Supplementary Materials: Origin, Fate and Control of Pharmaceuticals in the Urban Water Cycle: A Case Study

Figure S1. Sampling location Meuse at Eijsden.

Figure S2. Sampling point Jeker at Maastricht.

Figure S3. Sampling point Geul at Meerssen.

Figure S4. Sampling point Geleenbeek at Oud-Roosteren.

Figure S5. Sampling point Slijbeek.

Figure S6. Sampling point at intake of Water Treatment Plant Heel, Lateraalkanaal.

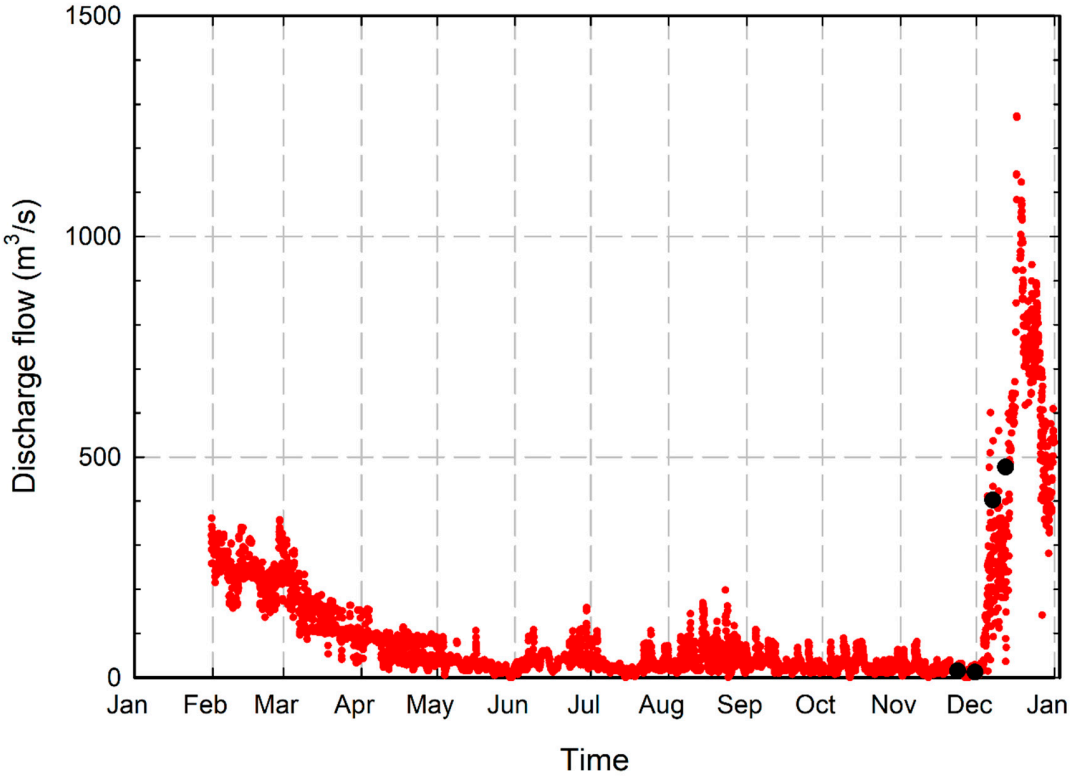

Figure S7. Discharge of the Meuse during 2011. The river showed an extreme low flow from May to early December. The black dots indicate the sampling dates for pharmaceuticals.

Table S1. Concentrations of pharmaceuticals in the Lateraal Kanaal, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.02	0.02	0.04	0.03
bezafibrate	0.01	0.01	0.01	0.01
carbamazepine	0.07	0.07	0.09	0.05
clindamycin	0.01	0.01	0.01	0.01
diatrizoic acid	0.29	0.27	0.23	0.20
diclofenac	0.02	0.02	0.04	0.03
erytromycin A	0.03	0.03	0.03	0.03
furosemide	0.01	0.01	0.01	0.02
gemfibrozil	0.02	0.01	0.05	0.02
guanylurea	4.40	3.40	4.40	1.50
ketoprofen	0.01	0.01	0.01	0.01
lincomycin	0.01	0.01	0.01	0.01
metformin	1.50	1.40	2.00	2.20
metoprolol	0.08	0.09	0.12	0.05
metronidazole	0.01	0.01	0.01	0.01
naproxen	0.01	0.01	0.03	0.03
niacin	0.01	0.03	0.01	0.01
paracetamol	0.01	0.01	0.05	0.01
propranolol	0.01	0.01	0.01	0.01
propyfenazonee	0.01	0.01	0.01	0.01
sotalol	0.12	0.13	0.18	0.13
sulfamethoxazole	0.02	0.02	0.03	0.02
tramadol	0.12	0.11	0.14	0.10
trimethoprim	0.01	0.01	0.01	0.01
venlafaxine	0.05	0.05	0.05	0.04
Sum	***6.9***	***5.8***	***7.6***	***4.6***

