EFFICIENT TREATMENT OF PHARMACEUTICAL RESIDUE AT SOURCE - EPIC

FINAL REPORT: Emissions and risk identification (WP1)

Finnish Environment Institute (SYKE)
University of Helsinki (UH) &
Subcontractor Law and Water

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Further information of WP1:

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http://www.syke.fi/hankkeet/epic
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Emissions and risk identification (WP1)

- 1.1 – Emission estimates from primary sources (SYKE, Law & Water, UH)
- 1.2 – Load estimation (SYKE, Law & Water)
- 1.3 – Identification of environmentally harmful APIs (SYKE, Law & Water, UH)

Partners – Emissions and risk identification (WP1)

- Work Package Coordinator: SYKE
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- Partner: UH
  - Tiina Sikanen, Sanja Karlsson, Jari Yli-Kauhaluoma
- Subcontractor: Law and Water
  - Niina Vieno

Needs generally – Emissions and risk identification

- Knowledge on emissions & effects of residues of Active Pharmaceutical Ingredients (APIs) on the environment is scarce
  - In Finland, no prioritization exercises have been carried out

    ⇒Unknown, which APIs should be targeted and where
- No prior screenings on the API-content of hospital wastewaters has been carried out in Finland
- Concentration information has very seldom been converted into loads
- API metabolism is not well understood among environmental experts and water utilities

Needs – 1.1, Emission estimates from primary sources

- API-emissions are known to originate from several primary emission sources, but previous screening results available in Finland cover only WWTPs receiving the sewages from these primary emission sources.
- Identifying significant primary sources for APIs would help in estimating where APIs should be removed. If a large portion of a certain API is emitted from individual point sources, it might be technically feasible to remove it there, and not dilute the emission to municipal sewage network. This kind of information could help in tailoring emission reduction measures for the identified APIs.

Needs – 1.2, Load estimation

- There is a mass of literary sources reporting the concentrations of a wide range of APIs in both waste waters, waste water sludge and environmental matrices. However, information on WWTP-specific sewage flows are usually not recorded during sampling campaigns.
- This kind of information would allow for reasonably reliable estimates on API-loads entering and exiting WWTPs. If we had reliable load estimates, we could eventually use this information also in estimating environmental concentrations.

Needs – 1.3, Identification of environmentally harmful APIs

- It is well-known among healthcare professionals, that APIs are metabolised to a varying extent in the human body. In the environment, depending on their chemical structures, the metabolites may also revert back into the original active forms, or be more persistent than the original API.
- Knowing which fraction of each API is excreted as the parent compound would help in estimating actual loads entering WWTPs and the environment. This kind of information has previously not been readily available to environmental experts and water utilities.

Approach – 1.1, Emission estimates from primary sources

- Sampling carried out in different types of locations
  - Three hospitals (HI)
  - One site providing supported housing (own WWTP)
  - Three household sewer lines (HSL)
  - Four WWTPs

Site	Type	N of samples		
		Inf.	Eff.	Sludge
HUS	HI	3		-
TYKS	HI	4 + 14		-
Eksote	HI	3		-
Rinnekoti	HI/WWTP	2	2	1
SYKE	HSL	3	-	-
HSY	HSL	3	-	-
Ylöjärvi	HSL/WWTP	2	2	-
HSY	WWTP	2	2	2
Kymen vesi	WWTP	1	1	1
TSP	WWTP	1	1	1
LRE	WWTP	1	1	1

Sampling & analyses

- Composite samples
  - WWTPs & HSLs using automated samplers
  - HIs manually
    - Samples for the one week emission screening at TYKS taken as grab-samples
- 98 – 236 substances were analysed in water samples
  - 60 in sludge samples
  - Pharmaceuticals & pesticides

