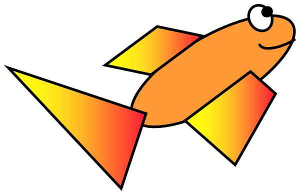
Catchment Management and Implementation

Water Quality Planning

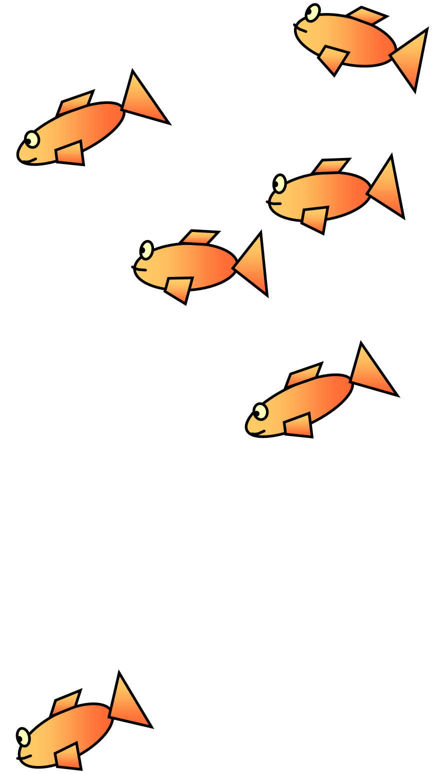
modelling for decision making



Tony Warn MBE

17 February 2016

- £20 billion of improvements



- models: RQP, SIMCAT

decision making ...

- where is the **red** on the map ?
- what caused it ?
- how confident are we ?
- what can we do ?
- is it worth doing ?

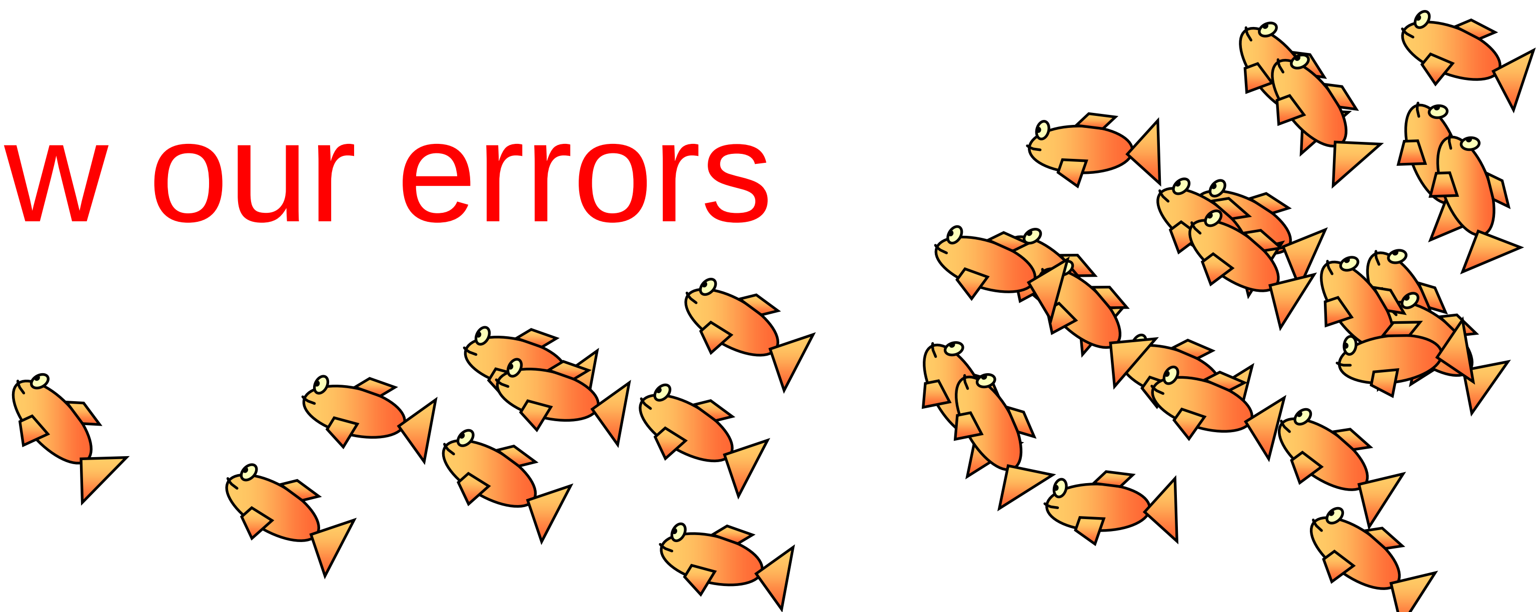
help from models

emphasise ...

- the “science” of taking decisions
  - not the “science” of rivers

this means we:

- use a correct form of standards and targets
- know our errors



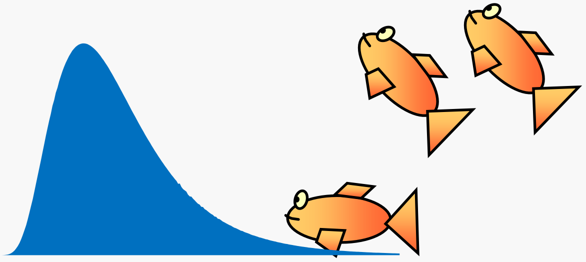
simplest requirement ...

- standards are means or percentiles

- to do the mixing correctly action
- to assess compliance RED

errors because…

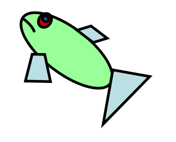
- 31 million seconds in a year
- we take 12 samples ?



know our errors ...

2.115

1.5 to 3.1



so don’t elaborate on the details …

what details?

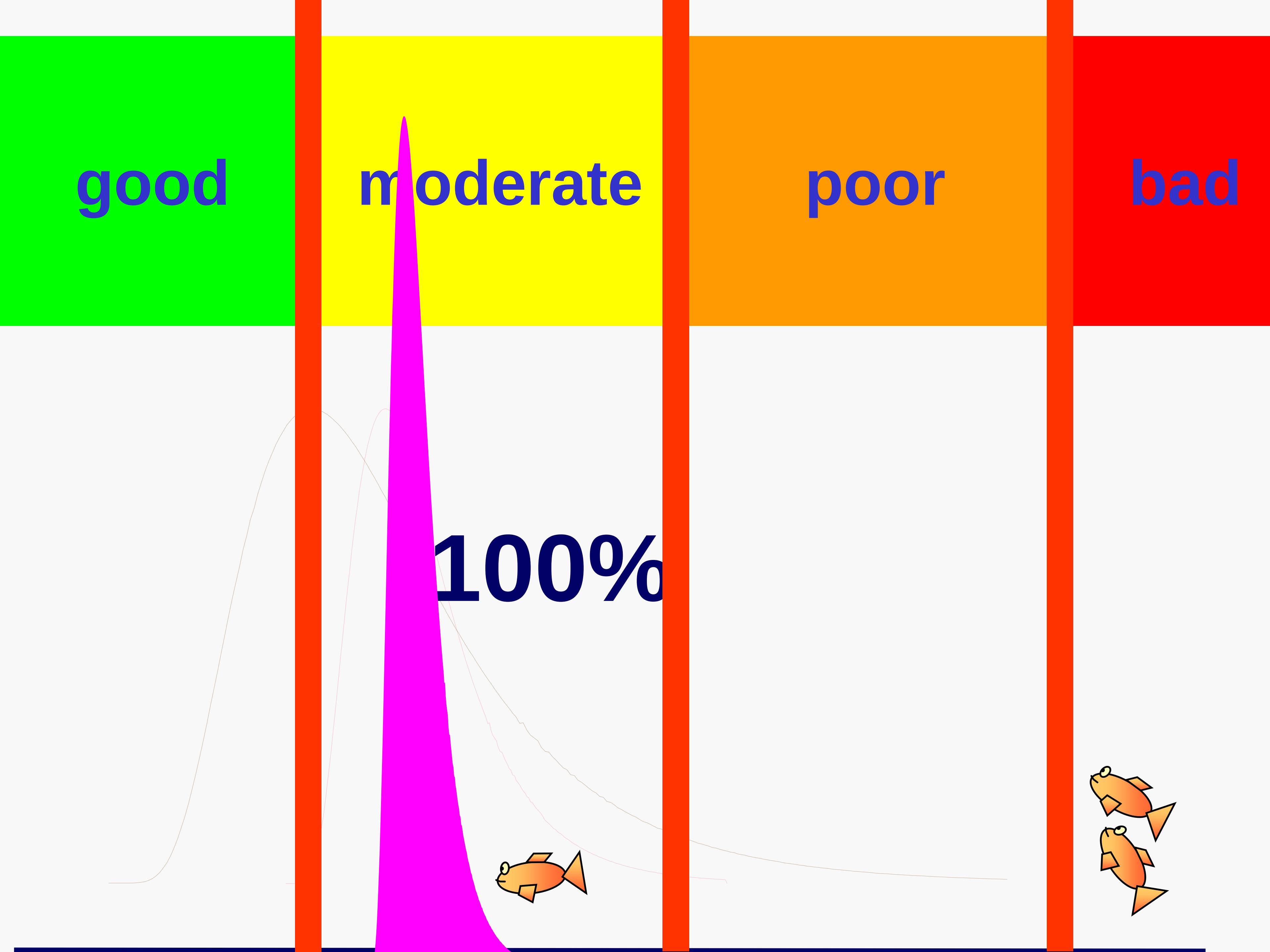
- depth, width …
- time of travel …
- hour-by-hour simulation …
- chemical speciation …
- settlement, re-suspension ...
- rainfall – run off …
- sewers ...
- event duration ...
- monthly breakdowns ...

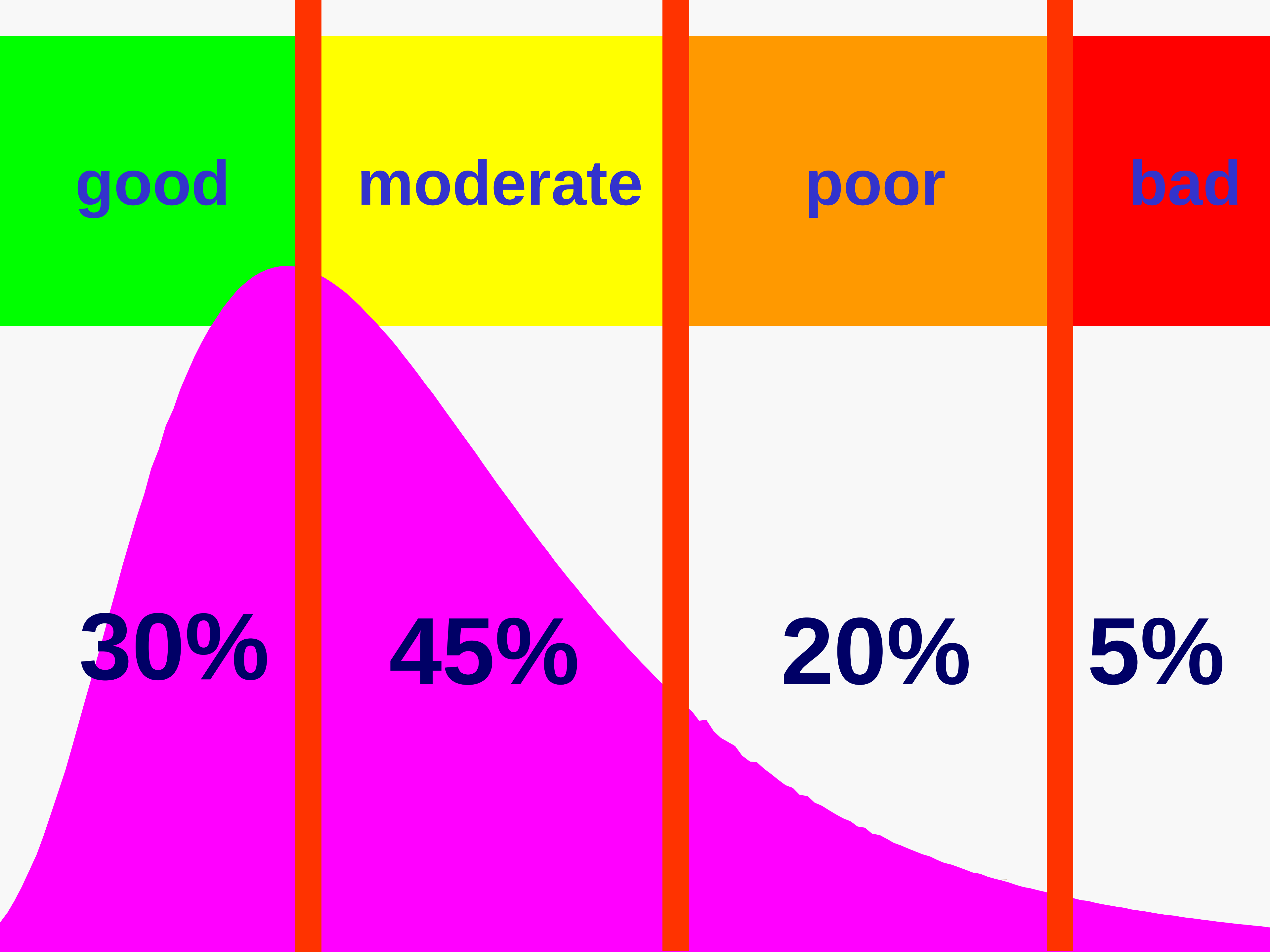
unionised ammonia

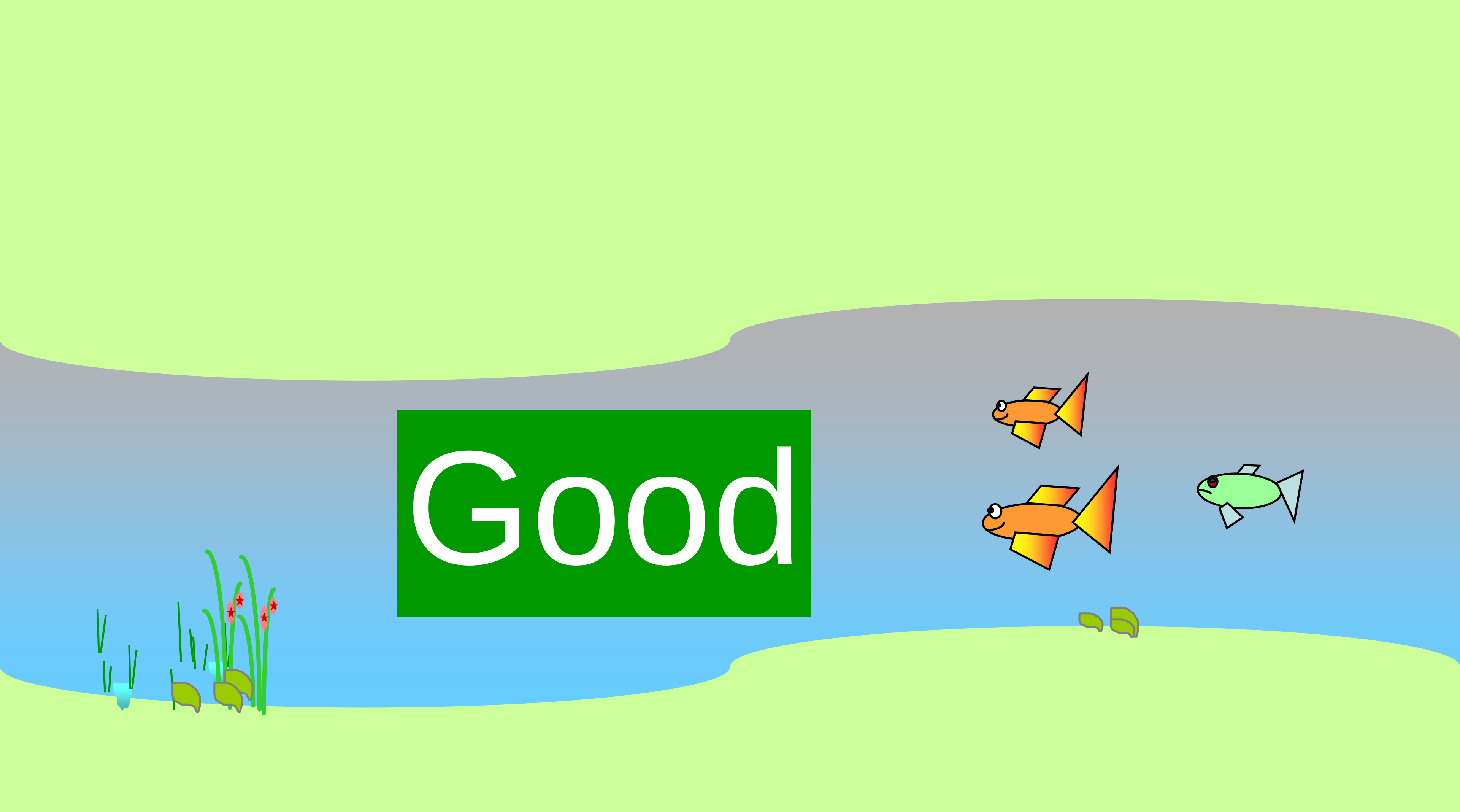
copper

standards differ every km

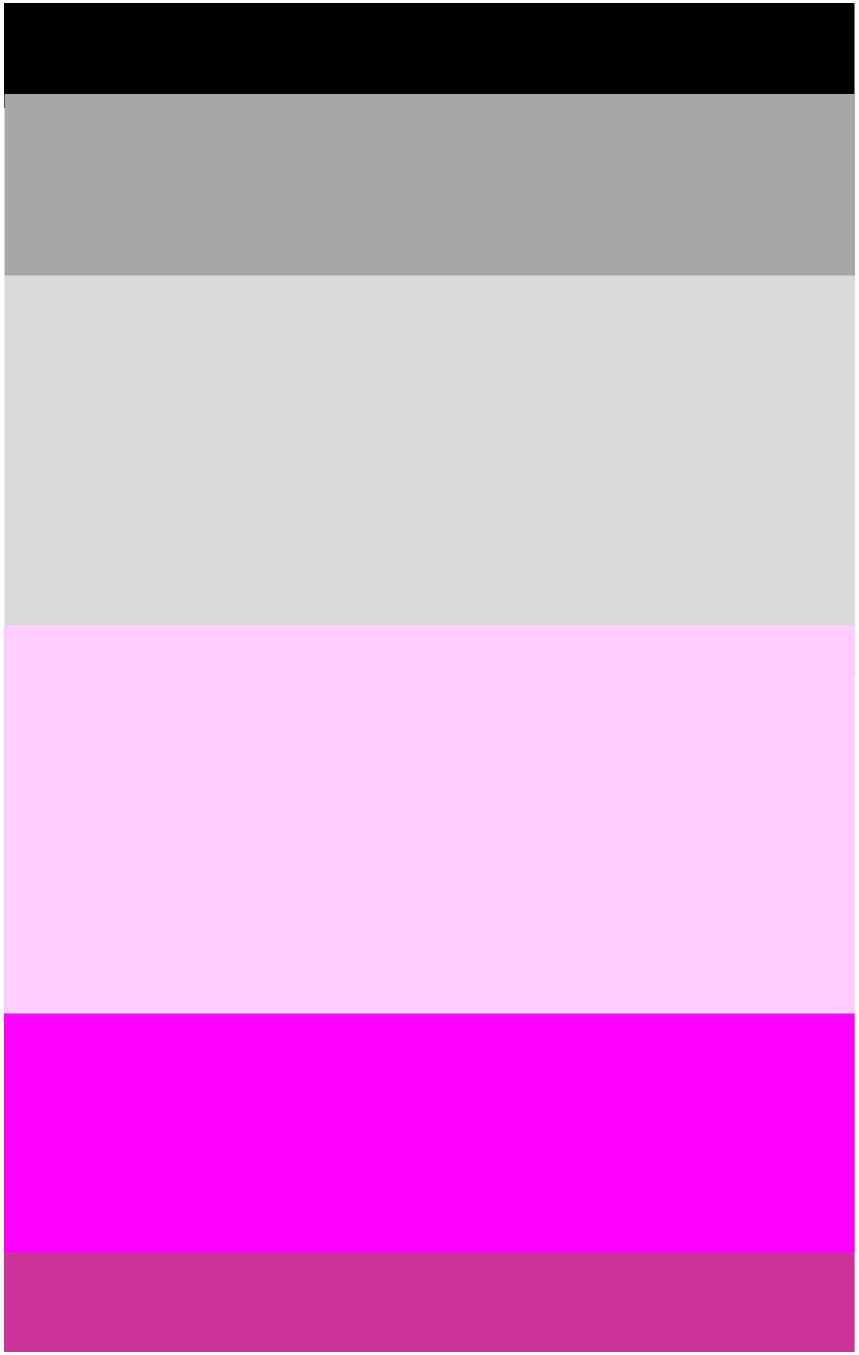
monthly data


good
moderate
poor
bad
100%


good
moderate
poor
bad
30%
45%
20%
5%



25% of face-value classes are wrong



Not **GOOD** - 95% confidence

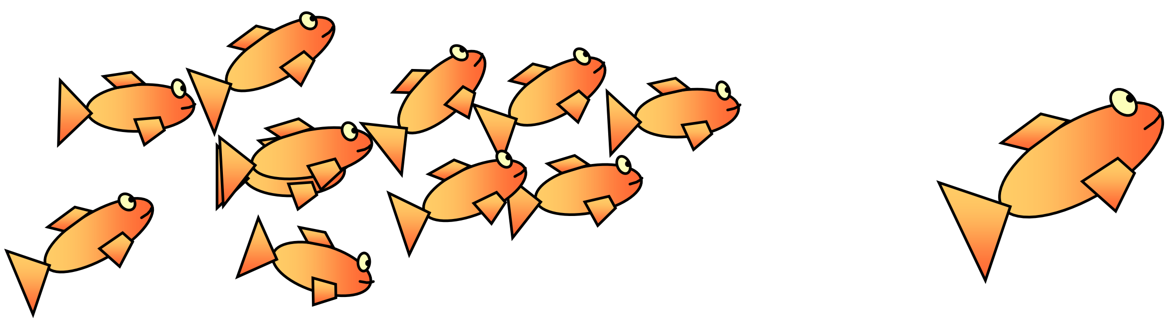
Not **GOOD** - 50% confidence

GOOD - 50% confidence

GOOD - 75% confidence

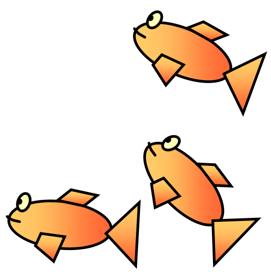
GOOD - 95% confidence

investigate actions needed to meet targets

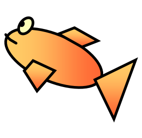


... for example

- national controls
- site-specific controls
- a mix of these



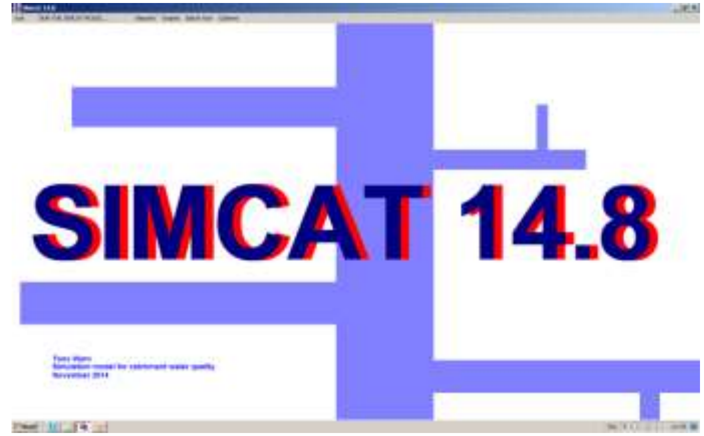
national controls?

