Digitalisation of the water sector and water education

DigiwatRO

Mathematical Model of a Collecting and Wastewater Treatment Integrated System

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Summary

1. Introduction
2. Structure of the Wastewater Collecting and Treatment Integrated System
3. Mathematical Model
4. The Influent
5. Simulation Results
6. Conclusions

1. Introduction

General **OBJECTIVE:**

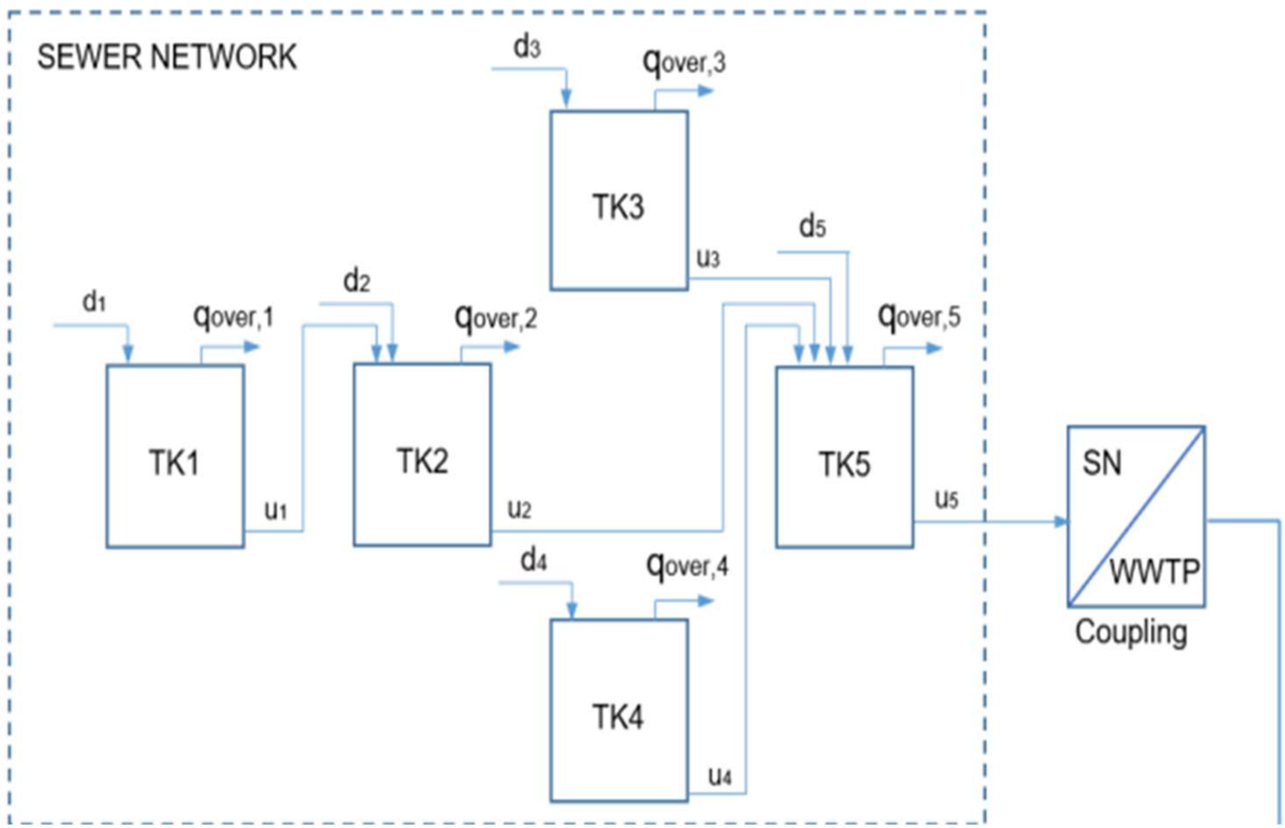
Development of a mathematical model of an integrated wastewater collecting and wastewater treatment system that serves a city that can be used later to optimize the whole integrated system.

