API emissions to the Baltic Sea

Lauri Äystö
Finnish Environment Institute, SYKE
CWPharma project final webinar
18th November 2020

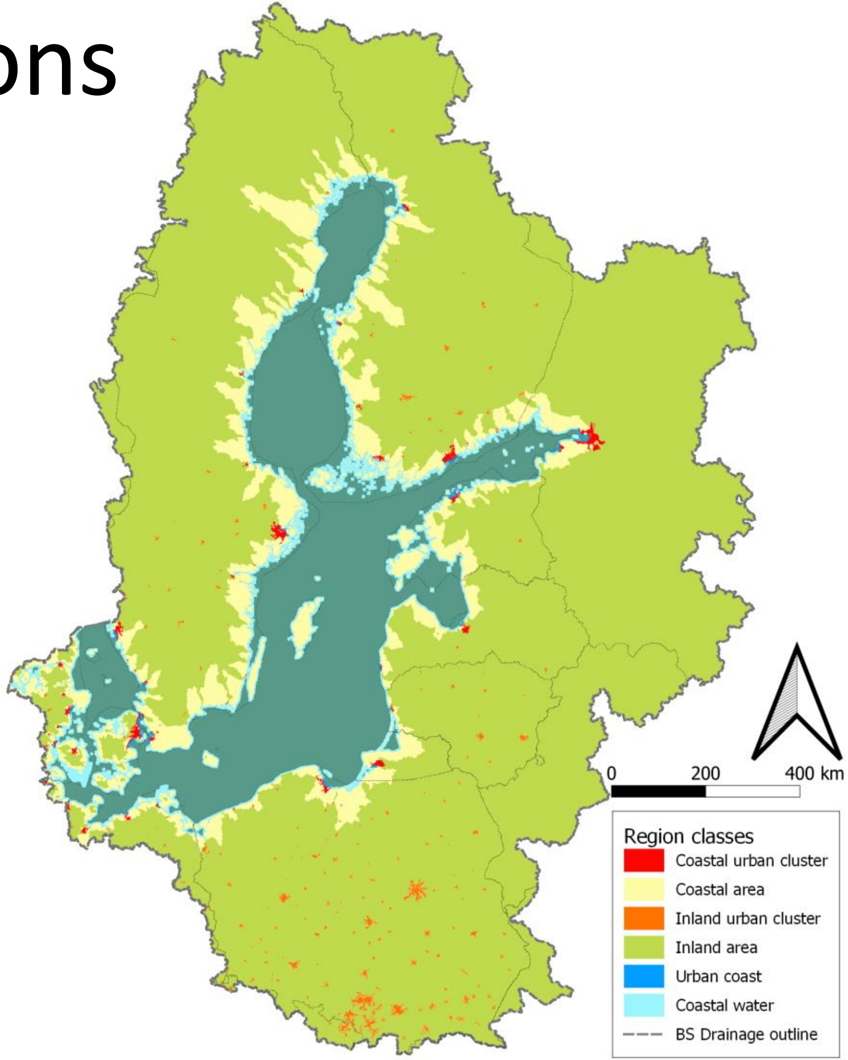
CWPharma calculation excercise

- **Aim**
  - Increase knowledge on total emissions of selected APIs into the Baltic Sea
  - Identify areas most relevant for API emissions

- **Approach**
  - Creating a GIS-based calculation tool, input country-specifically from partners or open sources
  - Same calculation tool to be utilized in WP5 for emission reduction

Scope of the calculations

- Sales as the driving parameter
- The calculation tool covers the Baltic Sea drainage basin
- Loads estimated to coastal areas & river mouths
- Rough concentration estimates based on loads



