

**Domestic wastewater characteristics in
French rural areas:
concentrations and ratios for treatment
plants under 2 000 Population Equivalent
(120kg of BOD₅ a day).**

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Cemagref, Lyon, France

SmallWatt 11, 3rd international congress, 26 April 2011





Plan

- **Introduction: context**
- **Data collection and sorting**
- **Main results**
 - **Concentrations**
 - **Ratios**
 - **Organic and hydraulic loads of treatment plants**



Context

- **2008 inventory in France:**
 - 19 400 treatment plants
 - 83% (16 100) of less than 2 000 PE in capacity
 - **Few data published on wastewater quality in rural areas**
 - Consequences on design and sizing: calculations made with unrealistic mean values (concentrations, ratios) and variation ranges
 - **Parameters changing versus time for a decade (Phosphorus)**
 - **Reality can be surprising.**
 - All stakeholders are concerned by several consequences amongst: appropriate plant sizing, treatment performance, construction and operational costs optimization, compliance with regulatory standards...
- National scale study
- mean concentrations, ratios and variation range of wastewater for communities under 2 000 PE in capacity
- BOD₅, COD, TSS, TKN, NH₄-N, NGL and TP



Collected data



- **Origin:** collected from Water Agencies databases
- **Characteristics:** 24h flow proportional samples
- **Limits:** original dataset of more than 21 000 entries had to be carefully sorted out in order to remove aberrant and incomplete data



Selecting significant data

- 21 415 measurements in original data set
- **Sorting criteria, examples of reasons used to suppress measurements:**
 - **Missing information: Volume, COD, BOD₅ or Capacity**
 - (*# 10 400 measurements*)
 - **Aberrant values: NH₄-N > TKN, Concentration < quantification limit**
 - (*# 500 measurements*)

**→ More than 50% of entries removed: 10 491 measurements
in final data collection**



Sorting workable data (1/3)

	Volume	DBO ₅	DCO	MES	NK	N-NH ₄	N-NO ₂	N-NO ₃	NGL	P _t
Unités	(m ³ /j)	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Moyenne	139.8	274	669.8	308.3	68.2	55	0.5	2.9	74.5	9.6
Maximum	3344	4977	9940	19000	967	230	115	205	531	157
Minimum	0.5	3	30	2	1.1	0.1	0	0.2	1.1	0.2