Table S2. Concentrations of pharmaceuticals in the Slijbeek, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.12	0.10	0.13	0.08
bezafibrate	0.02	0.02	0.04	0.02
carbamazepine	0.54	0.48	0.27	0.18
clindamycin	0.02	0.01	0.01	0.01
diatrizoic acid	0.16	0.15	0.09	0.12
diclofenac	0.15	0.12	0.07	0.05
erytromycin A	0.03	0.03	0.02	0.03
furosemide	0.24	0.18	0.17	0.09
gemfibrozil	0.66	0.53	0.48	0.27
guanylurea	29.0	13.0	8.30	4.20
ketoprofen	0.03	0.01	0.03	0.01
lincomycin	0.01	0.02	0.01	0.01
metformin	0.88	1.00	1.40	1.50
metoprolol	0.79	0.66	0.46	0.30
metronidazole	0.01	0.01	0.02	0.01
naproxen	0.09	0.07	0.11	0.07
niacin	0.01	0.01	0.07	0.01
paracetamol	0.01	0.01	0.01	0.01
propranolol	0.06	0.04	0.05	0.03
propyfenazone	0.01	0.01	0.01	0.01
sotalol	0.85	0.68	0.38	0.28
sulfamethoxazole	0.07	0.06	0.02	0.03
tramadol	0.43	0.32	0.21	0.17
trimethoprim	0.04	0.04	0.03	0.02
venlafaxine	0.14	0.10	0.07	0.06
Sum	***34.4***	***17.7***	***12.5***	***7.6***

Table S3. Concentrations of pharmaceuticals in the Geleenbeek, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.32	0.24	0.45	0.24
bezafibrate	0.01	0.02	0.05	0.03
carbamazepine	0.42	0.32	0.30	0.16
clindamycin	0.05	0.03	0.05	0.03
diatrizoic acid	0.12	0.11	0.20	0.13
diclofenac	0.34	0.23	0.26	0.16
erytromycin A	0.02	0.04	0.04	0.03
furosemide	0.78	0.47	0.84	0.56
gemfibrozil	0.11	0.10	0.23	0.15
guanylurea	29.0	14.0	15.0	6.5
ketoprofen	0.02	0.01	0.02	0.01
lincomycin	0.01	0.01	0.01	0.01
metformin	0.78	0.90	6.40	5.40
metoprolol	1.18	0.87	1.01	0.64
metronidazole	0.01	0.01	0.01	0.01
naproxen	0.04	0.04	0.18	0.16
niacin	0.01	0.08	0.21	0.11
paracetamol	0.01	0.01	0.01	0.12
propranolol	0.07	0.05	0.05	0.04
propyfenazone	0.01	0.01	0.01	0.01
sotalol	1.15	0.82	0.93	0.58
sulfamethoxazole	0.08	0.06	0.08	0.05
tramadol	0.62	0.46	0.42	0.28
trimethoprim	0.04	0.04	0.06	0.04
venlafaxine	0.23	0.18	0.17	0.10
Sum	***35.4***	***19.1***	***27.0***	***15.6***

Table S4. Concentrations of pharmaceuticals in the Geul, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.03	0.03	0.02	0.03
bezafibrate	0.01	0.01	0.01	0.01
carbamazepine	0.05	0.07	0.02	0.01
clindamycin	0.01	0.01	0.01	0.01
diatrizoic acid	0.12	0.03	0.01	0.02
diclofenac	0.11	0.12	0.07	0.07
erytromycin A	0.03	0.03	0.03	0.03
furosemide	0.07	0.06	0.06	0.07
gemfibrozil	0.02	0.01	0.01	0.01
guanylurea	3.80	3.00	1.00	1.20
ketoprofen	0.01	0.01	0.01	0.01
lincomycin	0.01	0.01	0.01	0.03
metformin	1.10	1.10	1.40	1.30
metoprolol	0.21	0.20	0.11	0.14
metronidazole	0.01	0.01	0.01	0.01
naproxen	0.03	0.03	0.03	0.03
niacin	0.04	0.03	0.15	0.04
paracetamol	0.01	0.02	0.16	0.16
propranolol	0.01	0.01	0.01	0.01
propyfenazone	0.01	0.01	0.01	0.01
sotalol	0.29	0.35	0.14	0.17
sulfamethoxazole	0.02	0.02	0.01	0.01
tramadol	0.15	0.17	0.09	0.09
trimethoprim	0.01	0.01	0.01	0.01
venlafaxine	0.05	0.06	0.04	0.04
Sum	***6.2***	***5.4***	***3.4***	***3.5***