Selected APIs

- Calculations were carried out for ↓

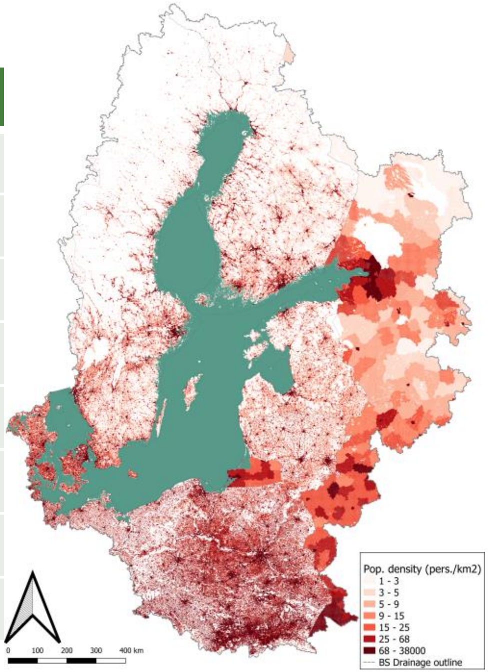
Population density ↓

RQ>1

High cons.

High det. freq.

API	Sales										Per capita avg [4]
	Sales	DE	EE	FI	LV	SE	PL	LT	DK[2]	RU	
Diclofenac	kg/a	27 000	1 500	2 500	2 000	2 800	8 000	510	910	20 000[3]	0.61
	mg/d/p.	0.90	3.1	1.2	2.7	0.78	0.58[1]	0.71[1]	0.44	0.37	
Clarithromycin	kg/a	11 000	410	220	450	630	8 600	130	470		0.41
	mg/d/p.	0.37	0.86	0.11	0.63	0.17	0.62[1]	0.18[1]	0.23		
Metformin	kg/a	1 600 000	23 000	150 000	29 000	110 000	670 000	19 000	92 000		51
	mg/d/p.	54	47	75	41	32	48[1]	26[1]	44		
Ibuprofen	kg/a	340 000	15 000	120 000	20 000	120 000	8 500	3 900	64 000		13
	mg/d/p.	11	32	61	28	32	0.61[1]	5.5[1]	31		
Ofloxacin	kg/a	22 000	3,7	11	27	0,013			0,017		0.013
	mg/d/p.	0.02	0.008	0.005	0.04	3.59E-06			8.2E-06		
Tramadol	kg/a	21 000	320	1 700	360	3 500			6 400		0.87
	mg/d/p.	0.72	0.67	0.86	0.5	0.97			3.1		
Venlafaxine	kg/a	19 000	120	2 000	57	3 600			2 400		0.70
	mg/d/p.	0.64	0.24	0.98	0.08	0.99			1.1		
Carbamazepine	kg/a	37 000	1 000	3 000	1 400	5 900	27 000	400	1 800		1.4
	mg/d/p.	1.2	2.2	1.5	2.0	1.6	2.0[1]	0.56[1]	0.88		



1) MORPHEUS
2) Medstat.dk
3) HELCOM 2014
4) Calculated as population weighted per capita consumption based on countries with sales statistics available. This value was used whenever no country-specific value was available.

CWPharma

Interreg
Baltic Sea Region

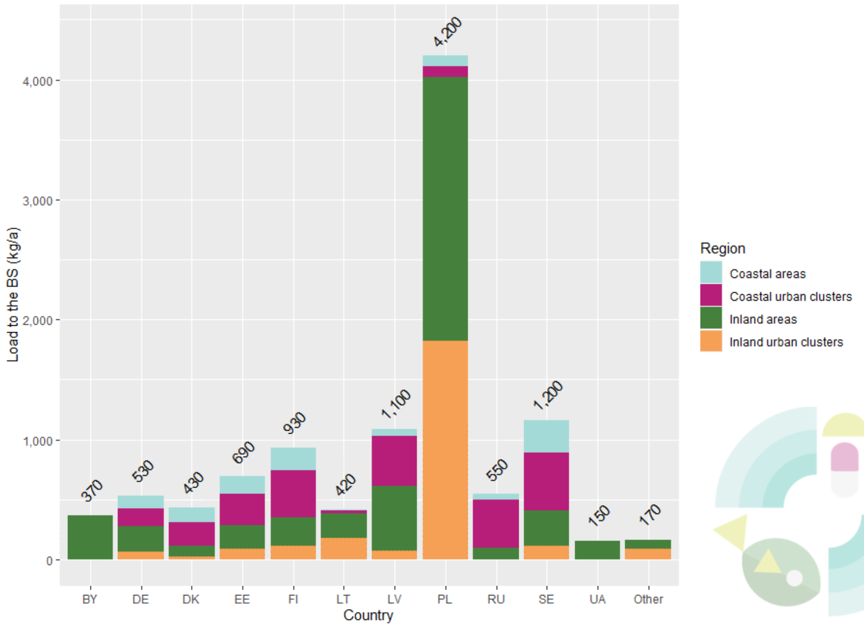
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

