Long-term observation of the end-of- treatment sludge quality from a Parisian WWTP treating wastewater from 6.5 M inhabitants

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Introduction

Wastewater contains a wide range of biological and chemical markers related to human activity. The collection and analysis of these markers in the effluents (wastewater and sludge) allow to qualify the public health of the population and to evaluate the impact of the chemicals used in daily life on the environment.

In line with these studies, the Innovation Department of SIAAP and its scientific partners (ISA and LEESU) has created an Observatory of the city with the objectives of:
• Monitoring the long-term dynamics of known and/or potential pollutants according to French regulations.
• Contributing to studies aimed at a better understanding of anthropogenic activities.
• Structuring and centralizing data (wastewater and end-of-treatment sludge), ensuring their storage for 10 years.
• Providing technical and scientific knowledge by publishing every two years the data generated by the Observatory of the city via the open platform Zenodo.

Regarding the end-of-treatment sludge, the Seine Aval (SAV) plant has been chosen as a strategic location, since the catchment area corresponds to the Parisian west catchment (6.5 million inhabitants). Data on the sludge micropollution (in metals, polycyclic aromatic hydrocarbons – PAHs and polychlorinated biphenyls – PCBs) are available since 1980 and are provided in the present dataset.

Catchment area and network description

The urban catchment of the Seine Aval (SAV) wastewater treatment plant (WWTP) corresponds to the catchment area of western Paris as shown in Figure 1 and Table 1. This catchment area is characterized by a heavy urbanization, with an area of 800 km² (117 municipalities including the city of Paris) and more than 6 million inhabitants, the rate of soil sealing reaches 36% (Table 1). This characteristic of the catchment induces a quality of wastewater of domestic type during dry weather. During rain events and since the network type is mostly combined (62.5%), strong variations of volume and quality are observed.

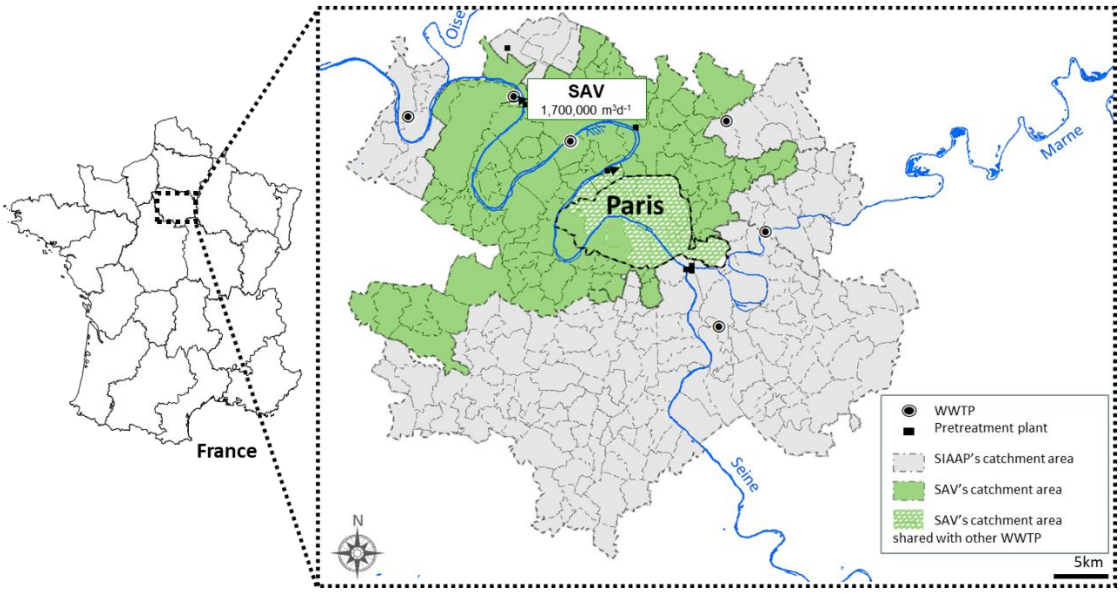

Figure 1. SIAAP Cathcment area (grey) - SAV Catchment area (green)

Table 1. Data on catchment area, population and characteristics of SIAAP and SAV network.

	SIAAP	SAV
Catchment area (km²)	1914	800
Municipalities	288	117
Population * (inhab.)	9 188 686	6 182 691
Density (inhab./km²)	4 801	7724
Soil sealing (%)	29	36
Sewer network type (%) **		
Combined	28,7	62,5
Mixed	6,9	10,7
Separate	64,4	26,8

* Data source: INSEE 2017, imported in November 2020 "https://www.insee.fr/en/statistics/4799309"

**Based on the areas of the municipalities with connected network, database updated in December 2019 by SIAAP.

SAV WWTP description

SAV is located downstream of the Parisian conurbation and has nowadays a capacity of 1 700 000 m^3/day. The treatment is based on a biofiltration process line (80% of the WWTP flow) and membrane bioreactor process line (20% of the WWTP flow). SAV is designed to efficiently reach the European standards (« Directive 91/271/EEC » 1991 - DERU; « Directive 2000/60/EC » 2000 - DCE).

