Characteristics and performance of small and medium wastewater treatment plants in Greece

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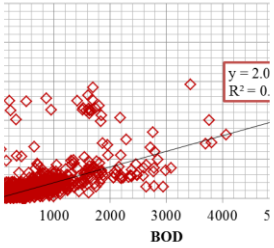
MAIN TOPICS

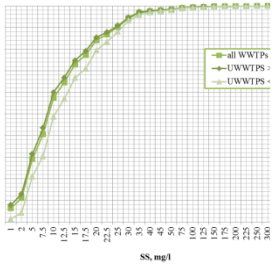
WASTEWATER MANAGEMENT IN GREECE

Legal framework ♦ Agglomerations ♦ P.E. ♦ Recipients ♦ Treatment provided

OPERATIONAL CHARACTERISTICS

Components Loads ♦ Ratios





PERFORMANCE INDICATORS

BOD ♦ COD ♦ SS ♦ Nutrients

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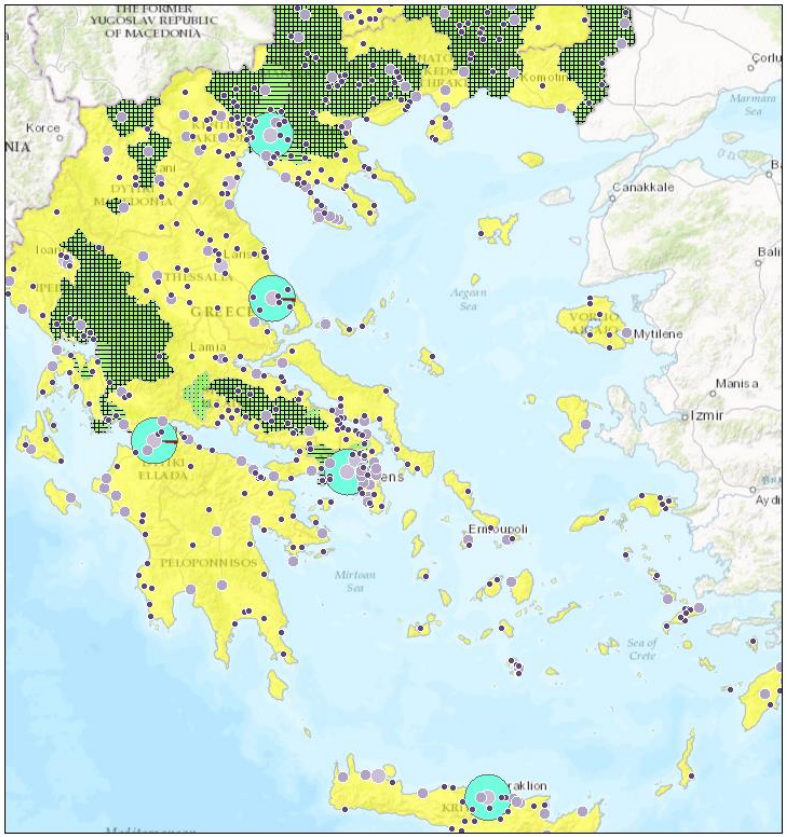
	Agglomeration size (in p.e.)		
	2000-10000	10000-15000	>15000
Normal area	2005	2000	1998
Sensitive area	2005	1998	1998



LEGAL FRAMEWORK

Urban Wastewater Treatment Directive

- Main EU legal document established in 1991
- Minimum requirements for collection and treatment of urban wastewater
- Implementation criteria
  - Agglomeration size in p.e.
  - Character of recipient with respect to its' sensitivity to eutrophication

UWWTD was adopted in 1997 in Greece

- Considerable progress has been made
- WWTPs that would serve smaller agglomerations (<10.000 p.e.) are still pending, the main constraint being the availability of adequate funding

