MORPHEUS
Model Areas for Removal of Pharmaceutical Substances in the South Baltic

Interreg South Baltic
EUROPEAN UNION
European Regional Development Fund

Relation between consumption, occurrence and technology

Insights from MORPHEUS

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BEFORE THE START...

Q&A

1. HOW MUCH of consumed amount (in %) of Azithromycin (antibiotic) is released out from the body (excretion rate) ?

A. 10%
B. 30%
C. 50%
D. 80%

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2. Where was the highest consumption of Diclofenac in 2015?

A. Poland
B. Germany
C. Sweden
D. Lithuania

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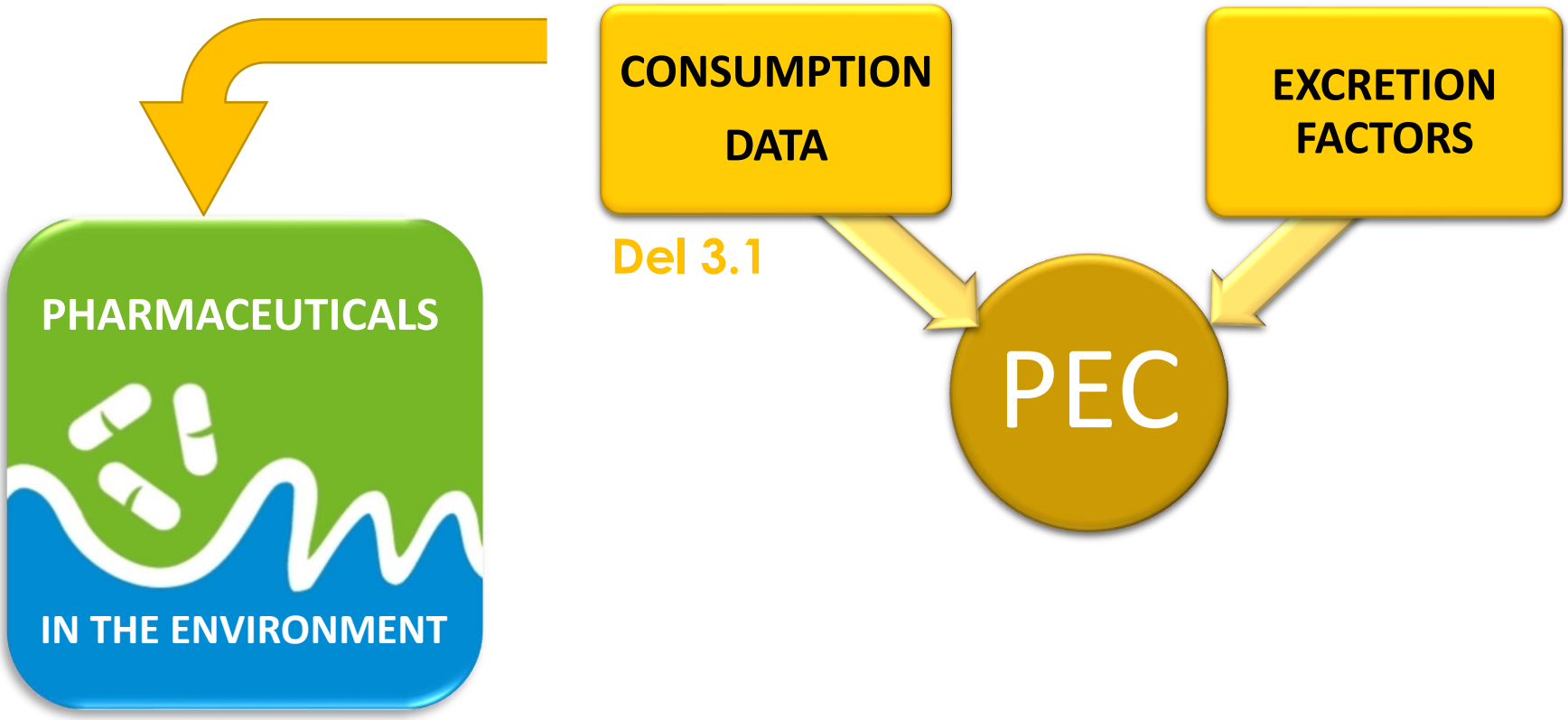
C. Sweden

D. Lithuania

TOP – DOWN APPROACH



BOTTOM – UP APPROACH

CONCENTRATIONS IN WWTP
inlet and outlet

Del 4.1

CURRENT TREATMENT TECHNOLOGIES

Del 5.1

MEC

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Del 3.1

CONSUMPTION DATA

EXCRETION FACTORS

TOP - DOWN APPROACH

PEC

PHARMACEUTICALS

IN THE ENVIRONMENT

Del 4.1

CONCENTRATIONS IN WWTP
inlet and outlet

MEC

Del 5.1

CURRENT TREATMENT TECHNOLOGIES

BOTTOM - UP APPROACH

EXAMPLES

- **Azithromycin** (J - Antiinfectives for systemic use)
- **Carbamazepine** (N - Nervous system)
- **Diclofenac** (M - Muscolo-skeleton system)
- **Metoprolol** (C - Cardiovascular system)