EU STRATEGY FOR THE BALTIC SEA REGION
FLAGSHIP

Results

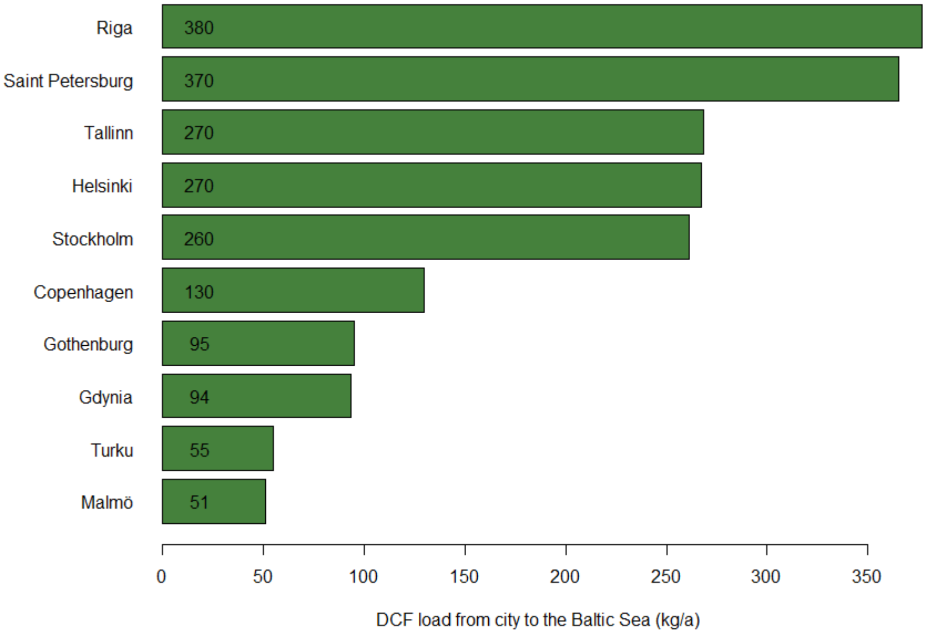
Diclofenac

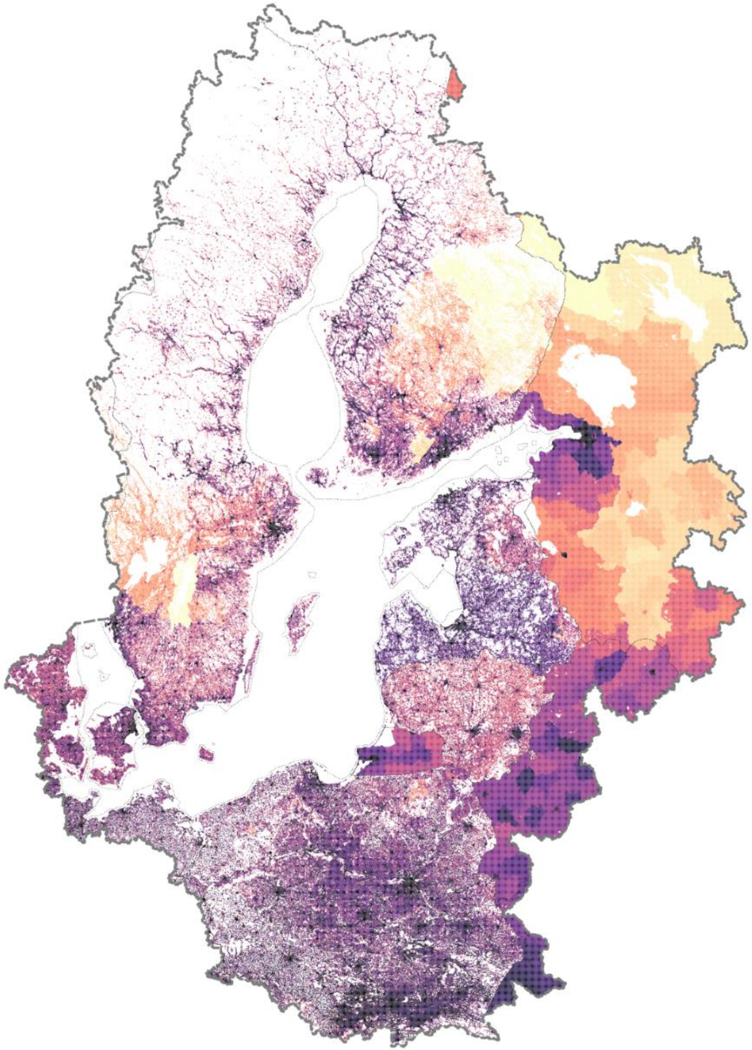
- Total load to the Baltic Sea was estimated to be 9.6 – 12 tonnes
- The majority of this load was estimated to originate from inland areas in Poland
- Coastal urban clusters accounted for 20 – 25% of the total load



