

# Investigating Water Quality and the Wastewater Treatment Cycle in Relation to Caithness General Hospital (Wick, Highlands)

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Hydro Nation Scholars Programme



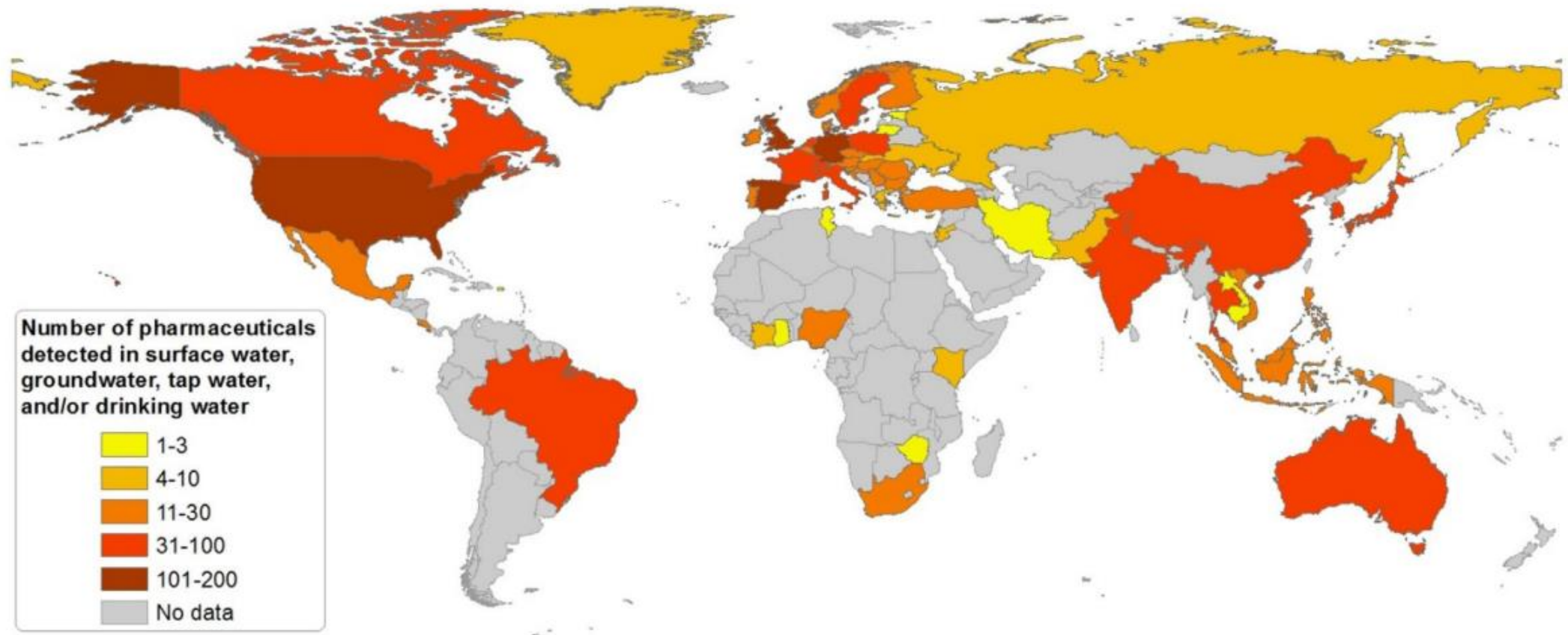
# Pharmaceuticals

- Extensively used: >102 mil prescriptions, Scotland 2016
- Enter environment via wastewater