- uniform standards on all discharges?
- a ban on chemicals? 
- limits on land-use?

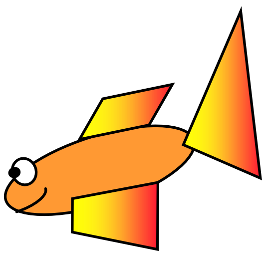
few data (big errors)

- weaken case for site-by-site controls
- promote regional or national controls

£?

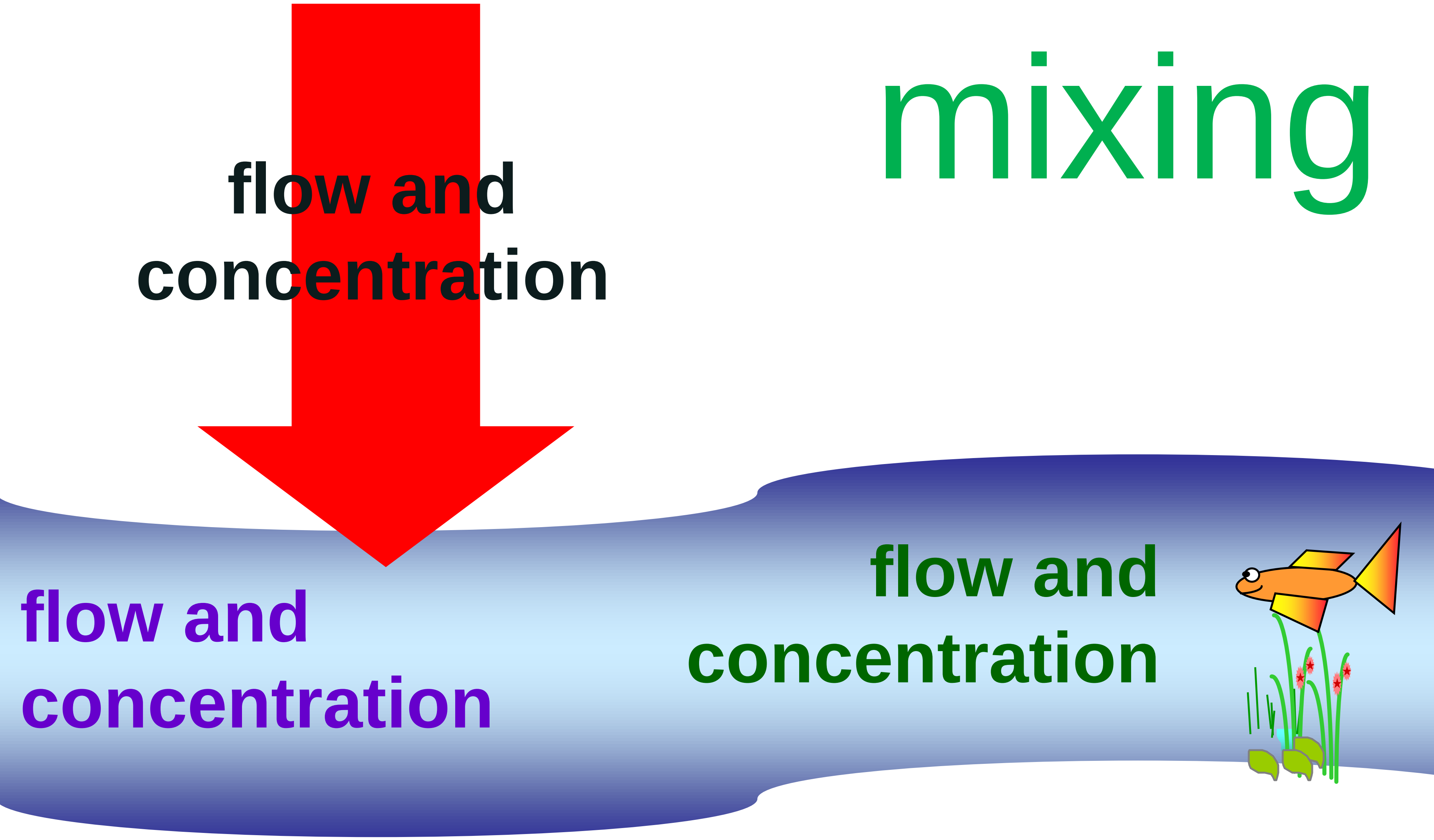


- work out controls ✓
- quantify the errors ✓
- relate to national targets ✓

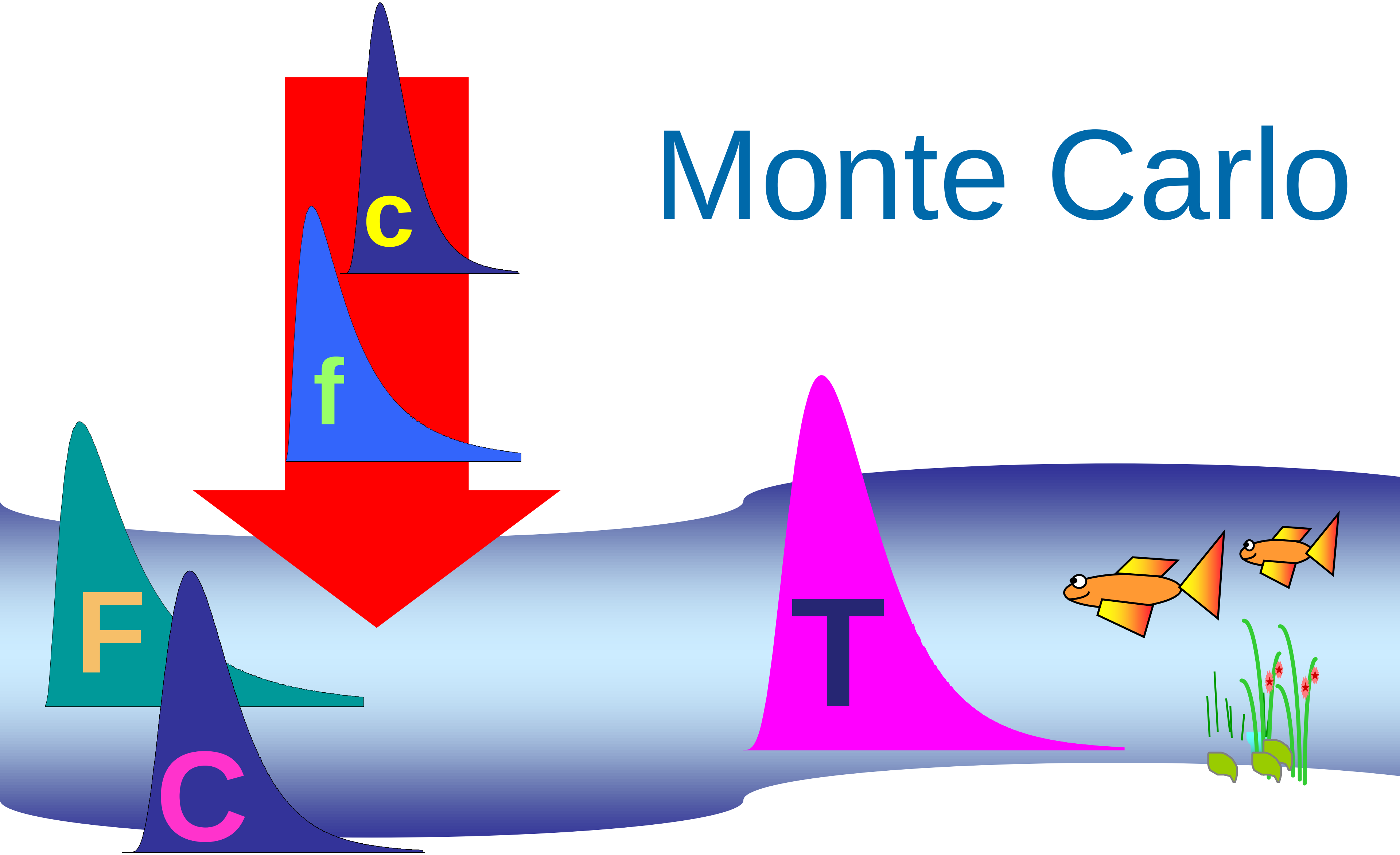


SIMCAT calculates …

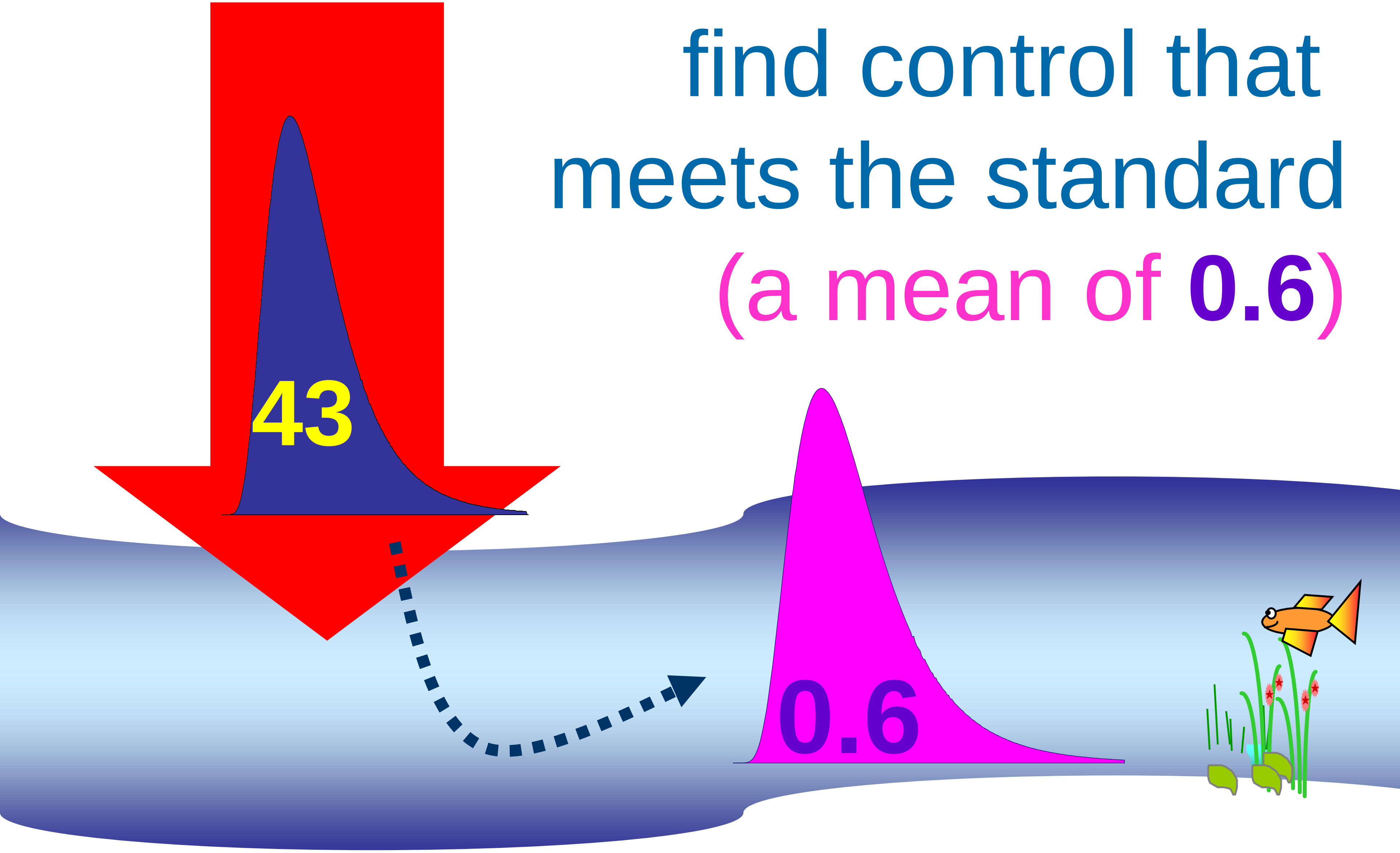
- river quality
- compliance with standards
- breakdown of causes of bad quality
- actions to meet targets
- for a single discharge, a small river, catchments or the whole country
    - industrial investment
    - diffuse pollution
    - growth and climate change
    - new laws and policies


mixing
flow and concentration
flow and concentration
flow and concentration

Monte Carlo



find control that meets the standard (a mean of **0.6**)



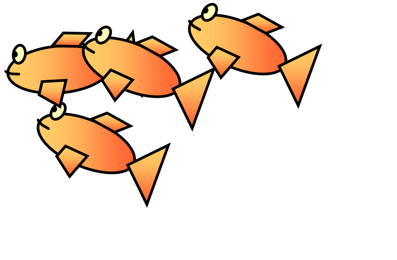
take note of errors ...