The development of this model followed the steps:

- Modeling of the sewer network (SN) - BSM sewer benchmark.
- Modeling of the WWTP with SIMBA software – using ASM2d model
- Coupling between the Sewer Network and Waste Water Treatment Plant model
- Simulation of the integrated mathematical model using an influent with two pluviometric events and two static operating points for WWTP.

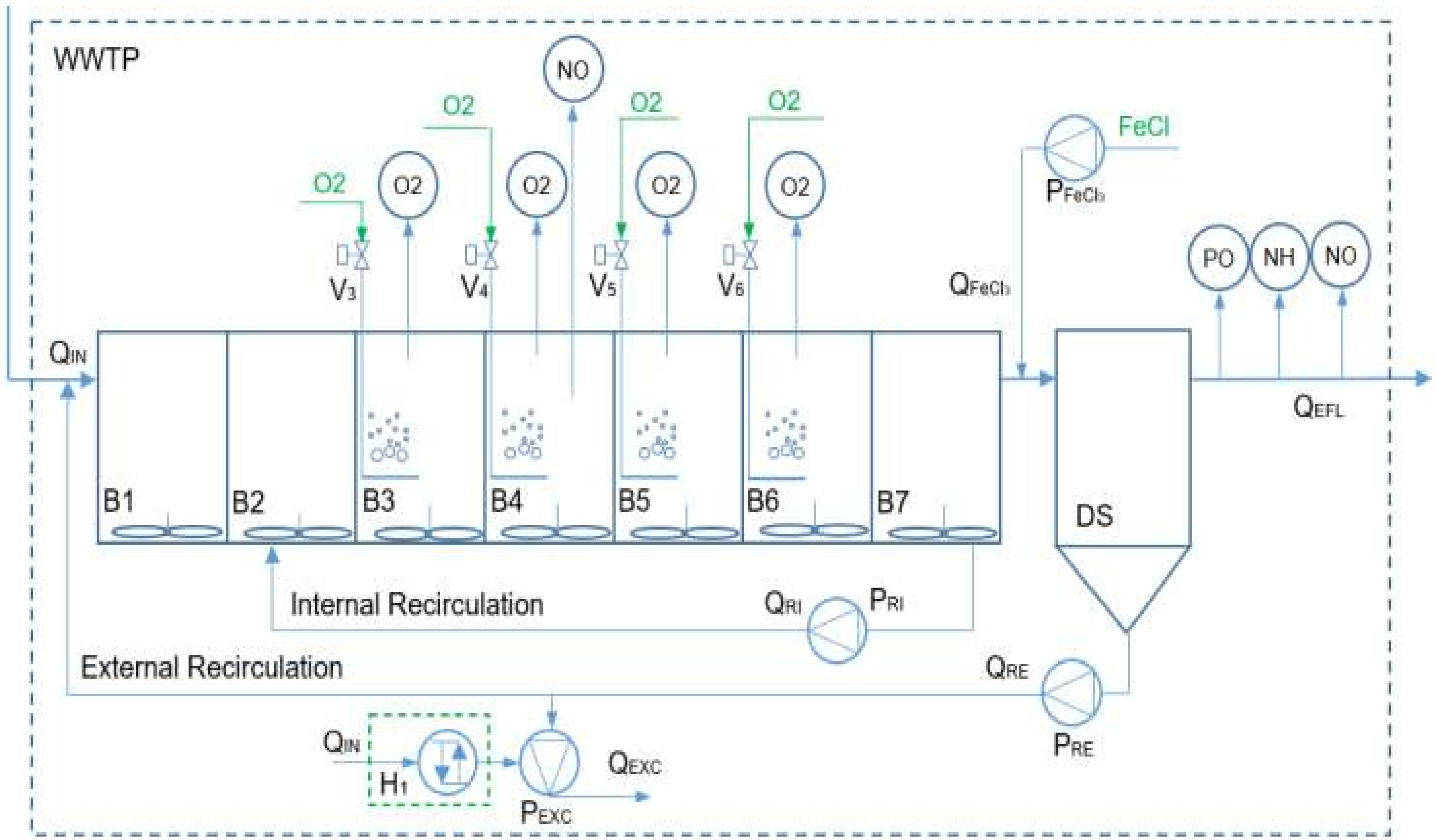
2. Structure of the Integrated System

The scheme of the collecting system.