PEC, MEC & removal efficiency

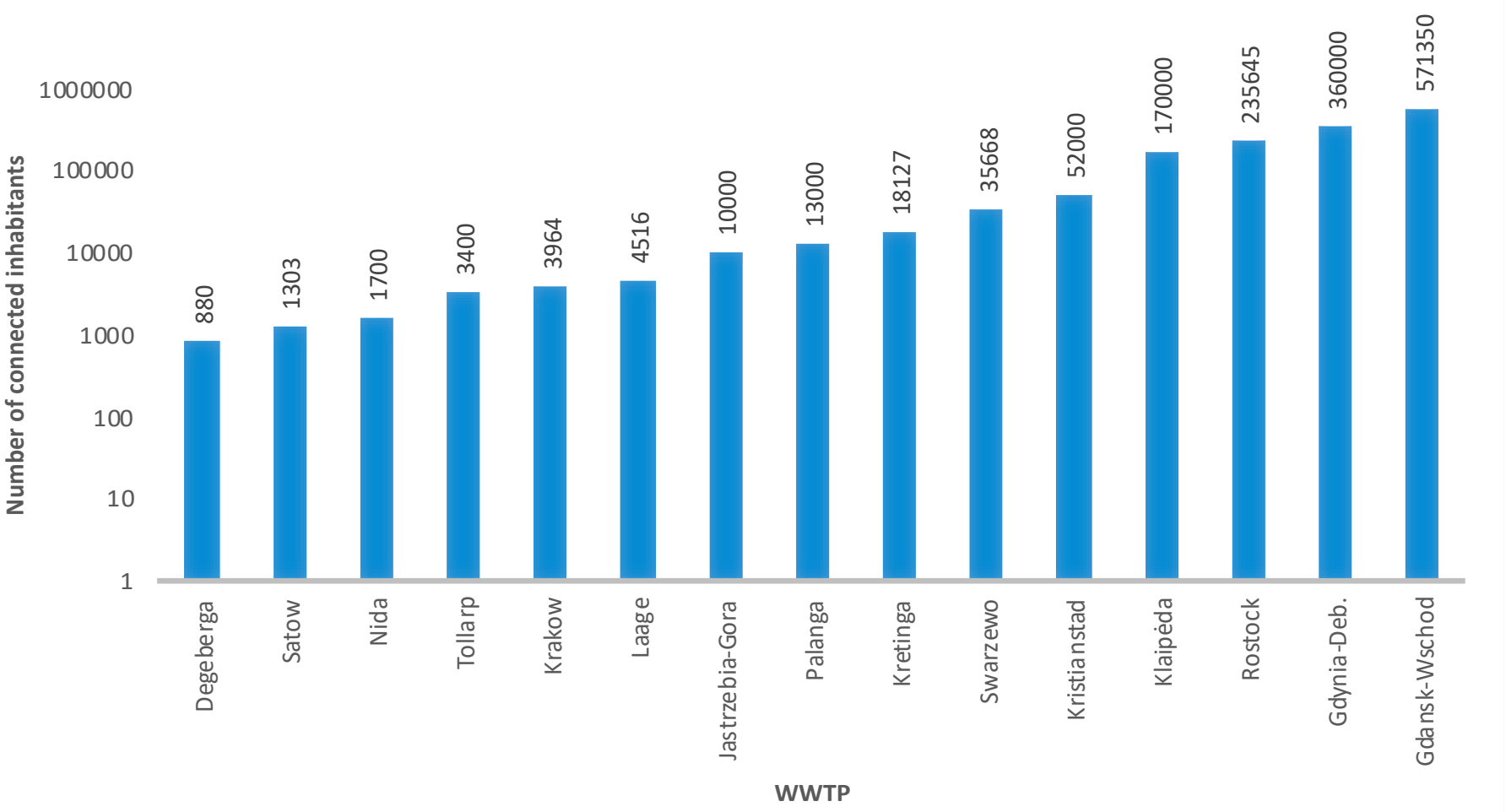
a bit of theory

$$PEC\left[\frac{kg}{a}\right] = intake * excretion\ rate * connected\ inhabitants\ of\ WWTP$$

$$MEC\left[\frac{kg}{a}\right] = concentration\ (inflow) * average\ flow$$

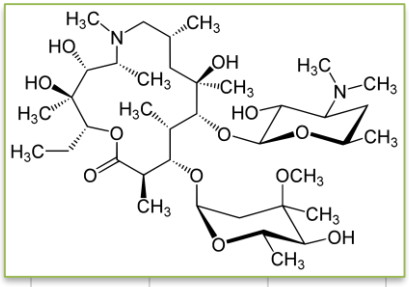
$$removal\ efficiency\ [\%] = \frac{inlet\ conc. - outlet\ conc.}{inlet\ conc.} * 100\%$$

WWTPs size


Number of connected inhabitants
1000000
100000
10000
1000
100
10
1
880
1303
1700
3400
3964
4516
10000
13000
18127
35668
52000
170000
235645
360000
571350
Degeberga
Satow
Nida
Tollarp
Krakow
Laage
Jastrzebia-Gora
Palanga
Kretinga
Swarzewo
Kristianstad
Klaipėda
Rostock
Gdynia-Deb.
Gdansk-Wschod
WWTP