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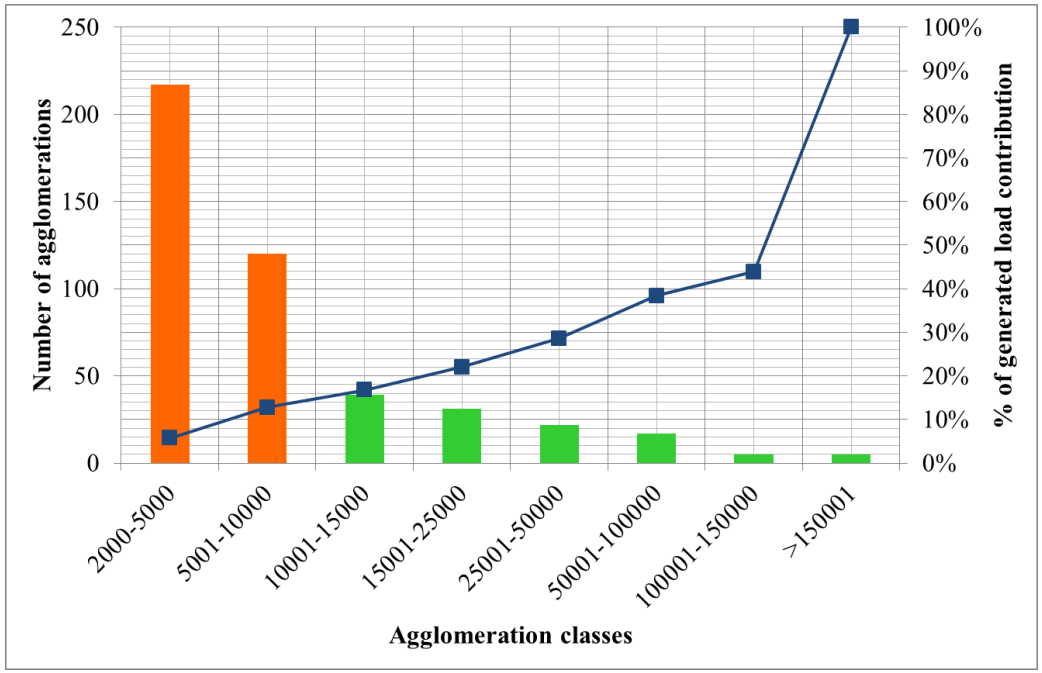
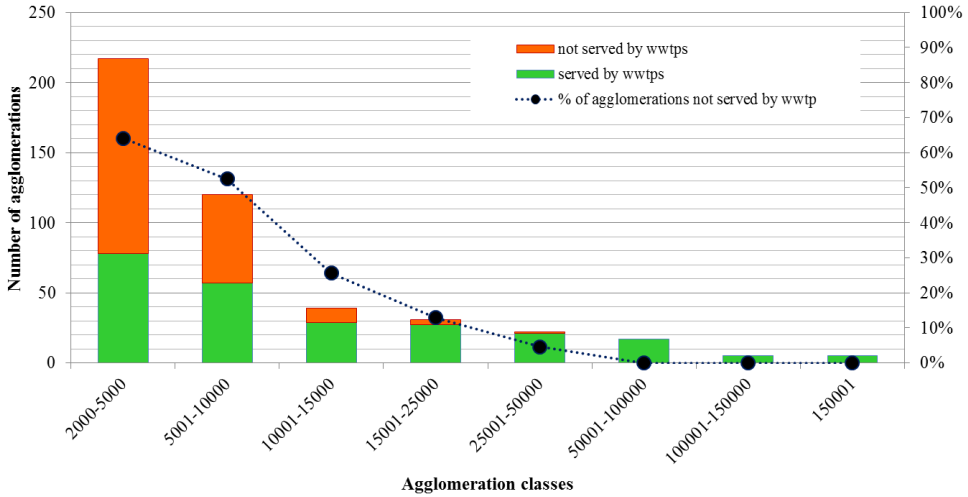