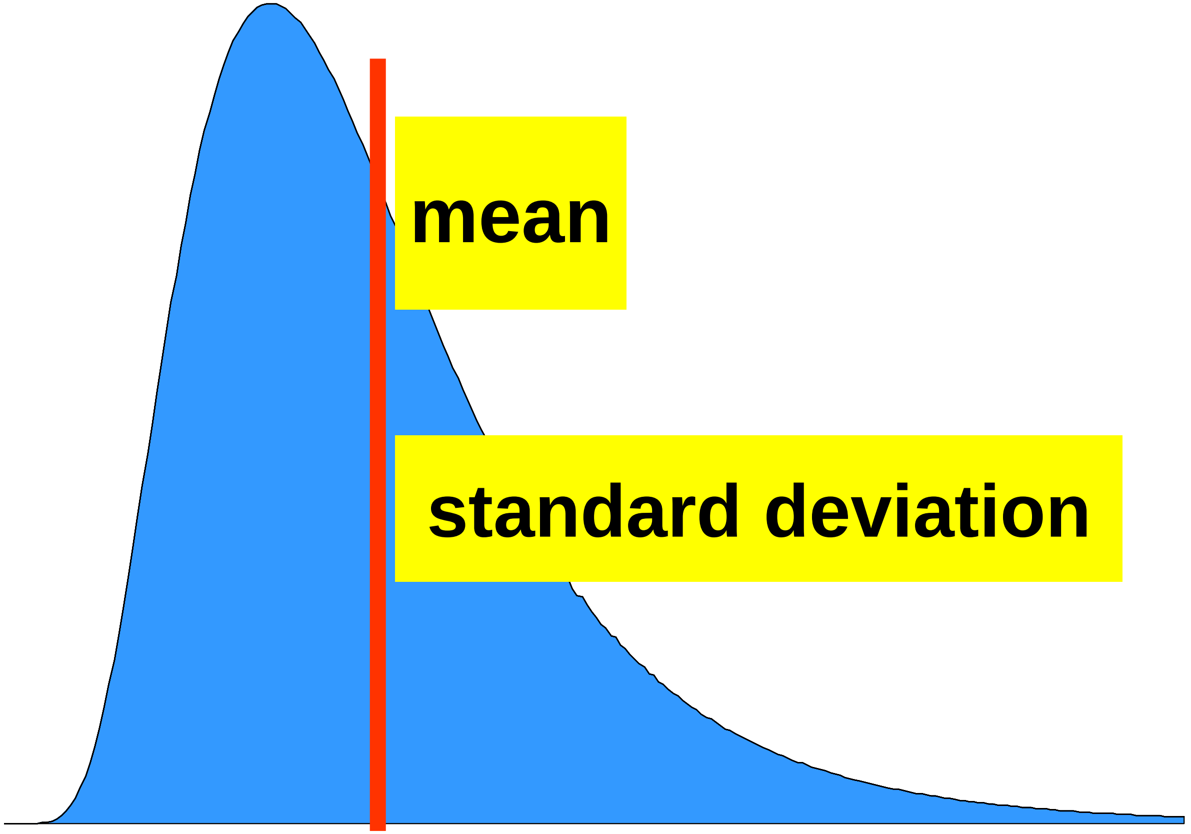
mean = 43

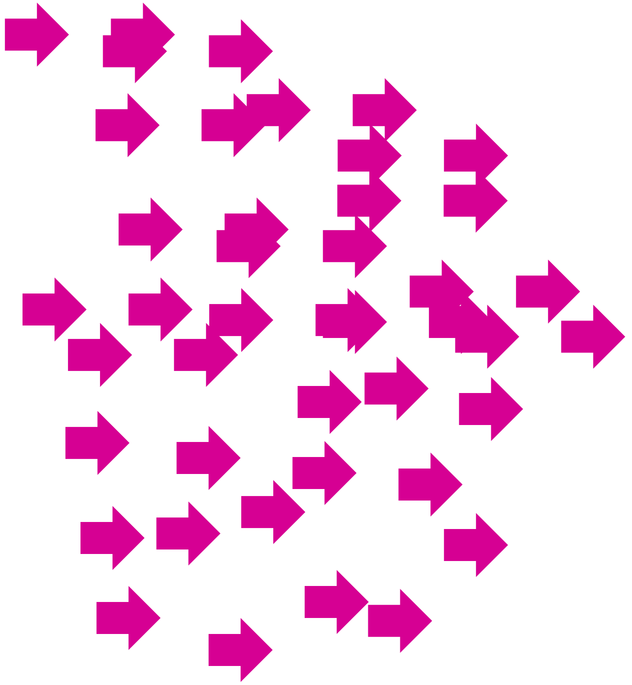
29 - 56

43

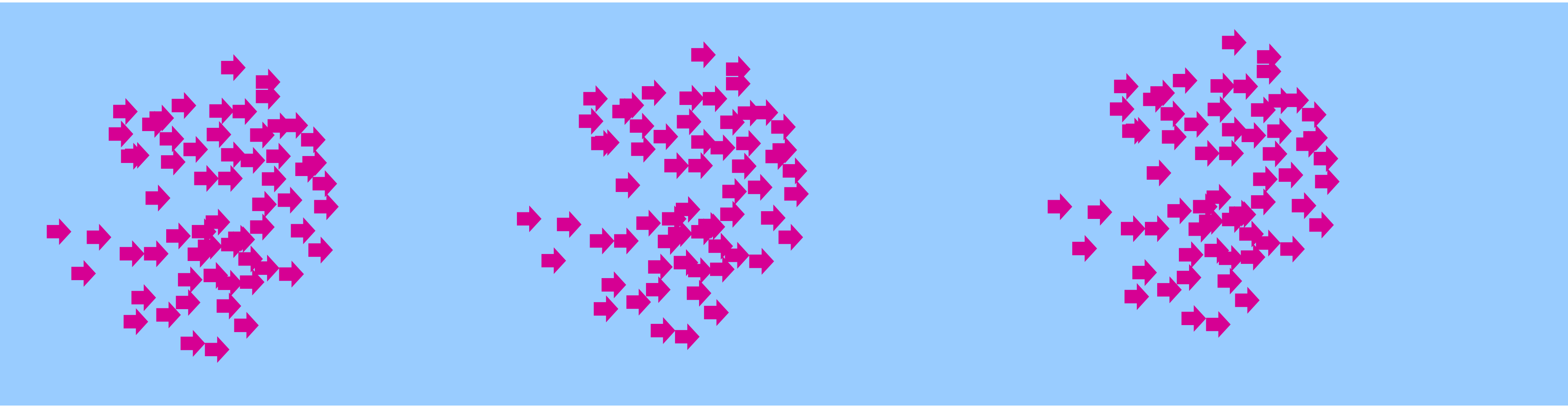
how SIMCAT works





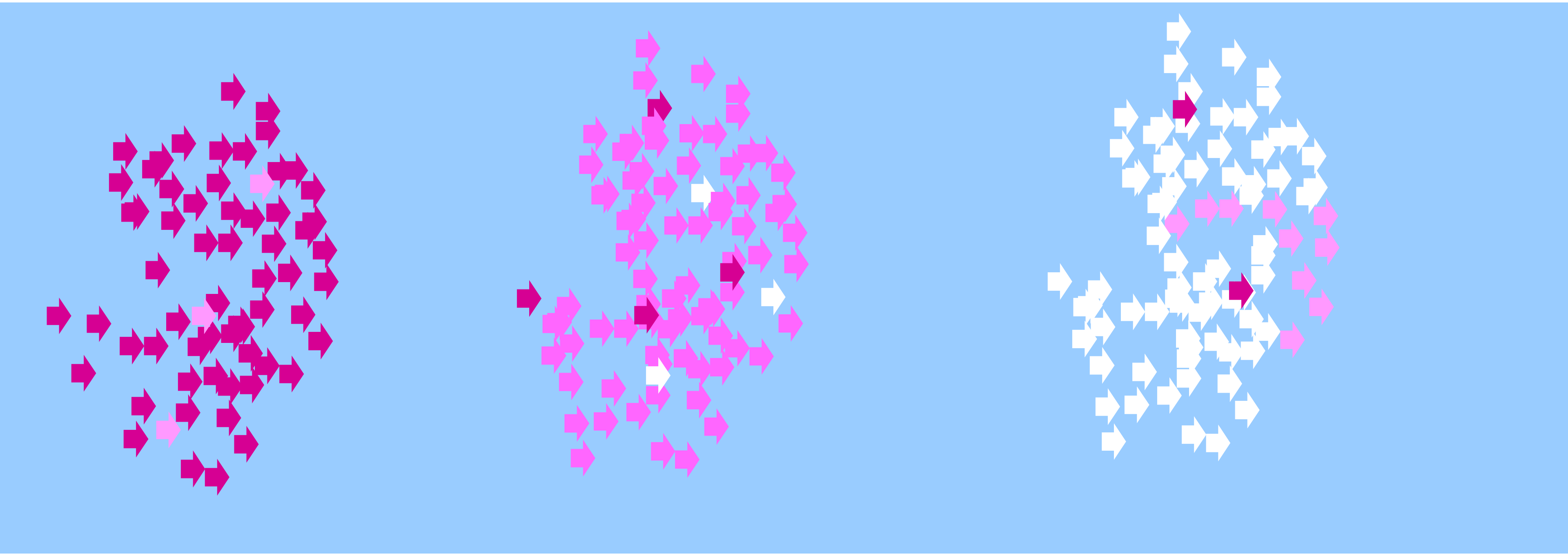


log-normal, etc …

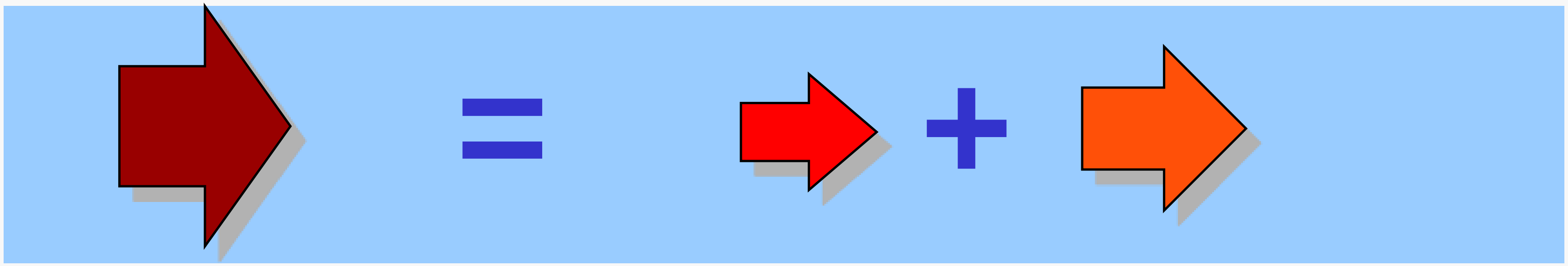


flow and pollutants

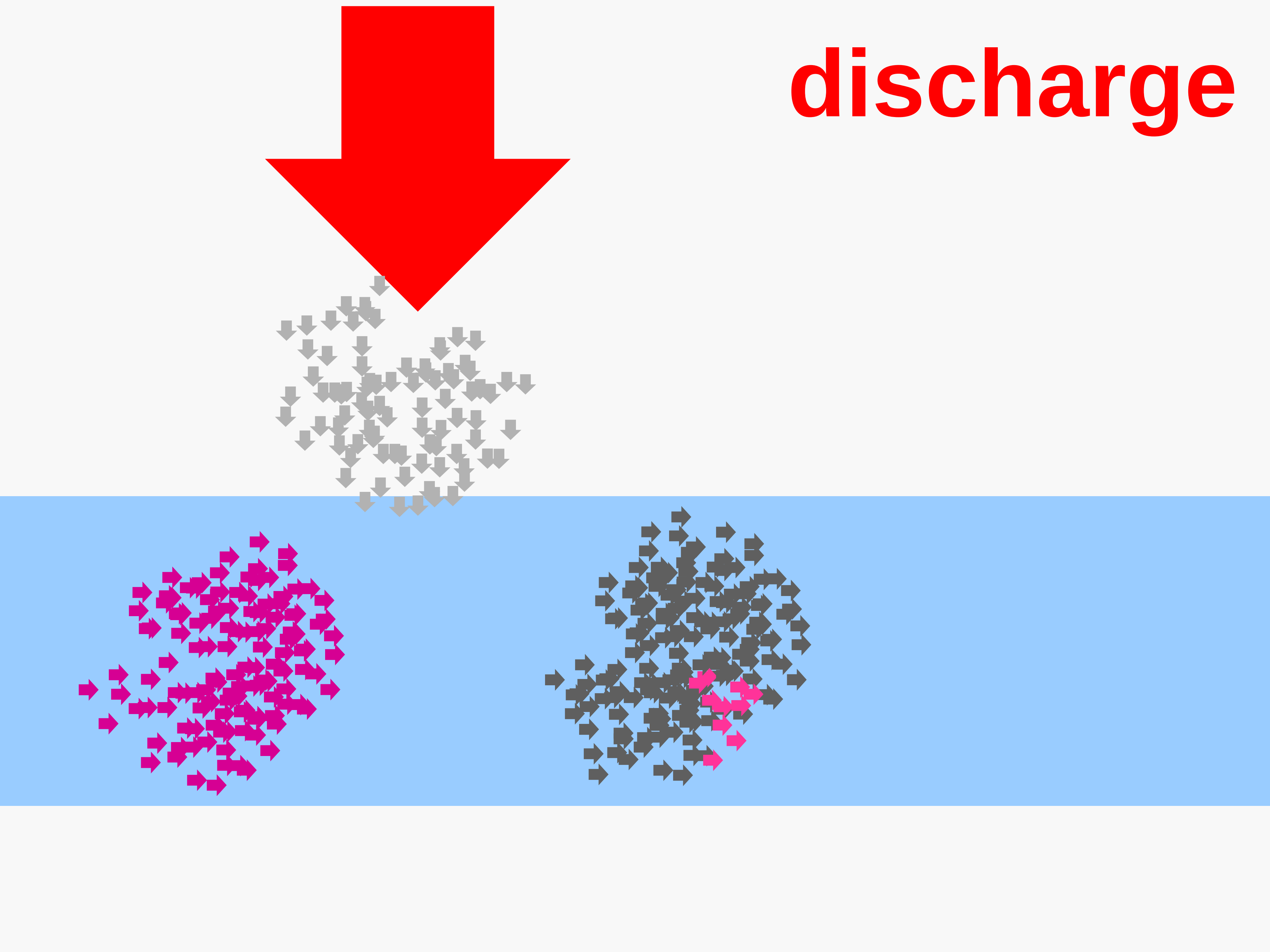
natural purification



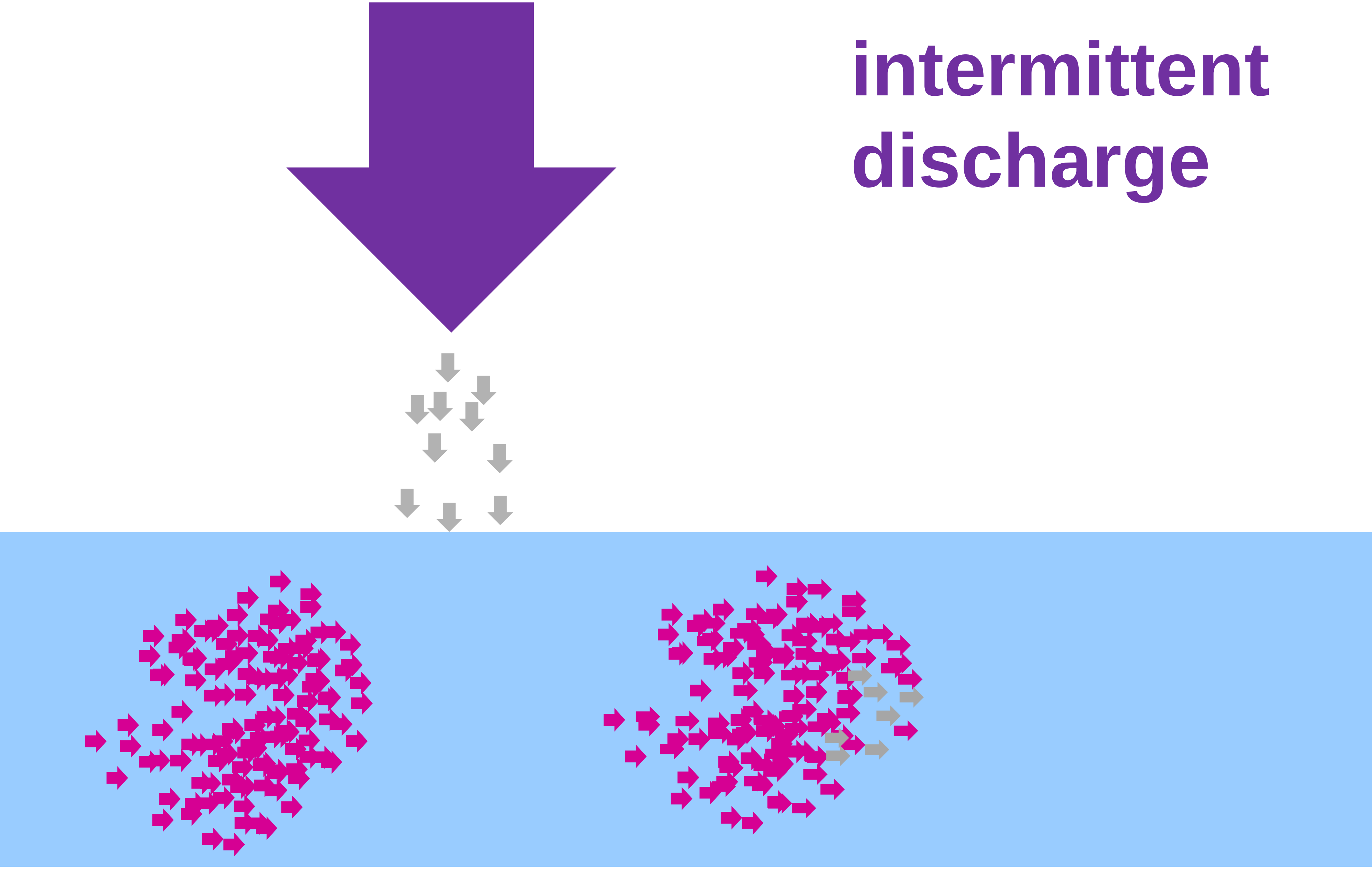
speciation

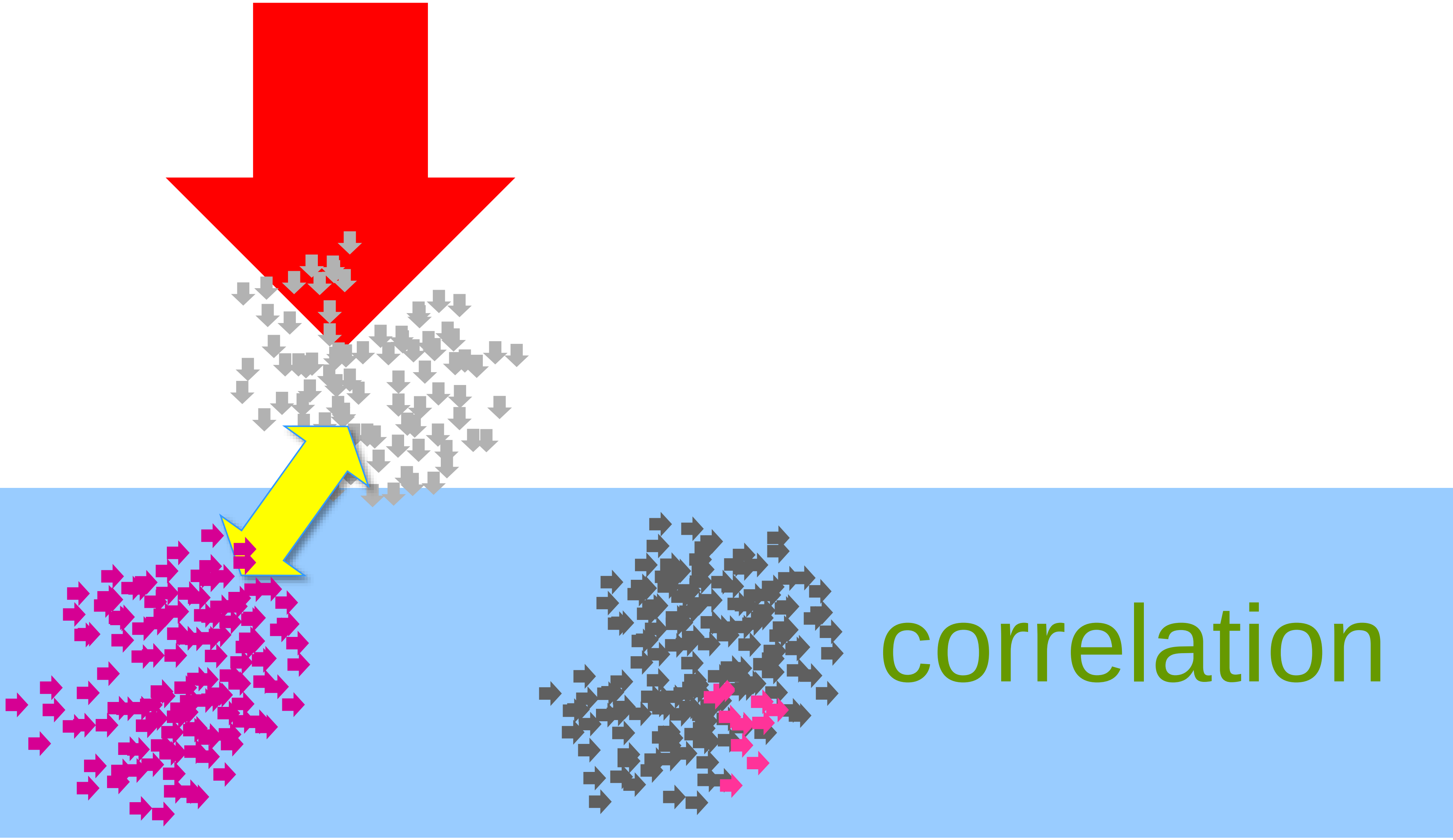


total copper = dissolved + solid


discharge

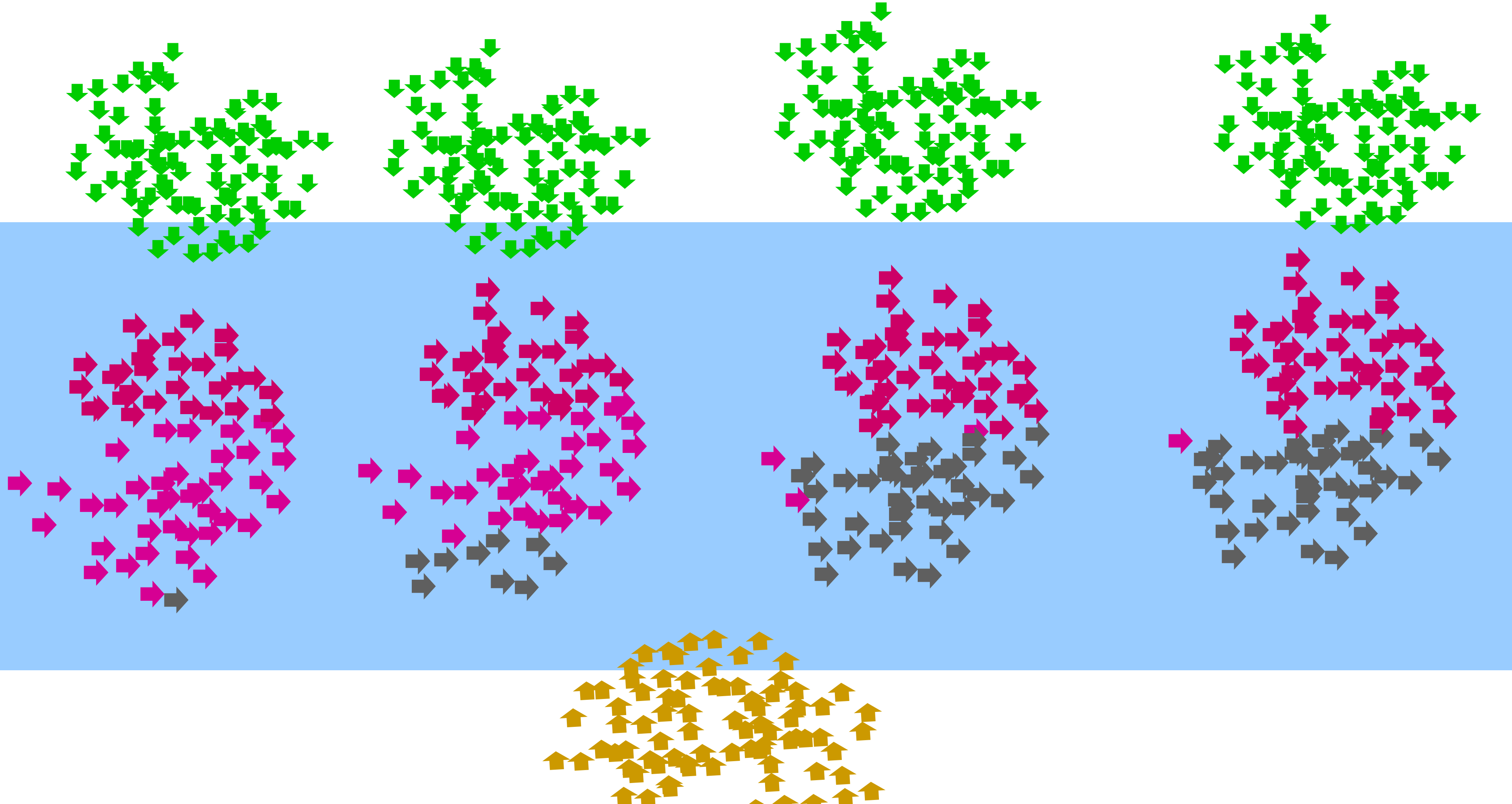
intermittent discharge



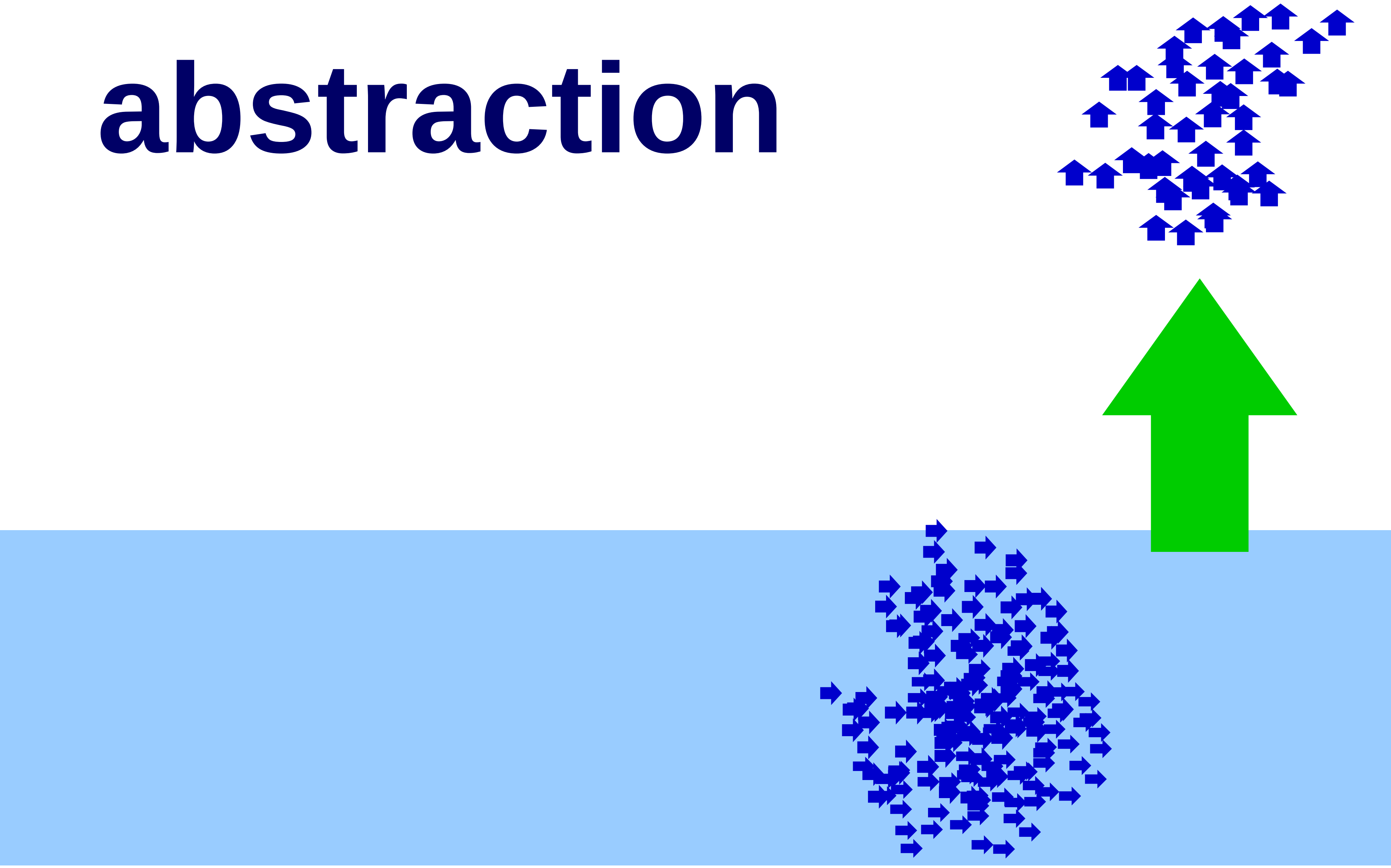


rainfall ...temperature

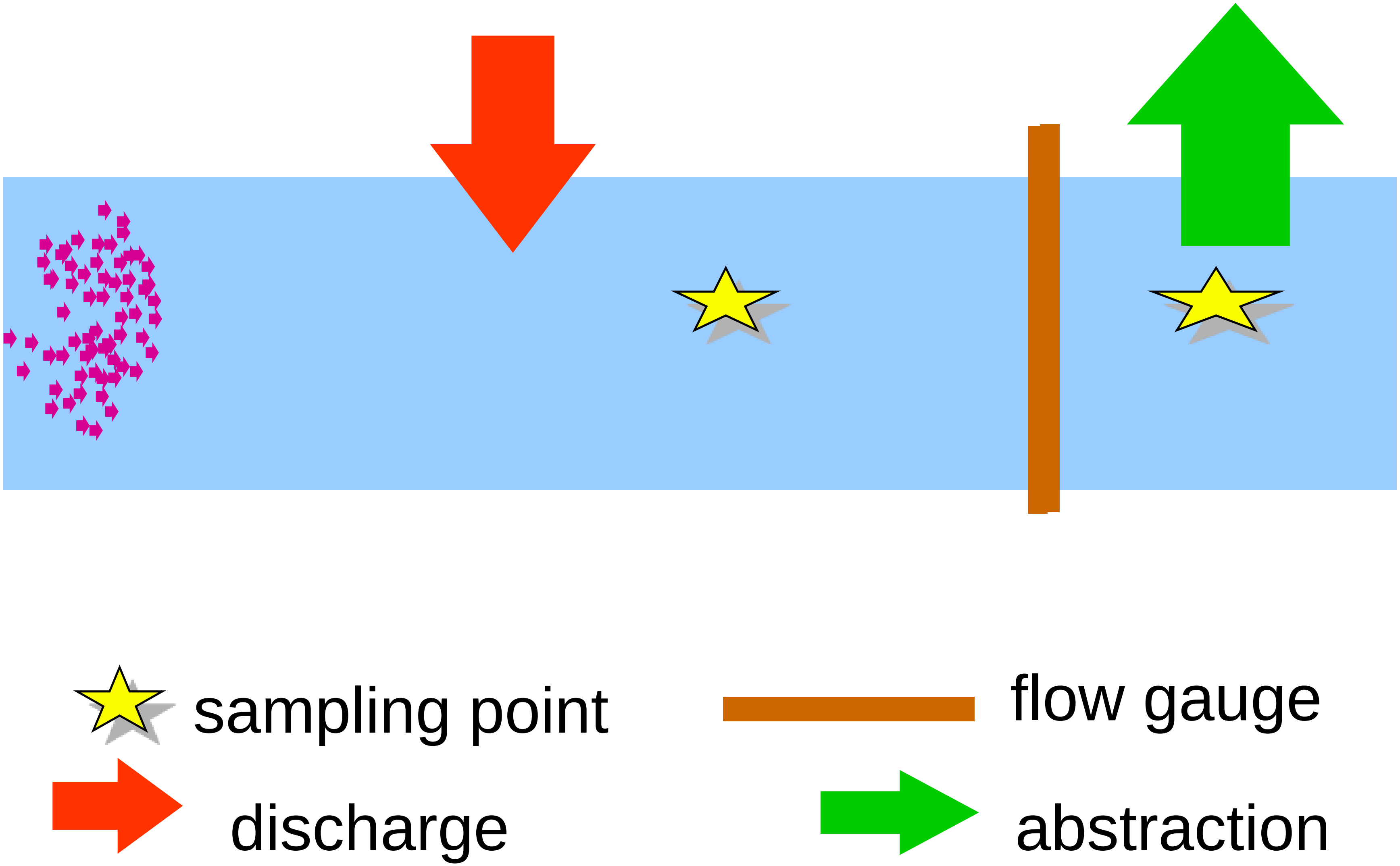
diffuse pollution