DCF emissions

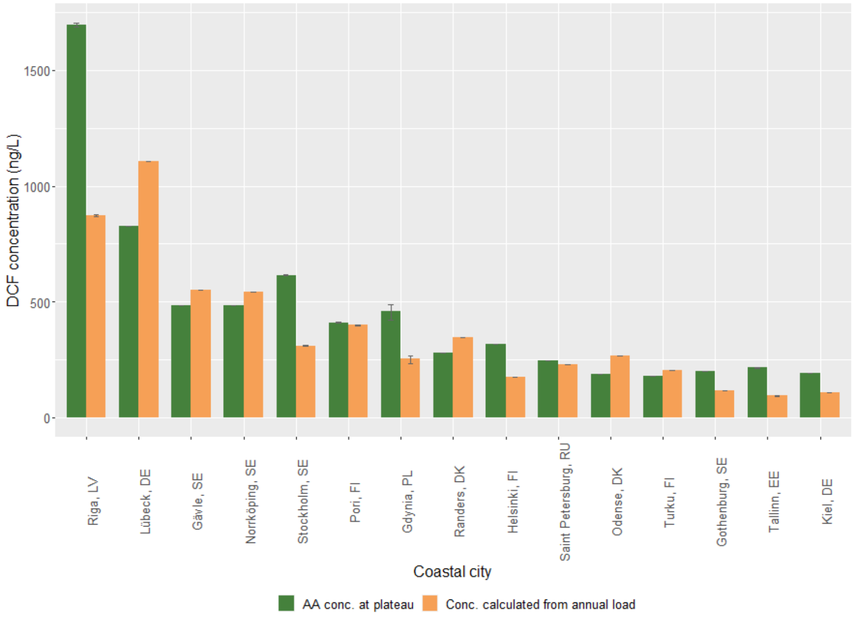
Regionally & city-wise

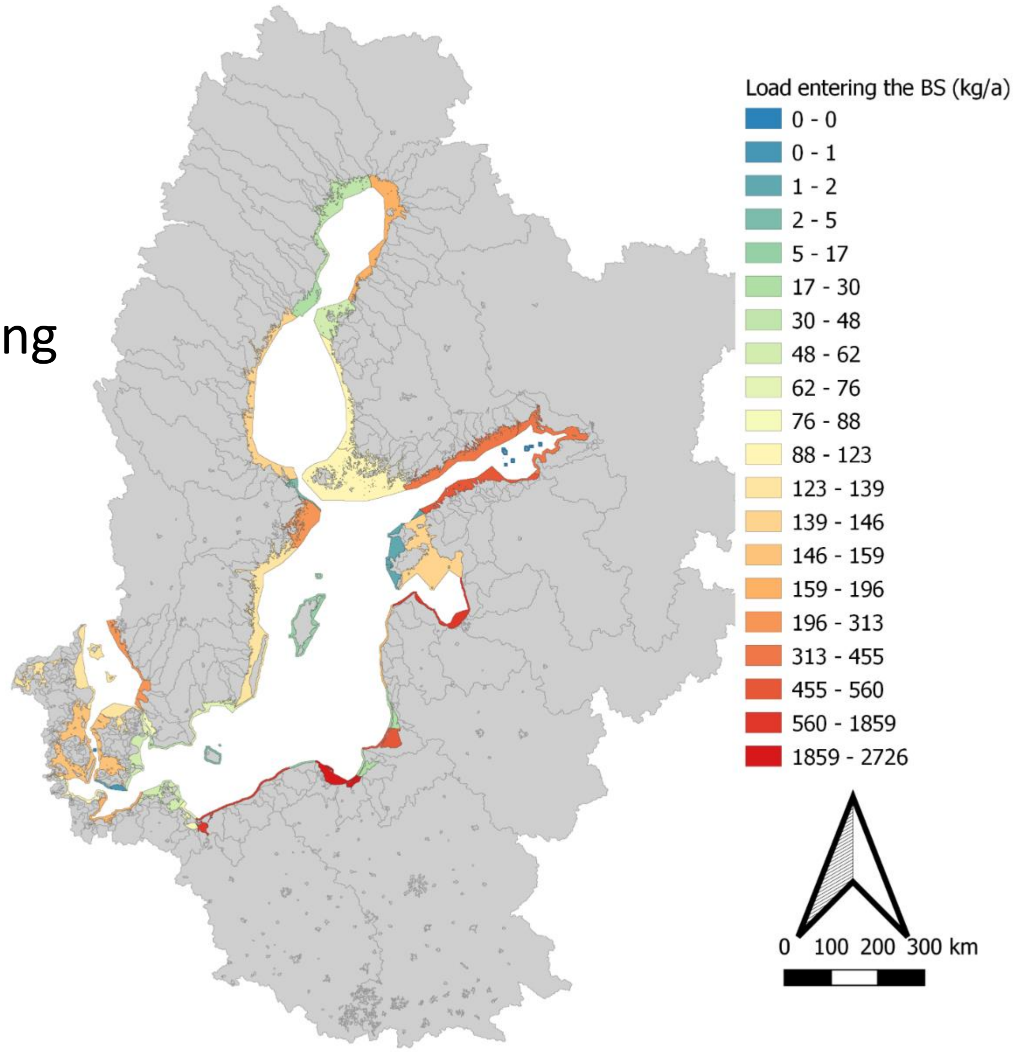




DCF coast

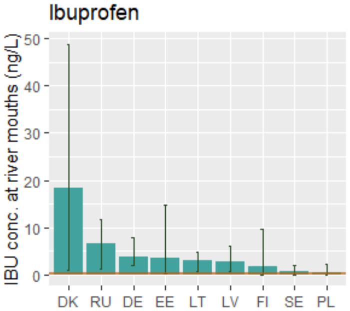
