Exposure modeling of engineered nanoparticles in the environment

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Supporting Information

Table S1: Derivation of the weighting factor “article” for the allocation of the nano-Ag volume to the product categories

	First 40 products with Google (05/29/2007)	%	Number of products in WWI (*1*) (03/04/2007)	%	Number of products in www.products.ec21.com (05/30/2007)	%	Total number	Average %	Weighting factor "article"
Plastics	11	27.50	26	38.81	31	42.47	68	37.78	0.38
Metals	2	5.00	8	11.94	21	28.77	31	17.22	0.17
Cosmetics/ Supplements	9	22.50	11	16.42	8	10.96	28	15.56	0.16
Sprays/Liquids for cleaning	6	15.00	10	14.93	4	5.48	20	11.11	0.11
Textiles	11	27.50	12	17.91	8	10.96	31	17.22	0.17
Paint/Sealings	1	2.50	0	0.00	1	1.37	2	1.11	0.01
total	40		67		73		180	100	1.00

Table S2: Derivation of the weighting factor “weight” for the allocation of the nano-Ag volume to the product categories

	Mean weight of the articles in the category [g]	Mean concentration of the articles in the category [µg/g]	Mean amount of nano-Ag per article [µg]	% [weight]	Weighting factor „weight“
Plastics	100	100	10000	0.88	0.0088
Metals	50	100	5000	0.44	0.0044
Cosmetics/ Supplements	100	500	50000	4.41	0.044
Sprays/Liquids for cleaning	500	100	50000	4.41	0.044
Textiles	200	100	20000	1.76	0.017
Paint/Sealings	1000	1000	1000000	88.11	0.88

Table S3: Derivation of the weighting factor "article" for the allocation of the nano-TiO_2 volume to the product categories

Derivation of the weighting factor "article"

	Google (05/29/2007)	%	Number of products in WWI (*1*) (03/04/2007)	%	Number of products in www.products.ec21.com (05/30/2007)	%	Total number	Average %	Weighting factor "article"
Sporting goods/ plastics	5	23.81	8	42.11	1	14.29	14	29.79	0.30
Cosmetics/ Supplements	0	0.00	6	31.58	0	0.00	6	12.77	0.13
Coatings/Cleaning/ paste	8	38.10	3	15.79	4	57.14	15	31.91	0.32
Energy	0	0.00	1	5.26	0	0.00	1	2.13	0.02
Metals	8	38.10	0	0.00	2	28.57	10	21.28	0.21
Paint	0	0.00	1	0.00	0	0.00	1	2.13	0.02
total	21		19		7		47	100	1.00

Table S4: Derivation of the weighting factor “weight” for the allocation of the nano-TiO_2 volume to the product categories

	Mean weight of the articles in the category [g]	Mean concentration of the articles in the category [µg/g]	Mean amount of nano-Ag per article [µg]	% [weight]	Weighting factor „weight“
Sporting goods/ plastics	200	300	60000	0.42	0.004
Cosmetics/ Supplements	200	20000	4000000	28.30	0.28
Coatings/Cleaning/ paste	200	300	60000	0.42	0.004
Energy	100	50000	5000000	35.37	0.35
Metals	50	300	15000	0.11	0.001
Paint	1000	10000	10000000	70.75	0.71

Table S5: Compilation of production volumes of nano-Ag from the literature

Specification	**Amount [t/a]**	**Source**
Amount produced/handled by 3 companies in Switzerland (particle size <1µm) in liquid form	3.1	(*2*)
Imports of nano-Ag in paints to Switzerland	0.5	Burkhardt, Pers. Comm.
Amount produced by one company in Switzerland for sprays	0.003	Koch, Pers. Comm.
Production in Europe	110-130	(*3*)
Worldwide	0.1 - 1	DiRienzo, Pers. Comm.
Worldwide	300 – 800	Centonze, Pers. Comm.