Photos: Lauri Äystö

Approach – 1.2, Load estimation

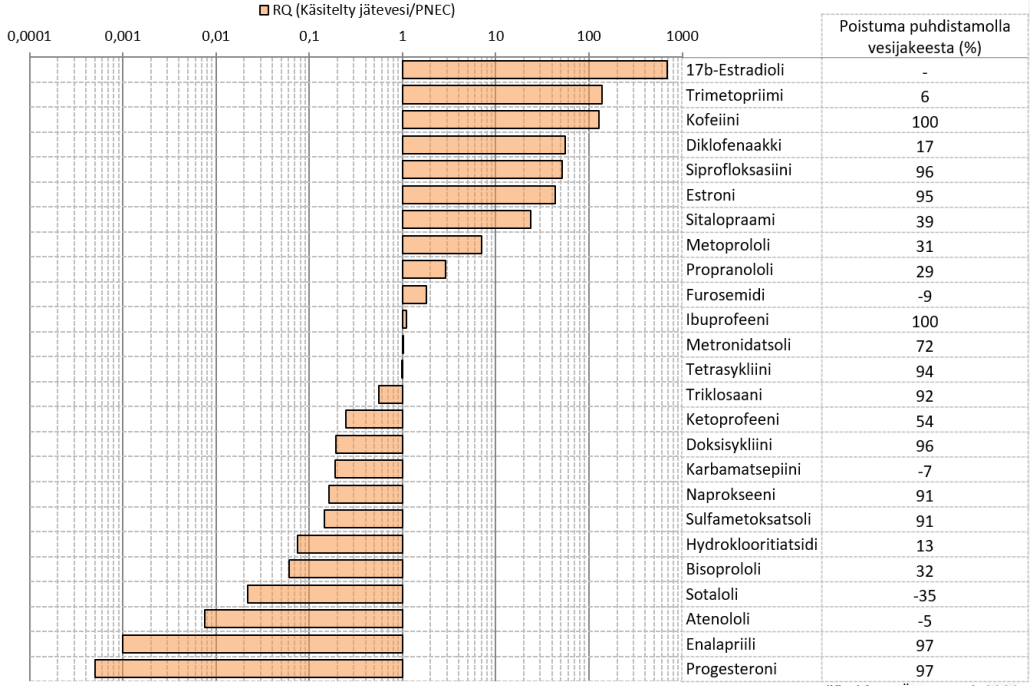
- Sewage flow information was collected from sampling sites during each sampling campaign
- Site-specific loads were calculated for each sampling campaign based on concentration data from the chemical analyses and sewage flow information collected during sampling
- To normalize calculated API-loads between sites of highly differing sewage flow volumes, the number of connected inhabitants was collected for WWTPs and household sewer lines, and the number of beds from the hospital sites
  - These numbers were used in deriving per capita loads in different sites

Approach – 1.3, Identification of environmentally harmful APIs

- Information on the excreted fractions and main metabolites of different APIs was collected
- This information was supplemented with national sales statistics and information on ecotoxicity tests (PNEC-values)
- These data were combined to identify which APIs should be included into further screening campaigns

Main outputs – Selected results 1/3
Emissions and risk identification

- The concentrations of certain APIs detected in water decreased efficiently during conventional activated sludge treatment
- Several APIs were still identified to occur in effluent waters in concentrations exceeding their PNEC-values (RQ>1). (Äystö et al. 2020)



	Poistuma puhdistamolla vesijakeesta (%)
17b-Estradioli	-
Trimetopriimi	6
Kofeiini	100
Diklofenaakki	17
Siprofloksasiini	96
Estroni	95
Sitalopraami	39
Metoprololi	31
Propranololi	29
Furosemidi	-9
Ibuprofeeni	100
Metronidatsoli	72
Tetrasykliini	94
Triklosaani	92
Ketoprofeeni	54
Doksisykliini	96
Karbamatsepiini	-7
Naprokseeni	91
Sulfametoksatsoli	91
Hydrooksitiatsidi	13
Bisoprololi	32
Sotaloli	-35
Atenololi	-5
Enalapriili	97
Progesteroni	97

