Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supplementary information

Data "% of area equipped for irrigation by surface water" provided by AQUASTAT in given year were calculated as:

[% of area equipped for irrigation by surface water] = 100*[Area equipped for irrigation by surface water]/[Area equipped for irrigation: total]

Data "% sprinkler irrigation intensity out of total irrigation" were calculated as:

[% sprinkler irrigation intensity out of total irrigation] = 100*[Area equipped for full control irrigation: sprinkler irrigation]/[total agricultural water managed area]

These two groups of data in the same period from 2013 to 2017 were collected for EU28. However, few abnormal results were higher than 100%. This is because of the incoherence of data collection time between two parameters in the calculation as shown in Table S. Solutions and corresponding values are also shown in Table S1.

Table S1. Discrepancies and solutions of irrigation related parameters

	National data information		**reference**	**solution and reference**	**value**
Poland	% of area equipped for irrigation by surface water				
	total area equipped for irrigation	area equipped for irrigation by surface water	Irrigation area sheet-Poland, AQUASTAT 2019	calculate surface water percentage out of the sum of total areas for all the irrigation water sources (surface water and groundwater)	102.7/(102.7+11.6)
value (1000ha)	75.81	104.1			
data collection time	2013	2007			
Latvia	% of area equipped for irrigation by surface water				
	total area equipped for irrigation	area equipped for irrigation by surface water	Irrigation area sheet-Latvia, AQUASTAT 2019	use surface water% data in 2007 provided by Irrigation report Latvia-AQUASTAT 2016	93%
value (1000ha)	0.63	0.77			
data collection time	2013	2007			
Estonia	% of area equipped for irrigation by surface water				
	total area equipped for irrigation	area equipped for irrigation by surface water	Irrigation area sheet-Estonia, AQUASTAT 2019	use surface water% data in 2005 provided by Irrigation report Estonia-AQUASTAT 2016	86%
value (1000ha)	0.458	1.17			
data collection time	2010	2005			
Estonia	% sprinkler irrigation intensity				
	Area equipped for full control irrigation: sprinkler irrigation	total agricultural water managed area	Irrigation area sheet-Estonia, AQUASTAT 2019	no coherent data provided by Irrigation report Estonia-AQUASTAT 2016	N/A
value (1000ha)	3.68	0.43			
data collection time	1995	2010			
Lithuania	% sprinkler irrigation intensity				
	Area equipped for full control irrigation: sprinkler irrigation	total agricultural water managed area	Irrigation area sheet-Estonia, AQUASTAT 2019	no coherent data provided by Irrigation report Lithuania - AQUASTAT 2016	N/A
value (1000ha)	9.247	4.49			
data collection time	1995	2010			

Table S2. AgNP concentrations measured in surface water in EU scope (from[1])

Location	**Measured**	**Distribution**	**Reference**

	time		
River, Vltava, Czech Republic	2017	Uniform(100,3200)	[2]
Surface water, 1.5 km downstream, Germany	2013-2014	Uniform(0.9,2.3)	[3]
River Isar, next to WWTP effluent discharge areas, Germany	2013-2014	Uniform(2.0,8.6)	[3]
River, next to WWTP effluent discharge areas, Germany	2016	Uniform(2.42,69.18)	[4]
River, Germany	2016	Uniform(1,2)	[4]
IJssel, Holland	2018	Uniform(0.3,2.5)	[5]
Meuse, Holland	2018	Uniform(0.3,6.6)	[5]
Pre-alpine lakes, Germany	-	Normal(2.35,0.08)	[4]
Wastewater influent, Germany	2013-2014	Uniform(10.1,357)	[3]