MEC vs. PEC

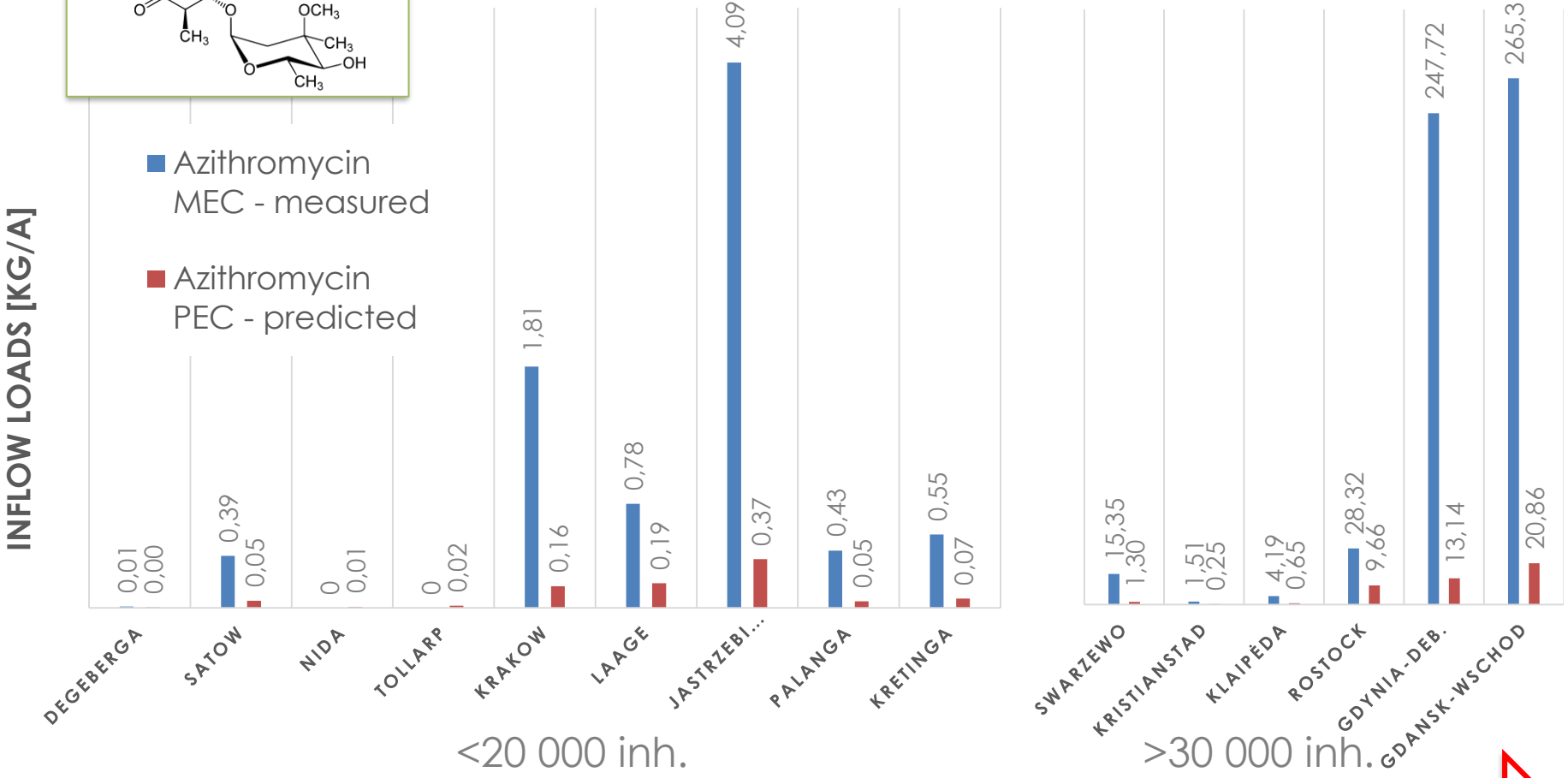
Azithromycin



excretion rate – 50%

PEC=0.0684*MEC

R^2 = 0.8535

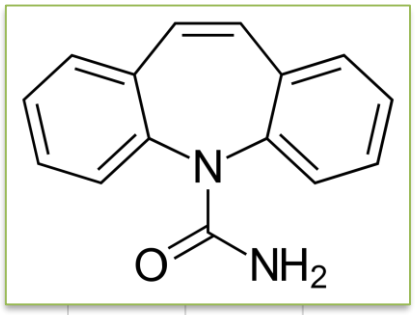


INCREASING *number of connected inhabitants*

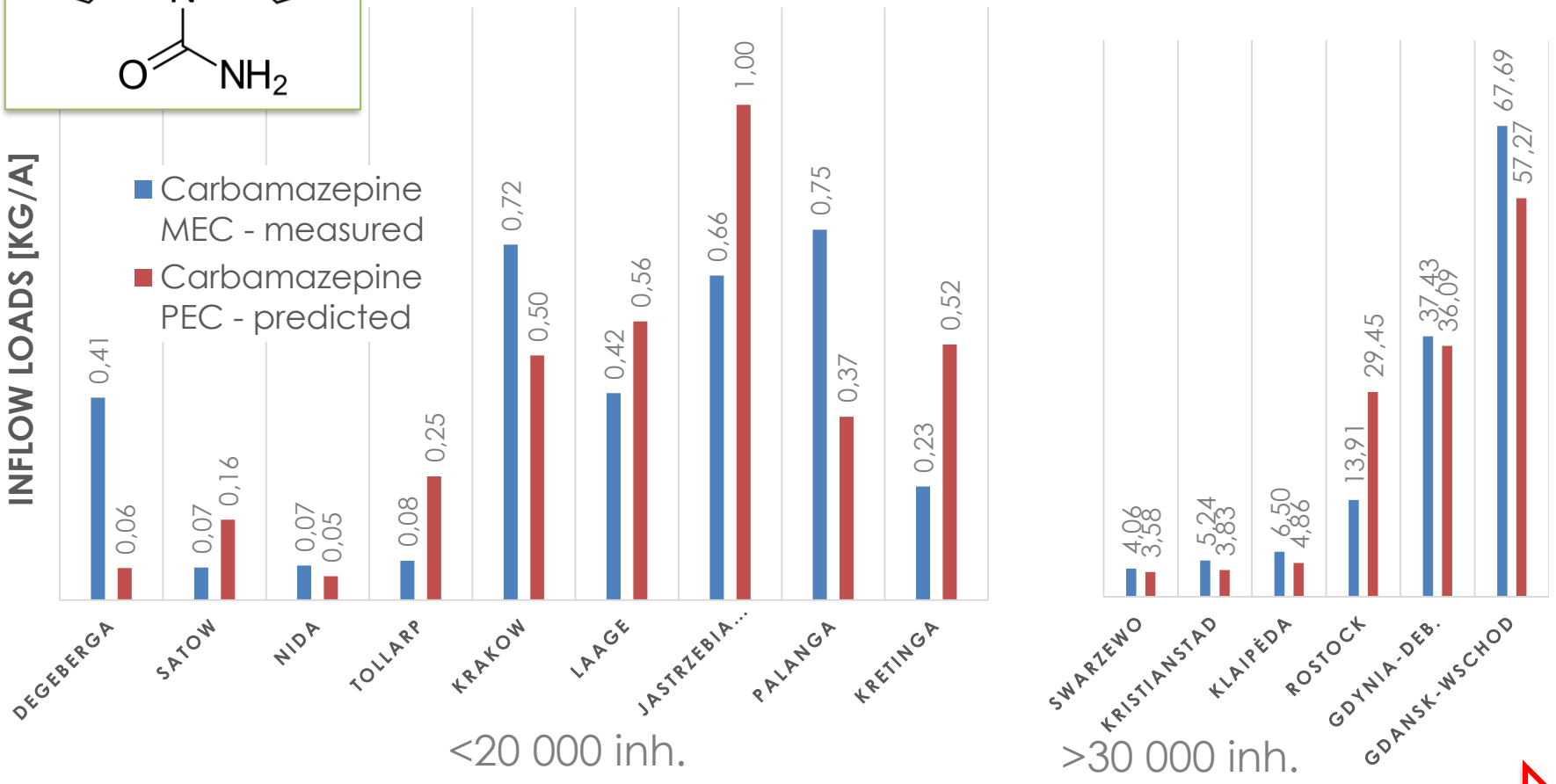
MEC vs. PEC

Carbamazepine

excretion rate – 14%



PEC=0.9107*MEC
R^2 = 0.9272



<20 000 inh.

>30 000 inh.