→ Aberrant values still remaining



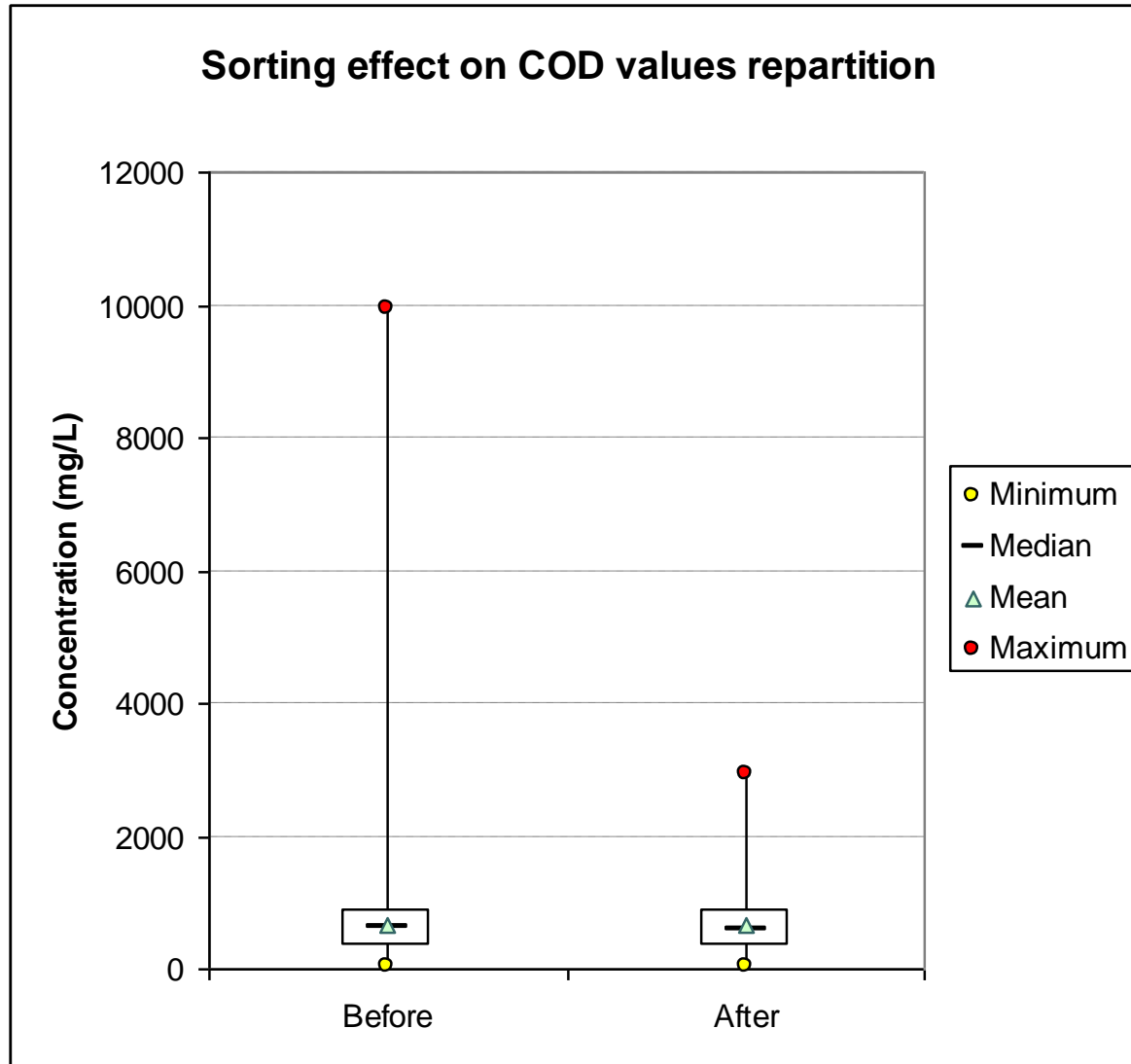
Sorting workable data (2/3)

- **Removing values can be a slippery process**
- **Choice of a statistical test: Chauvenet's criteria**
 - **Normal distribution hypothesis. Calculation of probability for a value to be more than X standard deviation away from the mean.**
 - **If theoretical occurrence is < 0.5 , value is considered dubious.**

→ **Thresholds determination for maximal values**

	BOD₅	COD	TSS	TKN	NH₄-N	N_{tot}	P_T
Threshold (mg/L)	1 230	2 930	2 100	223	150,3	210,8	39,2
Number of measurements above threshold	54	19	26	8	3	1	20

Sorting workable data (3/3)