- Coastal concs likely over-estimated, but help pinpointing hotspots

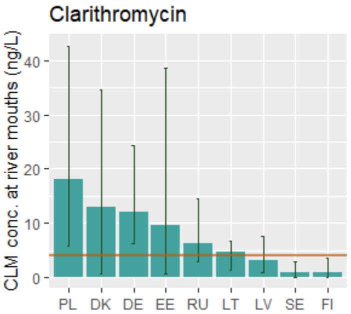


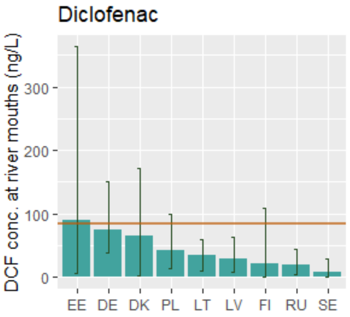


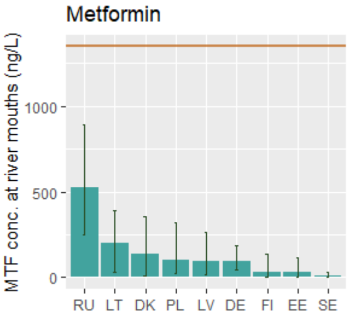
Predicted concentrations at river mouths

