

Sensitivity analysis of temporal parameters in a dynamic LCA framework

Allan Hayato Shimako, Ligia Tiruta-Barna, Ana Barbara Bisinella de Faria, Aras Ahmadi, Mathieu Spérandio

LISBP, Université de Toulouse, CNRS, INRA, INSA, Toulouse, France, 135 Avenue de Rangueil, F-31077 Toulouse, France

Supplementary Information document

SI.1. Dynamic effluent for the WWTP case study

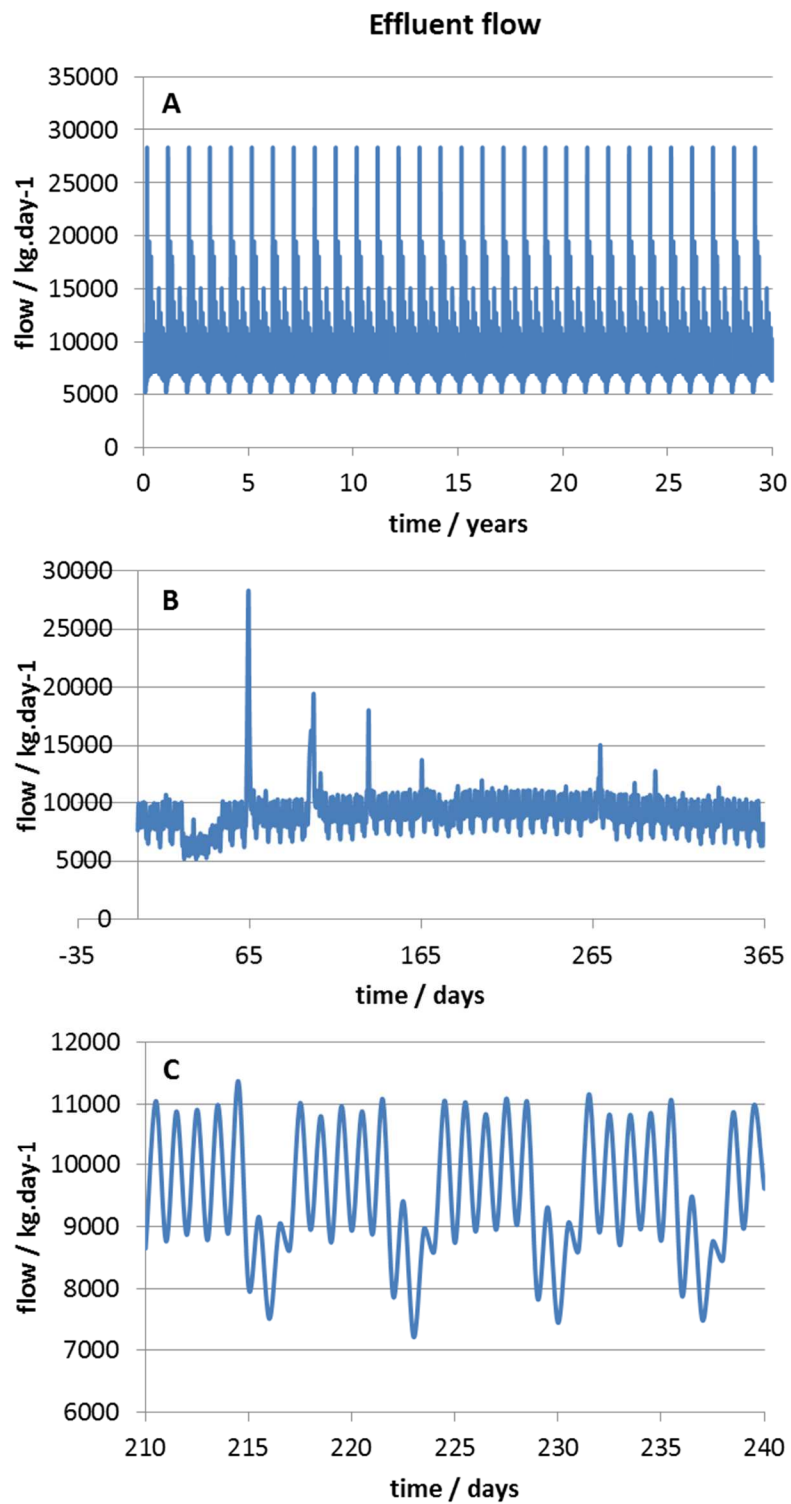


Figure 1.1 – Dynamic effluent flow for the case study of a WWTP. Three different time periods for the effluent flow are shown: A represents the representative period of 30 years; B represents a period of 1 year (first year); and C represents a period of 1 month (month 7).

SI.2. Conventional and dynamic data for WWTP case study inventory.

Table 2.1. – Conventional inventory for the case study of a WWTP.