Table S5. Concentrations of pharmaceuticals in the Jeker, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.07	0.07	0.09	0.10
bezafibrate	0.01	0.01	0.01	0.01
carbamazepine	0.16	0.16	0.09	0.10
clindamycin	0.03	0.03	0.03	0.03
diatrizoic acid	0.34	0.34	0.22	0.44
diclofenac	0.15	0.15	0.10	0.12
erytromycin A	0.02	0.02	0.02	0.02
furosemide	0.12	0.12	0.07	0.12
gemfibrozil	0.01	0.01	0.01	0.01
guanylurea	4.70	4.70	1.80	1.90
ketoprofen	0.05	0.05	0.03	0.05
lincomycin	0.05	0.05	0.02	0.02
metformin	5.50	5.50	5.80	5.90
metoprolol	0.06	0.06	0.01	0.05
metronidazole	0.01	0.01	0.01	0.01
naproxen	0.14	0.14	0.17	0.16
niacin	0.13	0.13	0.24	0.18
paracetamol	0.24	0.24	0.63	0.94
propranolol	0.06	0.06	0.05	0.05
propyfenazone	0.01	0.01	0.01	0.01
sotalol	0.53	0.53	0.37	0.47
sulfamethoxazole	0.04	0.04	0.02	0.04
tramadol	0.67	0.67	0.40	0.48
trimethoprim	0.01	0.01	0.01	0.01
venlafaxine	0.25	0.25	0.18	0.20
Sum	***13.4***	***13.4***	***10.4***	***11.4***

Table S6. Concentrations of pharmaceuticals in the Meuse at Eijsden, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
atenolol	0.04	0.05	0.04	0.02
bezafibrate	0.01	0.01	0.01	0.01
carbamazepine	0.06	0.07	0.06	0.01
clindamycin	0.01	0.01	0.01	0.01
diatrizoic acid	0.37	0.33	0.19	0.08
diclofenac	0.04	0.05	0.04	0.03
erytromycin A	0.03	0.03	0.03	0.03
furosemide	0.01	0.01	0.03	0.01
gemfibrozil	0.01	0.01	0.01	0.01
guanylurea	2.30	2.00	0.89	0.26
ketoprofen	0.01	0.01	0.01	0.01
lincomycin	0.01	0.01	0.01	0.01
metformin	3.90	4.20	2.90	1.90
metoprolol	0.02	0.01	0.01	0.01
metronidazole	0.01	0.01	0.01	0.01
naproxen	0.04	0.05	0.05	0.03
niacin	0.03	0.03	0.05	0.06
paracetamol	0.04	0.14	0.01	0.18
propranolol	0.01	0.02	0.02	0.01
propyfenazone	0.01	0.01	0.01	0.01
sotalol	0.16	0.17	0.17	0.07
sulfamethoxazole	0.01	0.02	0.02	0.01
tramadol	0.20	0.22	0.13	0.05
trimethoprim	0.01	0.01	0.01	0.01
venlafaxine	0.09	0.09	0.05	0.02
Sum	***7.4***	***7.6***	***4.8***	***2.9***

Table S7. Concentrations of metabolites in the Lateraal Kanaal, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	0.22	0.22	0.26	0.16
2-hydroxy carbamazepine	0.01	0.01	0.01	0.01
3-hydroxy carbamazepine	0.01	0.01	0.01	0.01
4-acetaminophen sulfaat	0.03	0.03	0.03	0.03
4-formylaminoantipyrine	0.02	0.02	0.02	0.02
alfa-hydroxy metoprolol	0.01	0.01	0.01	0.01
anhydro erythromycine A	0.05	0.05	0.05	0.05
carbamazepine-10.11-epoxide	0.01	0.01	0.01	0.01
hydroxy ibuprofen	0.50	0.50	0.50	0.50
N4-acetyl sulfamethoxazole	0.01	0.01	0.01	0.01
o-desmethyltramadol	0.01	0.01	0.09	0.08
oxcarbamazepine	0.01	0.01	0.01	0.01
Sum	***0.9***	***0.9***	***1.0***	***0.9***