Table S3. Country-specific sludge application and irrigation related parameters

reference	[6,7]	[8]	[9]	[10]	
data form	legislation limits	database provided calculated data	real data	real data	real data calculation
EU28	**maximum sludge application rate (t DW/ha)**	**% of area equipped for irrigation by surface water (%)**	**total agricultural water managed area (1000 ha)**	**Area equipped for full control irrigation: sprinkler irrigation (1000 ha)**	**sprinkler percentage (Ir_sp)**
Austria	2.5-10/2 yr	0.22052927	99.76	0	0.00%
Belgium	4/2 yr or 12/3 yr	0.509384776	19.18	0	0.00%
Bulgaria	0		115.5	23.18833652	20.08%
Croatia	0		29.68	1.473024523	4.96%
Cyprus	0	0.580592147	38.943	1.927305027	4.95%
Czechia	0		45.86	13.09265507	28.55%
Denmark	10/yr		299	0	0.00%
Estonia	-	0.86	0.43	3.68	
Finland	digestion (<5%) (assume neglegible)	0.638981391	102.1	58.78	57.57%
France	-		2691	2464.416272	91.58%
Germany	5/3yr	0.136457717	676.4	655.8076401	96.96%
Greece	-		1517	0	0.00%
Hungary	0		230	192.6188786	83.75%
Ireland	2/yr	0.8	1.1	0	0.00%
Italy	5 (Collivignarelli et al. 2019; EC, 2011 PART1)	0.631910766	4124	1591	38.58%
Latvia	-	0.93	0.672	0	0.00%
Lithuania	0		4.49	9.247	
Luxembourg	3/yr		0	0	
Malta	0	0.003047619	4.2	0.825688073	19.66%
Netherlands	2-4/yr		522.6	0	0.00%
Poland	-	0.898512686	75.81	3.276145203	4.32%
Portugal	6/yr	0.650237313	547.8	168.6	30.78%
Romania	0		334.7	99.23600265	29.65%
Slovakia	0		99.64	0	0.00%

Slovenia		0		7.604	5.267	69.27%
Spain		-		3681	0	0.00%
Sweden		-	0.880025526	156.7	0	0.00%
United Kingdom		-		207.6	95.60526316	46.05%
Fit distribution	Uniform (0,10)		Triangular (0,0.89851,1)			Triangular (0,0,1)

Table S4. Calculation of crop-specific irrigation needs out of total water needs

Area	Crop	Year	Area harvested (ha)[11]	Harvested irrigated area (1000 ha)[12]	Percentage of irrigation need out of total water needs
Ireland	Wheat	2017	67047	0	0.00
Ireland	Root vegetables	2017	0	0	0.00
Ireland	leafy vegetables	2017	5722	0.5	0.09
Europe	Wheat	2017	61879579	478.95	0.01
Europe	Root vegetables	2017	11604	7.377	0.64
Europe	leafy vegetables	2017	3619763	956.172	0.26

Table S5. Calculations of bioaccumulation factors for crops to AgNPs through root or leafy exposure

symbol	**crop (root exposure)**	**exposed AgNP concentration**	**unit**	**Ag concentration in edible parts**	**unit**	**reference**	**BF**
	Mustard	108	mg/L (Hoagland solution)	30	ug/ml w.w.	[13]	0.28
		324	mg/L (soil colloid)	42			0.13
	silverbeet (chard)	70	mg/kg	7		[14]	0.10
	spinach	70	mg/kg	7		[14]	0.10
	rocket	70	mg/kg	3.65		[14]	0.05
	lettuce	70	mg/kg	0.25	mg/kg d.w.	[14]	0.00
	lettuce	0.1				[15]	0.55
		0.5					0.64
		1					0.61
BF_lv_s							Triangular(0,0.0035714,0.64)
	Radish Sprouts	125	mg/L	114	mg/kg d.w.	[16]	0.91
		250	mg/L	204			0.82
		500	mg/L	900			
BF_rv3_s							Uniform(0.82,1.80)
BF_rv2_s	leek	70	mg/kg	3.65	mg/kg d.w.	[14]	0.05
	carrot	70	mg/kg	7	mg/kg d.w.	[14]	0.10
	beetroot	70	mg/kg	3.65		[14]	0.05
BF_rv1_s							Uniform(0.05,0.1)
BF_w_s	wheat	20	mg/kg	0.02	mg/kg d.w.	[17]	0.001

symbol	**foliar exposure**	**exposed AgNP concentration**	**unit**	**Ag concentration in edible parts**	**unit**	**reference**	**BF**