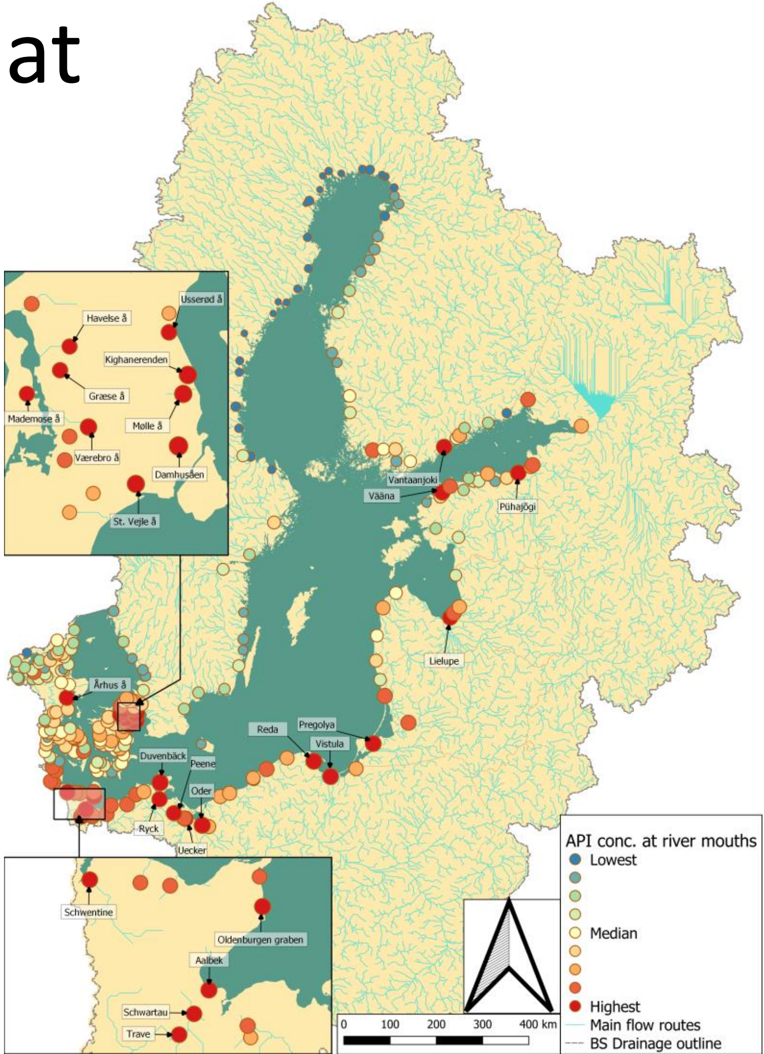
- Diclofenac, clarithromycin and ibuprofen were estimated to exceed PNECs at river mouths
- Concentrations generally higher than detected