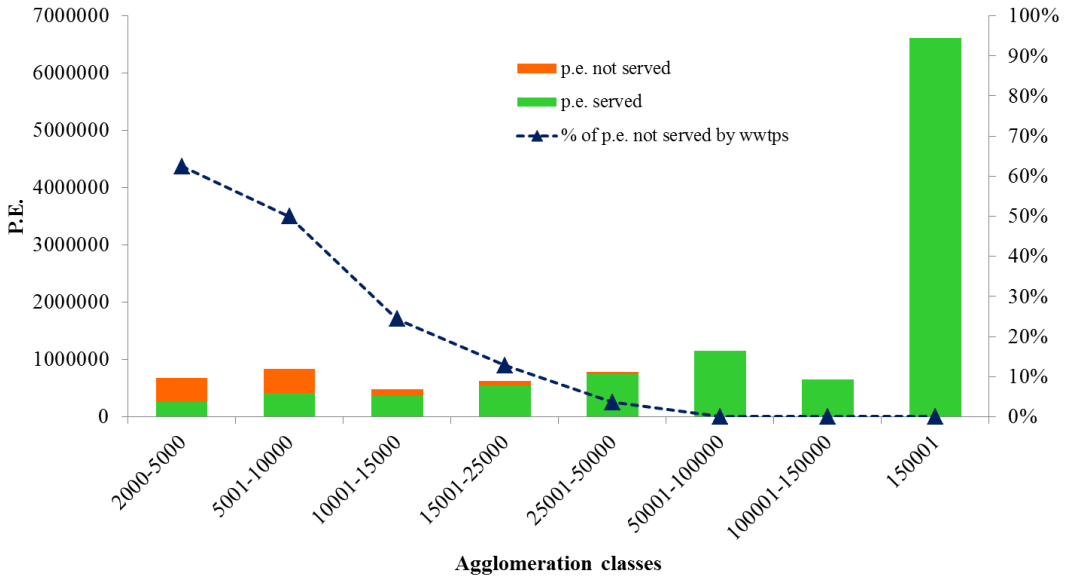
AGGLOMERATIONS ♦ P.E.

In Greece 457 agglomerations with p.e. greater than 2000, are identified corresponding to 11.8 million p.e. in total.

337 agglomerations for the two smaller classes (2000-10000 p.e.) contribute to 12-13% of the generated load.

Population in smaller communities adds up to 2.5 million.





POPULATION SERVED

- Large cities and agglomerations with more than 25.000 p.e. have practically complied with the UWWTD provisions.
- A small number of agglomerations (5) in the south-east Attica Region with total generated load 110.000 p.e. is still lacking infrastructure.
- As the agglomeration class becomes smaller, the percentage of areas that are not served by wastewater treatment plants significantly increases reaching 65% for agglomerations with population below 5000 p.e. with generating load corresponding to 420.000p.e.

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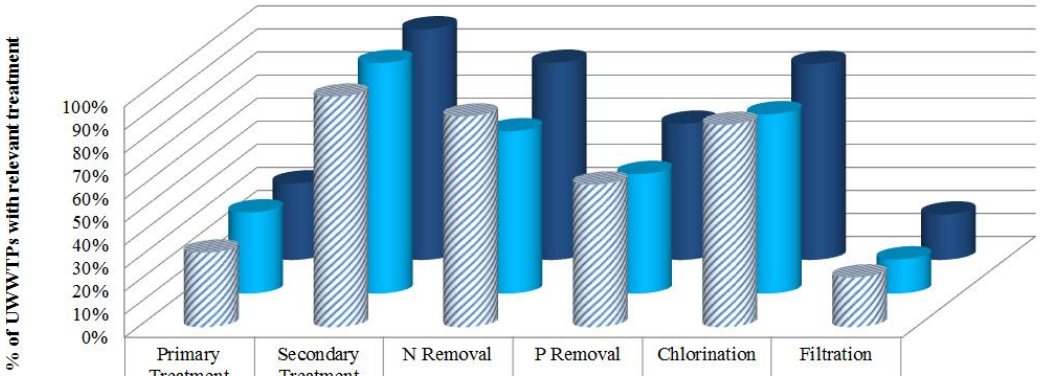

	Primary Treatment	Secondary Treatment	N Removal	P Removal	Chlorination	Filtration
>10000 p.e.	32%	100%	91%	62%	88%	22%
<10000 p.e.	35%	100%	70%	52%	78%	15%
all uwwtps	33%	100%	85%	59%	85%	20%

TREATMENT PROVIDED

- Secondary treatment for the removal of organic load is applied, which in most cases is supplemented by nitrogen removal (for more than 85% of the WWTPs) and/or phosphorus removal (60%).
- Similar practices are used for small and larger wastewater treatment plants
- Chlorination is the preferred method for disinfection.
- Tertiary treatment including filtration is not widely practiced → low percentage of wastewater reuse applications (less than 2% of the total wastewater produced).
- Sludge treatment: thickening-dewatering unit, supplemented by some form of stabilization (aerobic or anaerobic). Almost 40% of the plants perform anaerobic digestion and only 8% provide further treatment of sludge in drying plants.