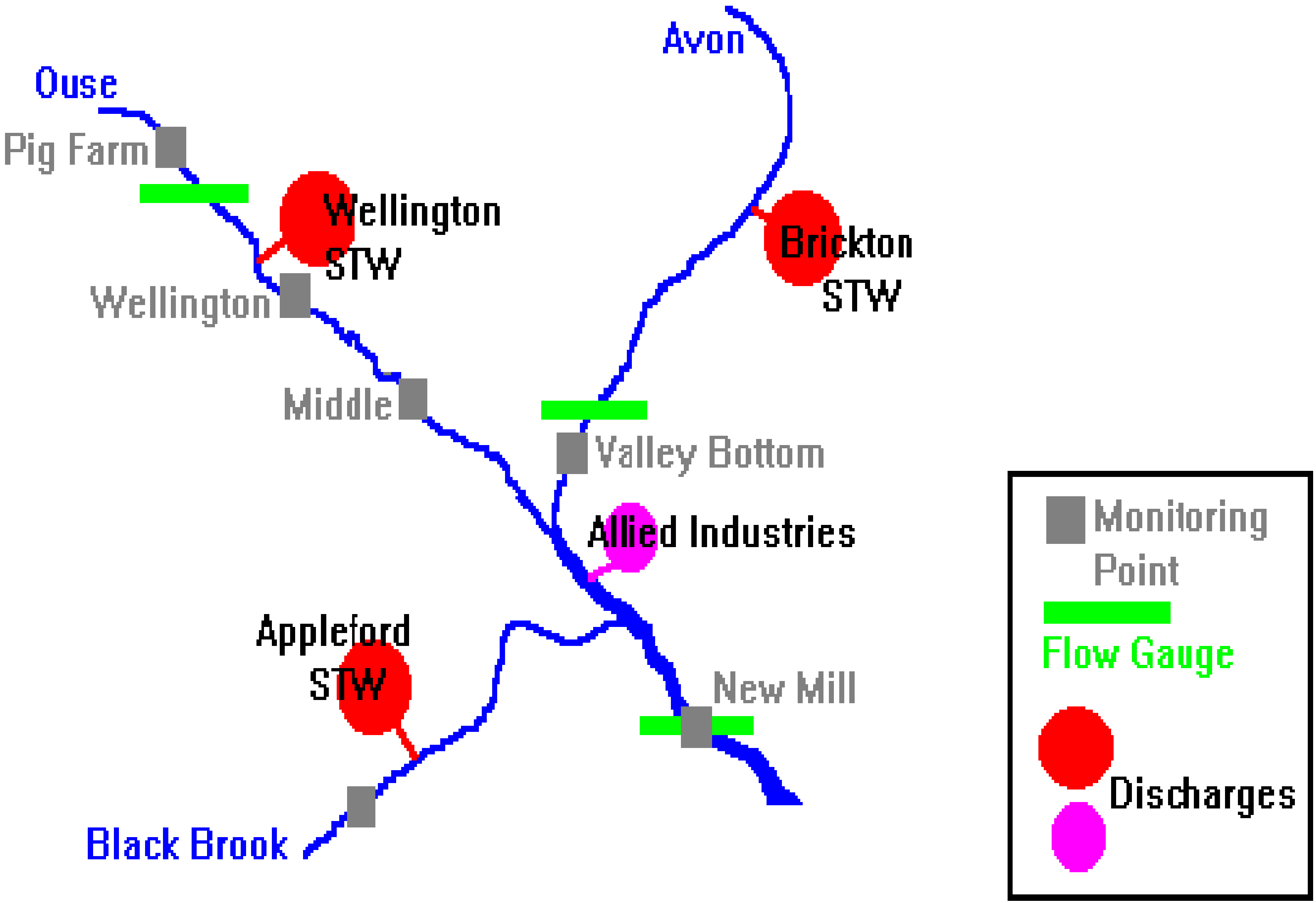


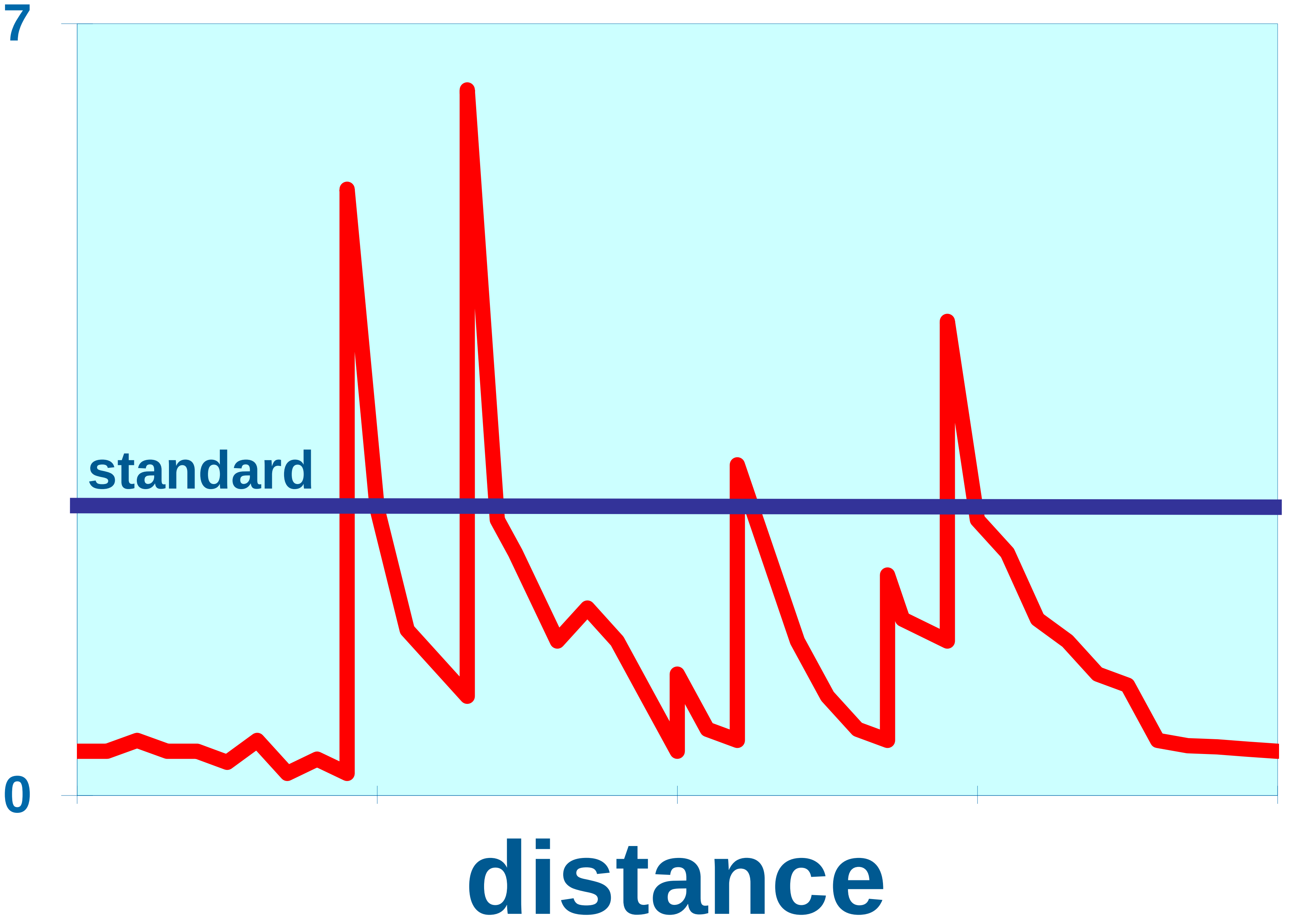
abstraction

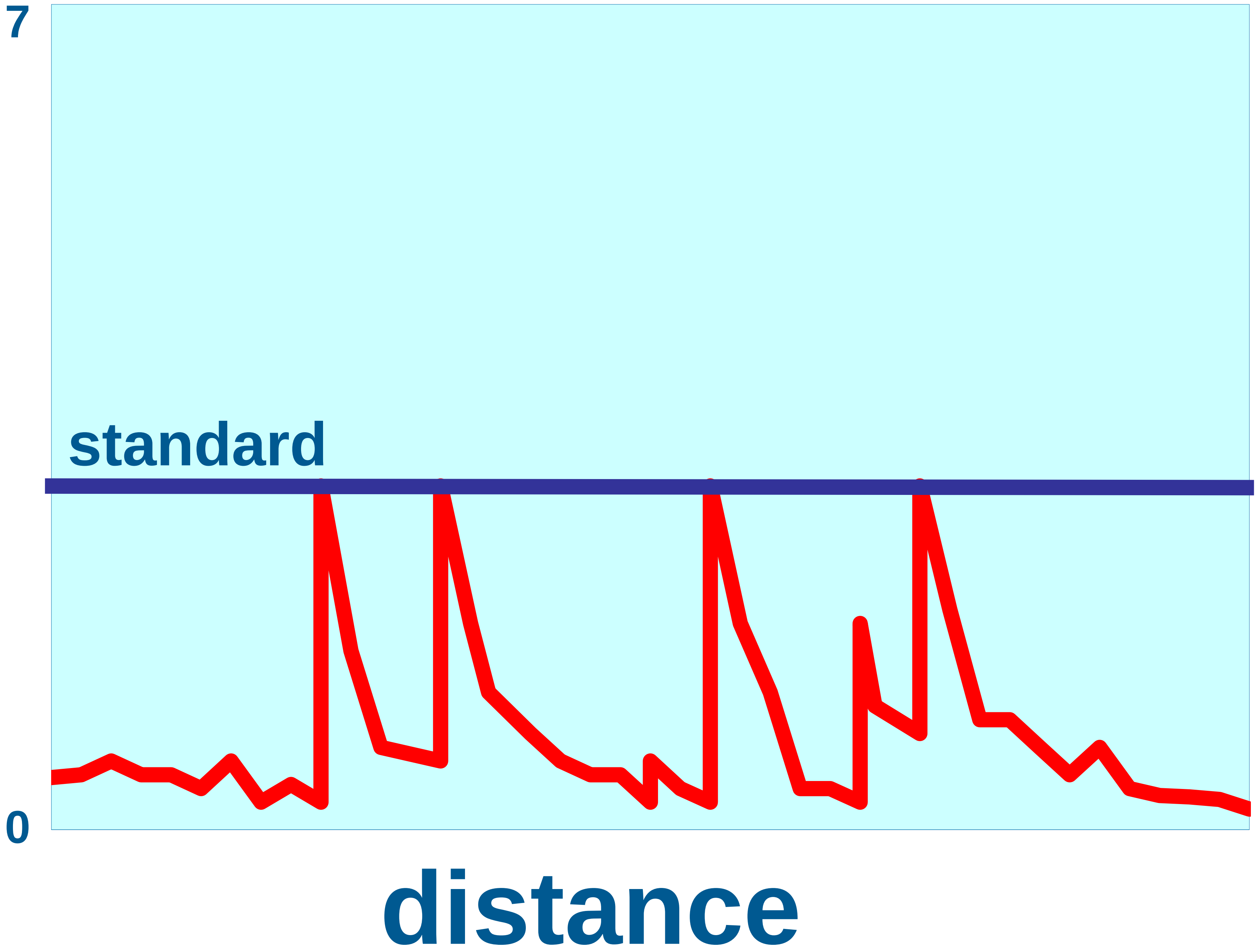


Reach



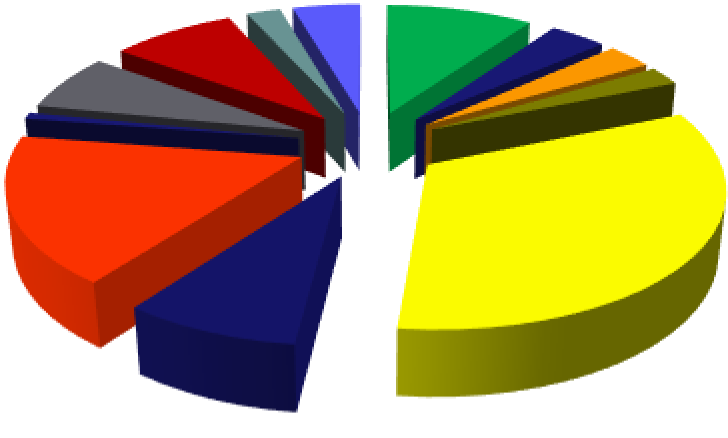

Ouse
Avon
Pig Farm
Wellington STW
Brickton STW
Wellington
Middle
Valley Bottom
Allied Industries
Appleford STW
New Mill
Black Brook
Monitoring Point
Flow Gauge
Discharges


7
standard
0
distance


7
standard
0
distance

backtracking…

- breakdown of loads from 100’s of discharges

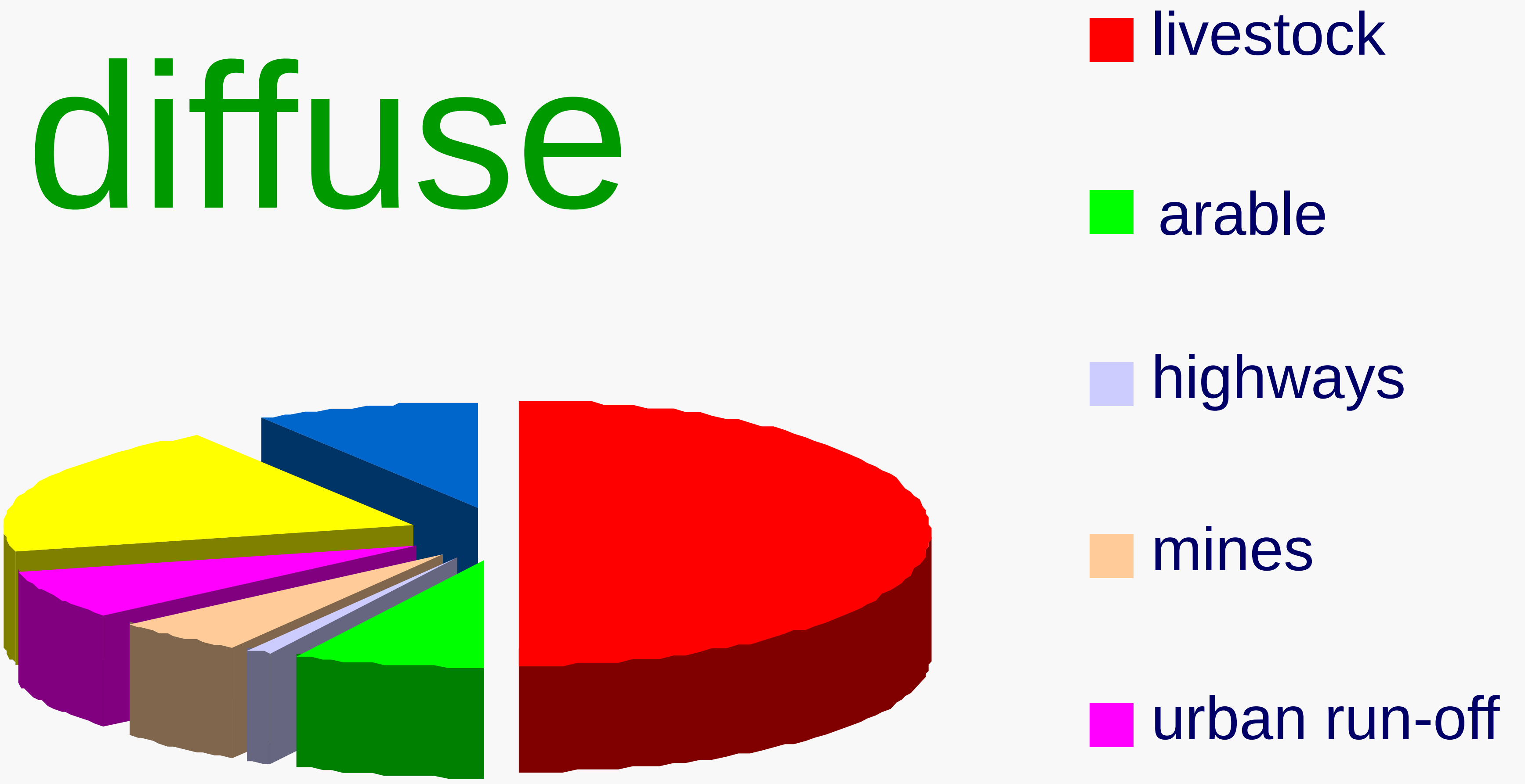


cause of river 90-percentile concentration

	%
Wellington STW	15.1
Brickton STW	0.4
Allied Industries	32.7
Appleford STW	2.5
Intermittent	4.9
Storm Overflow	19.1
DIFFUSE (agriculture)	25.3