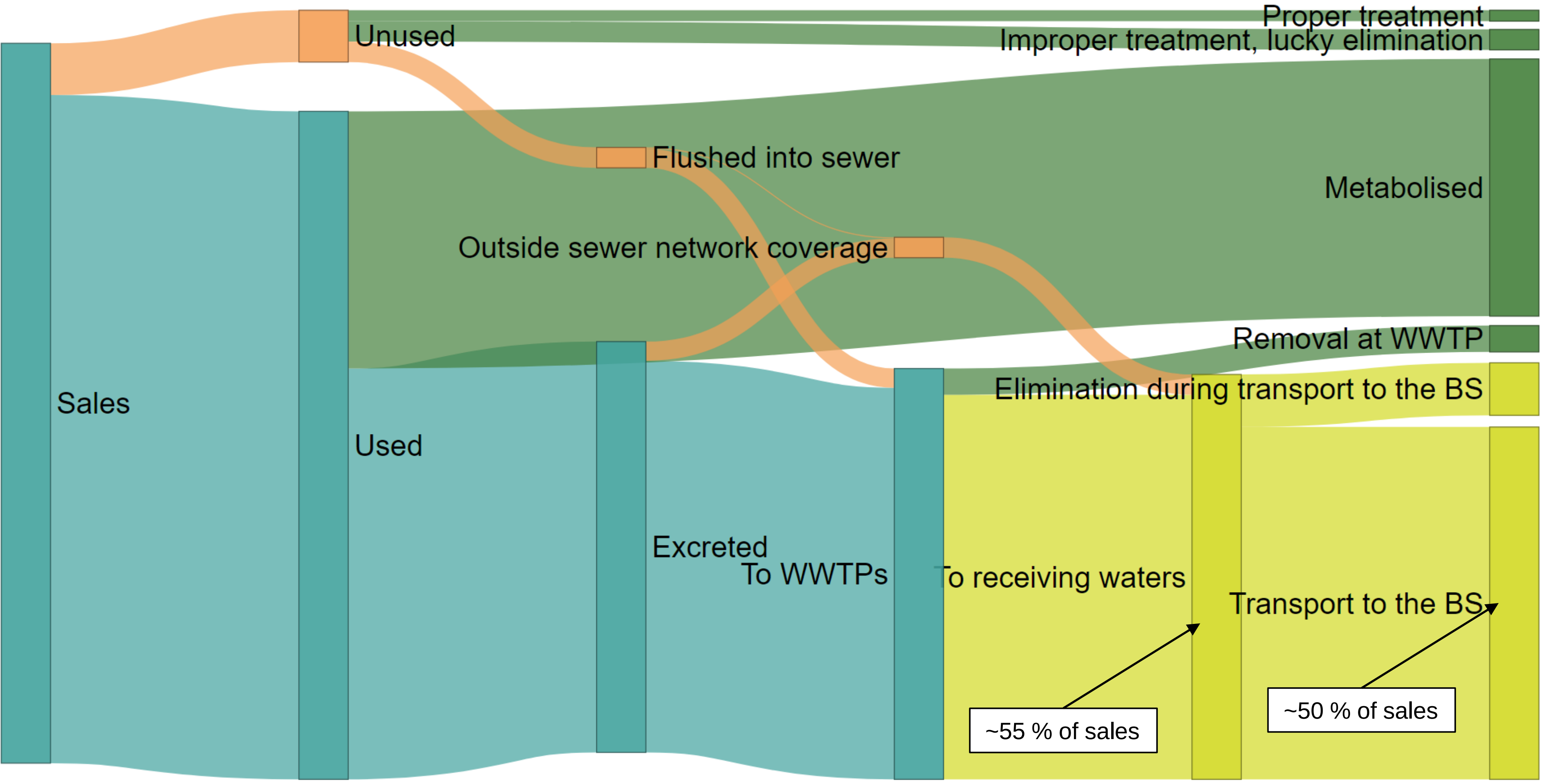








DCF flows


Sales
Unused
Used
Flushed into sewer
Outside sewer network coverage
Excreted
To WWTPs
To receiving waters
Transport to the BS
Proper treatment
Improper treatment, lucky elimination
Metabolised
Removal at WWTP
Elimination during transport to the BS
~55 % of sales
~50 % of sales

Conclusions (1/2)