Table S6: Compilation of production volumes of nano-TiO_2 from the literature

Specification	**Amount [t/a]**	**Source**
nano-TiO_2 use/production by 6 companies in Switzerland (particles <1 μm)	435	(*2*)
Worldwide production in 2006-10	5000	(*4*)
Worldwide production in 2011-14	>10'000	(*4*)

Table S7: Compilation of production volumes of CNT from the literature

Specification	**Amount (t/a)**	**Source**
CNT production in Switzerland by one company	1	(*2*)
Production CNT by BASF 2009	20	(*5*)
Production CNT by BASF 2011	500	(*5*)
CNT production by the Carbon Nanotechnology Research Institute (Jp) in 2008	120	(*6*)
MWCNT production by Hyperion	110	(*7*, *8*)
CNT production of 27 firms globally in 2004	108	(*9*)
CNT production of 27 firms globally in 2009	1000	(*9*)
Worldwide production in 2003	3	(*6*)
SWCNT and MWCNT worldwide	500	(*6*)
SWCNT production capacity worldwide in 2005	>27	(*10*)
SWCNT production worldwide capacity in 2007	50	(*10*)
SWCNT production capacity worldwide in 2008	100	(*10*)
MWCNT production capacity worldwide 2004	>99	(*10*)
MWCNT production capacity worldwide 2007	>268	(*10*)
MWCNT production capacity worldwide 2008	375	(*10*)