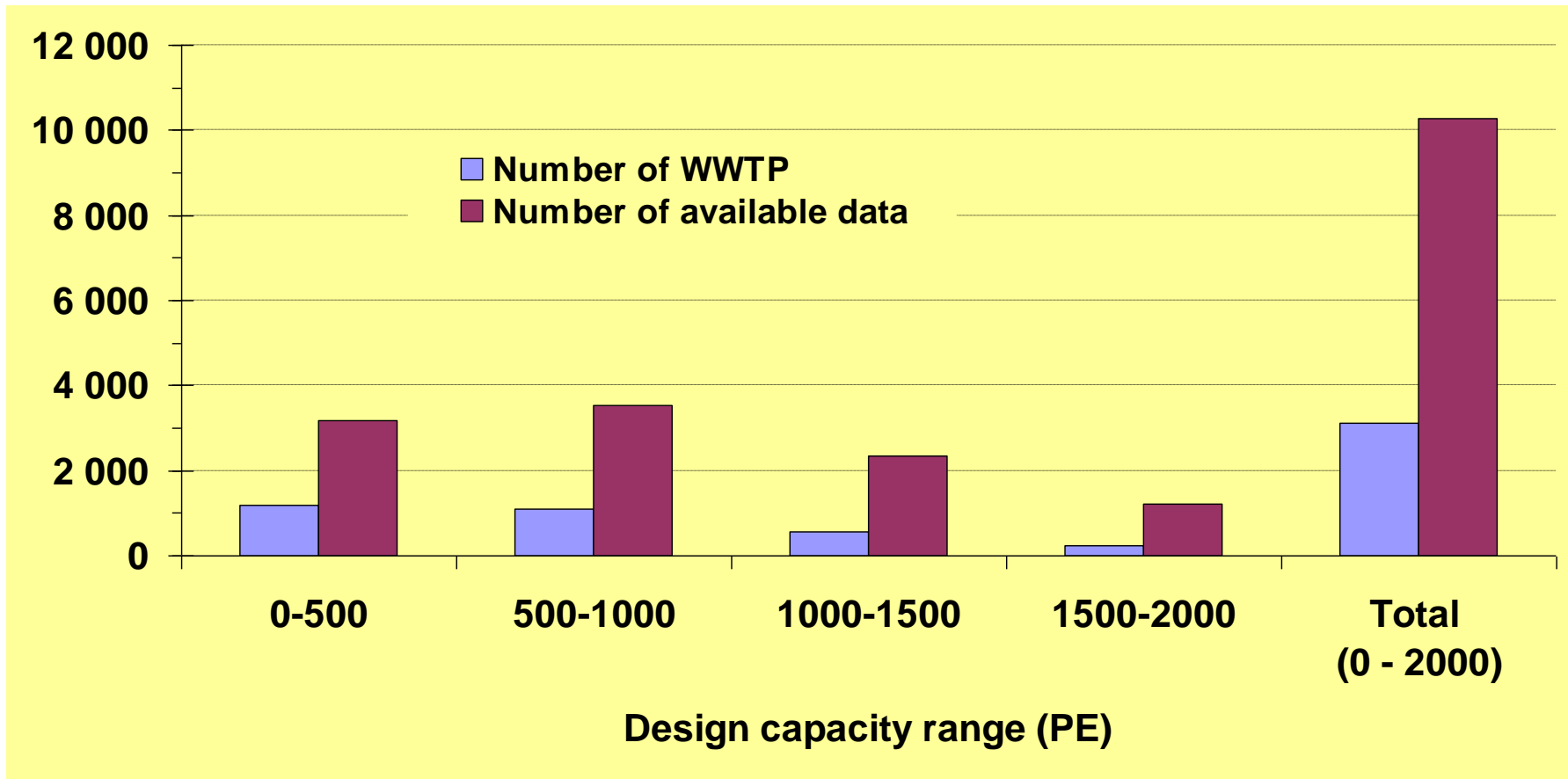


Used dataset

geographical origin of data: overall France

10 275 data ; 3027 WWTP

data collected between 1999-2009





Data processing

- **Selected mean value**
 - **Data series means**

- **Variation ranges**
 - **Security criteria: 5% of values were removed for each extrema**
 - *Values of concentration observed 90% of time are given*

Results: BDO₅, COD, TSS

BDO ₅ (mg/L)			
	This study	Litterature	Source
Mean	265	230 to 333	Besème et Iwema, 1990 ; Groupe Macrophytes, 2005
Variation range	upper bound	570	SATESE 22, 2007
	lower bound	39	Bécares <i>et al.</i> , 2009

Résultats: DBO₅, DCO, MES

COD (mg/L)				
		This study	Litterature	Source
Mean		646	530 to 800	Henze <i>et al.</i> , 1997 ; Groupe Macrophytes, 2005
Variation range	upper bound	1 341	1 342	SATESE 37, 2009
	lower bound	122	167	Bécares <i>et al.</i> , 2009