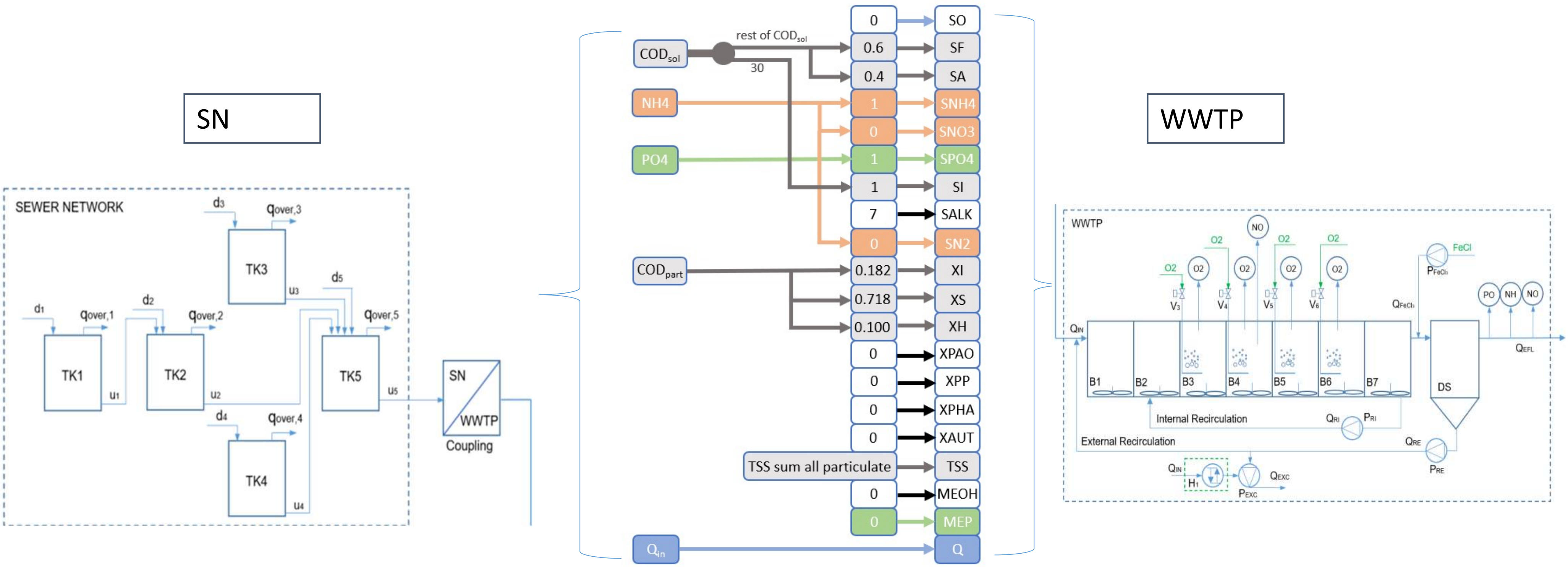
2. Structure of the Integrated System

The scheme of the WWTP



2. Structure of the Integrated System

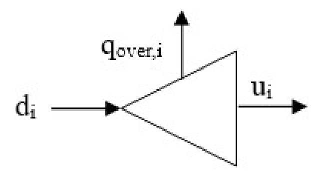
The coupling scheme

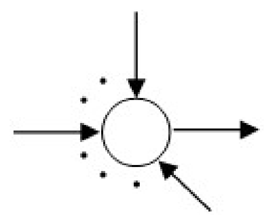


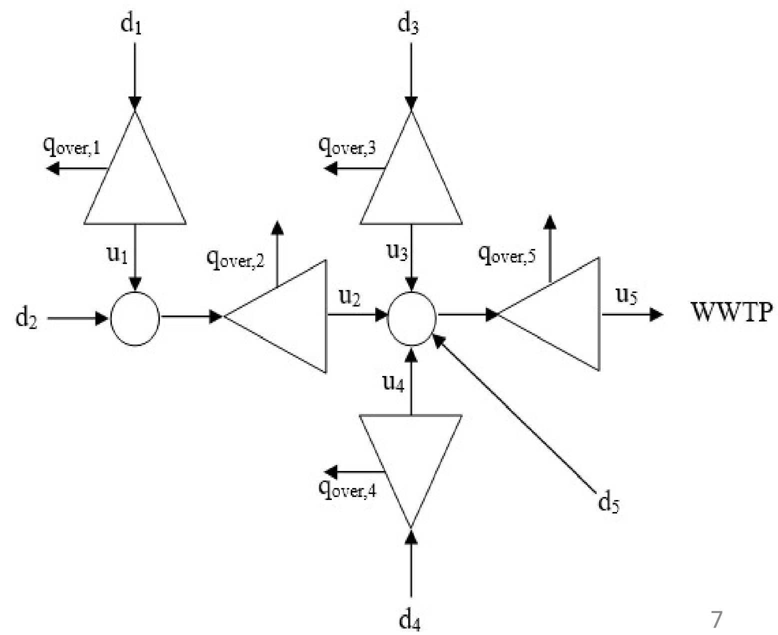
3. Mathematical model the Integrated System

The general scheme of the collecting system

Tank number	The population served [number of inhabitants]	The tank volume $[m^3]$	Maximum flow at the tank output $[m^3/day]$
1	35000 (first area)	1750	15750
2	40000 (second area)	2000	33750
3	25000 (third area)	1250	11250
4	75000 (fourth area)	3750	33750
5	75000 (fifth area)	3750	112500