Process	Operational data	Ecoinvent process	Unit	Value
WWTP	Infrastructure	wastewater treatment plant, class 2, CH	unit	2.3E-09
	Electricity	electricity mix [FR]	kWh	4.0E-01
	Methanol	methanol, at plant, GLO	kg	1.7E-02
	Iron chloride	iron (III) chloride, 40% in H ₂ O, at plant, CH	kg	6.2E-02
	Incineration		kg	3.2E-02
	Emission	carbon dioxide, fossil [air/ high population]	kg	7.6E-04
		methane, fossil [air/ high population]	kg	7.4E-17
		dinitrogen monoxide [air/ high population]	kg	6.1E-07
		copper [water/ unspecified]	kg	3.4E-08
		lead [water/ unspecified]	kg	1.1E-08
		zinc [water/ unspecified]	kg	1.2E-07
		chloroform [water/ unspecified]	kg	6.8E-08

Table 2.2. – Process relative dynamic parameters for the case study of a WWTP (T and r in year; α and β present a unit which is the ones presented in table 1 by year).

Process	Process model					
WWTP	α =see ¹	β =see ¹			T=30	r=see ¹
Electricity	α =0.02	β_{CO_2} =9.4E-7	$\text{B}_{\text{N}_2\text{O}}$ =1.4E-9	β_{CH_4} =2.1E-11	T=50	r=0.0027367
Methanol	α =0.033	β_{CO_2} =5.1E-7	$\beta_{\text{N}_2\text{O}}$ =3.4E-9	β_{CH_4} =3.8E-12	T=30	r=0.0027367
Iron chloride	α =0.02	β_{CO_2} =1.3E-6	$\beta_{\text{N}_2\text{O}}$ =2.3E-9	B_{CH_4} =4.0E-11	T=50	r=0.0027367
Infrastructure	α =0.333	β_{CO_2} =1.8E-3		B_{CH_4} =2.8E-6	T=3	r=3
		$\text{B}_{\text{N}_2\text{O}}$ =1.8E-8		B_{Pb} =2.9E-10		
Incineration	α =0.02	β_{CO_2} =2.1E-7		β_{Cu} =4.1E-10	T=50	r=0.0027367
		β_{Zn} =2.3E-9		β_{Pb} =3.9E-10		

¹ Temporal characteristics of this process was simulated in other software called Sumo.

Table 2.3. – Supply chain relative dynamic parameters for the case study of a WWTP (δ in year and a presents the same units as in table 1).

Producer	Consumer	Supply model	
Electricity	WWTP	cont ($a = -4.0E-01$)	$\delta = 0$
Methanol	WWTP	$a = -1.7E-02$	$\delta = 0.164$
Iron chloride	WWTP	$a = -6.2E-02$	$\delta = 0.164$
Infrastructure	WWTP	$a = -2.3E-09$	$\delta = 0.5$
Incineration	WWTP	$a = -3.2E-02$	$\delta = 0.019$

SI.3. Dynamic impact results for the case study of WTTP.

The table below presents the time step size used for the calculations of dynamic LCI and dynamic LCIA, on a basis of 365.24 days/year.

Table 3.1 – Time step size in common units used for the dynamic calculation and their correspondence in days

Time step size in common units	0.5 day	1 day	1 week	1 month	1 season	1 year
Time step size in days	0.5	1	7	30.44	91.31	365.24

Table below shows the relative difference between the cumulated values for the dynamic toxicity impact between the different step sizes and the reference interval of 1 year. The results for organic, inorganic and all substances show that the results for cumulated dynamic ecotoxicity and human toxicity do not have an important difference for different step sizes, at 100 years.

Table 3.2 – Relative difference between cumulated values for toxicity impact for organic, inorganic and all substances. Results for different dynamic LCIA time step sizes (0.5 day, 1 day, 1 week, 1 month, 1 season and 1 year), for a calculation time span of 100 years

All substances			
	Ecotoxicity	Human cancer	Human non-cancer
0.5 day	1.6%	1.7%	1.7%
1 day	1.6%	1.7%	1.7%
1 week	1.5%	1.5%	1.6%
1 month	1.4%	1.7%	1.6%
1 season	1.0%	0.9%	1.0%
Organic substances			
	Ecotoxicity	Human cancer	Human non-cancer
0.5 day	0.8%	0.8%	0.8%
1 day	0.8%	0.8%	0.8%

1 week	0.8%	0.8%	0.8%
1 month	0.8%	0.8%	0.8%
1 season	0.5%	0.8%	0.8%
Inorganic substances			
	Ecotoxicity	Human cancer	Human non-cancer
0.5 day	1.6%	1.7%	1.7%
1 day	1.6%	1.7%	1.7%
1 week	1.5%	1.5%	1.6%
1 month	1.4%	1.5%	1.4%
1 season	1.0%	1.0%	1.1%

The influence of the integration time step for climate change impact calculation (convolution product calculation) is represented in table below.

Table 3.3 - Dynamic mean temperature change - values calculated for 100 years. Results for different time steps (0.5 day, 1 day, 1 week, 1 month, 1 season and 1 year) for the dynamic model resolution. In all calculations, the inventory time step was fixed to 1 year.

ΔT value at year 100 (K)	0.5 day	1 day	1 week	1 month	1 season	1 year
Carbon dioxide	5.5E-17	5.5E-17	5.5E-17	5.5E-17	5.6E-17	5.8E-17
Methane	6.0E-19	6.0E-19	6.0E-19	6.0E-19	6.0E-19	6.3E-19
Dinitrogen monoxide	8.6E-20	8.6E-20	8.6E-20	8.6E-20	8.7E-20	9.1E-20
Total	5.6E-17	5.6E-17	5.6E-17	5.6E-17	5.6E-17	5.9E-17