BF_lv_f	lettuces	45	mg/kg(crop)	9.4	mg/kg(crop)	[18]	0.21

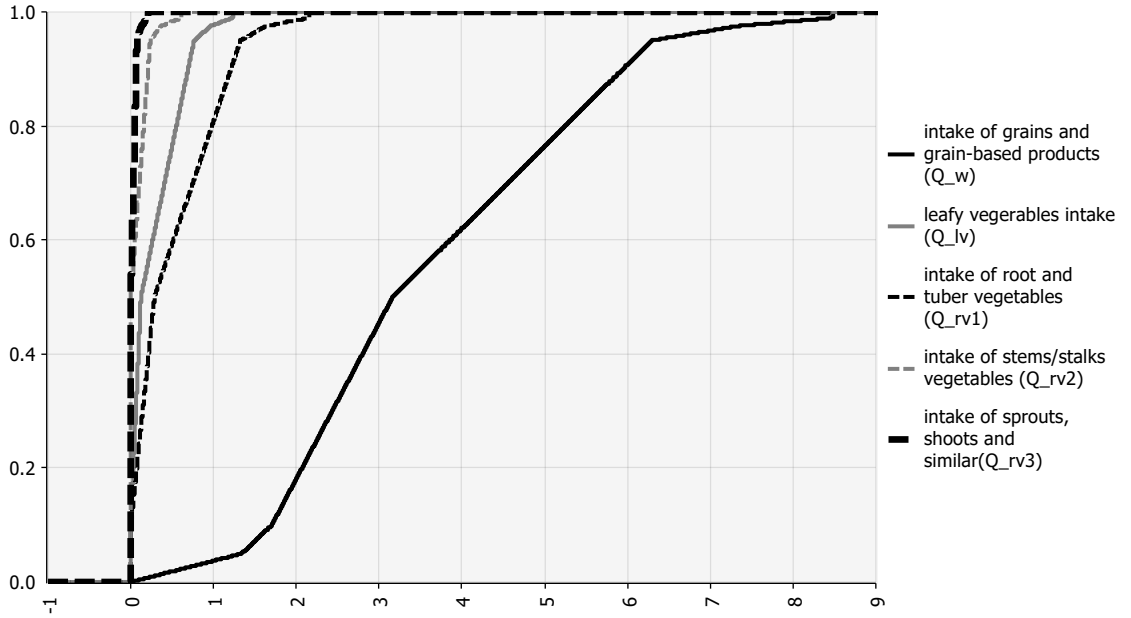
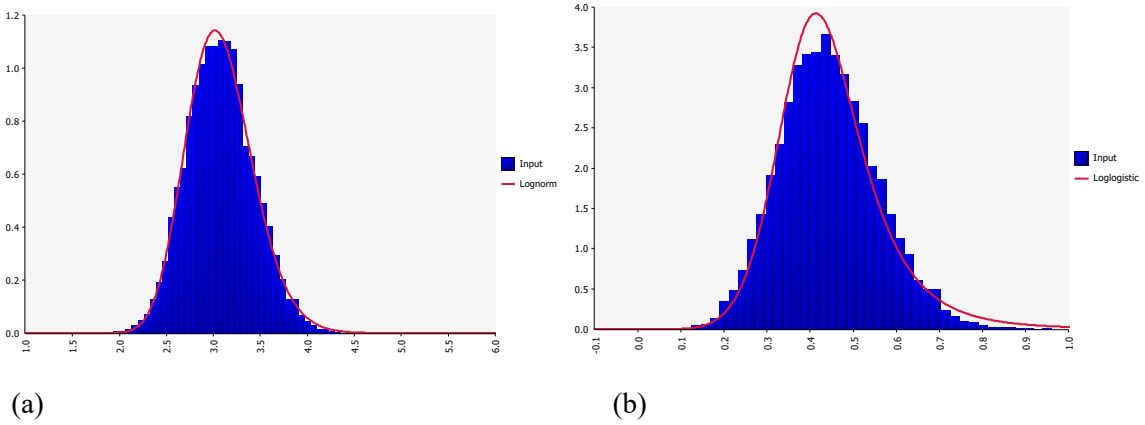
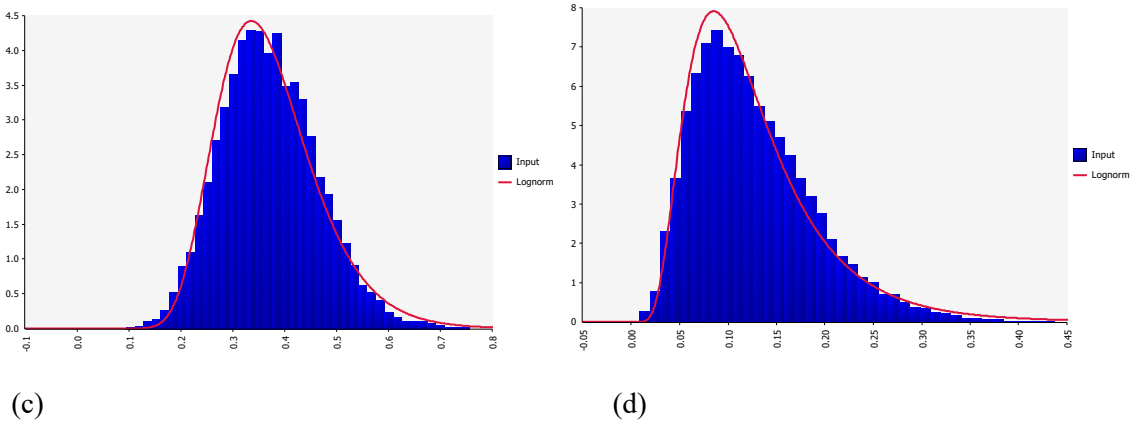