Résultats: DBO₅, DCO, MES

TSS (mg/L)				
		This study	Litterature	Source
Mean		288	238 to 485	Besème et Iwema, 1990 ; SATESE 37, 2009
Variation range	upper bound	696	684	SATESE 37, 2009
	lower bound	53	55	Bécares <i>et al.</i> , 2009

Results: NH₄-N, TKN, Ntot

		TKN	NH ₄ -N	Ntot
Units		mg/L	mg/L	mg/L
Mean		67,3	54,9	72,6
Variation range	upper bound	123,1	98,3	122,6
	lower bound	14,1	12,0	20,2
Number of measurements		9416	4266	1861

Résultats: P_t

Pt (mg/L)			
	This study	Litterature	Source
Mean	9,4	9.3 to 35	Pons <i>et al.</i> , 2004 ; Leclerc <i>et al.</i> , 1986 ; Pujol <i>et al.</i> , 1990
Variation range	Upper bound	35	Leclerc <i>et al.</i> , 1986 ; Pujol <i>et al.</i> , 1990
	Lower bound	3	Bécares <i>et al.</i> , 2009

Results: Ratios

		COD/BOD₅	KN/COD	TP/COD	TSS/COD	BDO₅/KN
Mean		2.62	0.12	0.02	0.46	3.88
Variation range	Upper bound	3.93	0.18	0.03	0.79	6.5
	Lower bound	1.83	0.06	0.01	0.23	1.9

		BOD₅/TP	NH₄-N/KN	BDO₅ / KN / TP		
Mean		28,53	0,74	100	30,02	4,26
Variation range	Upper bound	47,01	0,97	100	52,59	7,94
	Lower bound	12,6	0,5	100	15,41	2,13