74.7

diffuse


livestock
arable
highways
mines
urban run-off
land drainage
atmospheric

national and regional summaries

50,400 km

current quality

% length	
18	
39	good
24	
10	
8	bad

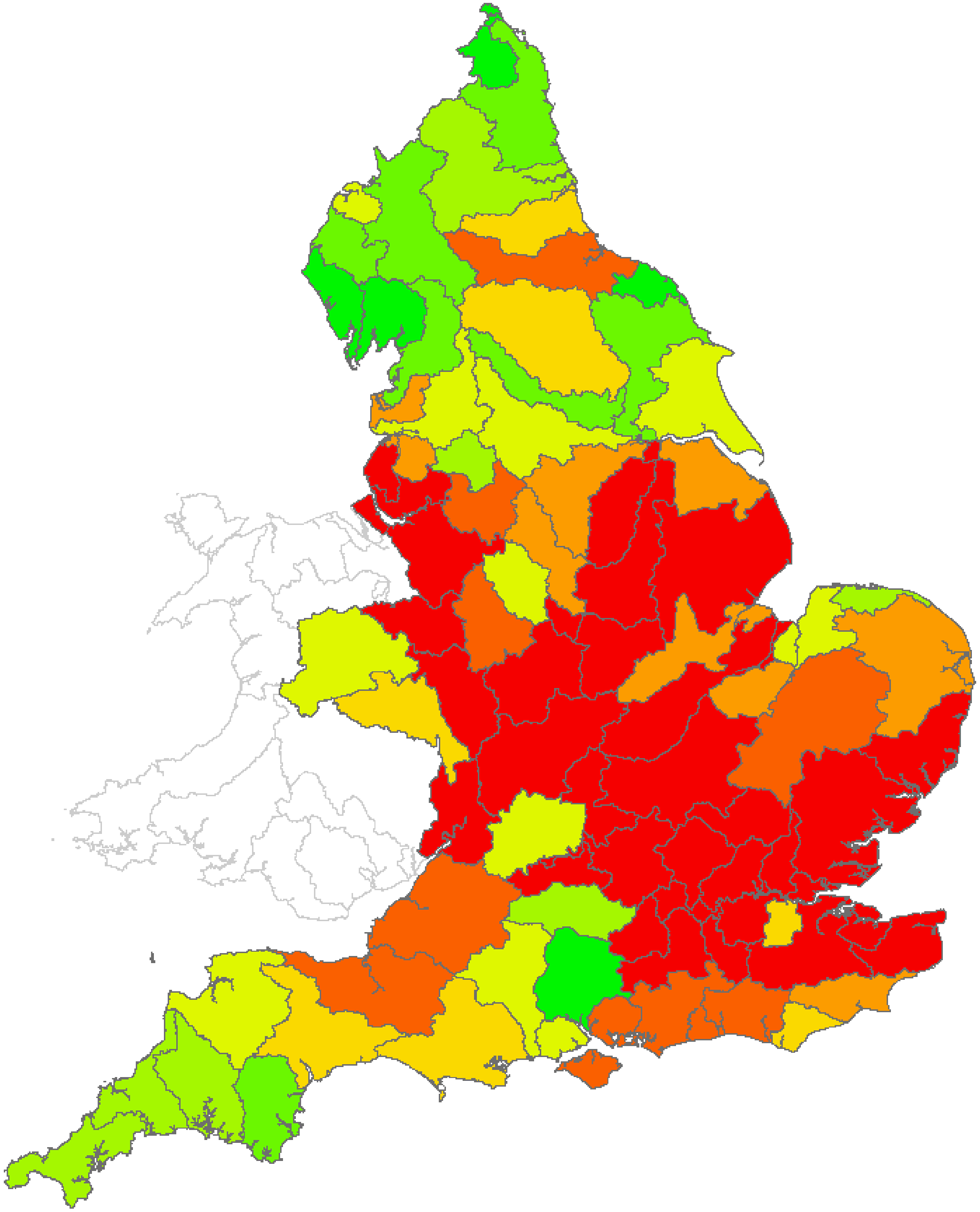
target for 2025

national controls

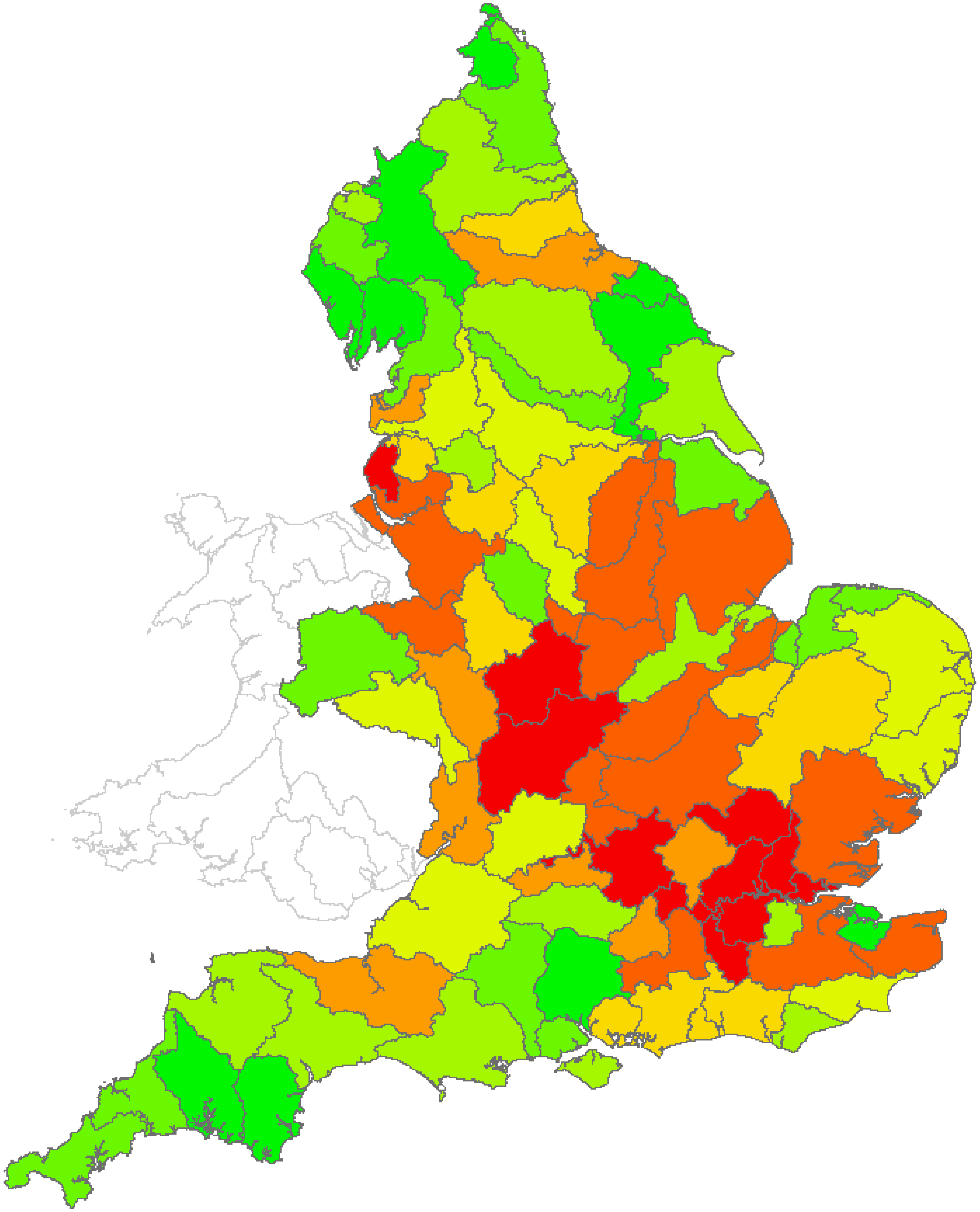
site-specific controls

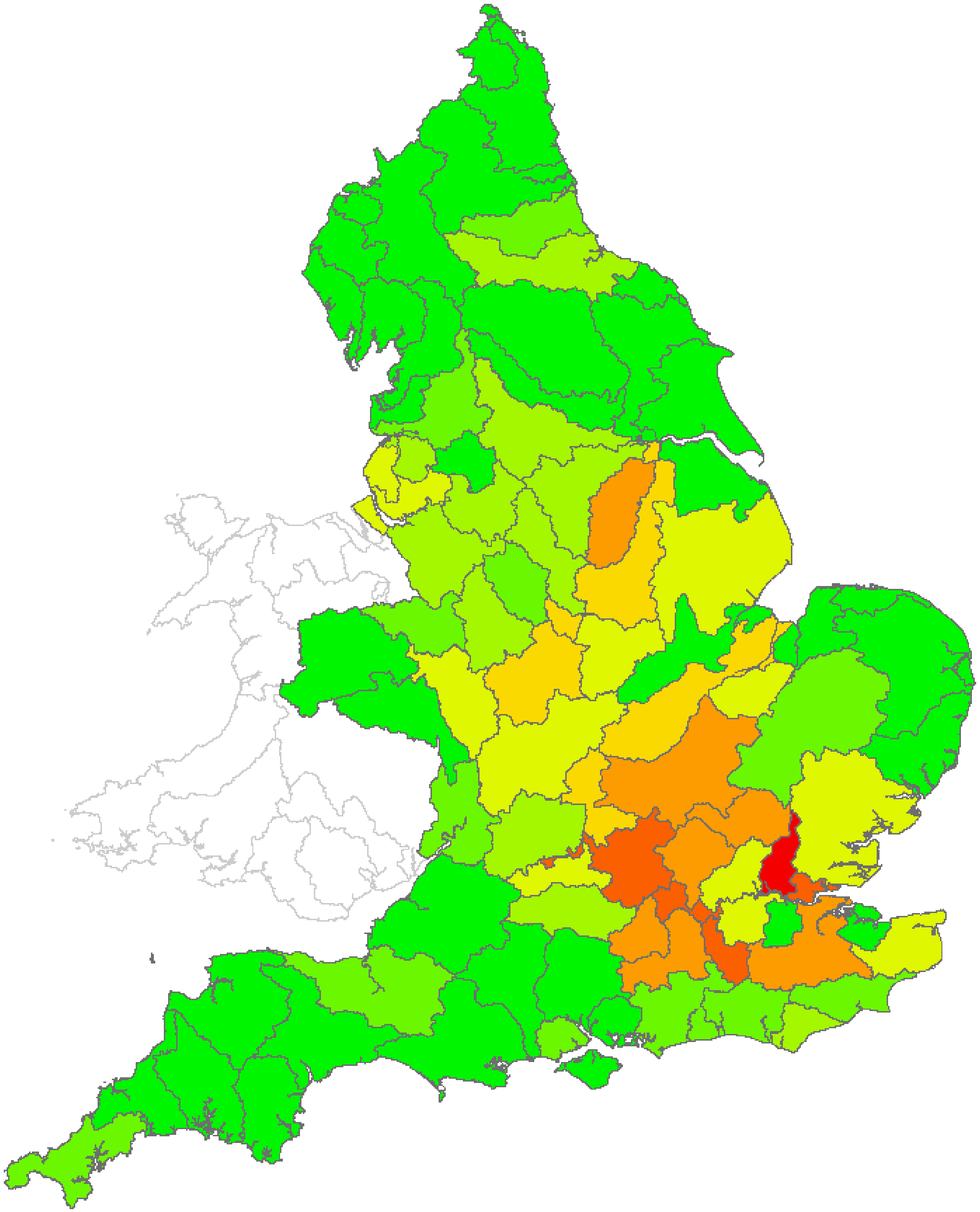
% length	
20	
60	good
20	
-	
-	

SIMCAT baseline

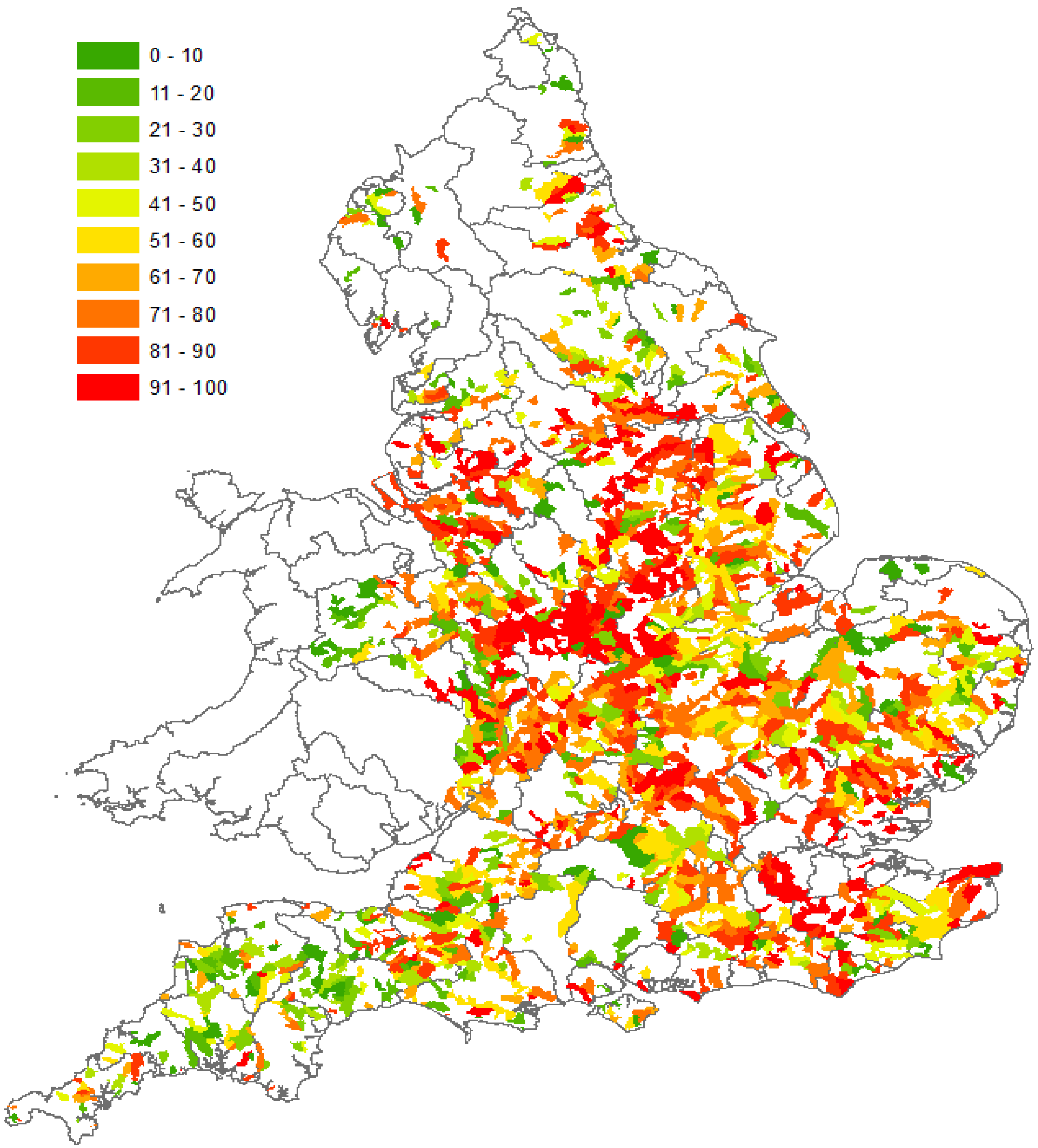


SIMCAT – point source reductions





point and diffuse reductions



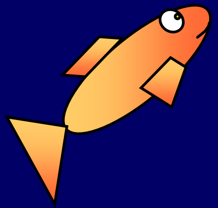
% reductions needed for discharges

discharges: cost

£4 billion

benefit:

