ha)
FERTILSER	P205	LATE JULY	every year	100	
TILLAGE	plough	EARLY AUGUST	every year		
PLANT		LATE AUGUST	every year		
FERTILSER	34.5%N	EARLY OCT	every year	40	
FERTILSER	34.5%N	EARLY MARCH	every year	80	
FERTILSER	34.5%N	EARLY APRIL	every year	80	
HARVEST	combine	LATE JULY	every year		2.3
CHOP STRAW		LATE JULY			

Data quality – calibration/validation

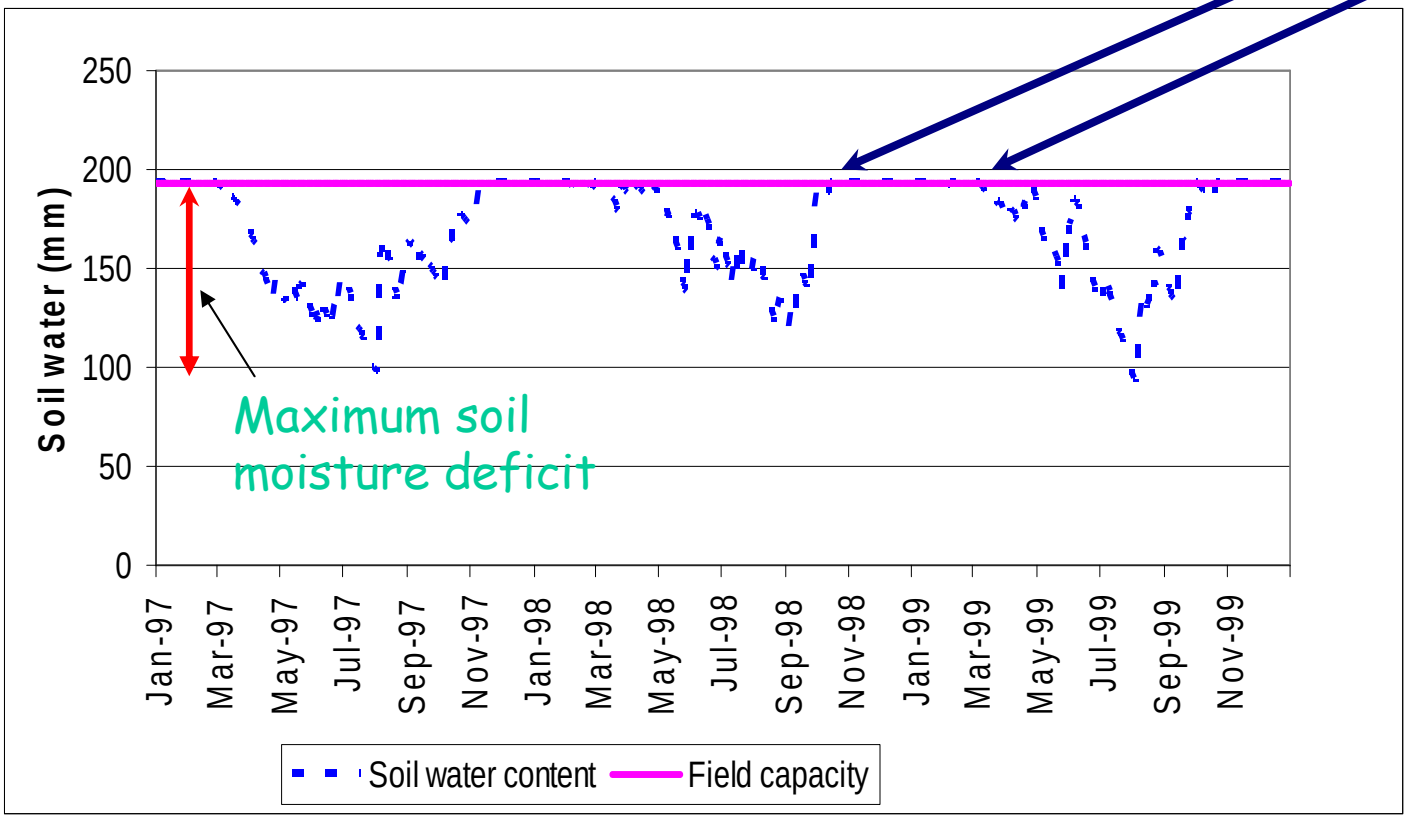
- River flow data – is routinely monitored at a large number of sites in the UK. Data resolution is normally 15-minutes.
- Water quality data – is monitored at 8000 sites nationally, but data resolution is normally 4-weeks and event-based pollutants are not well represented
- Some research quality data are available and we are investigating calibration of the model using routine 4-weekly data and validation against more detailed research data