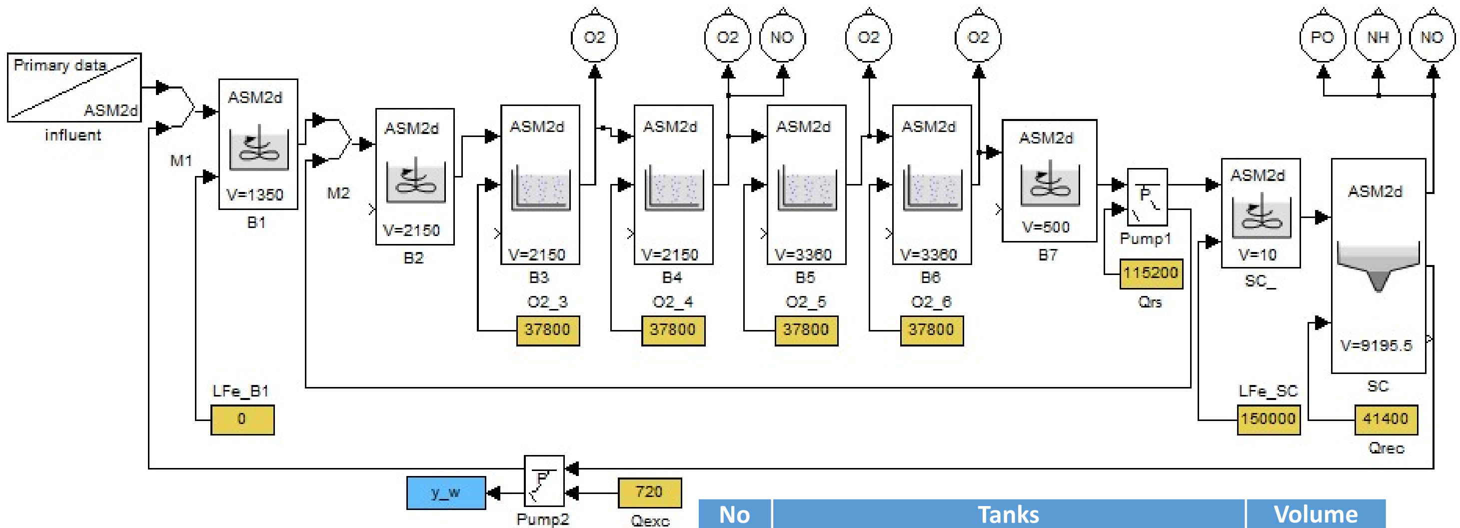






3. Mathematical model the Integrated System

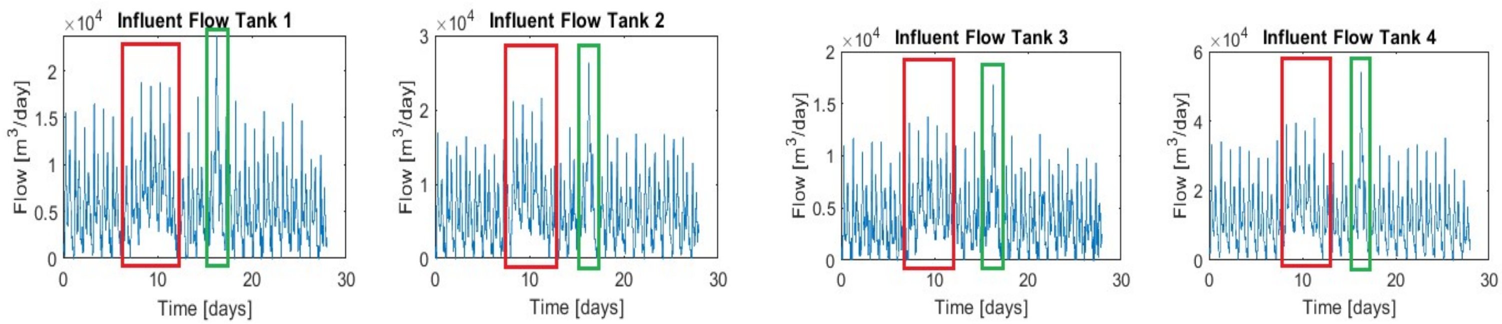
The general scheme of the collecting system



No	Tanks	Volume [m³]
1	Anoxic tank with continuous mixing (B_1)	1200
2	Anoxic tank with continuous mixing (B_2)	2200
3	Aerated tank (B_3)	2200
4	Aerated tank (B_4)	2200
5	Aerated tank (B_5)	3300
6	Aerated tank (B_6)	3300
7	Deaeration tank (B_7)	500
8	Secondary clarifier (SC)	9000