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DATA ANALYSIS

- Data from more than 200 WWTPs were used
- More than 230,000 data entries for influent and effluent concentrations were processed for the period 2011-2015
  - 77% of data were reported by the operators of wastewater treatment plants with a capacity greater than 10000 p.e.,
  - The average number of samples collected per year is 12 for the small and medium sized wastewater treatment plants and almost double for the larger plants
- Quality parameters of BOD_5, COD, SS, TN, NH_4-N, NO_3-N and TP were observed

Open data source: http://astikalimata.ypeka.gr/ is the official national platform for data storage and presentation of operational results from wastewater treatment plants in Greece.

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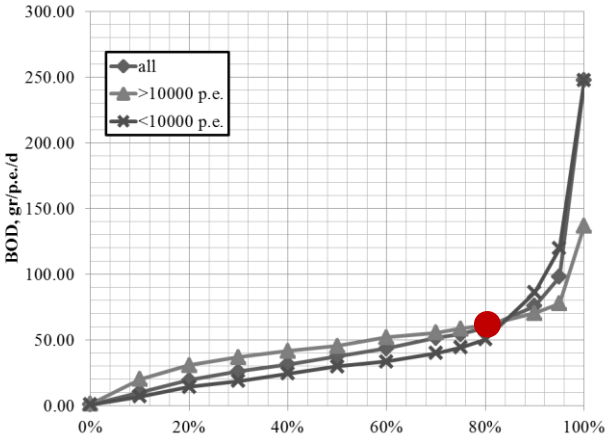
Influent characteristics

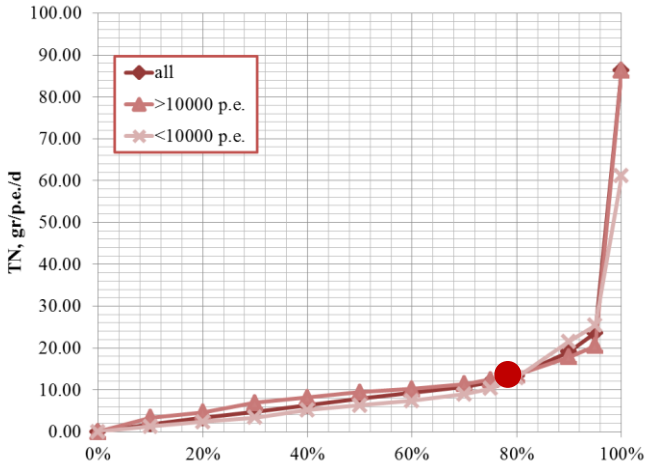
(mg/l)	All data	WWTP capacity		Typical composition of raw municipal wastewater with minor contributions of industrial wastewater		
		>10000 p.e.	<10000 p.e.	High	Medium	Low
BOD	292	304	250	560	350	230
COD	603	639	472	1,200	750	500
SS	282	305	197	600	400	250
TN	54	55	51,4	100	60	30
TP	10	10,2	9,75	25	15	6

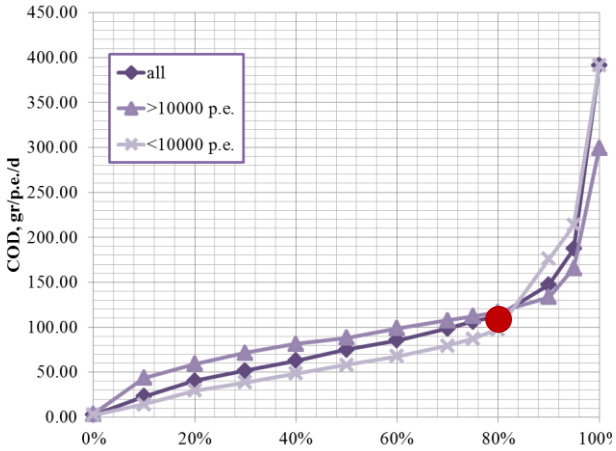
Mean influent concentrations suggest sewage of low to medium strength