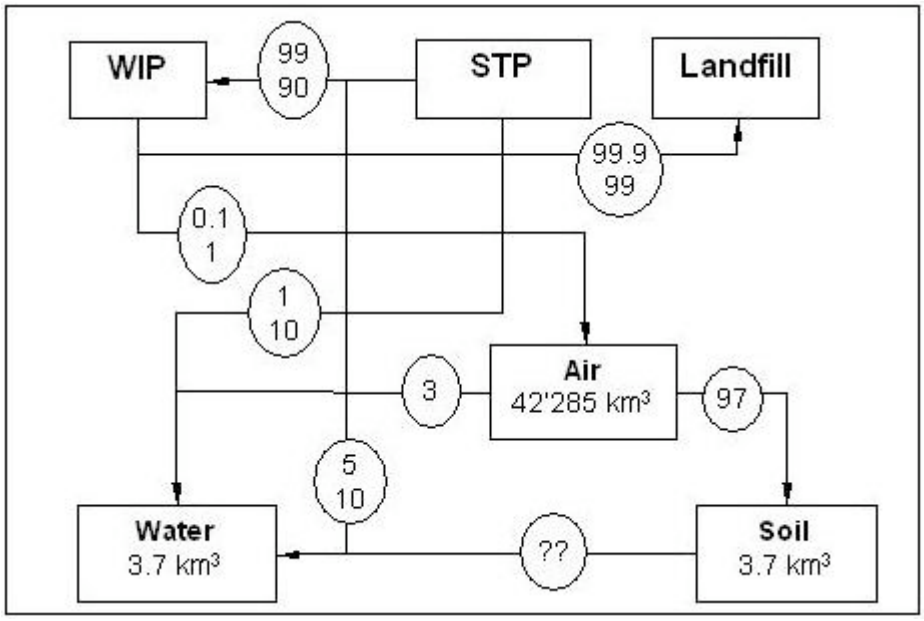
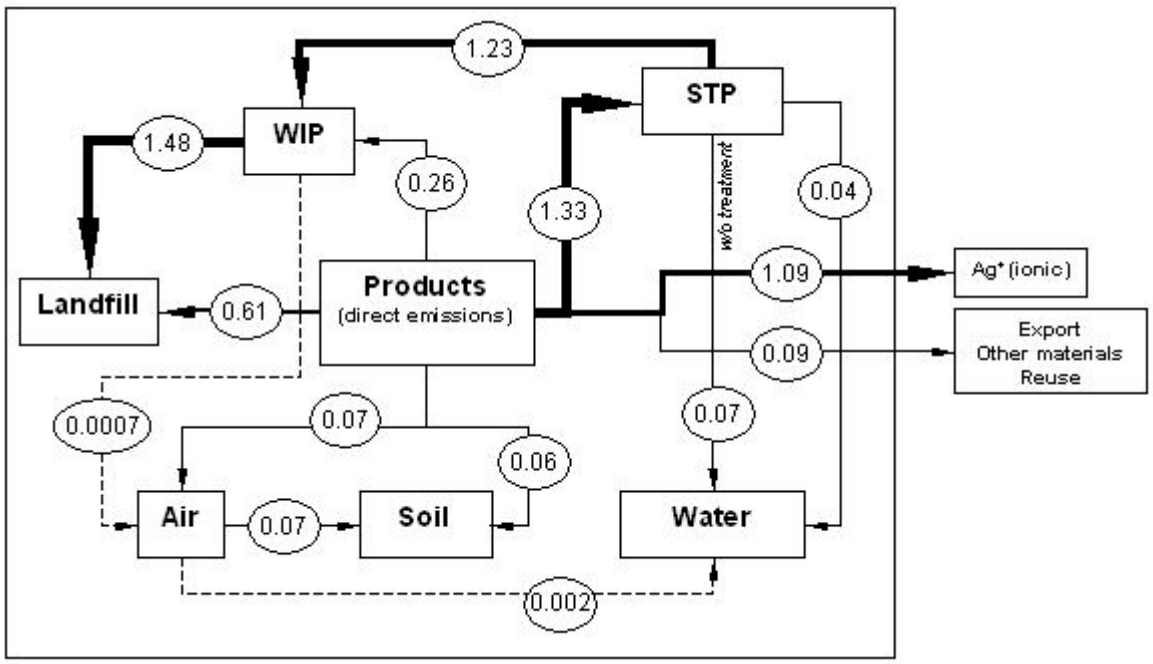
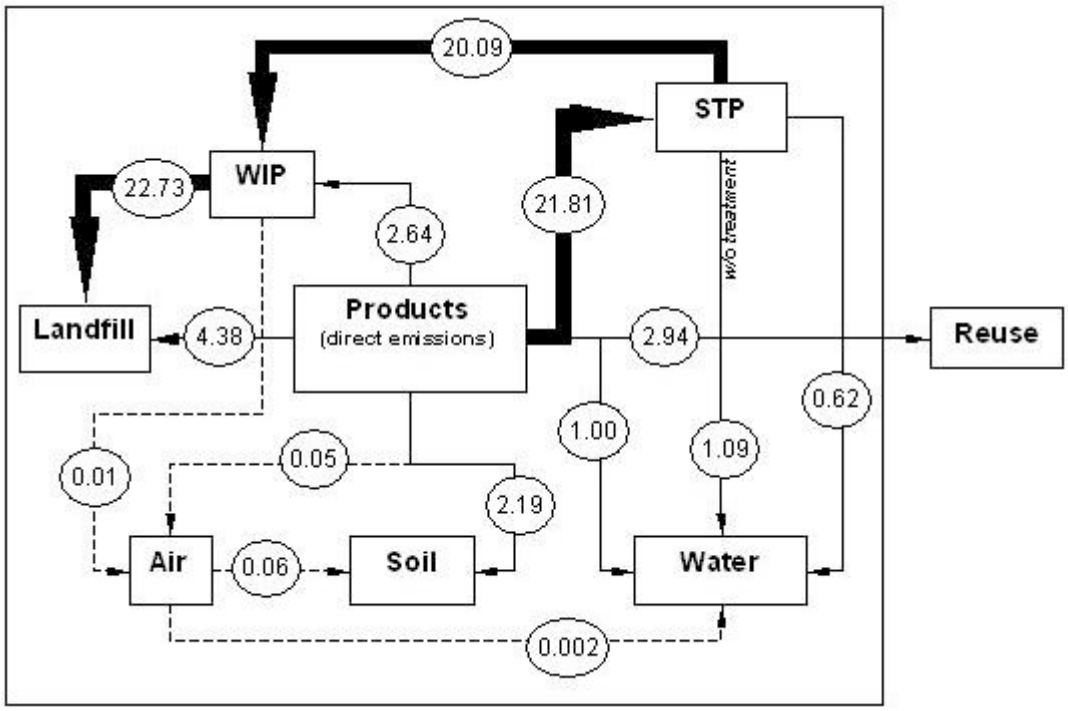