4. The Influent

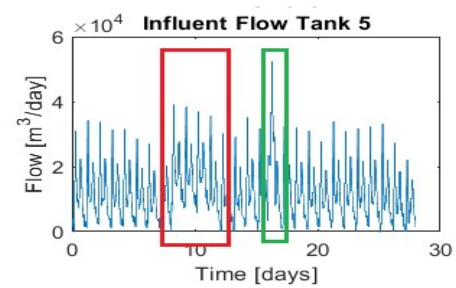
The influent in SN tanks



Simulation horizon - 28 days

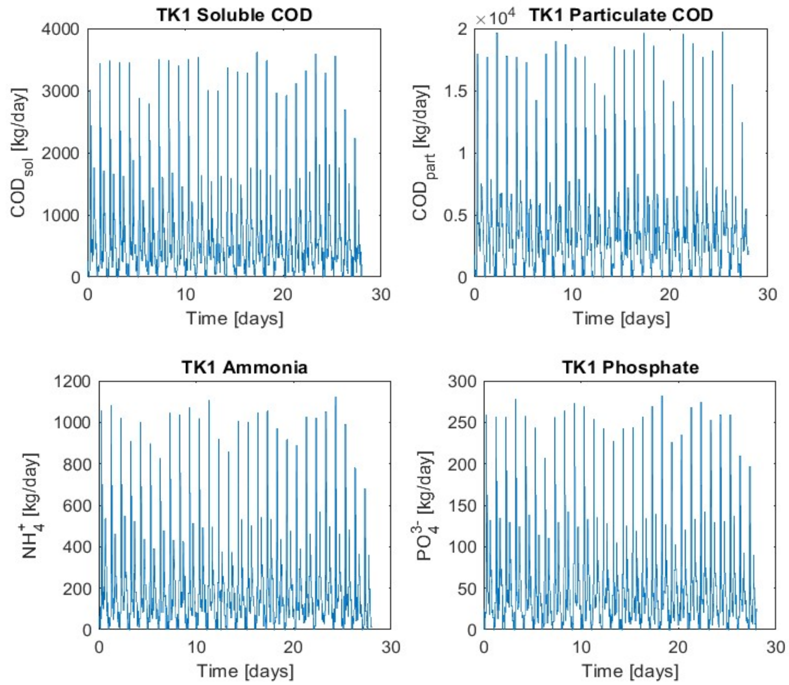
Pluviometric events:

- A rain event - red
- A storm event - green



4. The Influent

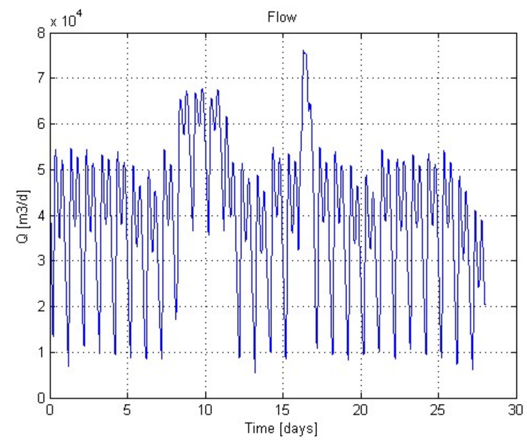
The SN influent loads

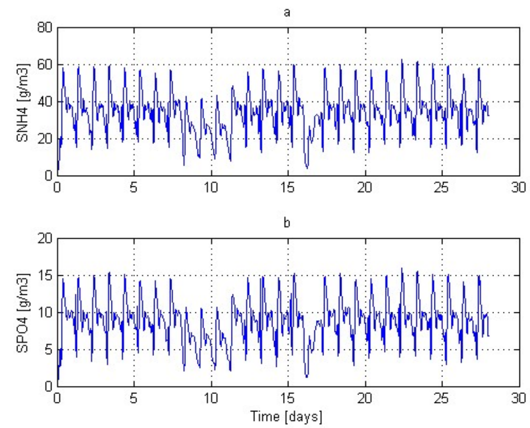


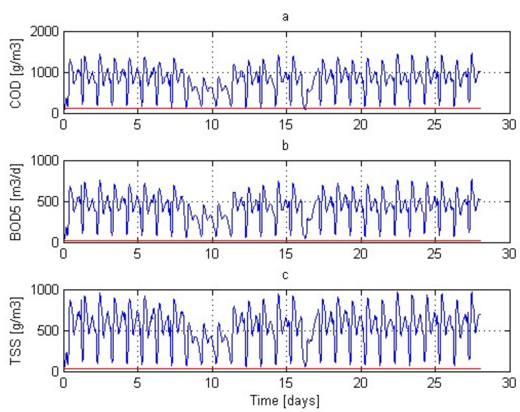
Tank	CODsol [Kg/day]	CODpart [Kg/day]	NH_4+ [Kg/day]	PO_4^{3-} [Kg/day]
TK_1	701.56	4042.88	211.93	55.35
TK_2	805.96	4658.18	241.27	62.57
TK_3	503.78	2943.23	151.41	39.05
TK_4	1497.68	8666.01	454.64	115.32
TK_5	1498.05	8626.34	451.08	116.49