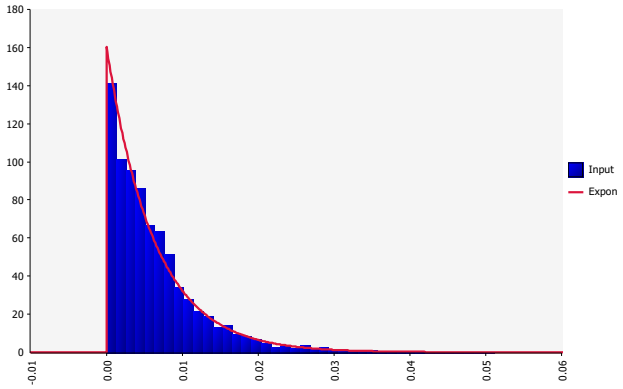
Fig. S1. Cumulative distributions fitted for crops' intake data in Ireland



(a) (b)

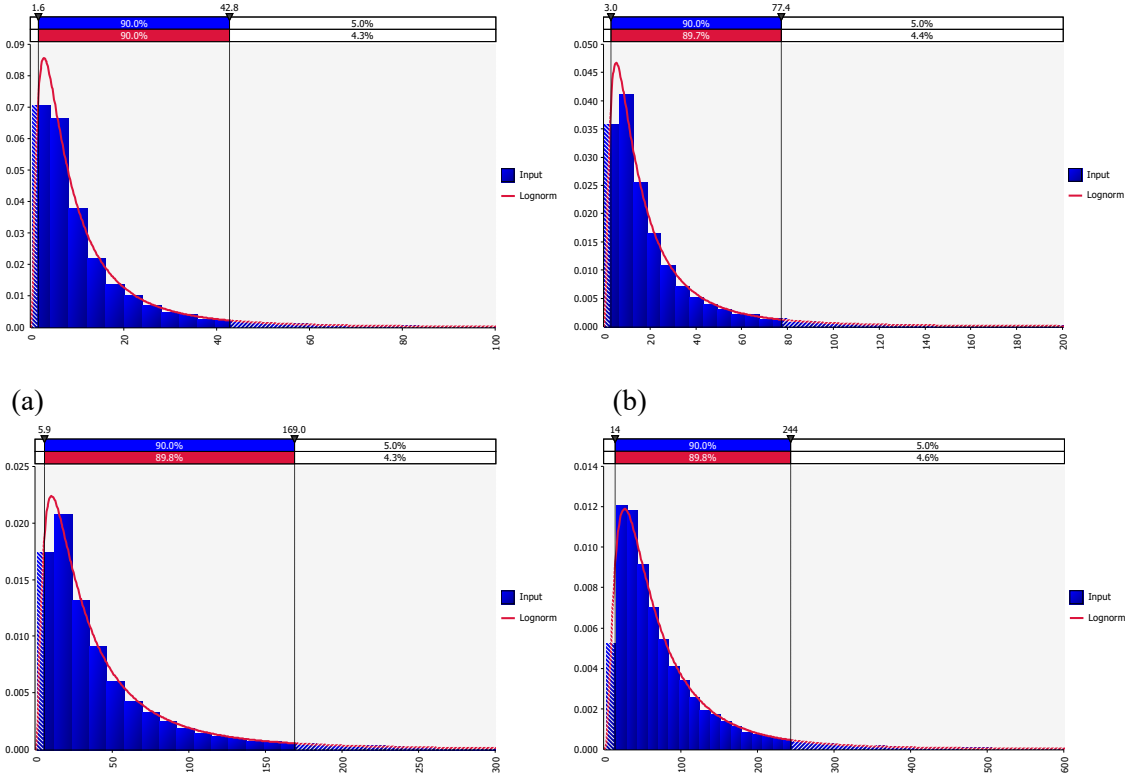


(c) (d)