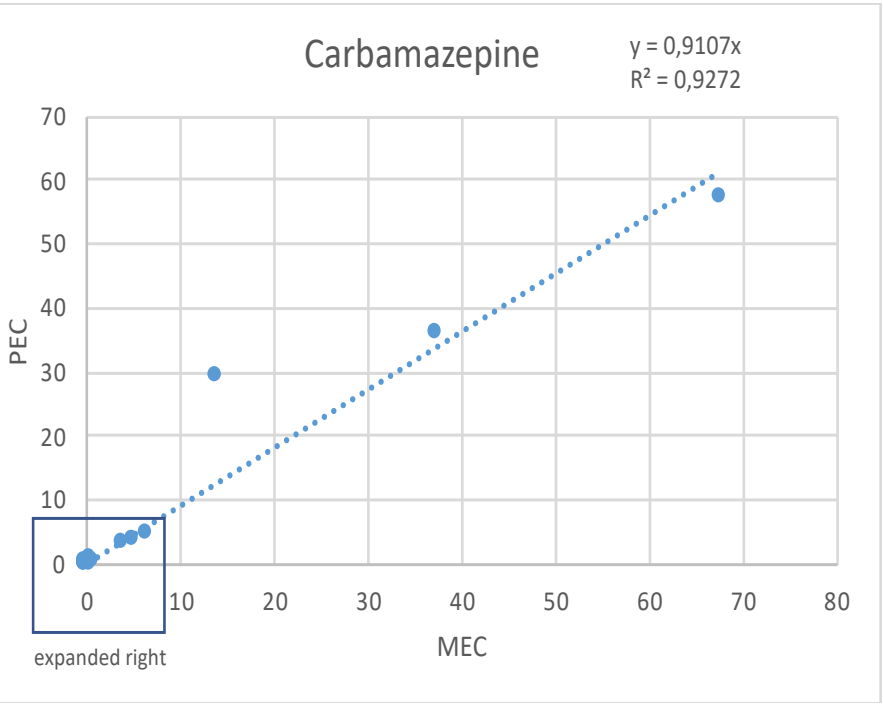
INCREASING *number of connected inhabitants*