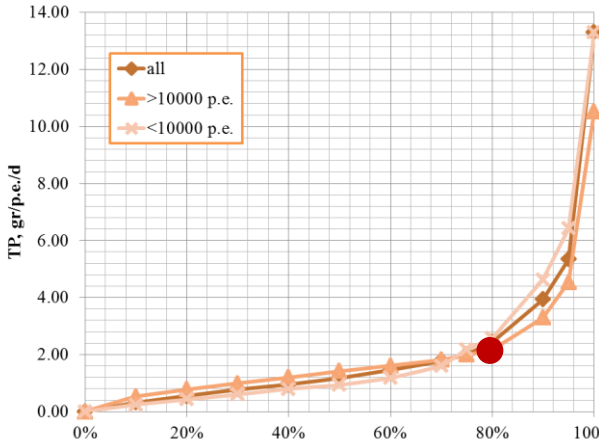
Person Loads

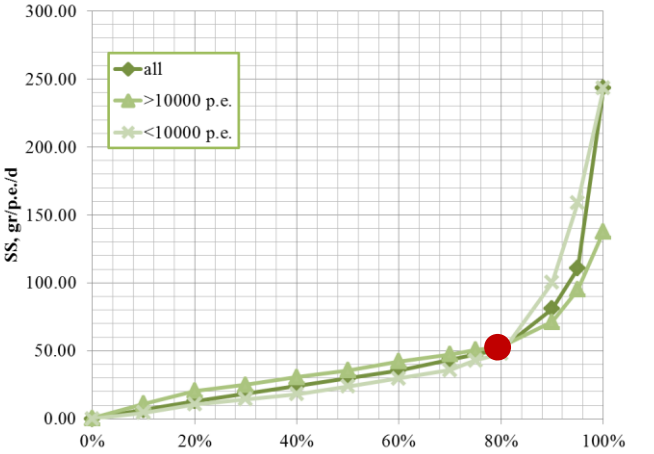


g/p.e./d	All data	WWTP capacity	
		>10000 p.e.	<10000 p.e.
BOD	60	60	50
COD	112	98	117
SS	51	48	53
TN	13.4	12.9	13.5
TP	2.4	2.2	2.6
Flow-L/p.e./d	275	300	250









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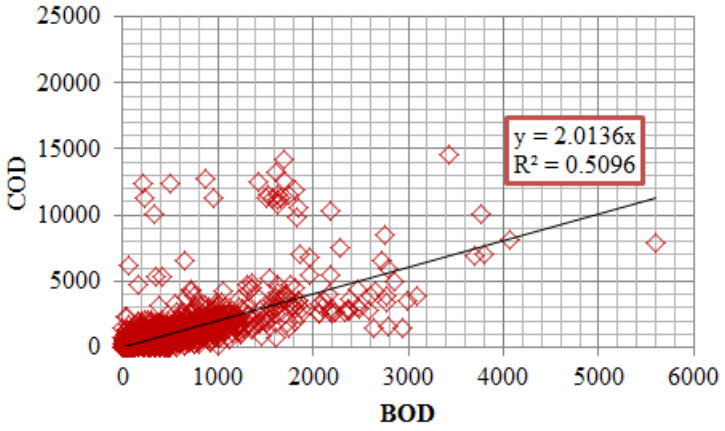