Table S8. Concentrations of metabolites in the Slijbeek, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	1.79	1.42	0.73	0.48
2-hydroxy carbamazepine	0.10	0.08	0.05	0.03
3-hydroxy carbamazepine	0.13	0.11	0.06	0.04
4-acetaminophen sulfaat	0.03	0.03	0.03	0.03
4-formylaminoantipyrine	0.02	0.02	0.01	0.01
alfa-hydroxy metoprolol	0.15	0.11	0.10	0.06
anhydro erythromycine A	0.11	0.06	0.10	0.03
carbamazepine-10.11-epoxide	0.07	0.06	0.03	0.02
hydroxy ibuprofen	0.50	0.50	0.50	0.50
N4-acetyl sulfamethoxazole	0.02	0.02	0.02	0.02
o-desmethyltramadol	0.20	0.15	0.01	0.08
oxcarbamazepine	0.01	0.01	0.01	0.01
Sum	***3.1***	***2.6***	***1.7***	***1.3***

Table S9. Concentrations of metabolites in the Geleenbeek, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	1.28	0.96	0.98	0.55
2-hydroxy carbamazepine	0.08	0.06	0.06	0.03
3-hydroxy carbamazepine	0.10	0.08	0.08	0.04
4-acetaminophen sulfaat	0.03	0.03	0.01	0.02
4-formylaminoantipyrine	0.25	0.15	0.19	0.11
alfa-hydroxy metoprolol	0.04	0.04	0.10	0.09
anhydro erythromycine A	0.06	0.05	0.05	0.04
carbamazepine-10.11-epoxide	0.05	0.04	0.04	0.02
hydroxy ibuprofen	0.50	0.50	0.83	0.87
N4-acetyl sulfamethoxazole	0.01	0.01	0.01	0.01
o-desmethyltramadol	0.33	0.24	0.22	0.14
oxcarbamazepine	0.15	0.07	0.12	0.05
Sum	***2.9***	***2.2***	***2.7***	***2.0***

Table S10. Concentrations of metabolites in the Geul, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	0.20	0.22	0.09	0.11
2-hydroxy carbamazepine	0.01	0.01	0.01	0.01
3-hydroxy carbamazepine	0.01	0.01	0.01	0.01
4-acetaminophen sulfaat	0.03	0.02	0.15	0.18
4-formylaminoantipyrine	0.06	0.08	0.04	0.04
alfa-hydroxy metoprolol	0.01	0.01	0.01	0.01
anhydro erythromycine A	0.05	0.05	0.05	0.05
carbamazepine-10.11-epoxide	0.01	0.01	0.01	0.01
hydroxy ibuprofen	0.50	0.50	0.50	0.50
N4-acetyl sulfamethoxazole	0.01	0.01	0.01	0.01
o-desmethyltramadol	0.01	0.08	0.01	0.01
oxcarbamazepine	0.01	0.01	0.01	0.01
Sum	***0.9***	***1.0***	***0.9***	***1.0***

Table S11. Concentrations of metabolites in the Jeker, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	0.42	0.39	0.26	0.31
2-hydroxy carbamazepine	0.02	0.02	0.02	0.02
3-hydroxy carbamazepine	0.03	0.03	0.02	0.02
4-acetaminophen sulfaat	0.40	0.43	0.69	1.12
4-formylaminoantipyrine	0.08	0.08	0.04	0.07
alfa-hydroxy metoprolol	0.01	0.01	0.01	0.01
anhydro erythromycine A	0.05	0.05	0.05	0.03
carbamazepine-10.11-epoxide	0.02	0.02	0.01	0.01
hydroxy ibuprofen	1.36	1.43	1.27	1.44
N4-acetyl sulfamethoxazole	0.03	0.03	0.02	0.03
o-desmethyltramadol	0.32	0.32	0.18	0.21
oxcarbamazepine	0.01	0.01	0.01	0.01
Sum	***2.8***	***2.8***	***2.6***	***3.3***

Table S12. Concentrations of metabolites in the Meuse at Eijsden, measured at four different dates in 2011.

	23-11-2011	30-11-2011	07-12-2011	12-12-2011
10.11-trans-diol-carbamazepine	0.18	0.19	0.17	0.07
2-hydroxy carbamazepine	0.01	0.01	0.01	0.01
3-hydroxy carbamazepine	0.01	0.01	0.01	0.01
4-acetaminophen sulfaat	0.07	0.13	0.03	0.47
4-formylaminoantipyrine	0.03	0.03	0.02	0.01
alfa-hydroxy metoprolol	0.01	0.01	0.01	0.01
anhydro erythromycine A	0.05	0.05	0.05	0.05
carbamazepine-10.11-epoxide	0.01	0.01	0.01	0.01
hydroxy ibuprofen	0.50	0.50	0.50	0.50
N4-acetyl sulfamethoxazole	0.02	0.02	0.01	0.01
o-desmethyltramadol	0.13	0.14	0.11	0.01
oxcarbamazepine	0.01	0.01	0.01	0.01
Sum	***1.0***	***1.1***	***0.9***	***1.2***