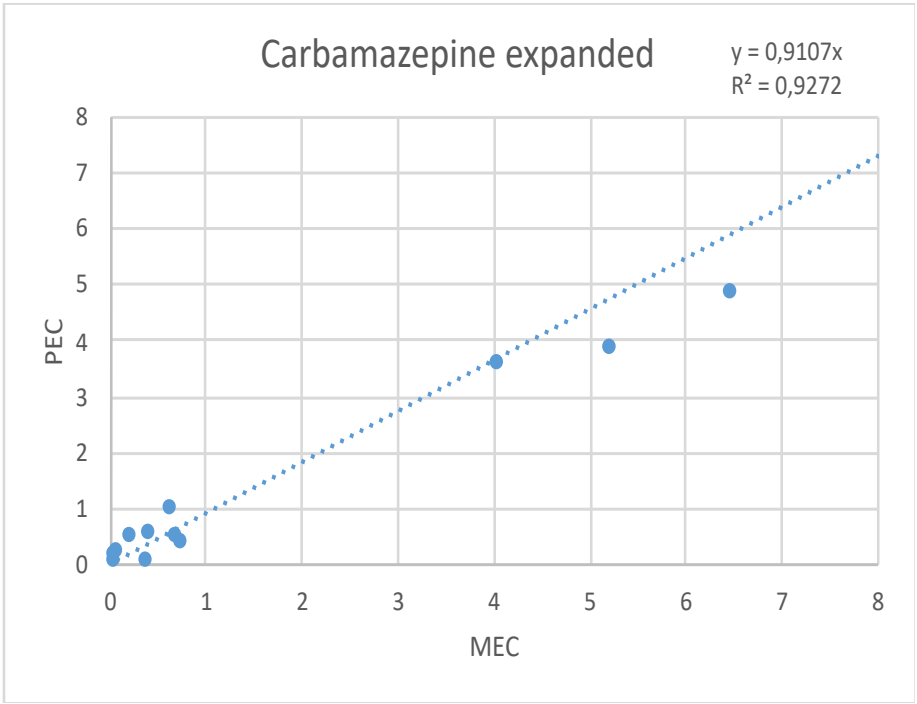
MEC vs. PEC

Carbamazepine

Linear relation between MEC and PEC

PEC=0.9107*MEC with an R^2 = 0.9272



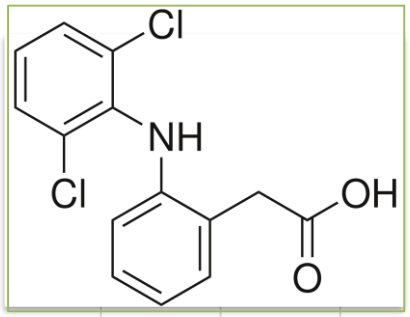


MEC vs. PEC

Diclofenac

excretion rate – 15%

PEC=0.1953*MEC
R^2 of 0.7613

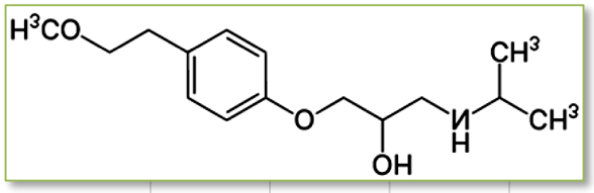


INCREASING *number of connected inhabitants*

MEC vs. PEC