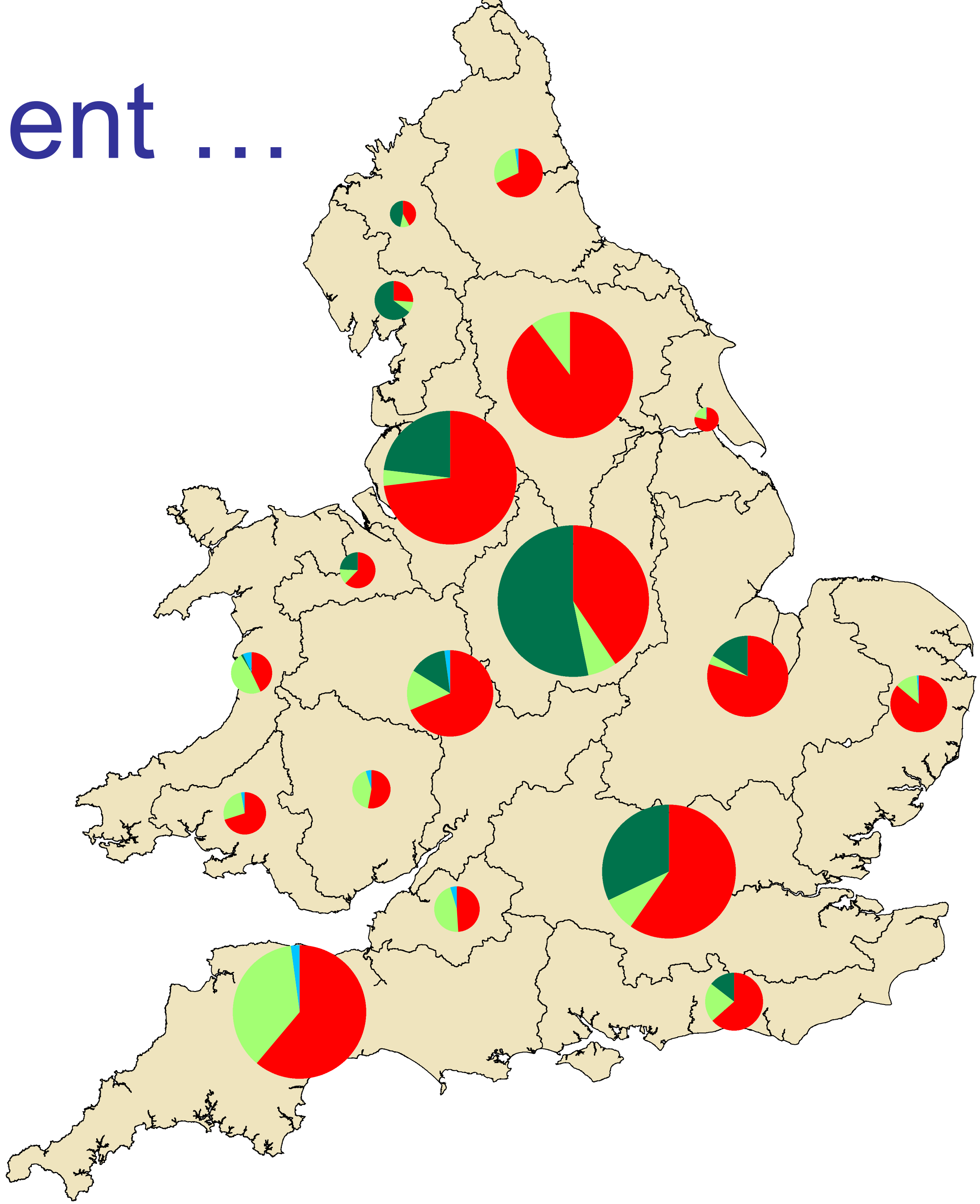
£6 billion



apportionment …

load from discharges

loads from diffuse



SAGIS –

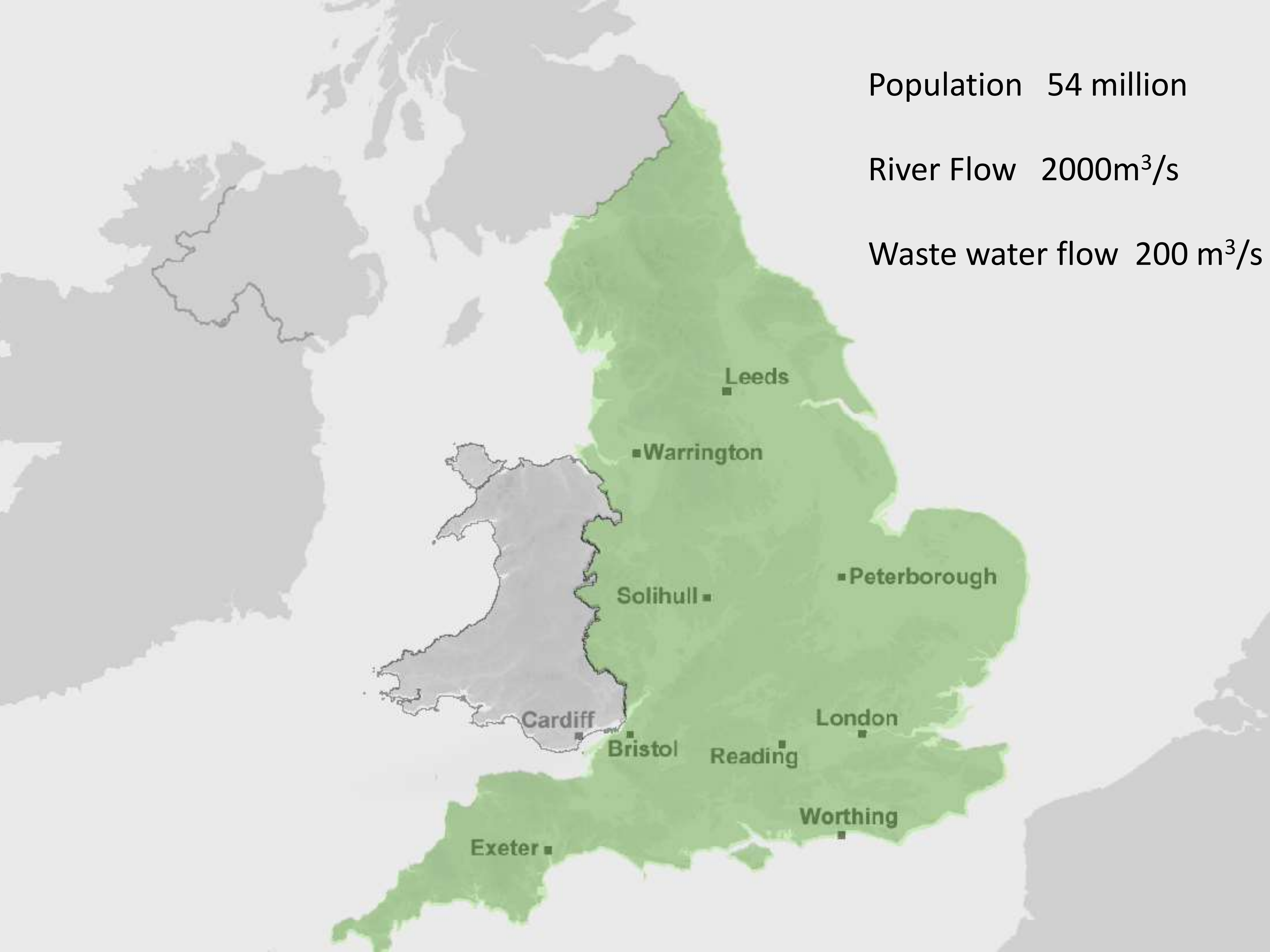
automate model production

input data

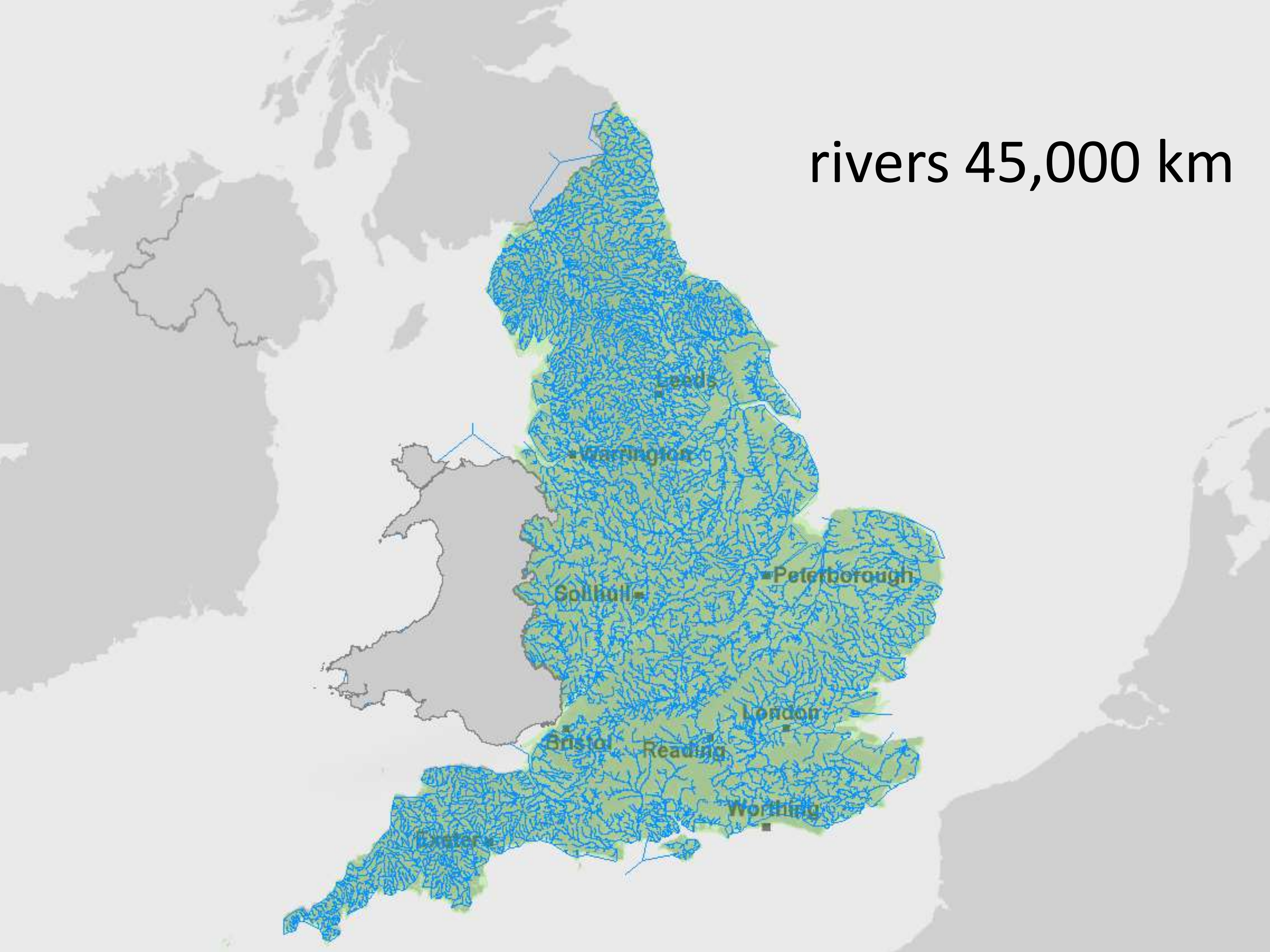
Population 54 million

River Flow 2000m^3/s

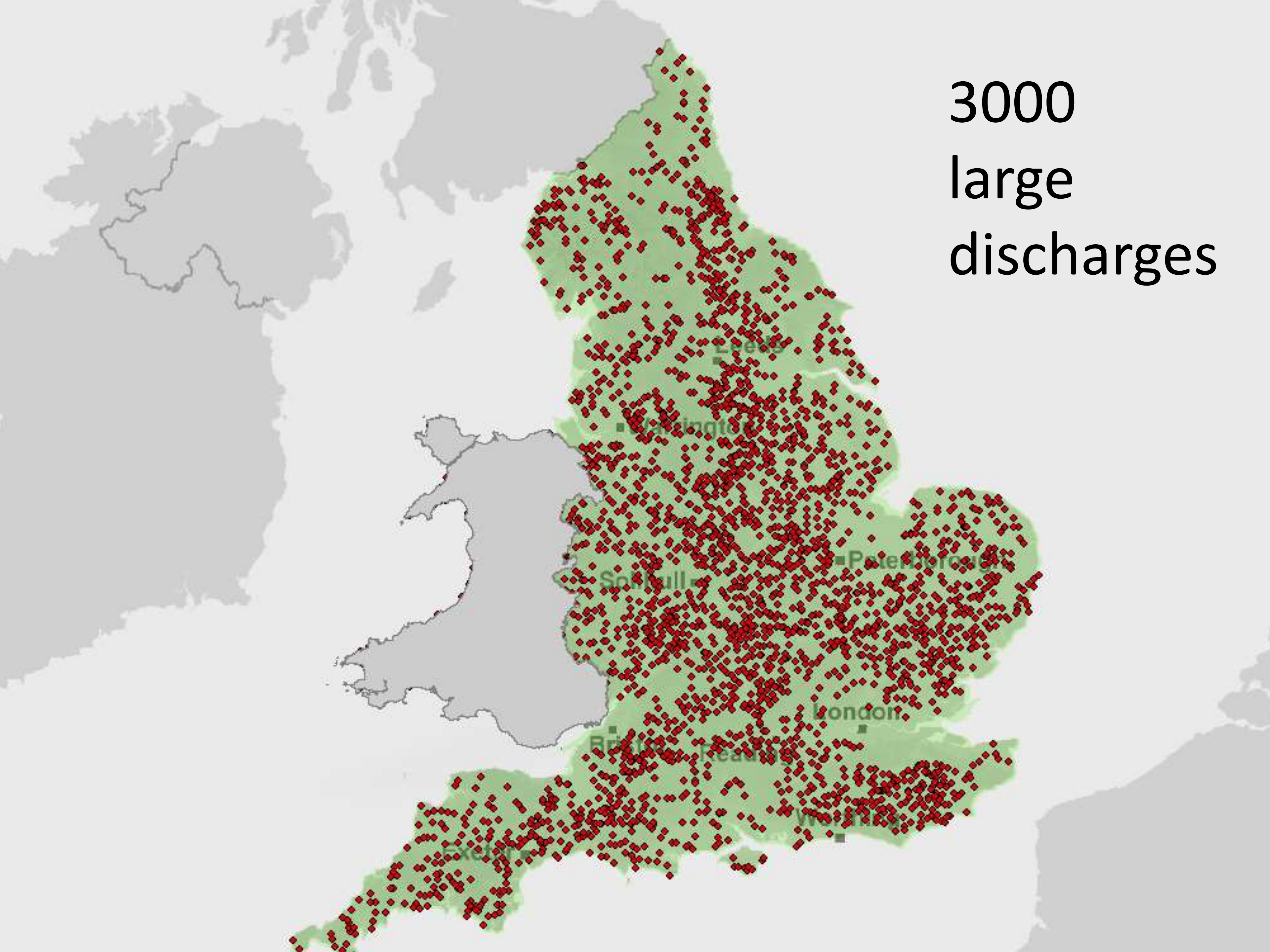
Waste water flow 200 m^3/s



rivers 45,000 km



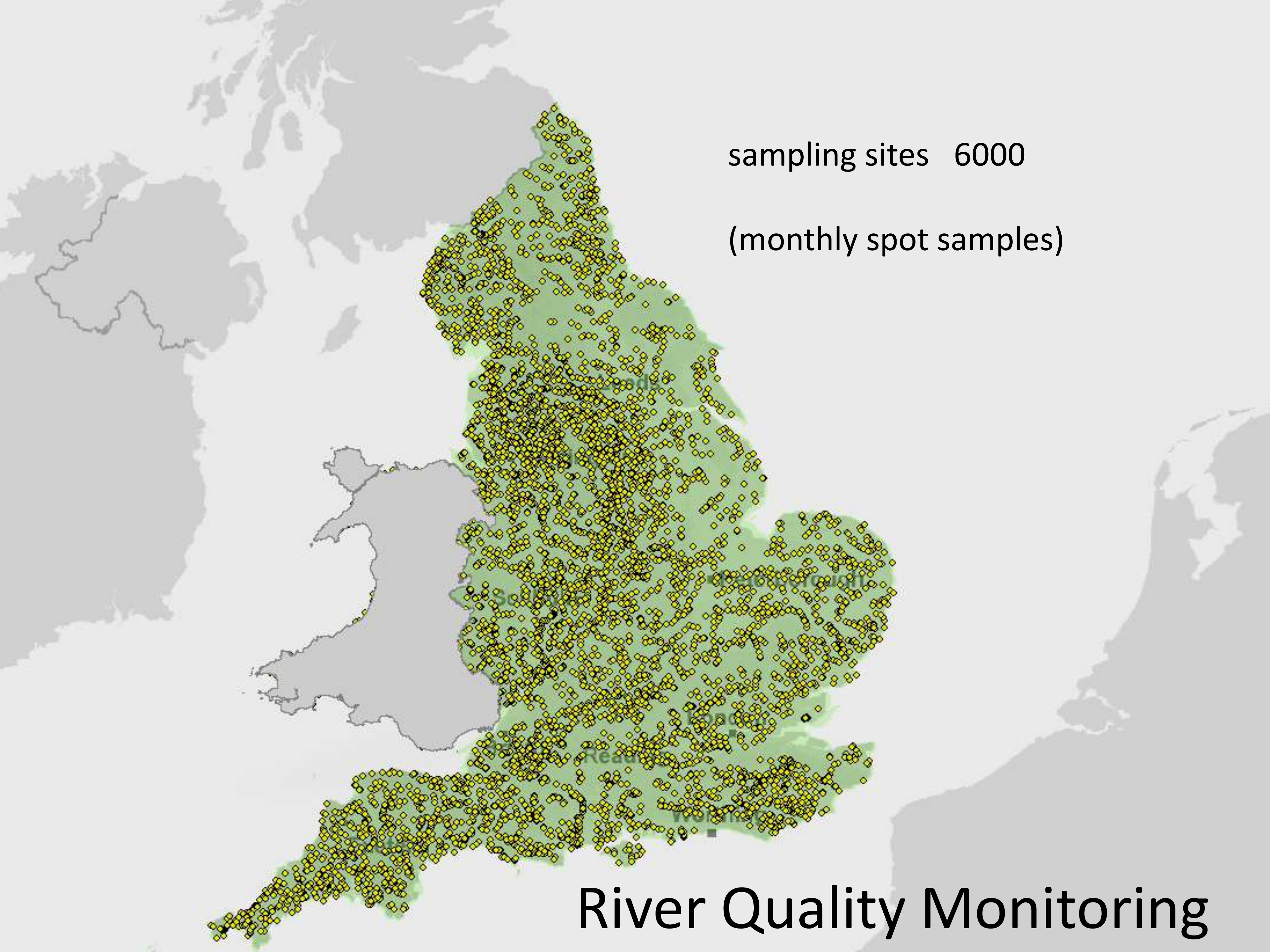
3000 large discharges

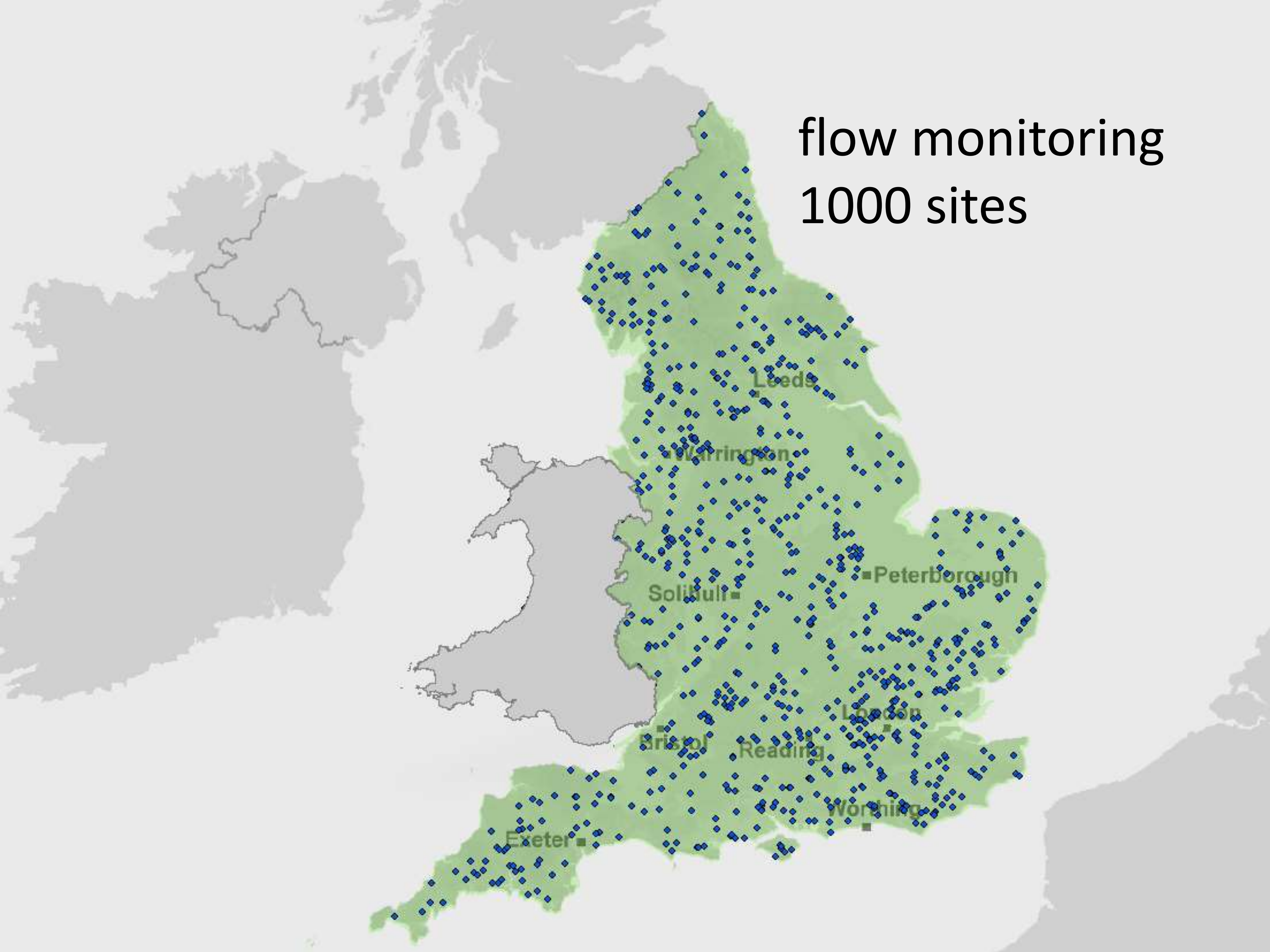


River Quality Monitoring

sampling sites 6000

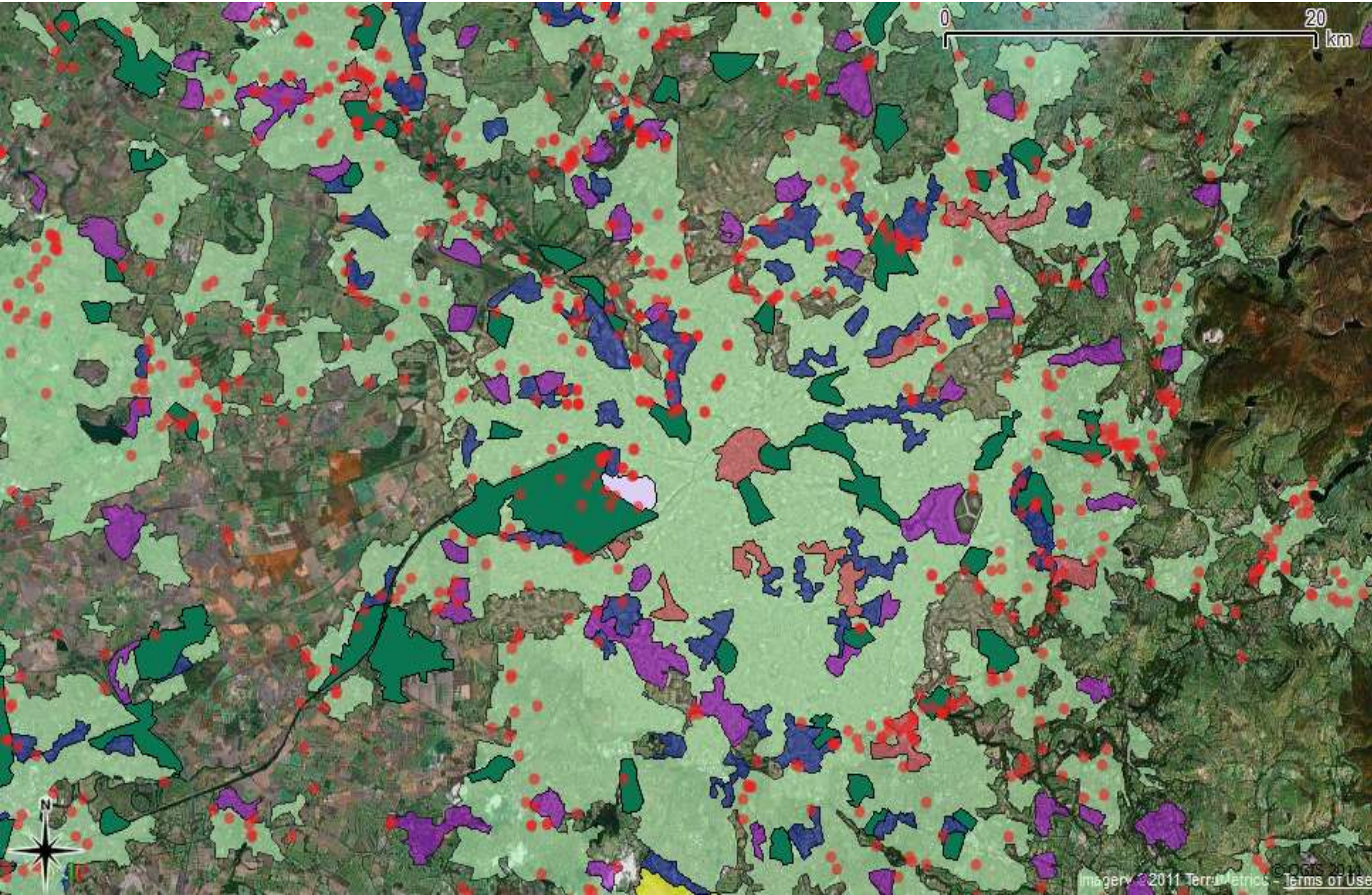
(monthly spot samples)