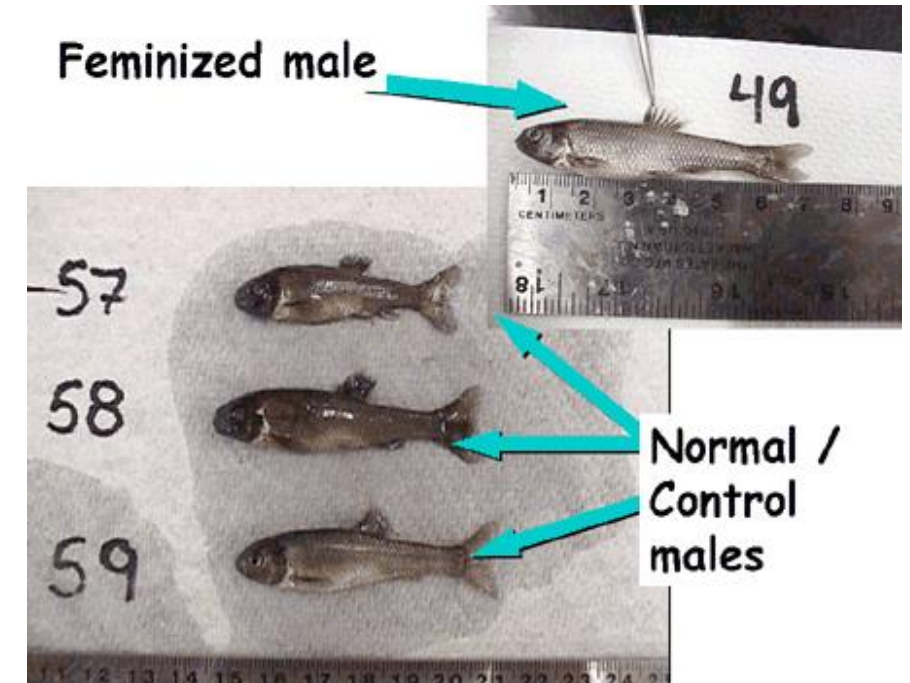
# 'Emerging' Environmental Contaminants

- Detection in water



# 'Emerging' Environmental Contaminants

- Biological activity
  - **Feminisation** of male fish
  - **Physiological changes** in amphibians
  - **Behavioural changes** in crustacean spawning
  - **AMR**



# Green Breakthrough Partnership



- Developed to address issue of pharma pollution
- Source control = best preventative step