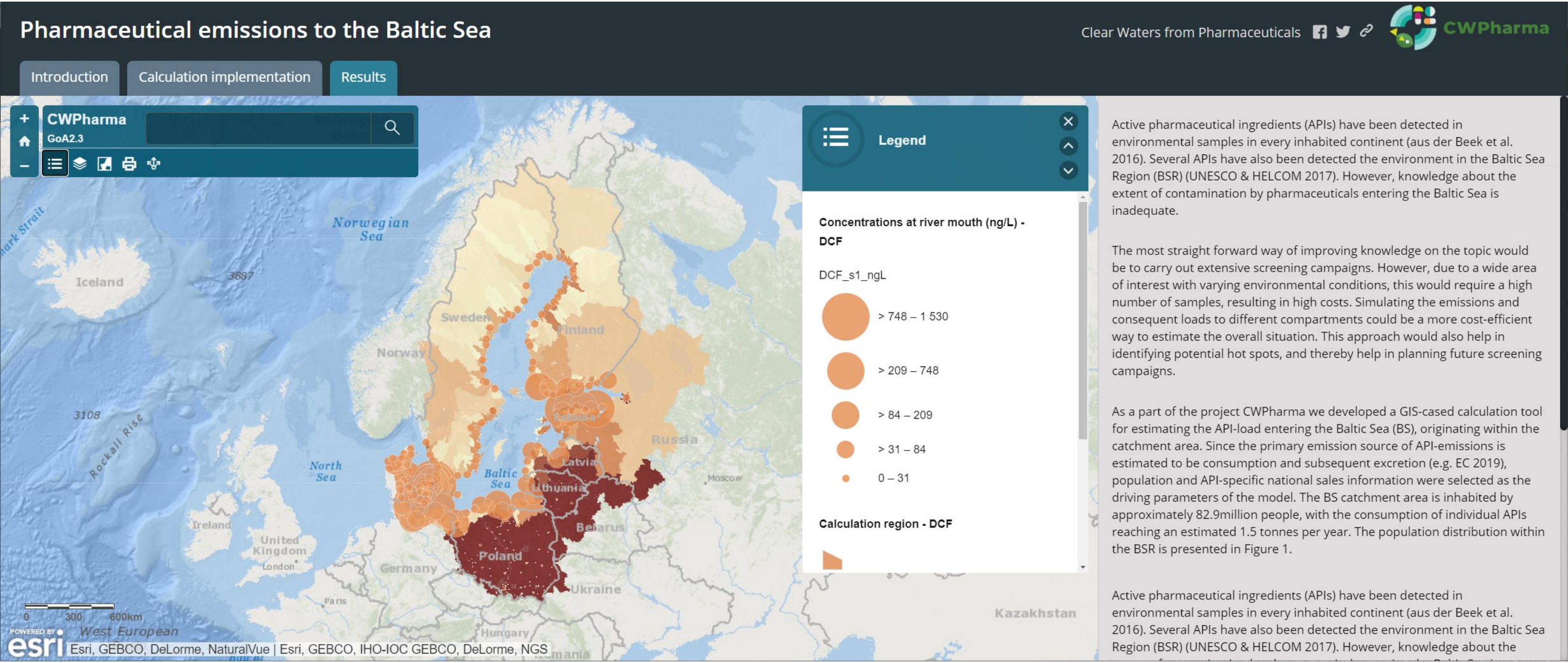
- National total emissions of the selected APIs were estimated to be highest in PL and RU
  - More variation in national per capita emissions
- Concentrations in river waters estimated to be generally highest in southern parts of the BSR

Country	Population	Per capita emission reaching the Baltic Sea (mg/a/person)								Notation
		IBU	DCF	CBZ	MTF	TRD	CLM	OFL	VFX	
DE	2 945 092	9,2	180	22	220	30	29	0.72	14	Highest
DK	4 879 992	25	89	16	180	130	18	0.00037	25	
EE	1 290 739	20	540	39	200	24	68	0,34	4,4	2. Highest
FI	5 313 289	15	180	18	310	22	8,2	0,24	11	
LT	3 026 584	4,8	94	7,7	260	37	10	0.71	16	3. Highest
LV	2 079 911	53	520	41	1200	21	52	2.4	1.8	
PL	38 431 200	0,52	110	41	200	36	50	0.60	16	...
RU	9 443 010	58	58	32	5800	30	37	1.8	14	Lowest
SE	9 349 371	8,8	120	18	130	28	13	0,00016	12	

Conclusions (2/2)

- The calculation tool seems to work well in estimating total loads, and in identifying potential hotspots for API occurrence
- Statistics on pharmaceutical sales and waste management should be improved to allow for more accurate simulations
- Information on river flow velocities, stratification of water bodies, and temperature fluctuations would help improve the simulations
- Usually little data on API degradation in the environment. More & better data would allow for more robust estimates.

Thank you!



More information:
Lauri Äystö
Lauri.aysto@ymparisto.fi
+358295251843

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP
SYKE
Tekniska verken
Umwelt Bundesamt
AARHUS UNIVERSITY
LÄNSSTYRELSEN ÖSTERGÖTLAND
IOŚ-PIB
EKUK
fimea
KALUNDBORG UTILITY
HSY
DWA
LATVIJAS HIDROEKOLOĢIJAS INSTITŪTS
LATVIJAS VIDES, ĢEOLOĢIJAS UN METEOROLOĢIJAS CENTRS
KOMPETENZZENTRUM WasserBerlin