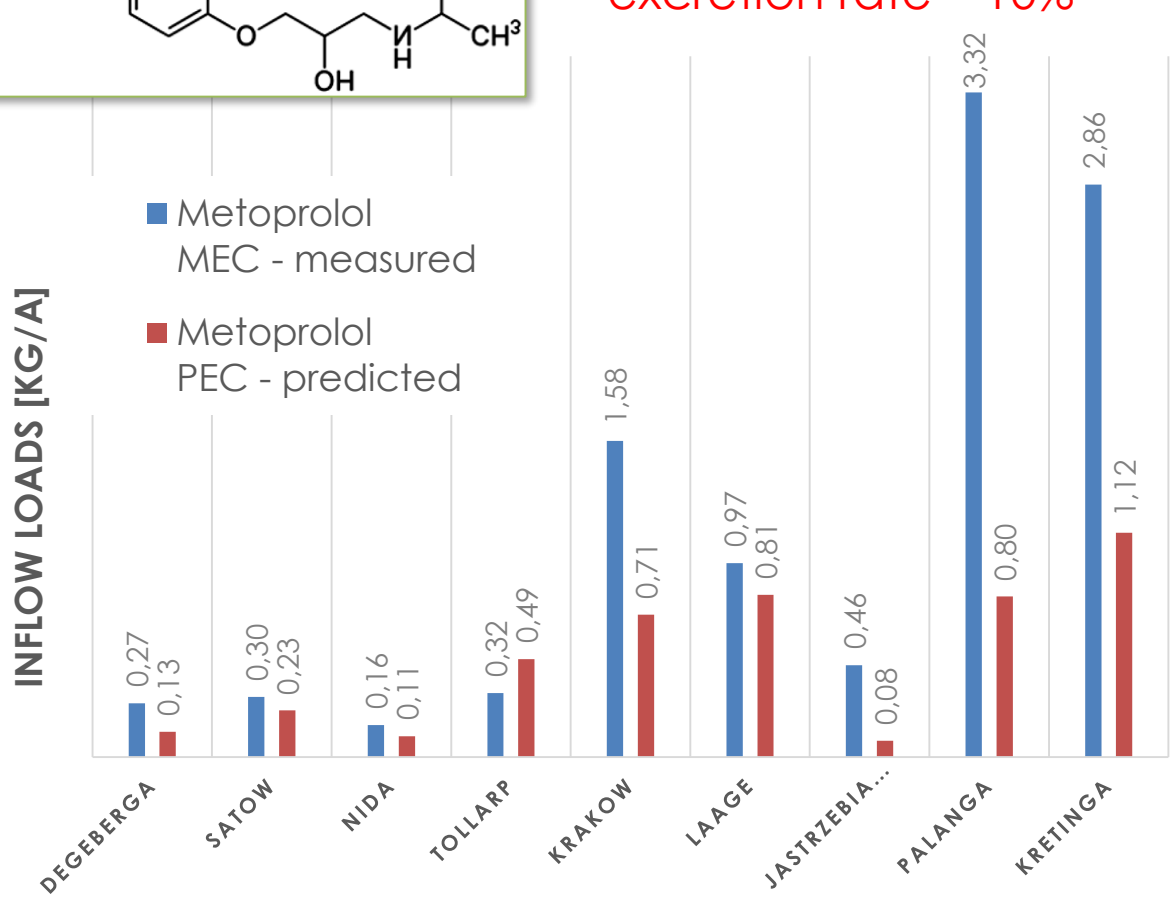
Metoprolol

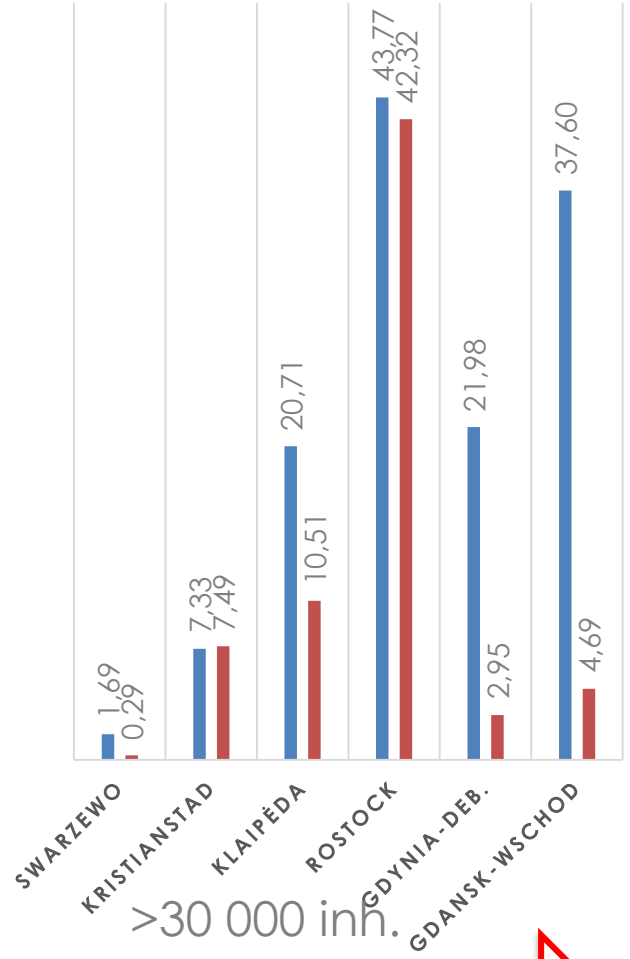
excretion rate – 10%



PEC=0.5495*MEC

R^2 = 0.5808





INCREASING *number of connected inhabitants*

MEC vs. PEC

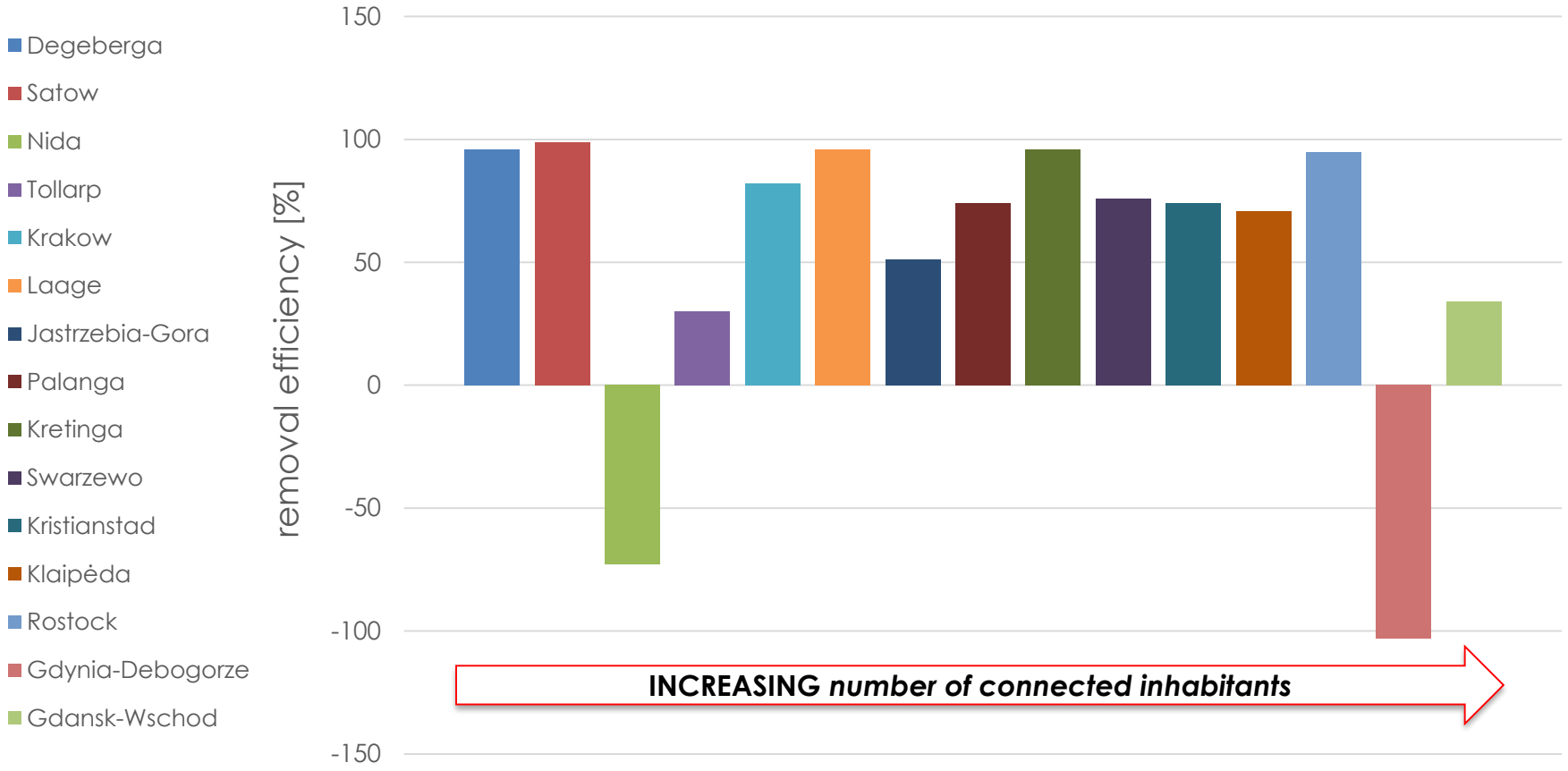
main hint

CARBAMAZEPINE and METOPROLOL showed the best correspondence between consumption and occurrence data in most of the WWTPs