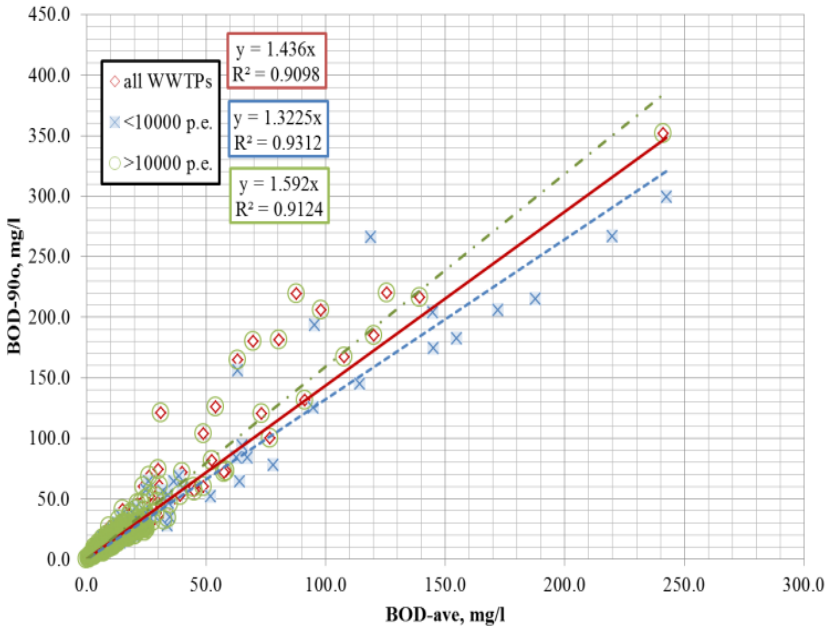
	All data	WWTP capacity		Typical ratios in municipal wastewater		
		>10000 p.e.	<10000 p.e.	High	Medium	Low
COD/BOD	2.0	2.1	1.8	2.5-3.5	2.0-2.5	1.5-2.0
COD/TN	4.6	4.3	6.7	12-16	8-12	6-8
COD/TP	26.6	27.3	24.0	45-60	35-45	20-35
BOD/TN	2.2	2.1	3.1	6-8	4-6	3-4
BOD/TP	14.6	16.2	10.9	20-30	15-20	10-15

COMPONENTS' RATIOs

- Wastewater with high COD to BOD ratio indicates that a substantial part of the organic matter will be difficult to degrade biologically.
- Wastewater with low carbon to nitrogen ratio may need external carbon source addition in order that biological denitrification functions fast and efficiently.

Operational characteristics and design assumptions

- BOD_5 (p90) / BOD_5 (p50) = 1.32 to 1.60
- Lower ratios corresponding to the smaller scale treatment plants.
  - more consistent effluent quality is obtained, perhaps due to limited in number and magnitude shock loads, which overshadow possible disadvantages in terms of personnel and experience.
- BOD_5 (p90) / BOD_5 (p50) = 1.60
  - 25 mg/l requirement from the Directive refers to the value to be achieved for 88%-93% of the samples, it is wise to design a plant aiming at a median BOD_5 concentration of 15 mg/l.



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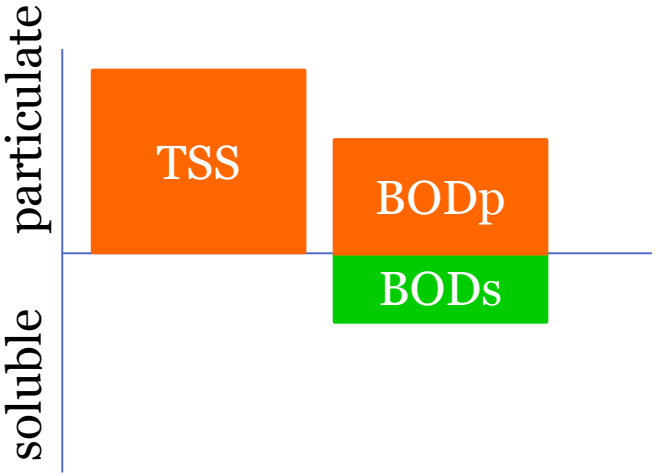