Water treatment

From 1937 until the end of the 1990's, the water treatment process of SAV was based on the biological treatment by activated sludge in aeration channels followed by decanters. However, due to the increase of the population in the Parisian region and the evolution of the regulation (DERU/DCE) several major changes have been made to the treatment process as follows:

2000: Addition of a phosphorus treatment unit (clarifloculation).

2007: Addition of a nitrogen pollution treatment unit (nitrification-denitrification).

2012: Addition of a nitrogen pollution treatment unit (post-denitrification).
2017: Upgrade of the nitrogen pollution treatment units and launching of the membrane bioreactor treatment line.

Sludge treatment

Although the water treatment line of SAV has significatively evolved since its construction, the sludge treatment line has remained essentially unchanged. The sludge treatment includes:

Thickening- homogenization: The purpose of the thickening-homogenization process is to prepare and pre-stabilize the sludge and to homogenize the sludge coming from the various water treatment processes, before it reaches the sludge digestion step.
Digestion: The objective of sludge digestion is to produce biogas and stabilize the sludge. This biological process uses mesophilic bacteria (temperature close to 35°C) that degrade volatile compounds and produce methane (CH_4), carbon dioxide (CO_2) and water. Digestion is slow and requires a residence time ranging between 16 and 30 days.
Thermal conditioning: This part of the process has two main objectives, first is to sanitize the sludge to obtain a product suitable for agricultural valorization, and second is to modify its chemical structure by breaking the bonds between water and dry matter (colloidal bonds) in order to optimize the following step (filtration). For this, sludge is heated up at 195°C and 20 bar, for 45 minutes.
Dehydration The objective here is to increase the dry matter content (up to 50%) using filter presses, at 8 to 10 bar.

The conventional process is illustrated in Figure 2.

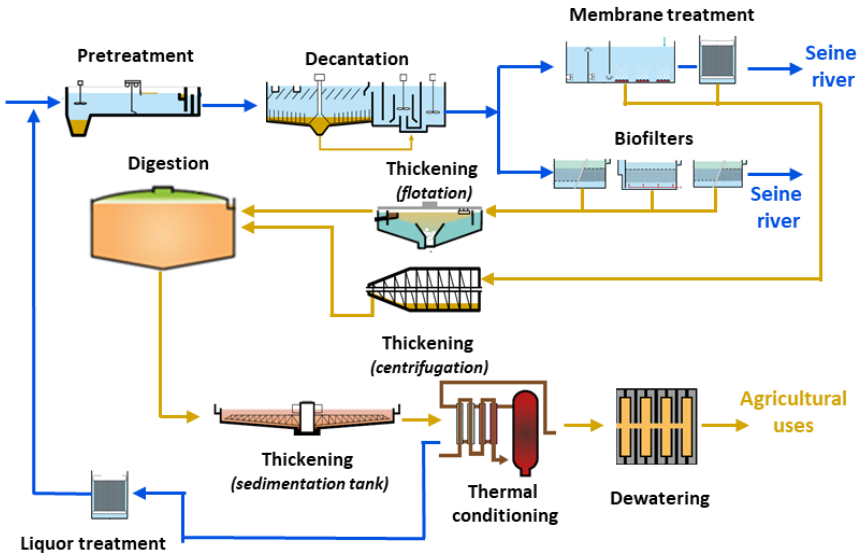

Figure 2. Schematic diagram of the wastewater and sludge process lines at SAV.

Dataset description

The dataset "Dataset _CakesSAV.xlsx" includes the monthly analysis of 42 micropollutants (trace metals, PAHs, PCBs, ammonium, calcium oxide, magnesium oxide and elementary analysis) of the end-of-treatment sludge (called "cakes") of SAV. The oldest analyses date back to 1980.
The quality of the sludge is commonly characterized by dry matter (DM, in % - 1% = 10 g/L) and volatile matter (VM, in % DM). The mean value for DM is 50.64 ± 1.52 % (n = 3985) from daily measurements from 2010 to 2020 and VM is 39.28 ± 1.54 (n=60) from monthly measurements between 2015 and 2020.

Physico-chemical analysis of several micropollutants is carried out once a month. An average representative sample from the dehydration process outlet is constituted using samples from each day of the week of the analysis. Details on each analytical method and the associated regulations are provided in the “Dataset_analyticalmethods_CakesSAV.xlsx”

The following files are available:

- Dataset _CakesSAV.xlsx
- Dataset_analyticalmethods_CakesSAV.xlsx