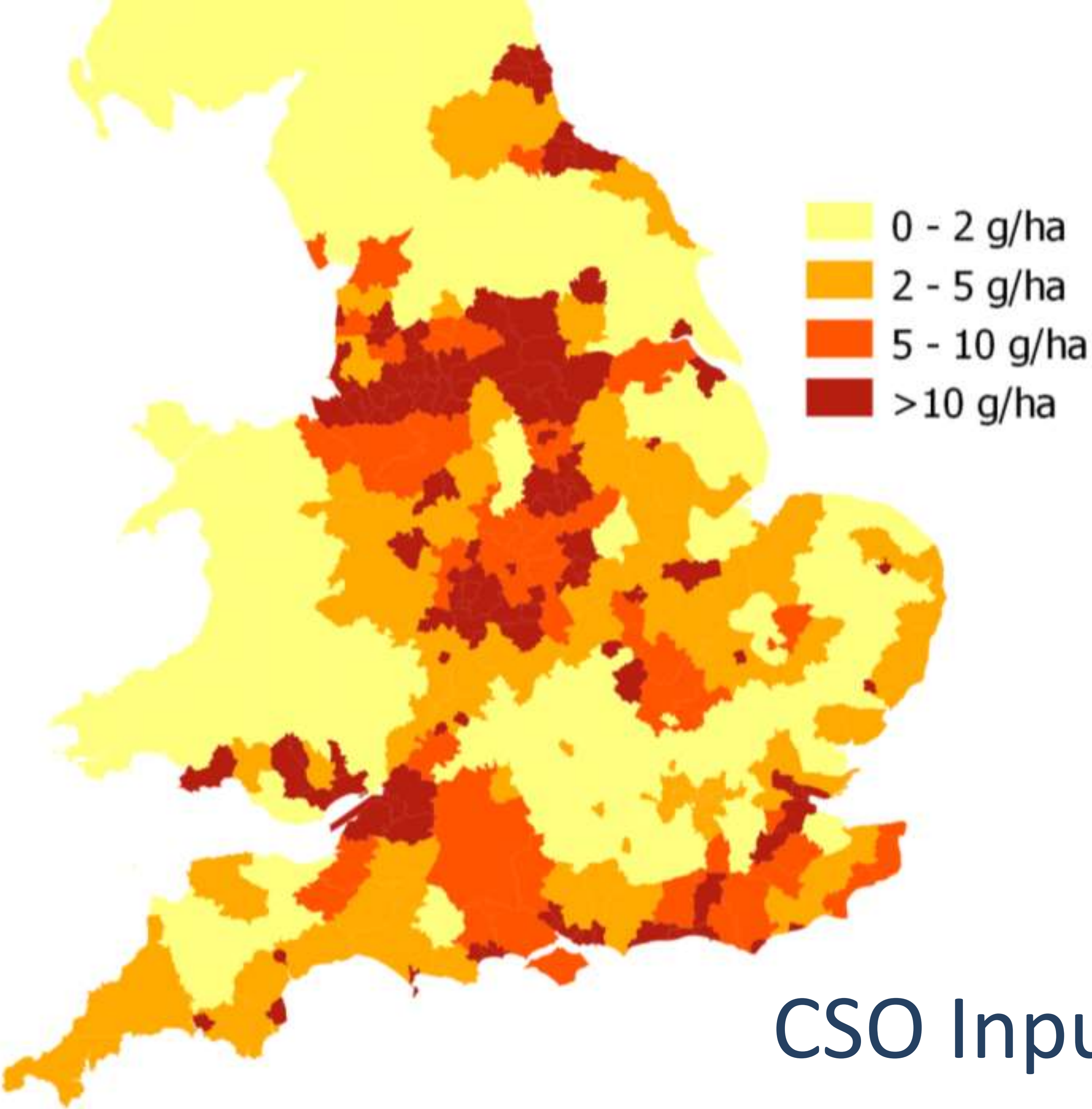




flow monitoring
1000 sites

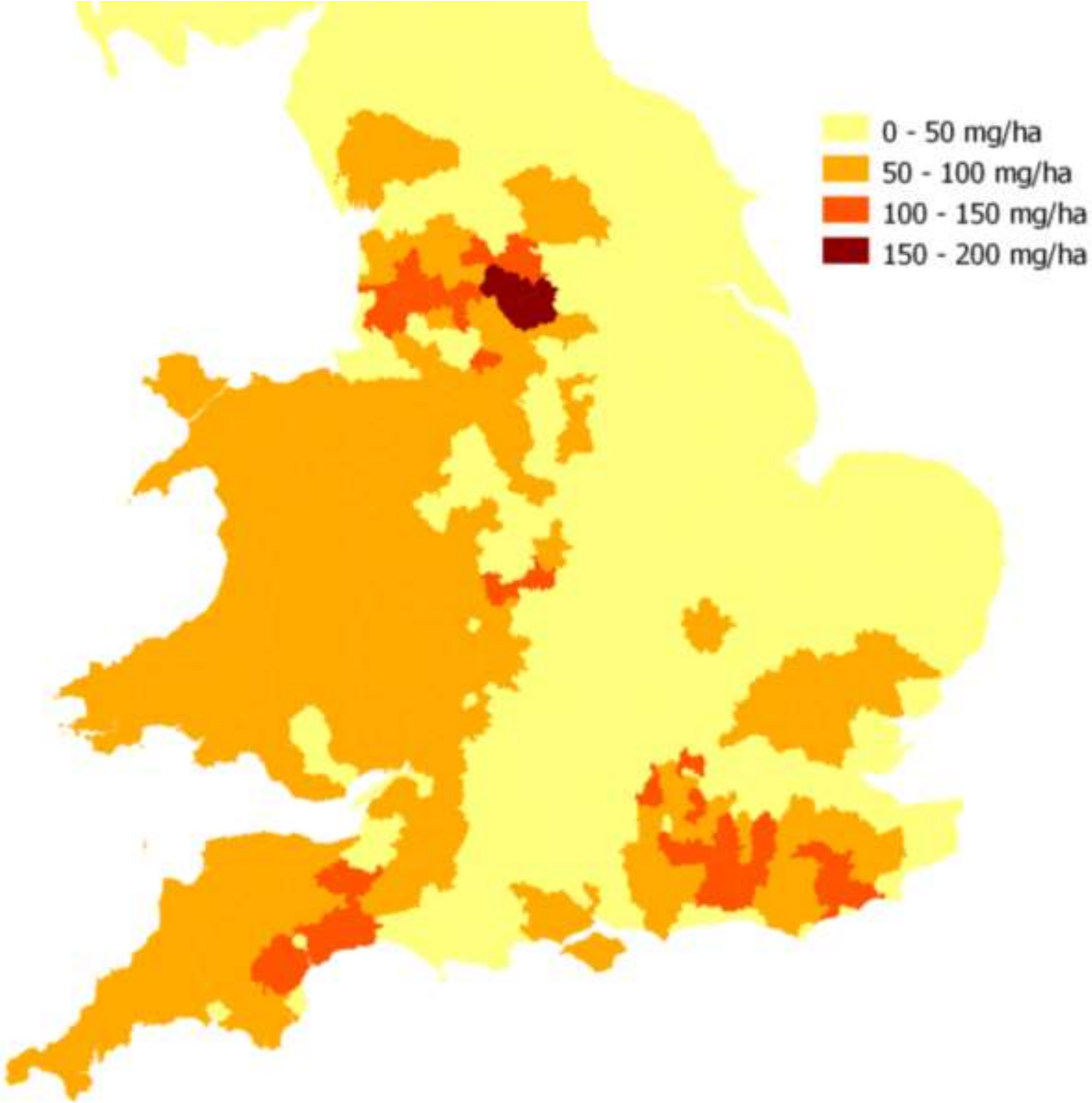
Combined Sewer Overflows



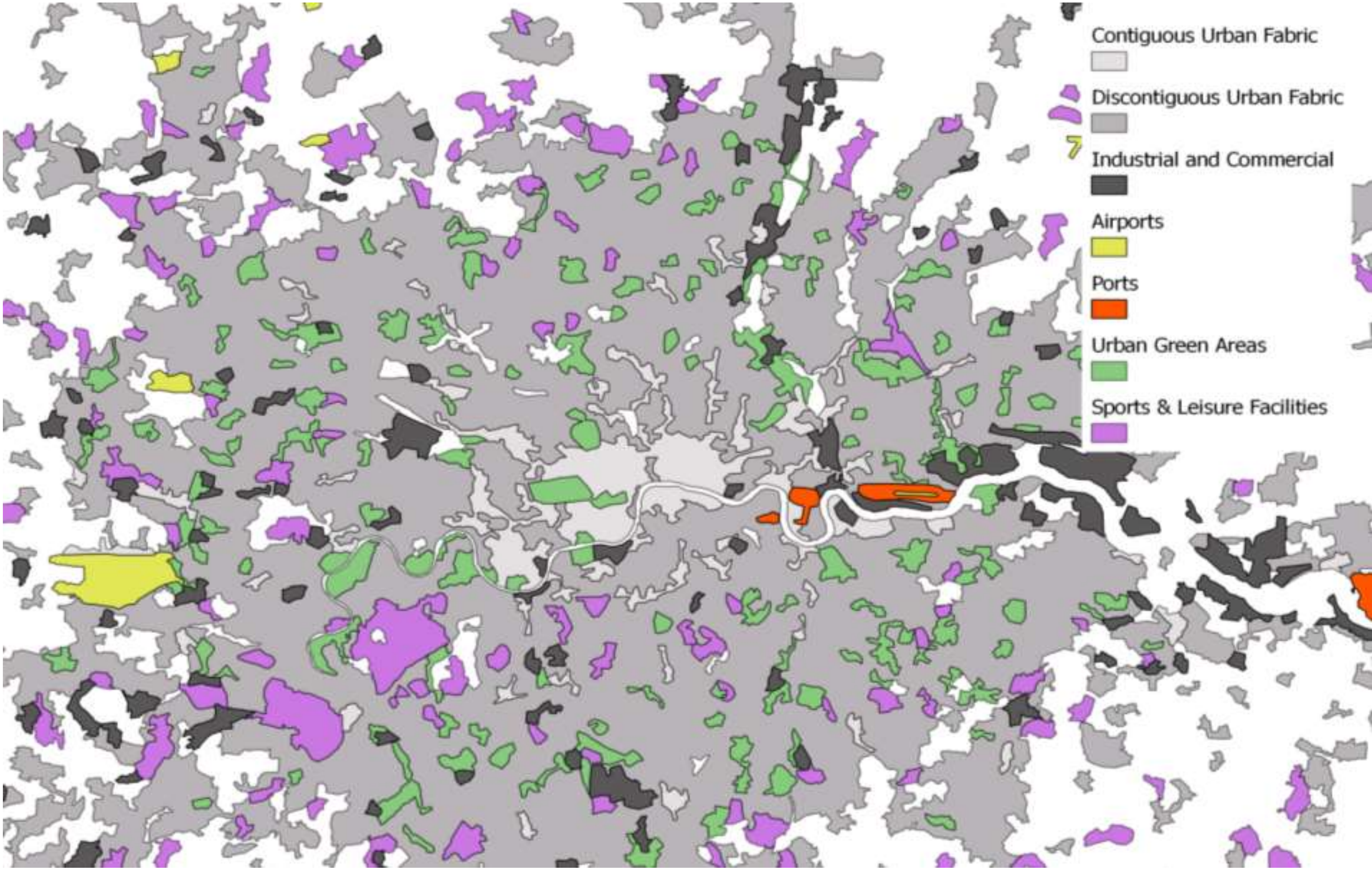


CSO Inputs (Zinc)

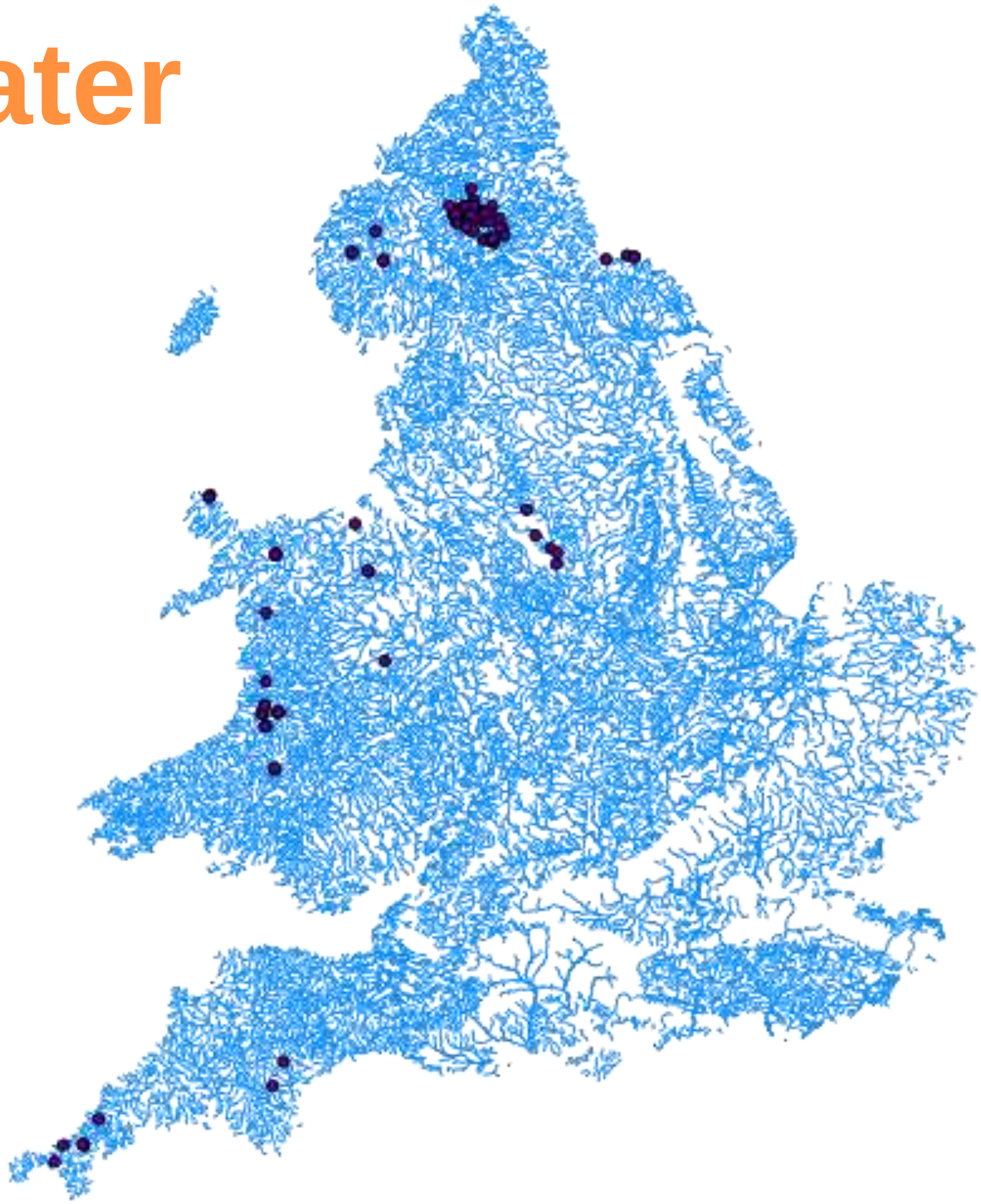
septic tank - loads



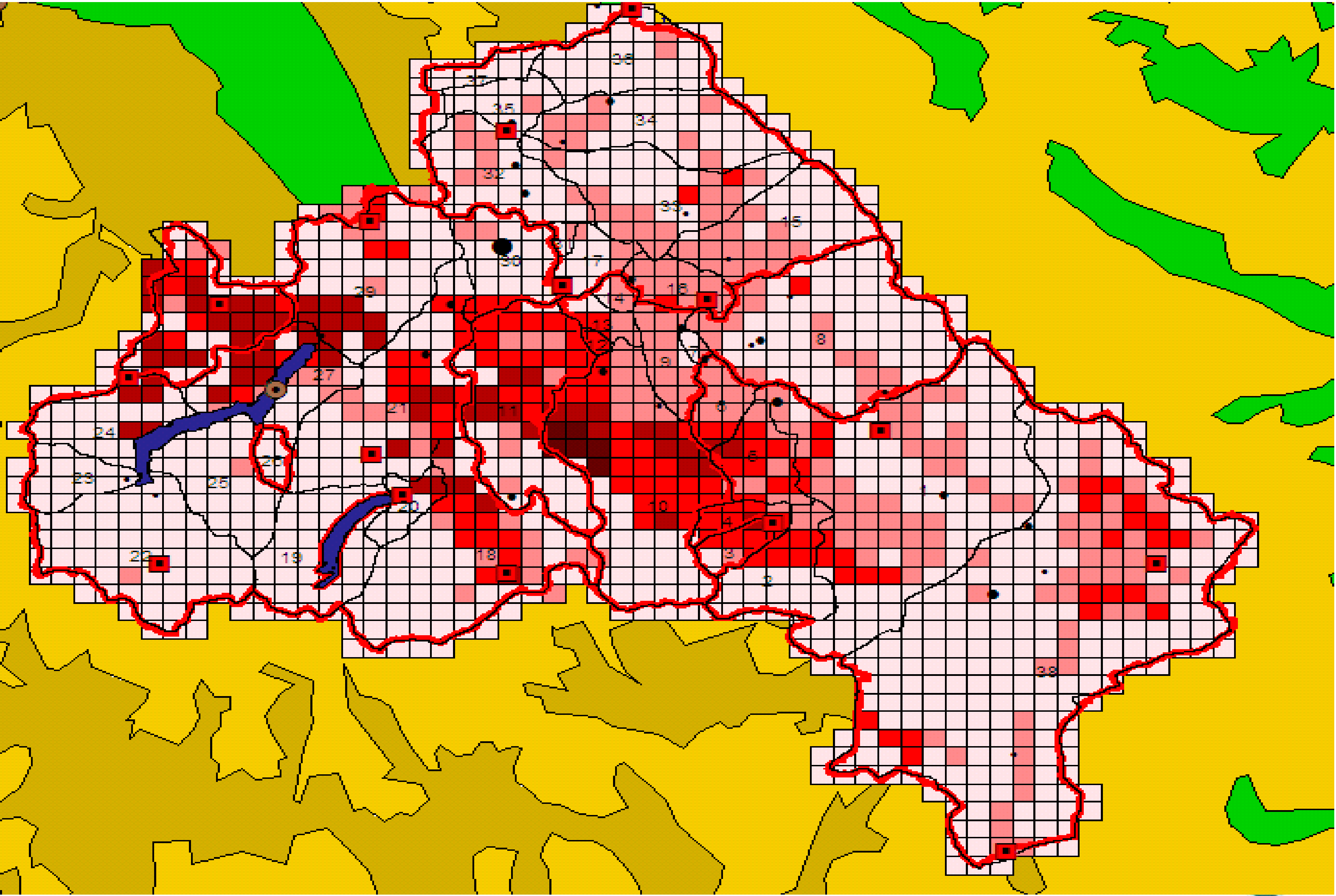
land use ...


Contiguous Urban Fabric
Discontiguous Urban Fabric
Industrial and Commercial
Airports
Ports
Urban Green Areas
Sports & Leisure Facilities