Ratios: application to PE definition

– 1 PE = 60g of BOD₅/day *

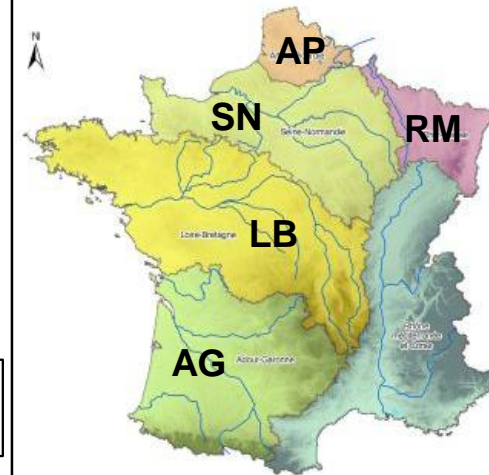
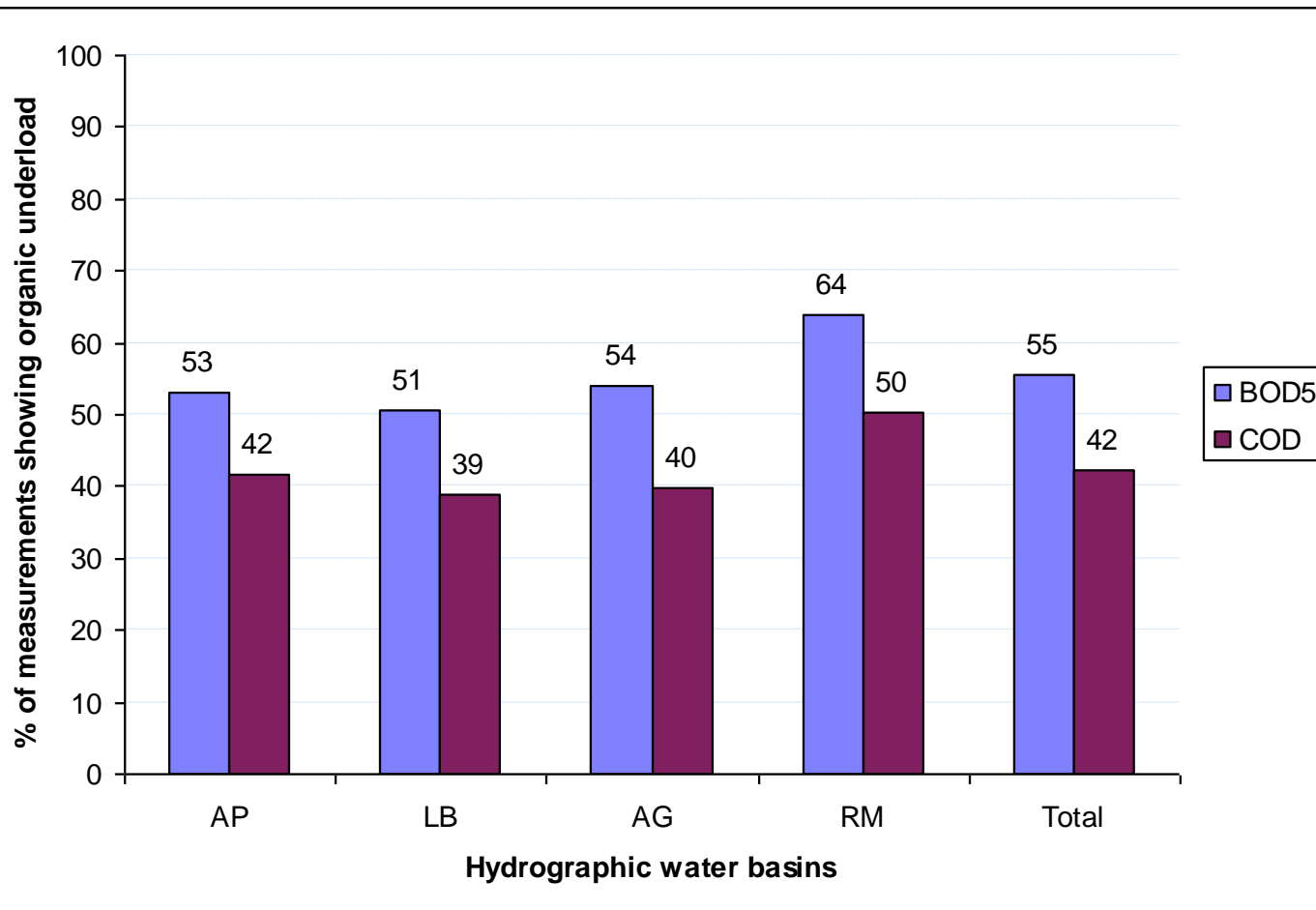
* *Urban waste water directive* [91/271/EEC](#)

	BDO ₅	COD	KN	NH4-N	TP
Defintion (g/day)	60				
Values from ratios application (g/day)		157	15.5	11.5	2.1