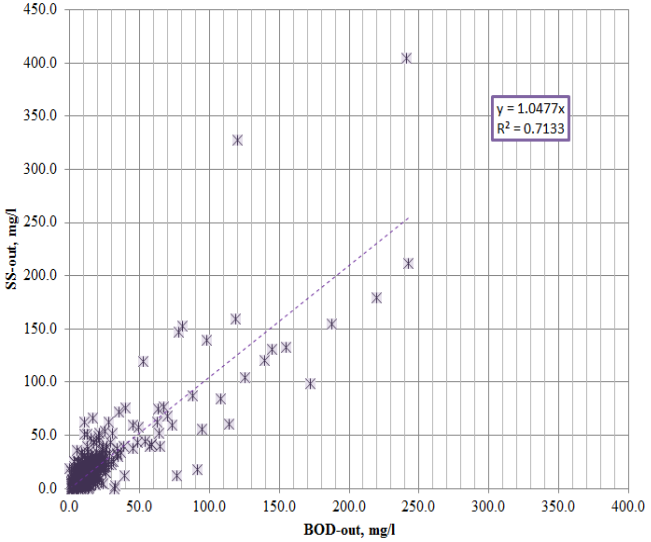

- Most design models are based on the expected soluble BOD_5 in the reactor
- The presence of SS in the effluent results in particulate BOD_5 in the effluent.
- The ratio of SS/BOD_5 is approximately 1.
- 1 mg of SS corresponds to 0.60-0.70 in terms of particular BOD_5

a safe design value for the soluble BOD_5 to be achieved is to the order of 4-5 mg/l.

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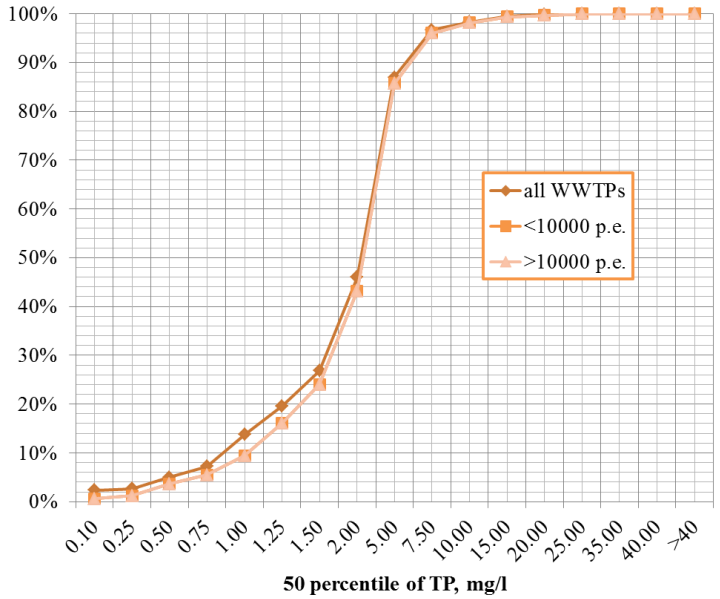

TREATMENT PERFORMANCE

- Compliance with the provisions of the UWWTD refers to effluent concentrations of BOD, COD and SS and depending on the type of the recipient nitrogen and phosphorus.

	UWWTD discharge limits, mg/l	All WWTPs	<10000 p.e.	>10000 p.e.
BOD-p90	25	86%	87%	86%
COD-p90	125	94%	94%	94%
SS-p90	35	87%	87%	87%
TN-p50	15	80%	79%	79%
TP-p50	2	46%	43%	43%

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CONCLUSIONS

MANAGEMENT

Wastewater treatment on Greece is satisfactory both in terms of the infrastructure, i.e. the WWTPs constructed and respective population served.

There are still challenges that have to be addressed…

OPERATION

Wastewater characteristics are in good agreement with low or medium strength wastewater which is expected considering the relatively limited industrial activity in the country.

PERFORMANCE

Almost 90% of the wastewater treatment plants meet the effluent standards set by the UWWTD for BOD, COD and SS

80% of the plants adequately remove nitrogen.

FUTURE CHALLENGES

- Meet the requirements of the UWWTD with respect to small to medium sized areas (>200 agglomerations of 2000-10000 p.e.)
- Promote sustainable wastewater management for communities with <2000 p.e. (SSW Guide)
- Optimise the operation of WWTPs
- Adopt wastewater reuse practices

ACKNOWLEDGEMENTS

Thanks are due to the Special Secretariat for Water for facilitating the provision of the data regarding Urban Wastewater Treatment in Greece. All data are open and available from the web site http://astikalimata.ypeka.gr/ which is the official national platform for data storage and presentation of wastewater treatment plants in Greece.

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