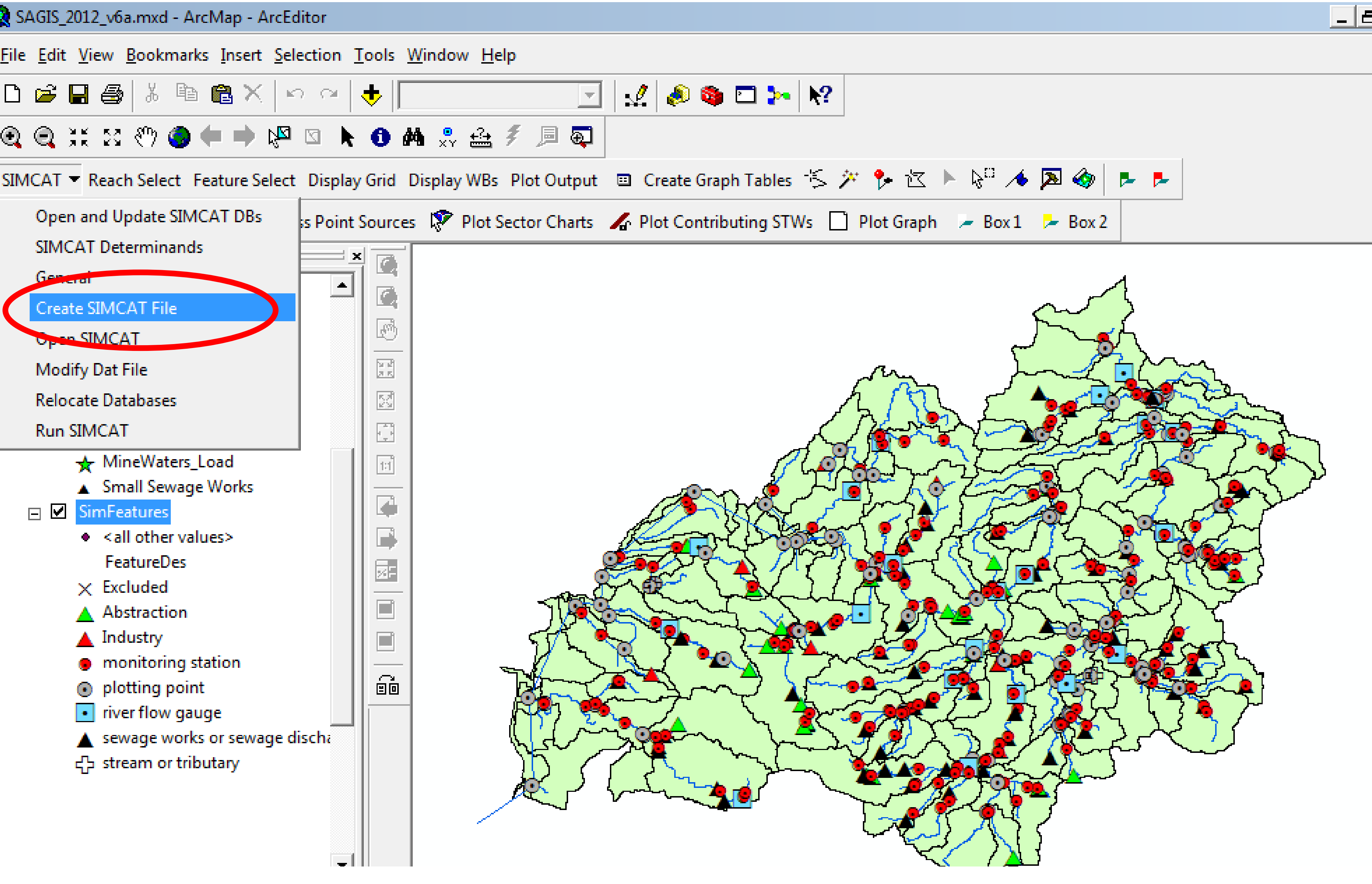
mine water



agriculture: sources of nutrients

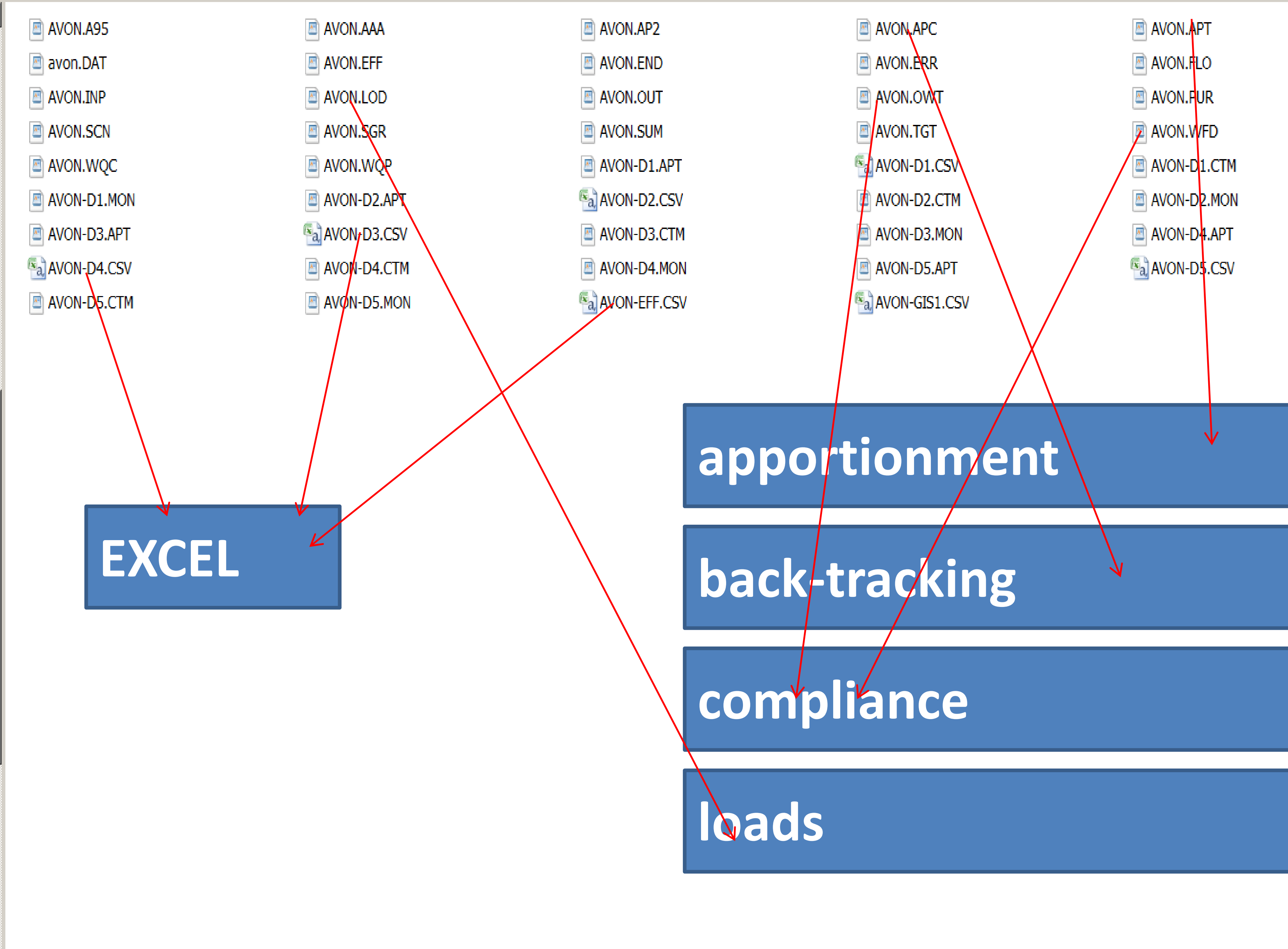


SIMCAT – GIS interface

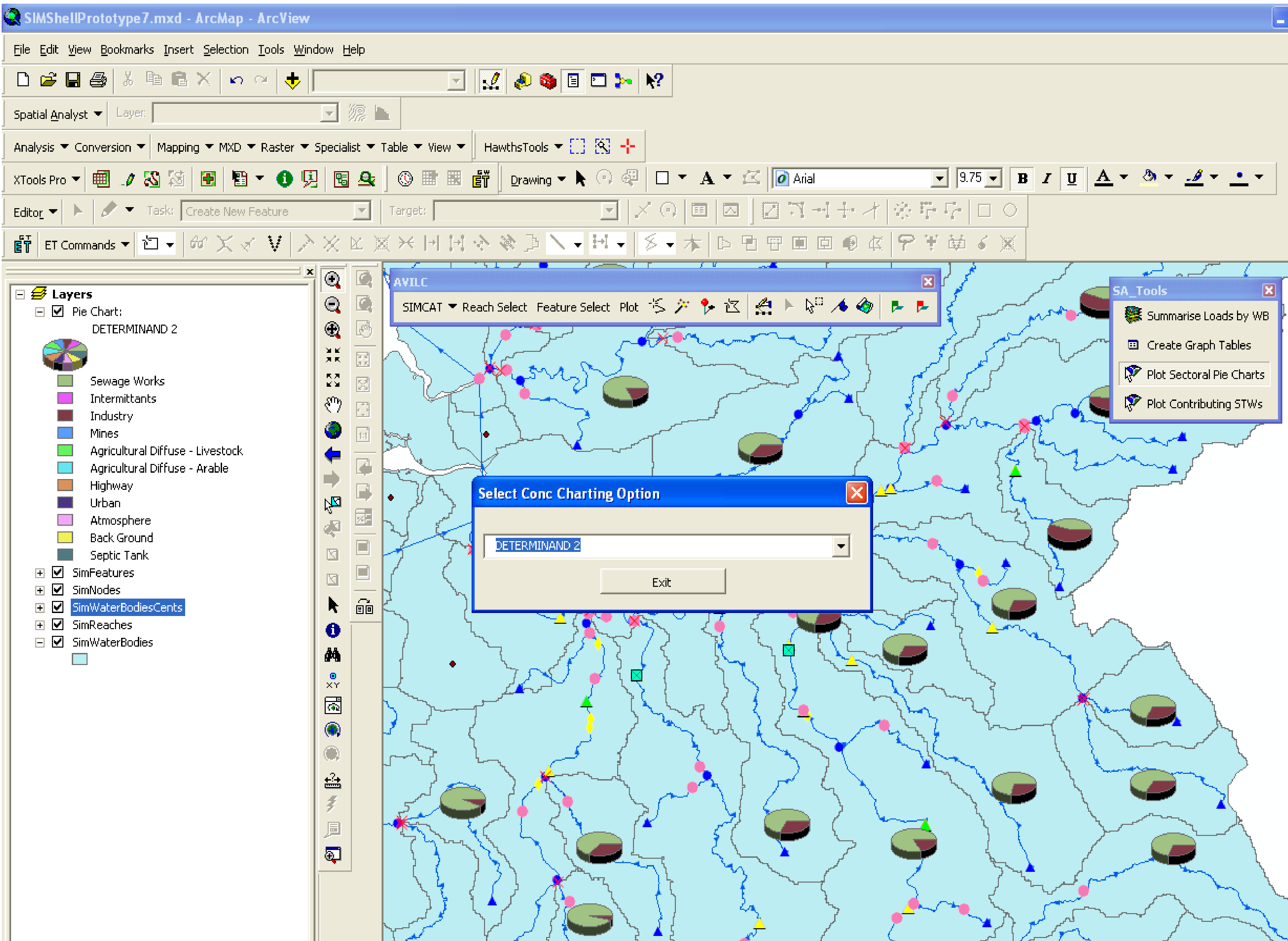



Simcat 14.8
Exit
RUN THE SIMCAT MODEL ...
Reports
Graphs
Batch Run
Options
0 Basic run
1 Gap filling of river flows
2 Use the gap filled river flows
3 Gap filling of water quality
4 Run the full gap filled model
5 Perform options 1 and 3 in sequence
6 Perfom options 1, 3 and 4 in sequence
7 Set effluent standards to meet river targets
8 As 7 with aspects of no deterioration
9 As 8 assuming mid-class upstream quality standards
SIMCAT 14
Tony Warn
Simulation model for catchment quality
February 2016

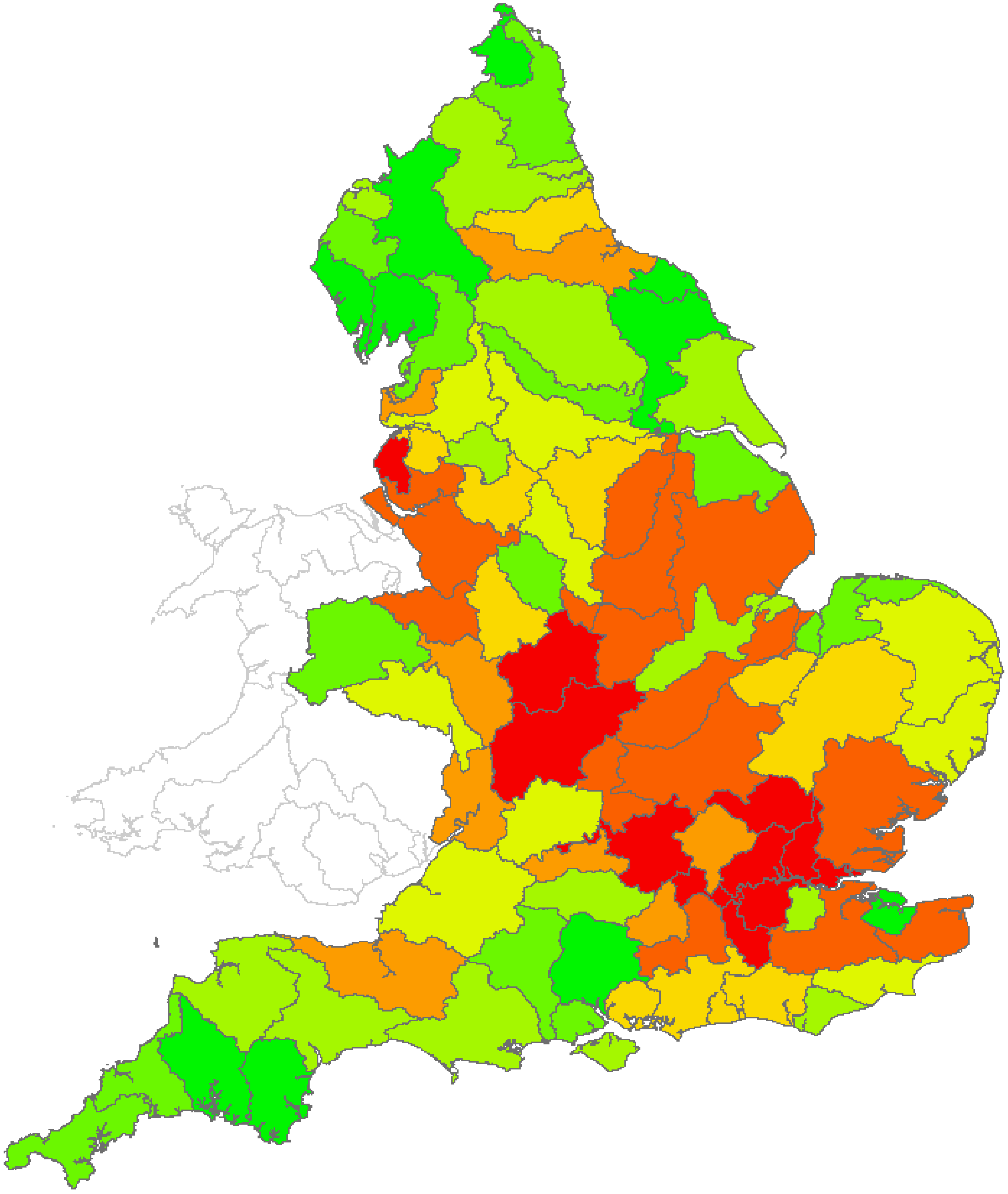
Required 95%-tile effluent quality			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Middle Ouse Monitoring Station	14.0	8.61	48.7	4.50	1.00	7.59	.231
Observed 95 or 5-percentiles			59.9	7.87	.834	3.75	.400
End of Reach: Upper Ouse	16.0	8.77	48.0	4.10	.835	7.77	.225
Head of River Avon	0.0	1.20	42.6	3.40	.286	6.56	.269
Head of River Avon	0.0	1.20	42.6	3.40	.286	6.56	.269
Avon Regulation	1.0	3.00	36.8	2.63	.220	7.24	.220
Brickton STW	3.0	4.74	55.5	6.77	1.83	5.32	.218
Required mean effluent quality			95.0	7.28	2.68	1.00	.200
Required 95%-tile effluent quality			103.3	18.9	5.91	.464	.427
Valley Bottom Monitoring Statio	9.0	5.19	47.1	4.68	.983	6.57	.177
Observed 95 or 5-percentiles			54.5	8.06	1.39	2.28	2.65
Valley Bottom Gauging Station	9.0	5.19	47.1	4.68	.983	6.57	.177
End of Reach: River Avon	12.0	5.40	44.2	3.93	.755	6.98	.168
Mix to form Middle Ouse	16.0	14.2	46.4	3.66	.736	7.67	.190
Allied Industries	17.0	14.3	47.3	3.92	.692	7.72	.195
Required mean effluent quality			380.0	80.0	-	-	4.50
Required 95%-tile effluent quality			417.1	175.6	-	-	8.34
End of Reach: Middle Ouse	18.0	14.4	47.1	3.82	.650	7.77	.194
Head of Black Brook	0.0	.200	42.6	3.68	.114	7.46	.150
Head of Black Brook	0.0	.200	42.6	3.68	.114	7.46	.150
Black Brook Monitoring Station	2.0	.338	26.0	1.86	.0415	7.06	.117
Observed 95 or 5-percentiles			55.5	3.89	.111	7.16	.151
Appleford STW	3.0	1.65	78.0	9.70	3.78	3.44	.244
Required mean effluent quality			95.0	9.76	3.43	2.00	.200
Required 95%-tile effluent quality			103.4	19.6	7.37	.813	.427
Intermittent	6.1	1.94	78.2	7.62	2.45	4.48	.210
Required mean effluent quality			380.0	20.0	-	-	.200
Required 95%-tile effluent quality			417.1	43.1	-	-	.427
End of Reach: Black Brook	10.0	2.20	68.9	5.84	1.61	5.34	.191
Mix to form Lower Ouse	18.0	16.6	49.8	3.92	.669	7.51	.182
Avon Stream	19.0	32.5	44.2	3.35	.346	7.42	.185
New Mill Monitoring Station	19.0	32.5	44.2	3.35	.346	7.42	.185
Observed 95 or 5-percentiles			62.1	8.64	.677	4.15	.621
New Mill Flow Gauging Station	19.0	32.5	44.2	3.35	.346	7.42	.185
New Mill Storm Overflow	21.0	32.7	44.1	3.21	.312	7.52	.184
Required mean effluent quality			-	-	-	-	-
Required 95%-tile effluent quality			-	-	-	-	-
Abstraction	25.0	-	43.7	2.97	.253	7.97	.181
End of Reach: Lower Ouse	25.0	-	43.7	2.97	.253	7.97	.181
Total river length	47.0						



AVON.A95
AVON.AAA
AVON.AP2
AVON.APC
AVON.APT
avon.DAT
AVON.EFF
AVON.END
AVON.ERR
AVON.FLO
AVON.INP
AVON.LOD
AVON.OUT
AVON.OWT
AVON.PUR
AVON.SCN
AVON.SGR
AVON.SUM
AVON.TGT
AVON.WFD
AVON.WQC
AVON.WQP
AVON-D1.APT
AVON-D1.CSV
AVON-D1.CTM
AVON-D1.MON
AVON-D2.APT
AVON-D2.CSV
AVON-D2.CTM
AVON-D2.MON
AVON-D3.APT
AVON-D3.CSV
AVON-D3.CTM
AVON-D3.MON
AVON-D4.APT
AVON-D4.CSV
AVON-D4.CTM
AVON-D4.MON
AVON-D5.APT
AVON-D5.CSV
AVON-D5.CTM
AVON-D5.MON
AVON-EFF.CSV
AVON-GIS1.CSV
EXCEL
apportionment
back-tracking
compliance
loads


SIMShellPrototype7.mxd - ArcMap - ArcView
File Edit View Bookmarks Insert Selection Tools Window Help
Spatial Analyst
Layer:
Analysis
Conversion
Mapping
MXD
Raster
Specialist
Table
View
HawthsTools
XTools Pro
Drawing
Arial
9.75
Editor
Task:
Create New Feature
Target:
ET Commands
Layers
Pie Chart:
DETERMINAND 2
Sewage Works
Intermittants
Industry
Mines
Agricultural Diffuse - Livestock
Agricultural Diffuse - Arable
Highway
Urban
Atmosphere
Back Ground
Septic Tank
SimFeatures
SimNodes
SimWaterBodiesCents
SimReaches
SimWaterBodies
AVILC
SIMCAT
Reach Select
Feature Select
Plot
SA_Tools
Summarise Loads by WB
Create Graph Tables
Plot Sectoral Pie Charts
Plot Contributing STWs
Select Conc Charting Option
DETERMINAND 2
Exit

SIMCAT – results



SIMCAT calculates …

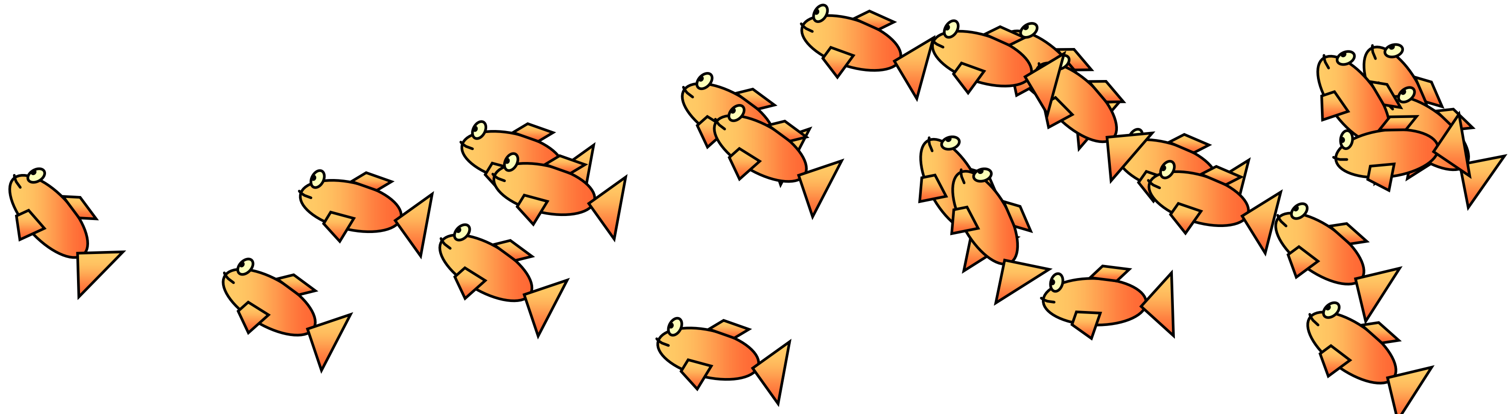
- river quality
- compliance with standards
- breakdown of causes of bad quality
- actions to meet targets
- for a single discharge, a small river, catchments or the whole country
    - industrial investment
    - diffuse pollution
    - growth and climate change
    - new laws and policies

emphasise …

- the “science” of taking decisions

important to:

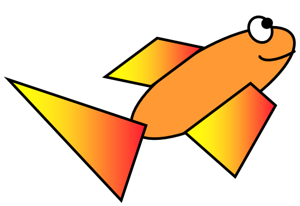
- know our errors
- use correct standards



Catchment Management and Implementation

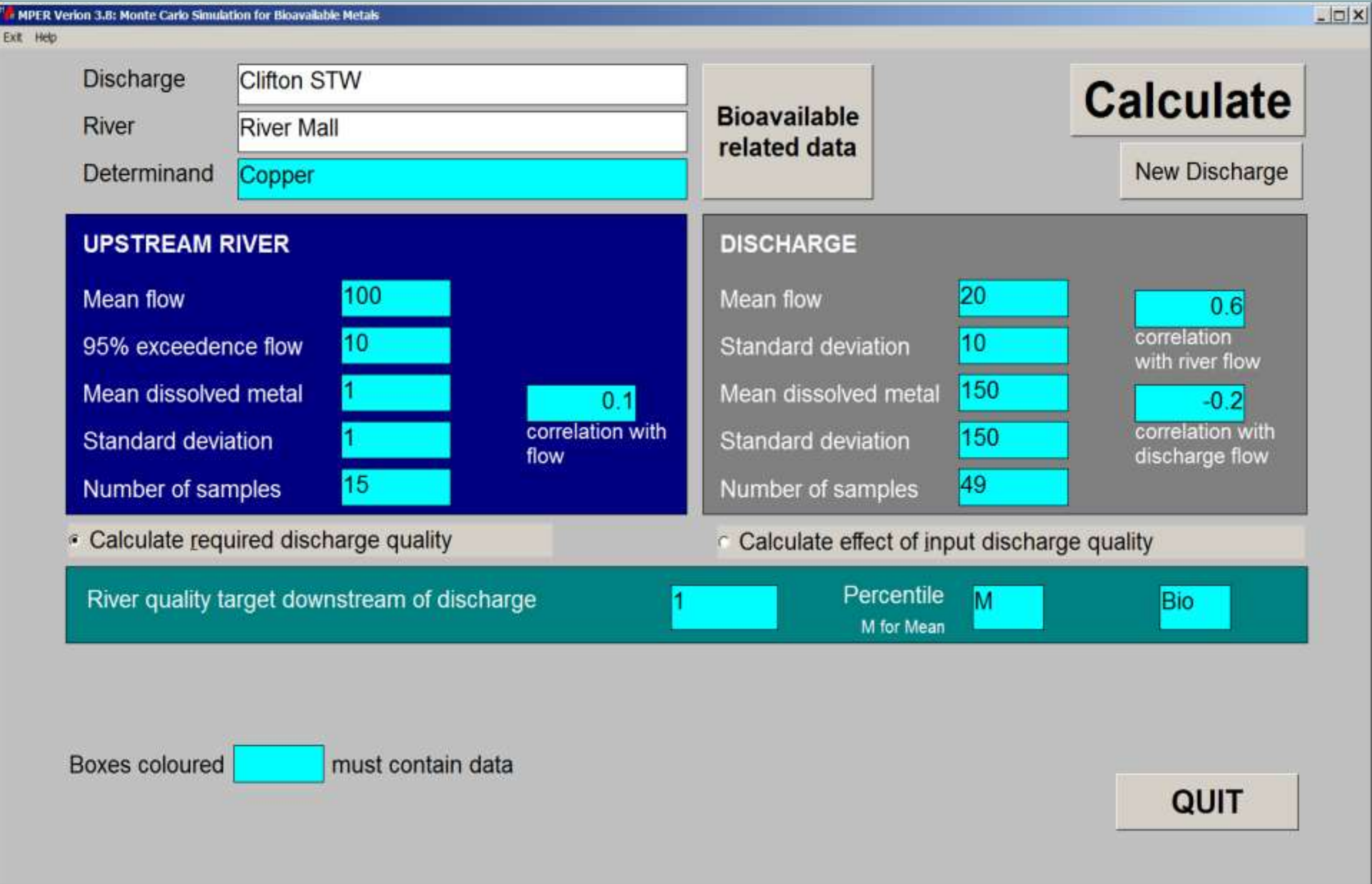
Water Quality Planning

modelling for investment and decision making



Tony Warn MBE

17 February 2016


MPER Verion 3.8: Monte Carlo Simulation for Bioavailable Metals
Exit Help
Discharge
Clifton STW
River
River Mall
Determinand
Copper
Bioavailable related data
Calculate
New Discharge
UPSTREAM RIVER
Mean flow
100
95% exceedence flow
10
Mean dissolved metal
1
Standard deviation
1
Number of samples
15
0.1
correlation with flow
DISCHARGE
Mean flow
20
Standard deviation
10
Mean dissolved metal
150
Standard deviation
150
Number of samples
49
0.6
correlation with river flow
-0.2
correlation with discharge flow
Calculate required discharge quality
Calculate effect of input discharge quality
River quality target downstream of discharge
1
Percentile
M for Mean
M
Bio
Boxes coloured
must contain data
QUIT

take note of errors ...

mean = 43

29 - 56

43

Clifton STW

River Mall

Copper

Bioavailable related data

Sensitivity

AM OF DISCHARGE

	12.4	8.87	16.0
	14.6		
d metal	38.0		
tal	1.00	0.659	1.34
	1.17		
ble metal	2.97		
	1.00		

GE QUALITY

	43.1	30.1	56.1
	41.9		
d metal	121		
rge quality	248		

SENSITIVITY

	% effect on permit	% effect on river
2% change in pH	19	19
Bioavailability equation	- 19	23
Sampling for discharge DOC	14	14
Sampling for pH	10	- 8
10% change in discharge DOC	8	- 7
20% boost in discharge DOC variation	7	- 6
Sampling for upstream DOC	6	6
10% change in discharge flow	2	2
0.2 shift in flow/quality correlation	1	1
10% change in river flow	- 1	- 1

QUIT