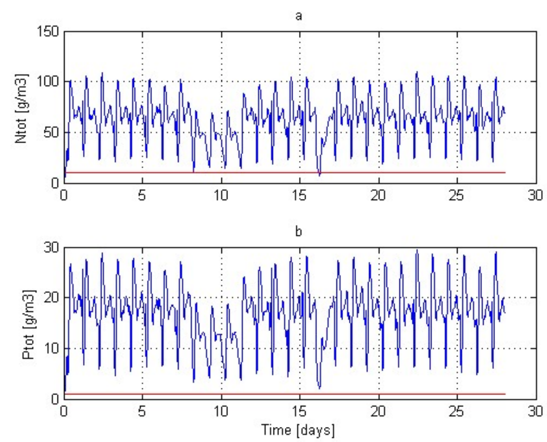
5. Simulation results

The WWTP influent flow and loads



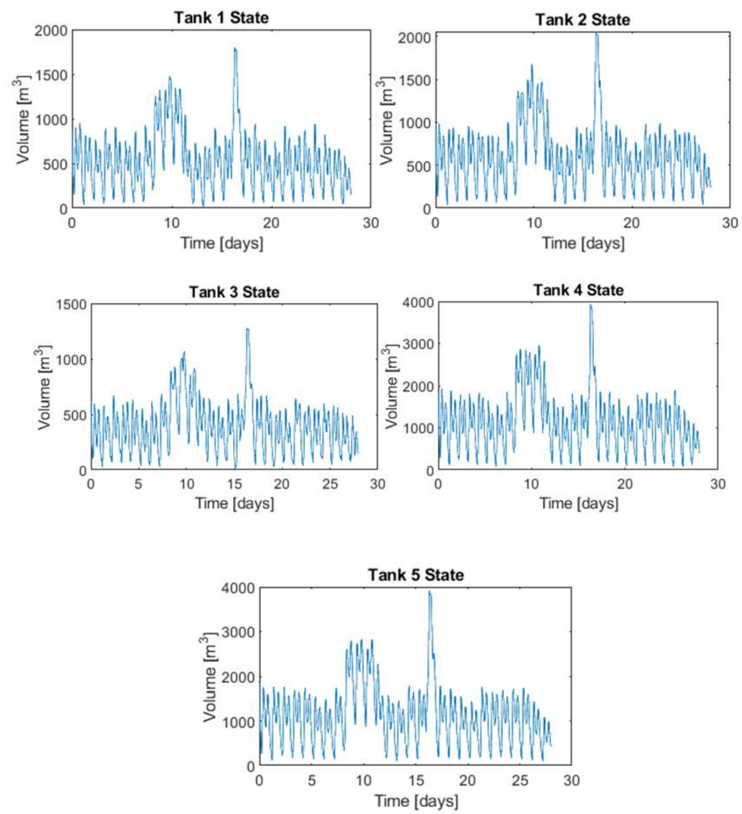


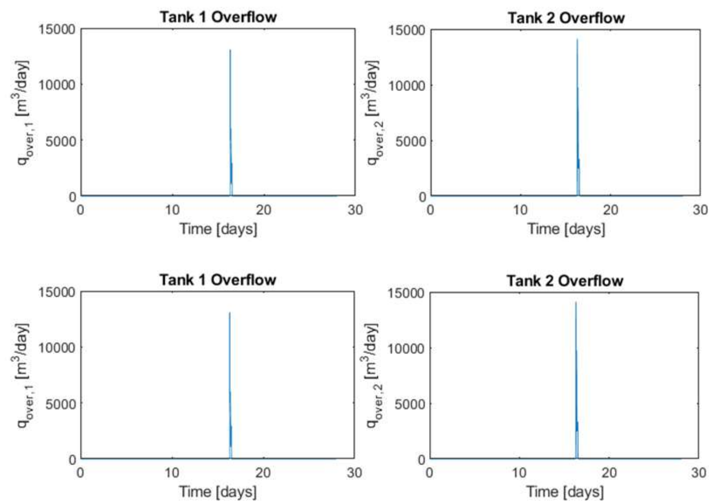


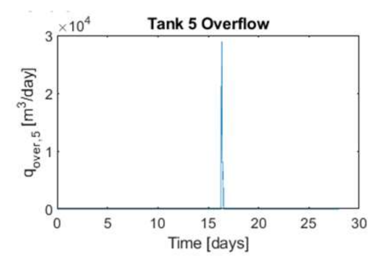


5. Simulation results

Wastewater volumes evolution in SN tanks – and Tank overflows



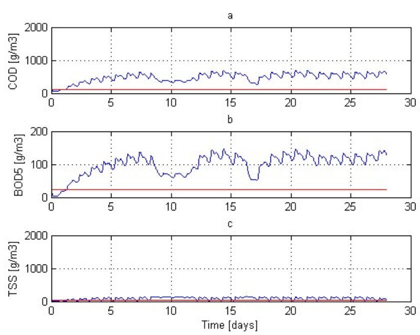


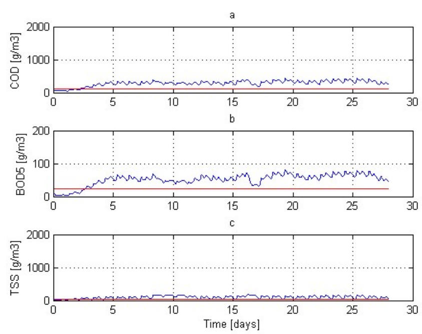


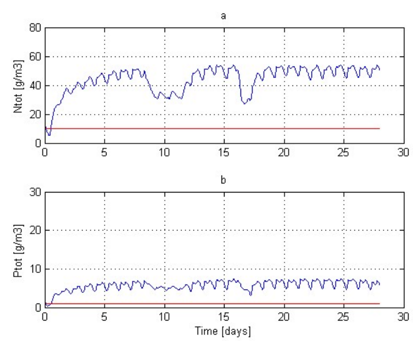
5. Simulation results

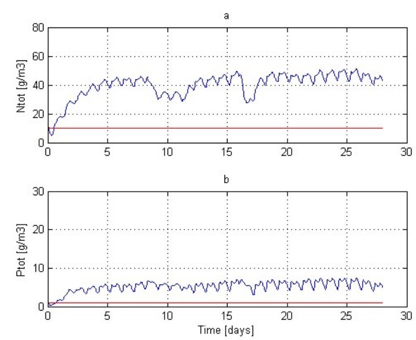
WWTP effluent evolution

Op. point	Q aeration [Nm³/day]	Q internal recirc. [m³/day]	Q external recirc. [m³/day]	Q excess sludge [m³/day]	$FeCl_3$ [g/day]
A	75.600	57.600	20700	320	75.000
B	151.200	115.200	41400	720	150.000.









point *A* - to average values regarding the aeration, the internal and external recirculation, the removal of the excess sludge and the addition of ferric chloride.

point *B* - to the maximum values of the variables mentioned above.

OP	IQI	EQI	OCI
A	196059	109368	25511
B	196059	90528	41275

6. Final conclusions.

The paper proposes a mathematical model of an integrated system consisting of a sewer network and a WWTP designed and built to treat the wastewater from a city with a population of 250,000 inhabitants.

A coupling between the sewer network model (BSM Sewer) and the WWTP model (ASM2d) was made.

The integrated model was validated by numerical simulation considering an influent collected from five collecting areas with loads specific to the considered city previously mentioned.

The obtained results showed that in the integrated system occur discharges only in the storm regime and it achieves a reduction of the wastewater loads related to the 5 collecting areas, but not enough to comply with the norms provided by the legislation.

The objective of the subsequent researches is to use the proposed mathematical model of the integrated system for the development of control algorithms (optimization) to achieve an efficient operation of the assembly sewer network - WWTP.