CONSUMPTION ⟷ **OCCURRENCE**

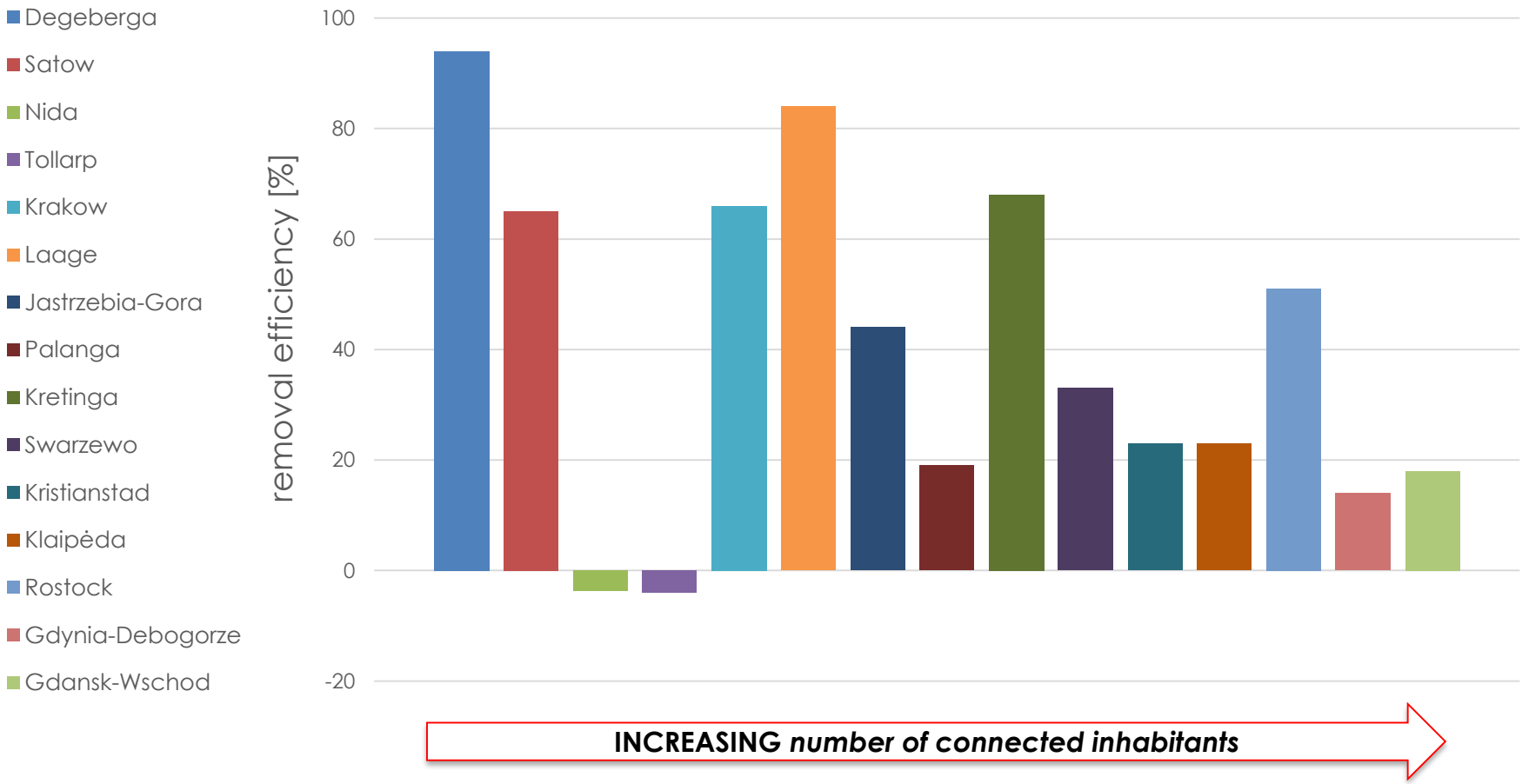
Removal efficiency vs. WWTP size

Azithromycin



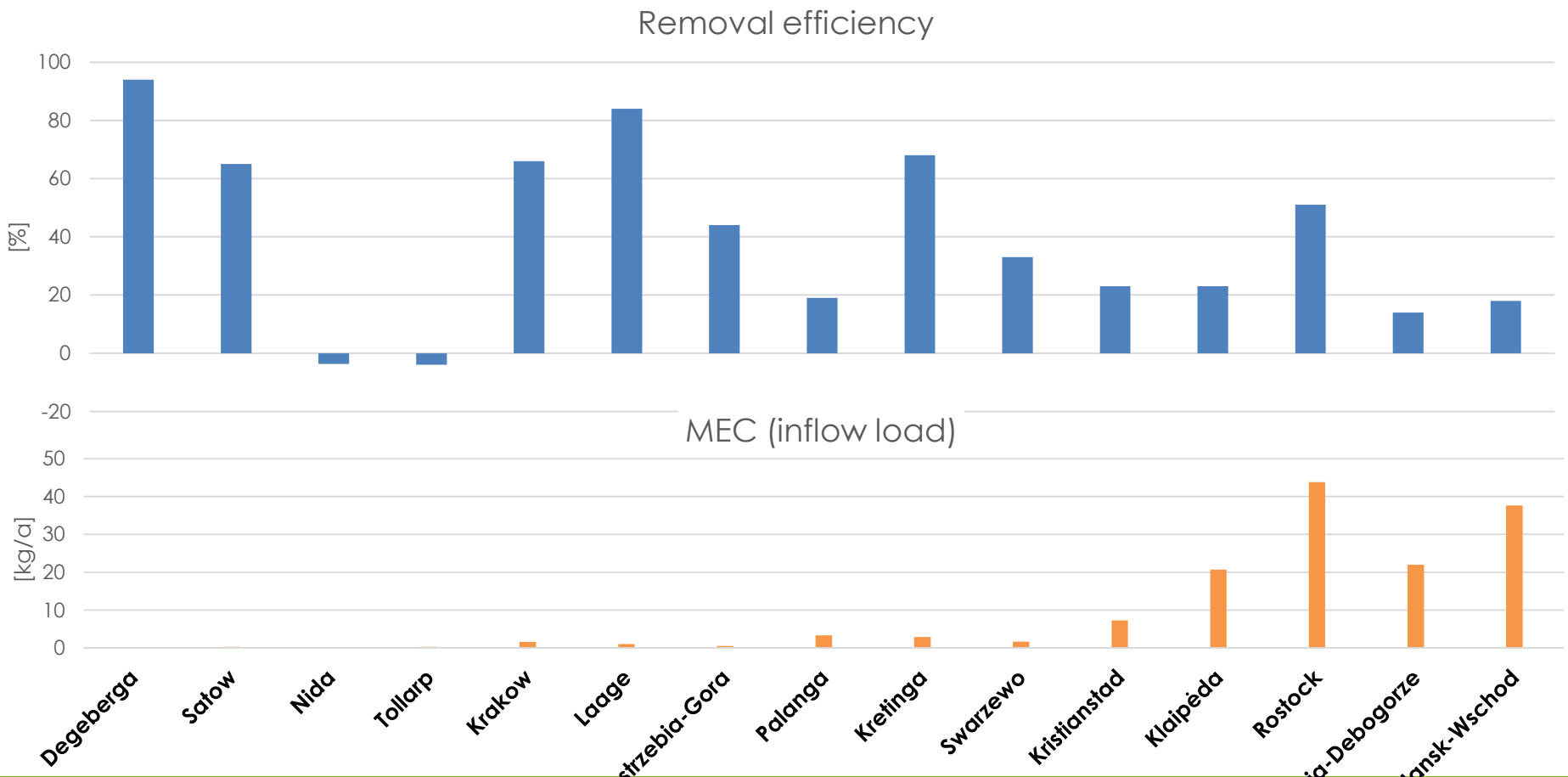
Removal efficiency vs. WWTP size

Metoprolol



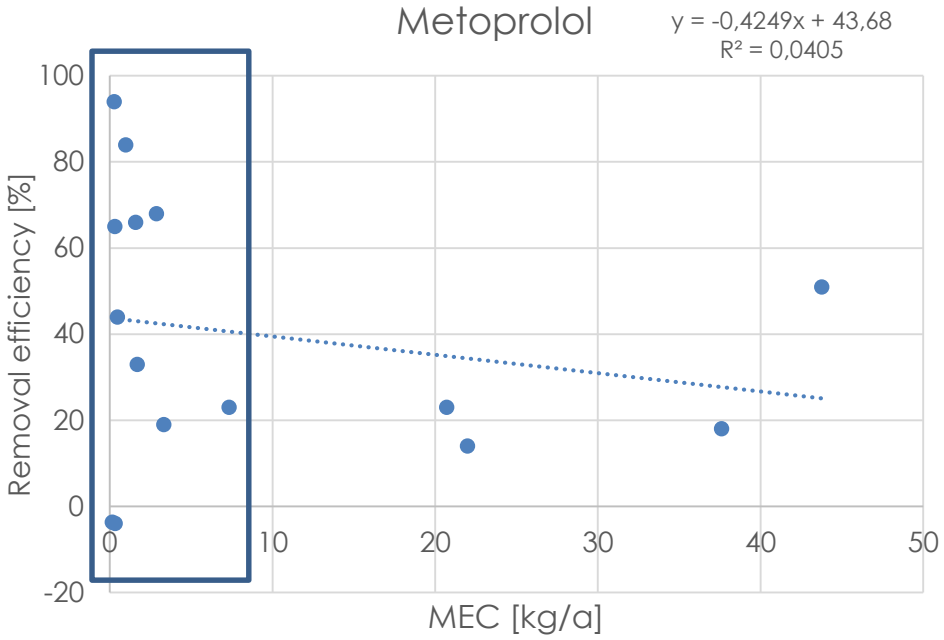
Removal efficiency, WWTP size & MEC

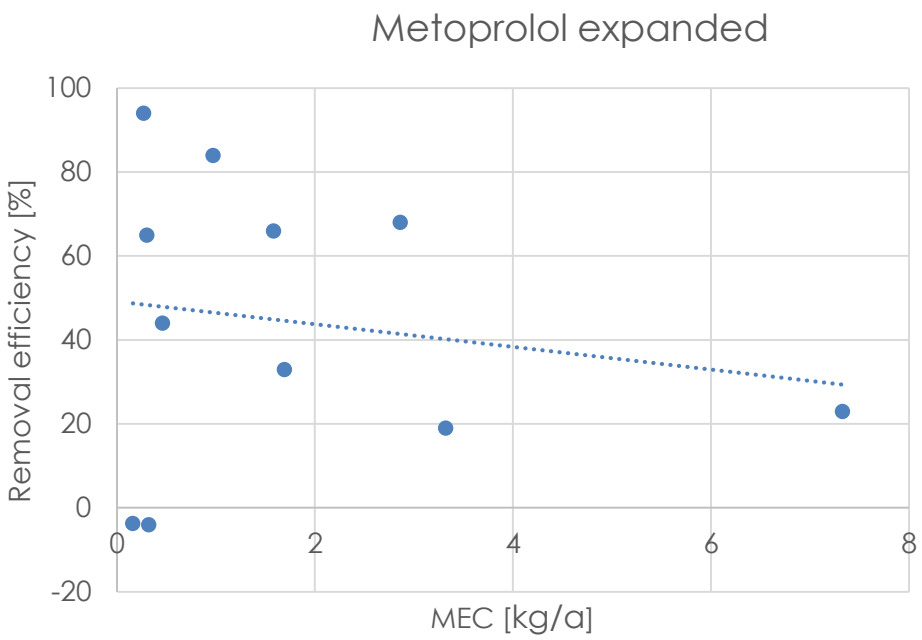
Metoprolol



Removal efficiency vs. MEC

Metoprolol





Removal efficiency vs. treatment methods

main hints