Figure S1: Overview over the flow coefficients (%) between the environmental compartments, WIP, STP and landfill. The upper number represents the coefficient used for the RE-scenario; the lower number is used in the HE-scenario. The dashed line from STP to the water compartment represents the fraction of the overflow discharge (untreated wastewater entering the water compartment).


1.23
STP
1.48
WIP
0.26
1.33
w/o treatment
0.04
Landfill
0.61
Products
(direct emissions)
1.09
Ag+ (ionic)
Export
Other materials
Reuse
0.09
0.0007
0.07
0.07
0.06
Air
0.07
Soil
Water
0.002


20.09
STP
22.73
WIP
21.81
2.64
w/o treatment
Landfill
4.38
Products
(direct emissions)
2.94
Reuse
0.62
1.00
1.09
0.01
0.05
2.19
Air
0.06
Soil
Water
0.002

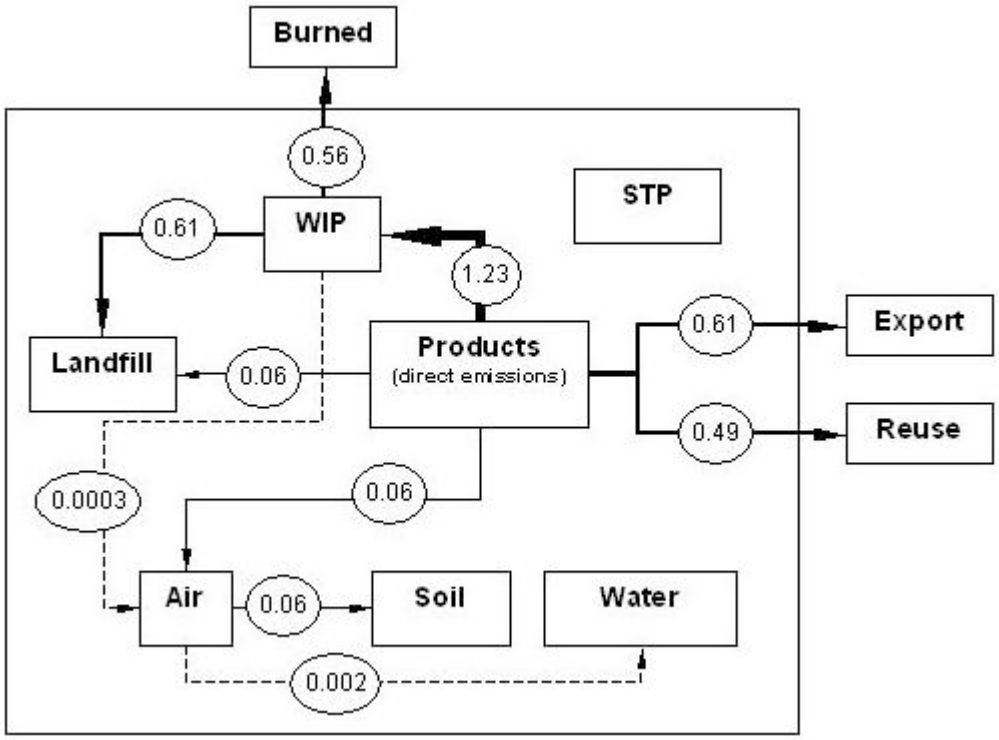


Figure S2: nano-Ag (a), nano-TiO_2 (b) and CNT (c) flows from the products to the different environmental compartments, WIP, STP and landfill (RE-scenario). All flows are in tons/year. The thickness of the arrows is proportional to the amount of silver flowing between the compartments. Dashed arrows represent the lowest volume.

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