Data quality – calibration/validation

- Soil moisture data – are not routinely monitored. Modelled data (based on climate data and crude land use patterns) are available from the Meteorological office
- Typical dates for reaching and leaving field capacity and maximum soil moisture deficit are available at a regional level, for typical cropping patterns, for the period 1940-1970 – this is increasingly not relevant to current climate conditions and crops

Cranfield UNIVERSITY
Silsoe

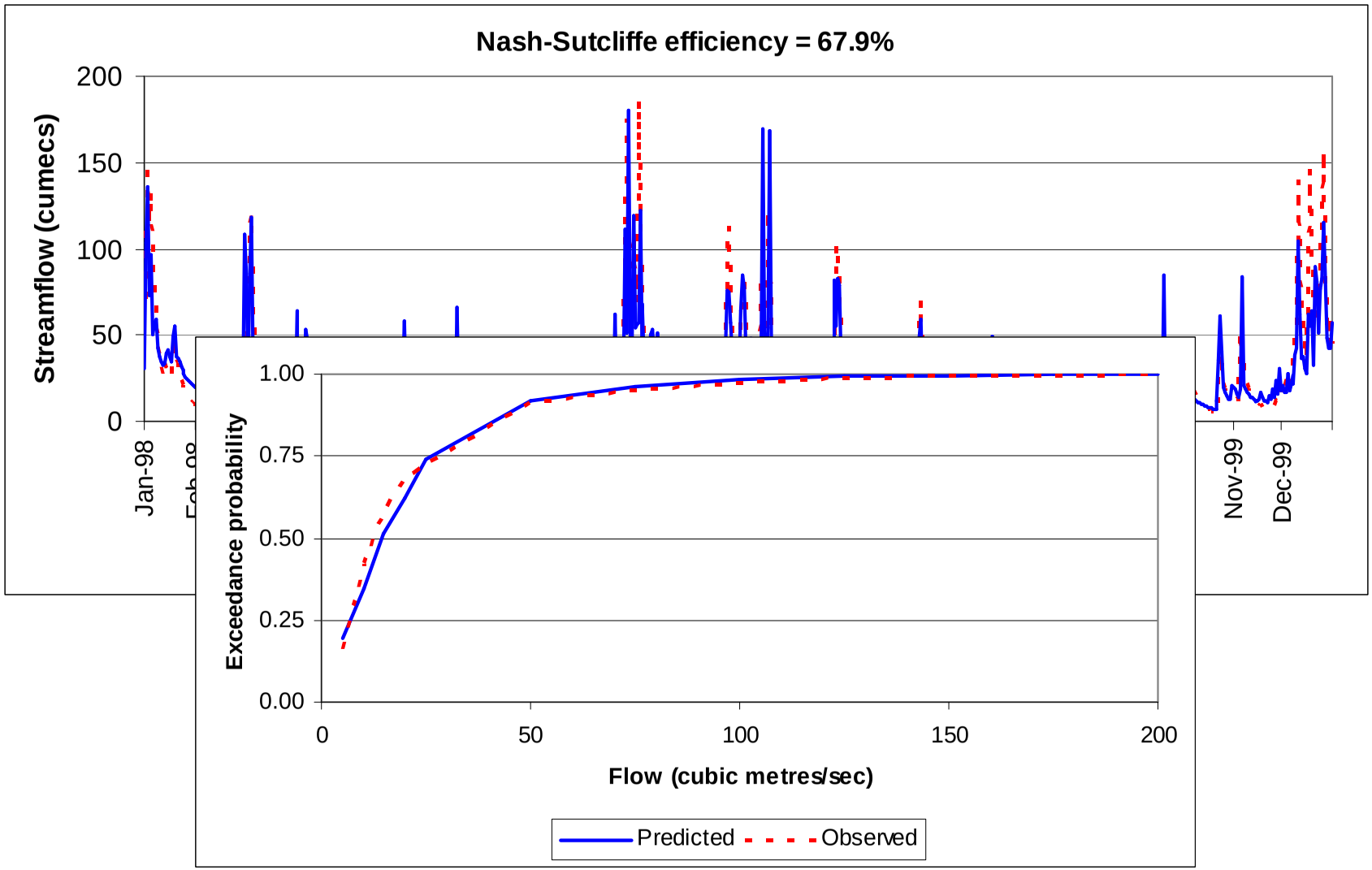
Soil moisture – model verification



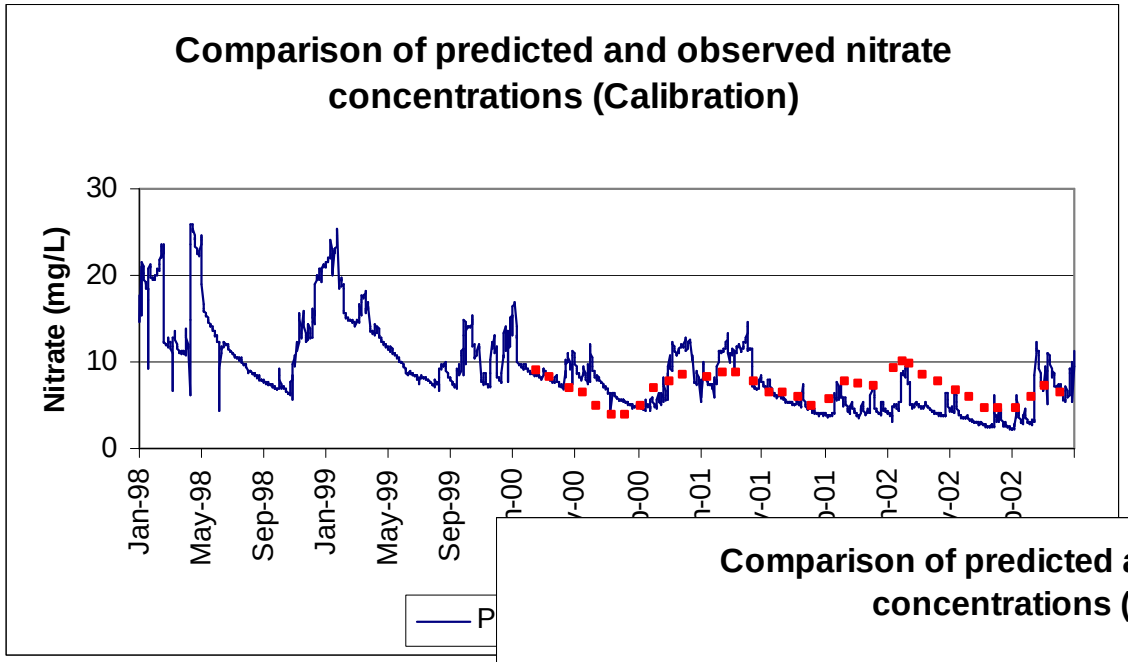
Date of reaching & leaving field capacity