**Aim: Pilot NHS Highland prescription formulary to incorporate environmental effects**



# Pilot project...

Determine hospital impact on wastewater in Wick, and receiving WWTP efficiency for pharma



# Monitoring campaign

20 sampling events  
5 Sites



Source ➤ Treated Tap water ➤ Hospital Outflow ➤ WWTP Influent ➤ WWTP Effluent

# Monitoring campaign

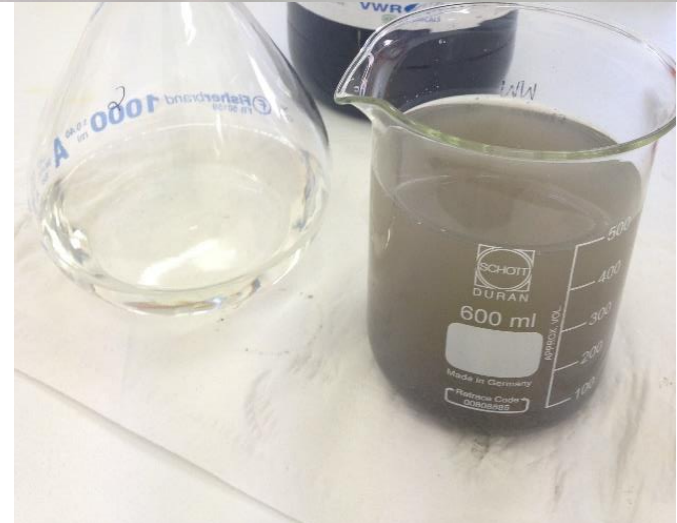
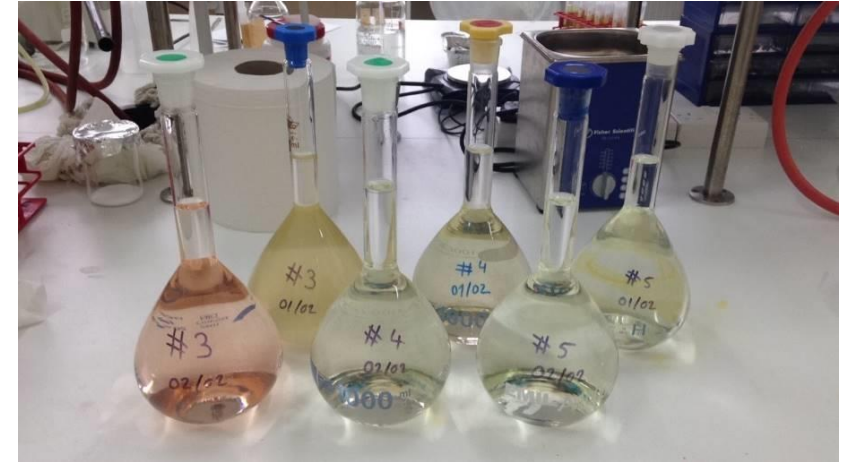
Anti-inflammatories – 3