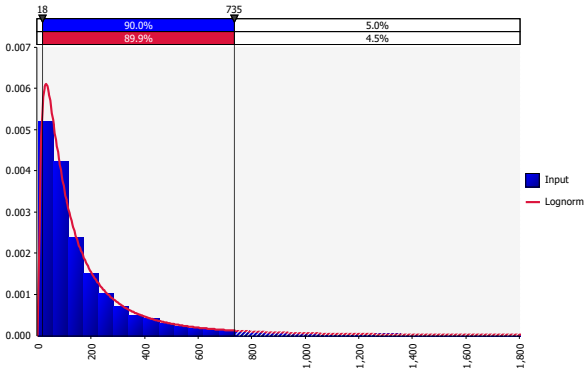
(e)

Fig. S2. Simulations and the best fit distributions of crops' intake data in EU average for (a) wheat and products, (b) leafy vegetables, (c) root and tuber vegetables, (d) stems/stalks vegetables, and (e) sprouts, shoots and similar

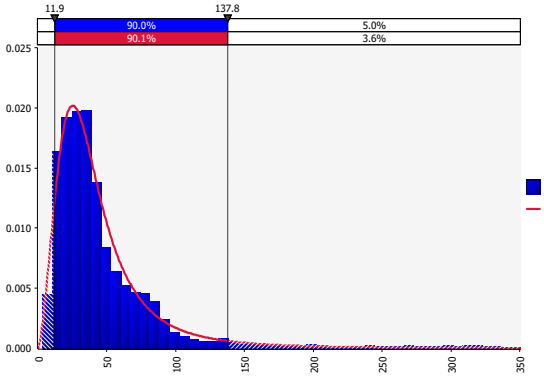


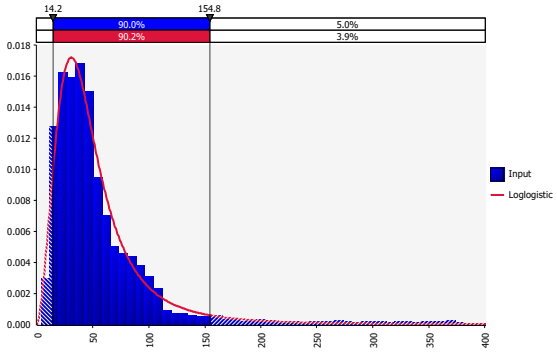
(a) (b)

(c) (d)

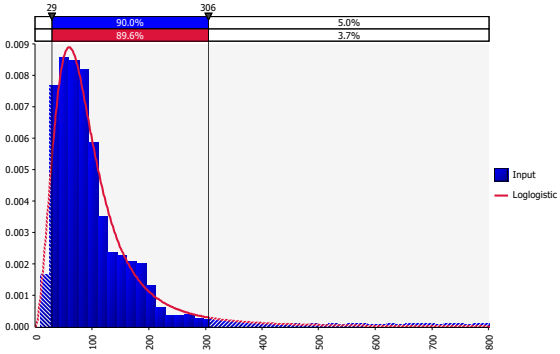


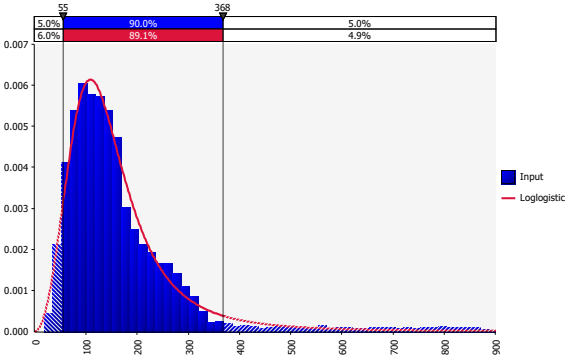
(e)



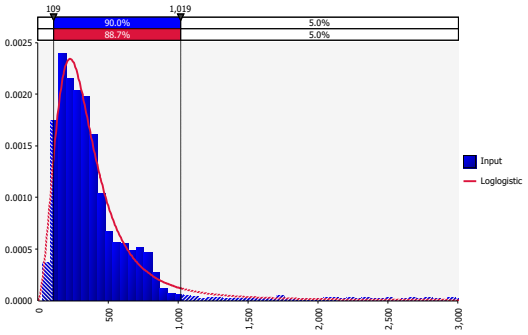


(f) (g)





(h) (i)



(j)

Fig. S3. The best-fit distributions for annual AgNP concentrations (C_sl) in Europe in (a) 2005, (b) 2007, (c) 2010, (d) 2012, (e) 2020; and in Ireland in (f) 2005, (g) 2007, (h) 2010, (i) 2012, (j) 2020

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