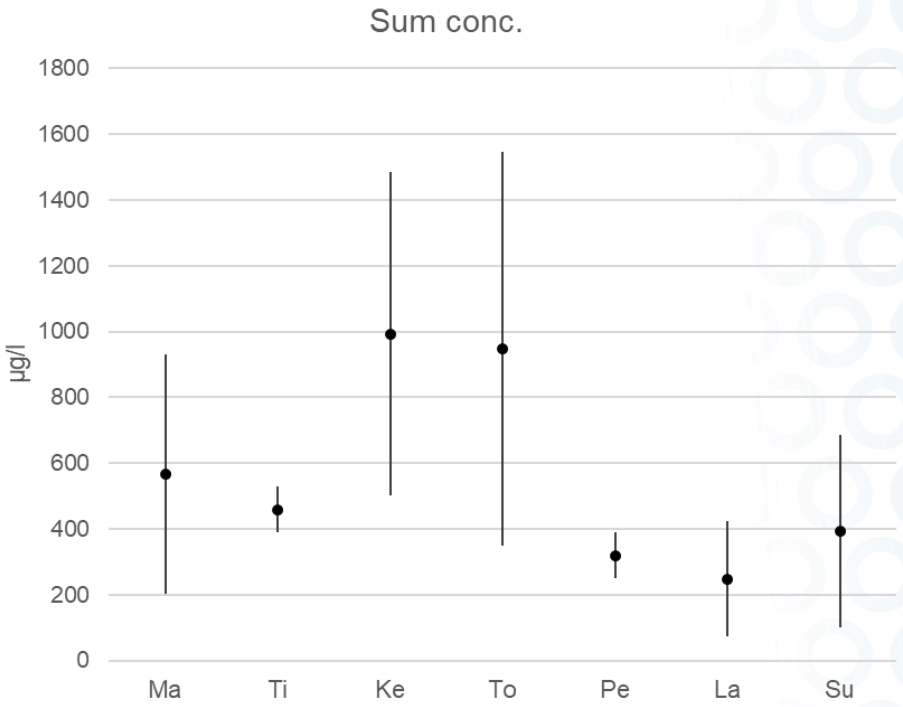
Modified from Äystö et al. 2020

Main outputs – Selected results 2/3
Emissions and risk identification

- Detected concentrations were commonly the highest in hospital wastewaters.
- Hospitals were identified as potentially significant emission sources for a handful of APIs (e.g. paracetamol, trimethoprim). (Äystö et al. 2020)
- Certain new APIs that have not been covered by previous sampling campaigns, were identified to pose high risk to surface waters. These APIs include e.g. clotrimazole and ampicillin. (Vieno et al. 2020)

Main outputs – Selected results 3/3
Emissions and risk identification

- One week hospital sampling
  - Grab-samples
  - Mon – Sun, at 8:00
  - Two samples/occasion
- Results
  - 52/132 APIs detected
    - 7 with 100 % DF
- Duplicate samples had high variability
- Results are submitted to Ympäristö & Terveys Journal



Main outputs – Publications
Emissions and risk identification

- Task 1.1 + 1.2
  - The results have been utilized in producing a professional article
    - Äystö et al. 2020, Vesitalous 1/2020
    - Äystö et al. 2020, Ympäristö ja Terveys 4/2020
  - Results are currently being processed into a scientific paper
    - To be submitted Q2/2020
- Task 1.3
  - The results have been utilized in producing three professional articles
    - Sikanen et al. 2020, Vesitalous 1/2020
    - Karlsson et al. 2020, Pharmaca Fennica 2020 (Collaboration with SUDDEN-project)
    - Vieno et al. 2020, Vesitalous 1/2020
  - Results are currently being processed into a scientific paper
    - To be prepared during spring 2020, publication time depends on selected journal

Main outputs – Presentations etc. Emissions and risk identification

- Posters
  - Task 1.1 + 1.2 presented in WaterJPI 2018, Helsinki
    - ”Pharmaceutical load to municipal wastewater treatment plants and their primary emission sources”
  - Task 1.3 presented in SETAC 2019, Helsinki
    - ”The impact of human metabolism and disposition on the occurrence of pharmaceuticals in wastewaters – A case study on Finnish influent wastewaters”
- Presentations
  - Task 1.1 + 1.2 presented in Nordiwa 2019, Helsinki
    - ”Pharmaceutical load estimation and reduction from hospitals”

Benefits – Emissions and risk identification

- Results help to
  - Identify substances that should be eliminated at WWTP and beforereaching WWTP
  - Identify locations where treatment methods should be applied
  - Direct further screening campaigns
  - During the project it became obvious, that hospitals have few suitable locations for waste water sampling

Photo: Lauri Äystö

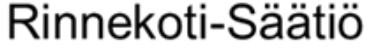
Collaboration/Stakeholders – Emissions and risk identification

- Project partners & Laki ja Vesi Oy
  - Sampling, data processing etc.
- HIs
  - Important background information concerning the sites
  - Invaluable help in finding sampling locations
- WWTPs & household sewer lines
  - Help in sampling, background information
- A lot of interest on the results from international contacts

Photo: SYKEkuva

Collaboration

Partners



Further information

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