Antibiotics – 2

Synthetic hormone – 1

Psychiatric drugs – 2

Water quality – 22 parameters

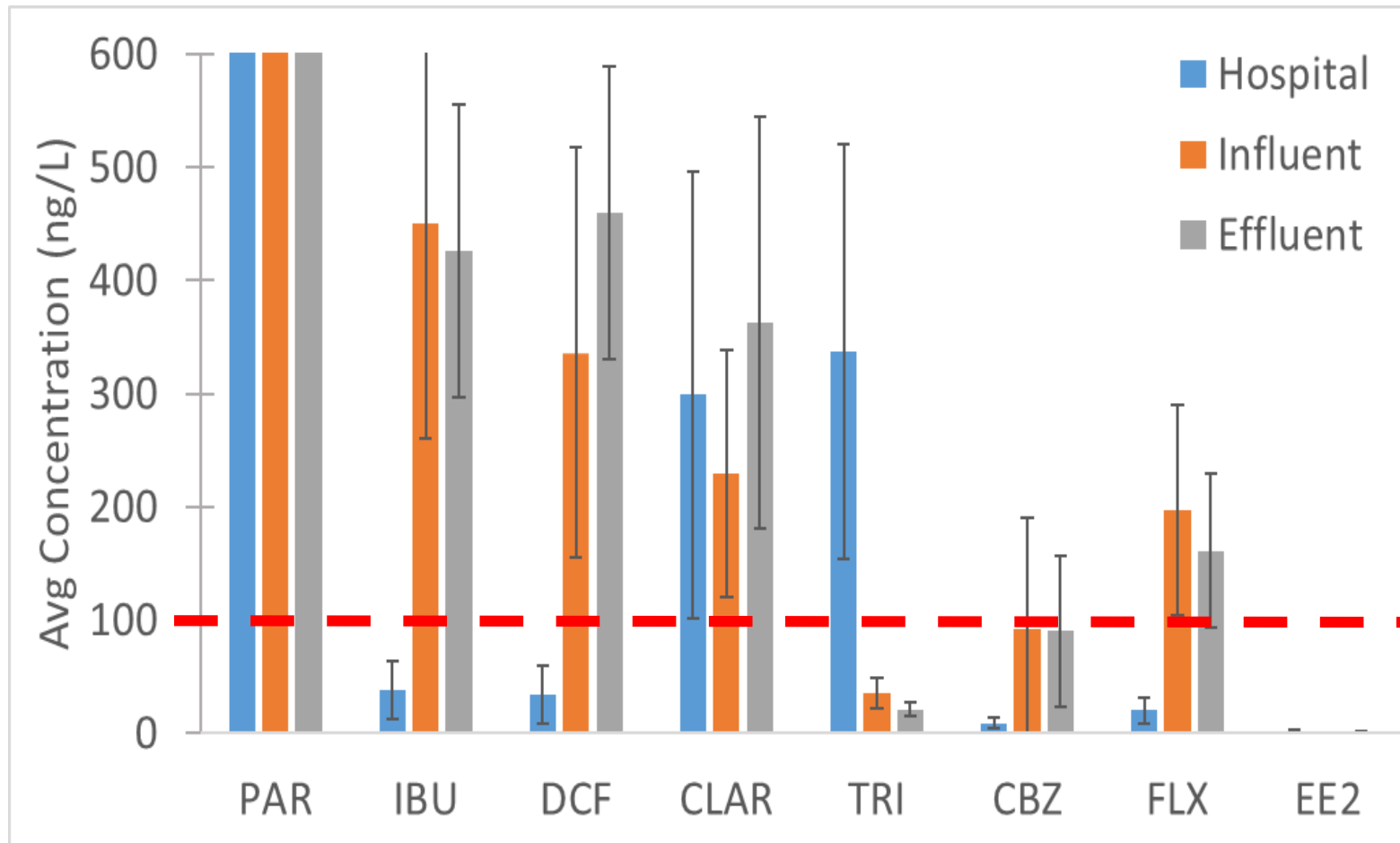




Pharma	Sample	Freq Detection (%)	Avg Conc (ng/L)	Min Conc (ng/L)	Max Conc (ng/L)	%RSD
Paracetamol	Hospital	100	34646	9307	62779	49
	Influent	100	67483	5849	105780	40
	Effluent	100	7846	985	18252	63
Diclofenac	Hospital	75	34	10	100	74
	Influent	100	336	40	684	54
	Effluent	100	460	212	709	28
Clarithromycin	Hospital	65	299	60	634	66
	Influent	63	230	102	432	47
	Effluent	100	363	117	755	50
Trimethoprim	Hospital	90	337	76	728	54
	Influent	42	35	12	47	39
	Effluent	74	21	15	30	28
Fluoxetine	Hospital	65	20	5.5	38	55
	Influent	63	197	17	341	47
	Effluent	37	161	70	251	42
17a- ethynylestradiol	Hospital	30	2	0.95	3.6	57
	Influent	5	<LOQ	<LOQ	<LOQ	0
	Effluent	15	1.06	1.06	1.1	4