Results: treatment plants organic load

– Organic load

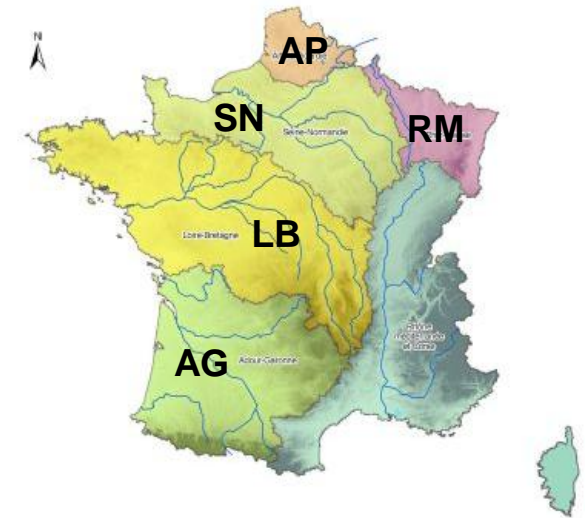
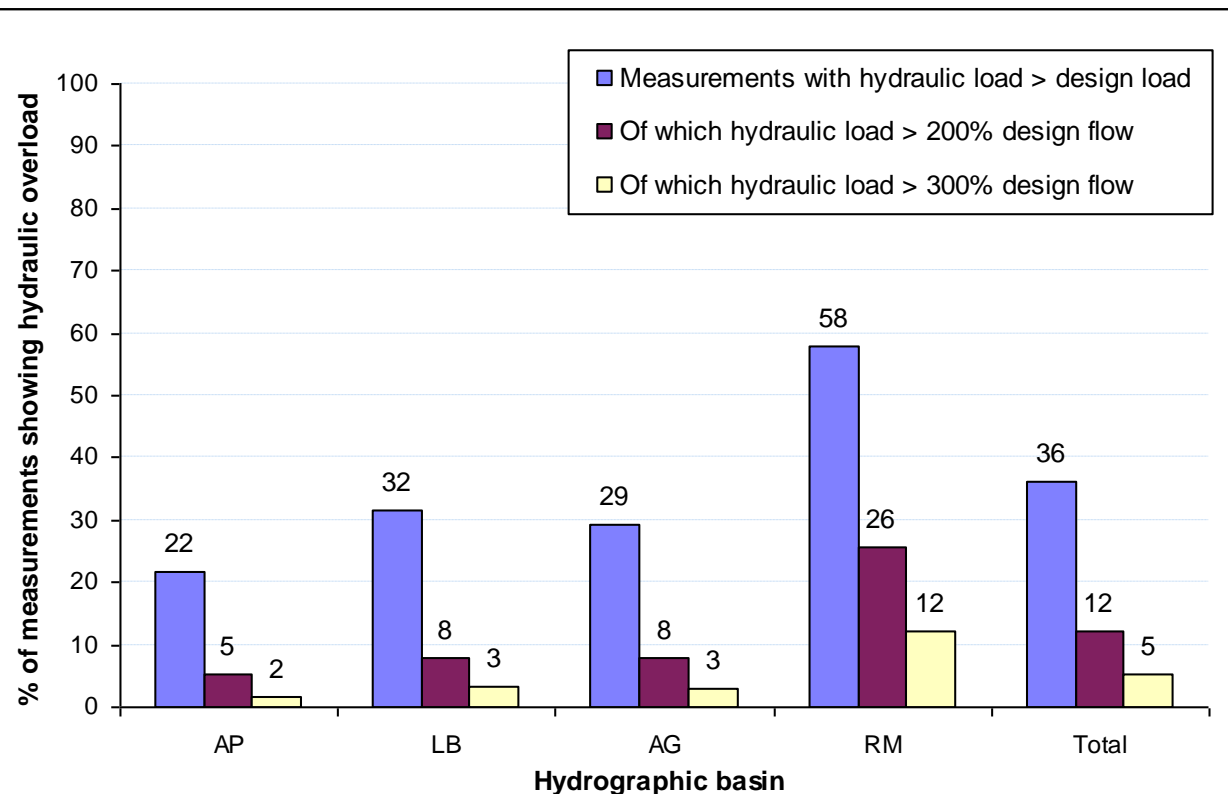
- *43% of plants running under 50% of their design organic load*
 - No correlation with capacity range
 - RM water basin shows particularly under loaded plants



Results: treatment plants hydraulic load

– Hydraulic load

- 43% of overloaded plants
- 12% of plants with overloading above 200% of design flow
 - No correlation with capacity range
 - RM water basin shows strong hydraulic overload proportion (~ 60%)





Conclusion

- **Mean values globally agree with literature**
- **Significant results**
 - **Large concentrations variation ranges, high upper bounds**
 - *Performance guarantee ranges have to be extended*
 - *Criteria used for design and sizing*
 - **Low mean value for TP concentration**
 - **High mean and maximal value for COD/BOD5 ratio**
- **Continuation**
 - **Per inhabitant released pollution load**
 - **Sewerage network influence on wastewater quality**



Thank you for listening