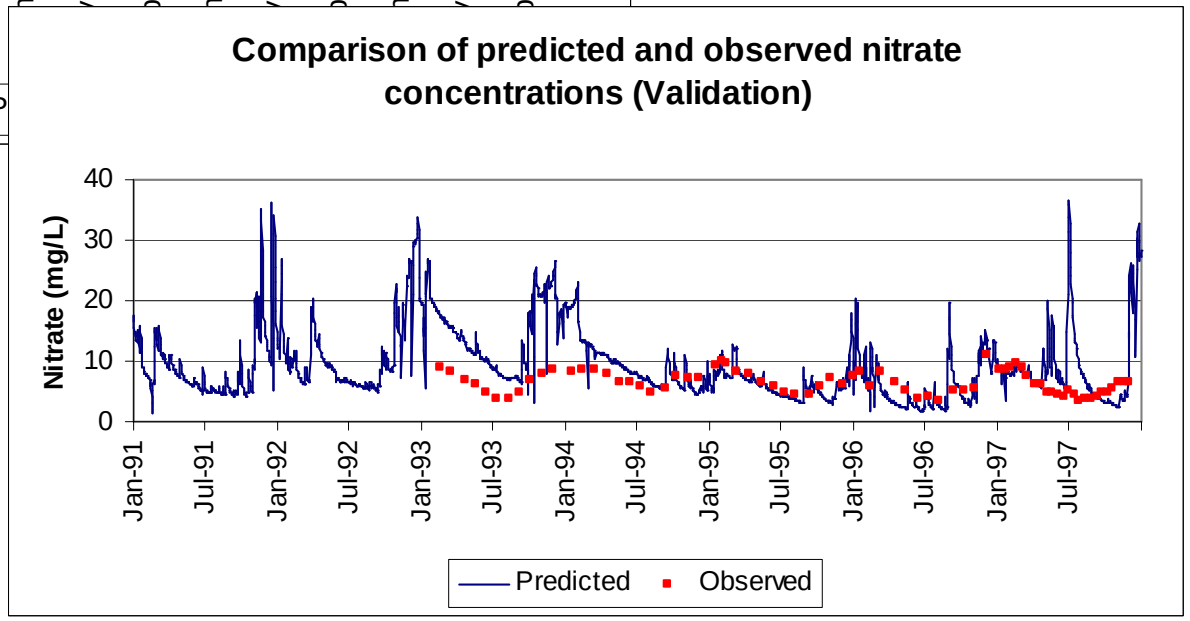
INSTITUTE OF WATER AND ENVIRONMENT

Results – river flow, Exe



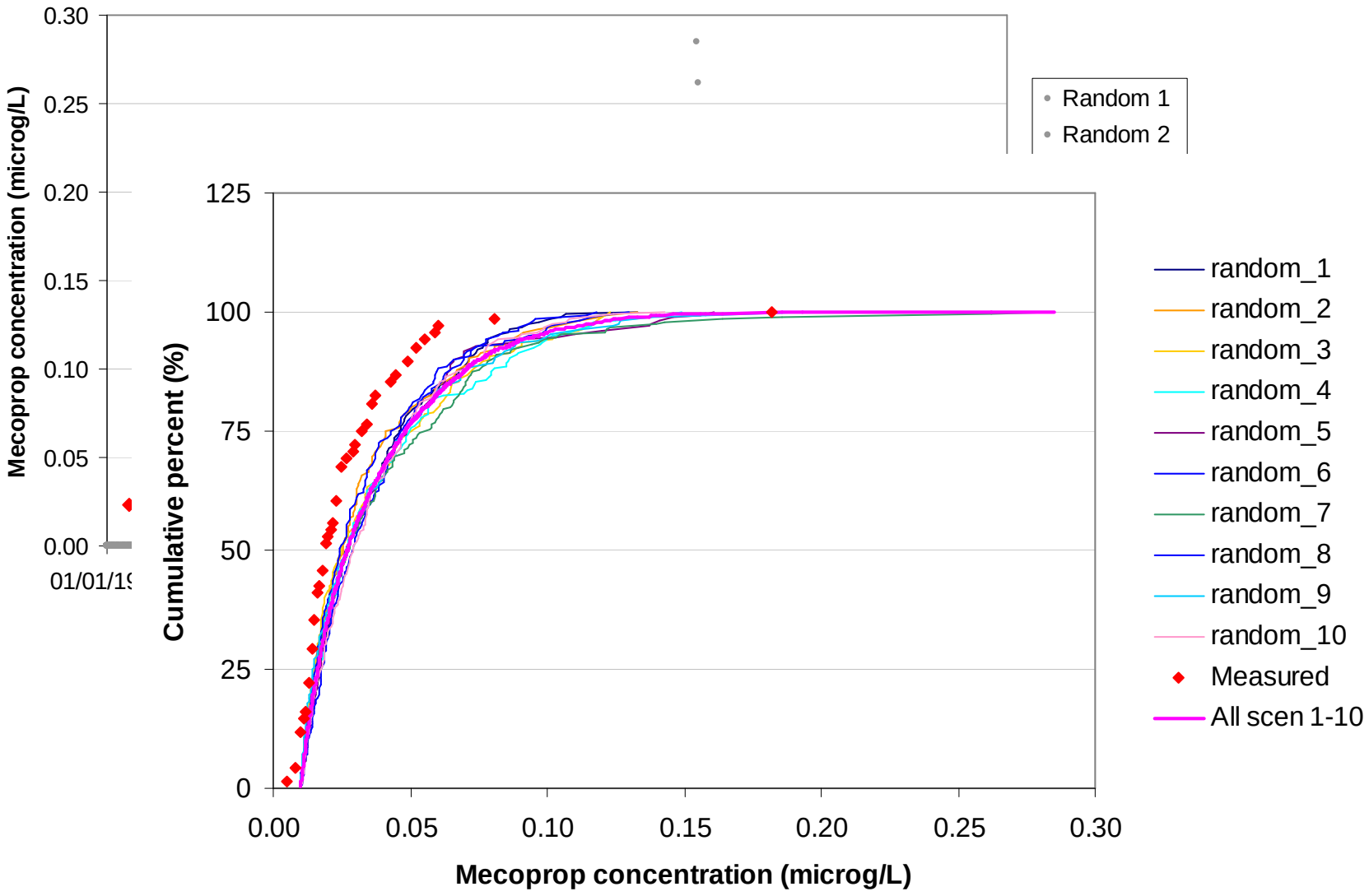
Results – nitrate modelling Wensum





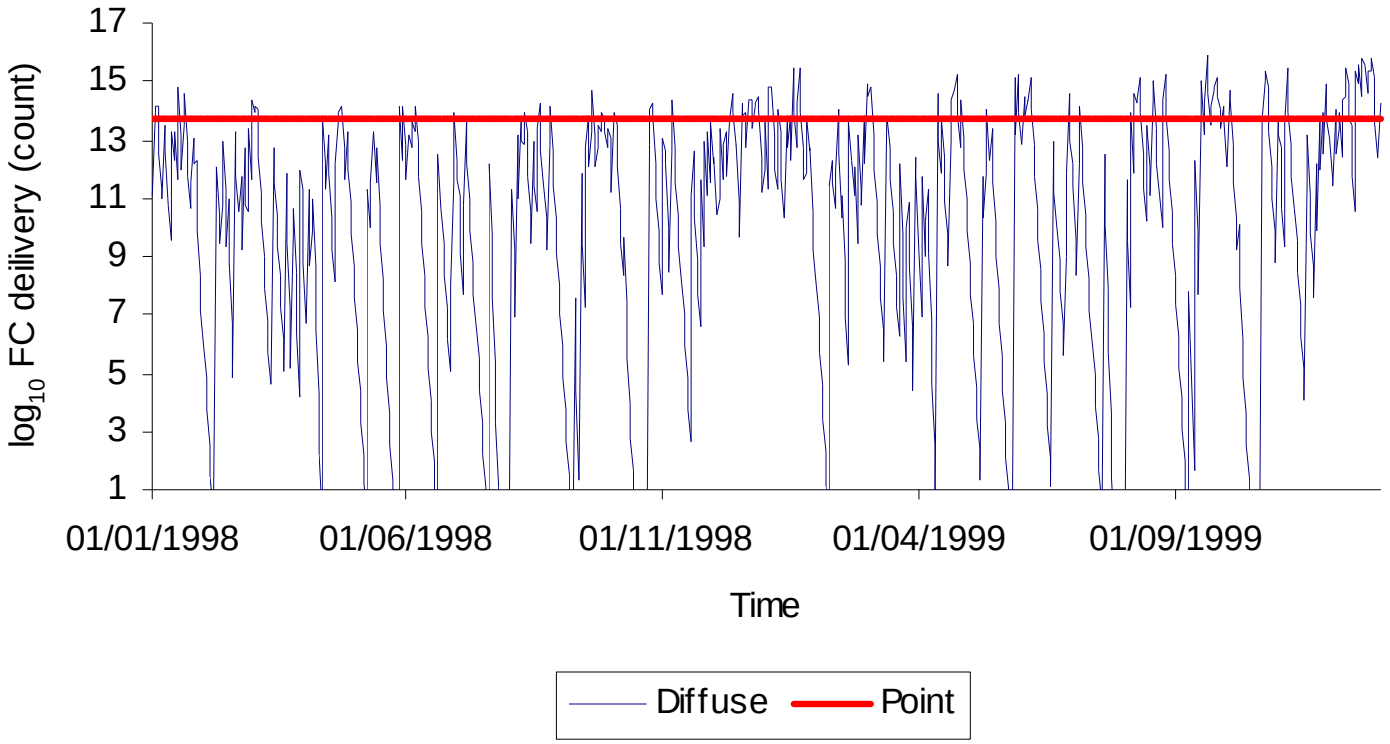
Cranfield UNIVERSITY
Silsoe

Results – pesticide modelling, Exe



INSTITUTE OF WATER AND ENVIRONMENT

Results – E.Coli



Operational issues

- Autumn planted crops – start to grow after seed planting and then go dormant over winter, but renewed growth in spring does not occur
- Irrigation – only occurs in Year 1
- Sediment modelling – in many UK and European rivers, riverbanks are an important (and often dominant) source of sediment. Where we are looking at sediment bound contaminants this can be a serious omission in SWAT

Conclusions

- In spite of the poor quality of spatial and temporal data available for river basin scale modelling in the UK, SWAT has been shown to work well in a variety of basins at a range of scales and for different operational ends
- SWAT has been used to model land use and climate change, pesticides, nutrients, E.Coli and LAS and has been shown to provide potentially useful outputs

Conclusions

- However, until it can be demonstrated that modelled changes actually happen in practice there will continue to be doubt cast on SWAT's ability to assess the impacts of change
- This is not necessarily a shortcoming of the model but of the data collection and availability policy in the UK
- We need better targeted monitoring!
- A recent EU study (Euroharp) has suggested that good representation of a river basin by a model is due to the model (25%), the modeller (50%) and good luck (25%)
- We need to keep training good modellers!

Cranfield UNIVERSITY
Silsoe

INSTITUTE OF WATER AND ENVIRONMENT

Questions?

Alpha _bf

- We estimate alpha_Bf from flow data where possible – taking an average over several flood events