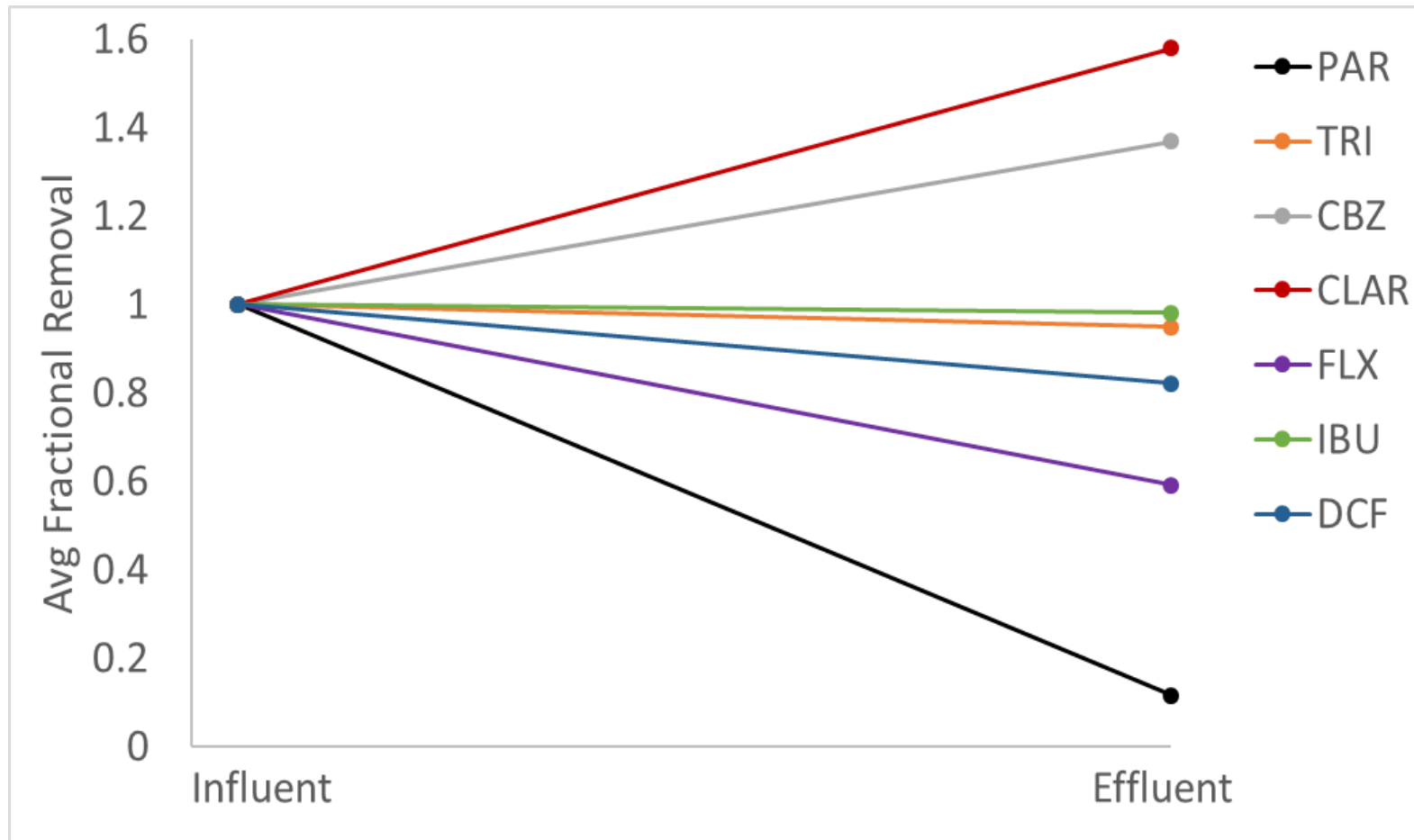
# Results

Avg concentrations, error bars std dev (n = 20)



# Removal Efficiency

Fractional removal WW influent → effluent



# Risk Assessment

Pharma	Avg Conc $\pm$ Stdev ( $\mu\text{g/L}$ )	PNEC ( $\mu\text{g/L}$ )	Avg $\text{RQ}_{\text{Wick}}$	Risk level
Diclofenac	0.161 $\pm$ 0.067 (n=7)	<0.001	161	High
Paracetamol	7.84 $\pm$ 4.90 (n=19)	1.0	7.84	High
Trimethoprim	0.426 $\pm$ 0.129 (n=18)	2.6	0.16	Moderate
Clarithromycin	0.362 $\pm$ 0.181 (n=19)	0.07	5.17	High
Carbamazepine	0.459 $\pm$ 0.129 (n=19)	13.8	0.03	Low
Fluoxetine	0.020 $\pm$ 0.005 (n=6)	0.05	0.40	Moderate
17a-ethynylestradiol	1.00e <sup>-3</sup> $\pm$ 4.00e <sup>-5</sup> (n=2)	<0.001	1.00	High

PNEC = Predicted No-Effect Conc

Risk Quotient (RQ)= Conc/PNEC

RQ>1 = High

1<RQ>0.1 = Moderate

RQ<0.1 = Low

# Conclusions

**Pharma quantifiable in hospital WW**

**CGH impacts pharma loads in Wick WW**

**Wick WWTP treatment ineffective**

**Rural environments at risk**

# Acknowledgements

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**Thank you!**

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