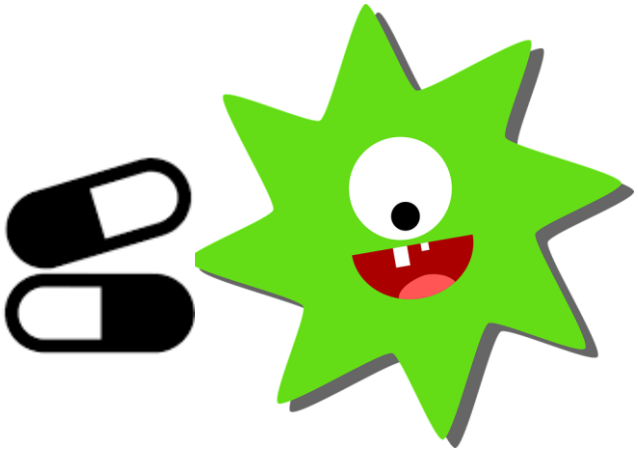
AZITHROMYCIN showed the best removal efficiency in most of the WWTPs (mean: 53.2%; median: 74%)

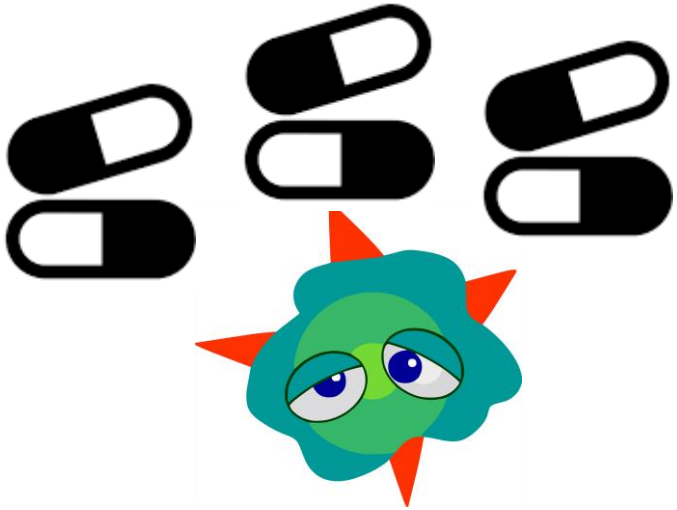
CONSUMPTION & OCCURRENCE ⟷ **TECHNOLOGY**

Removal efficiency vs. treatment methods

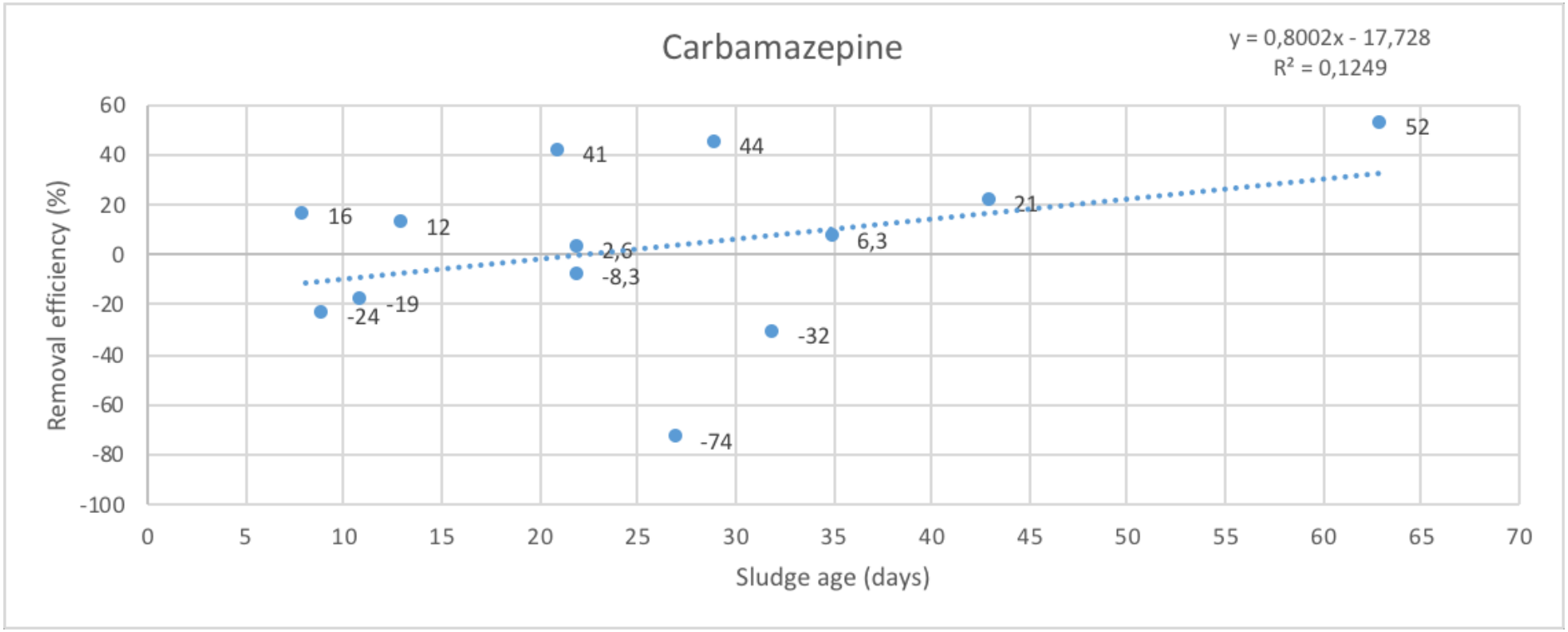
main hints

There are some observation that removal efficiency of **METOPROLOL** is decreasing during increase of inflow loads

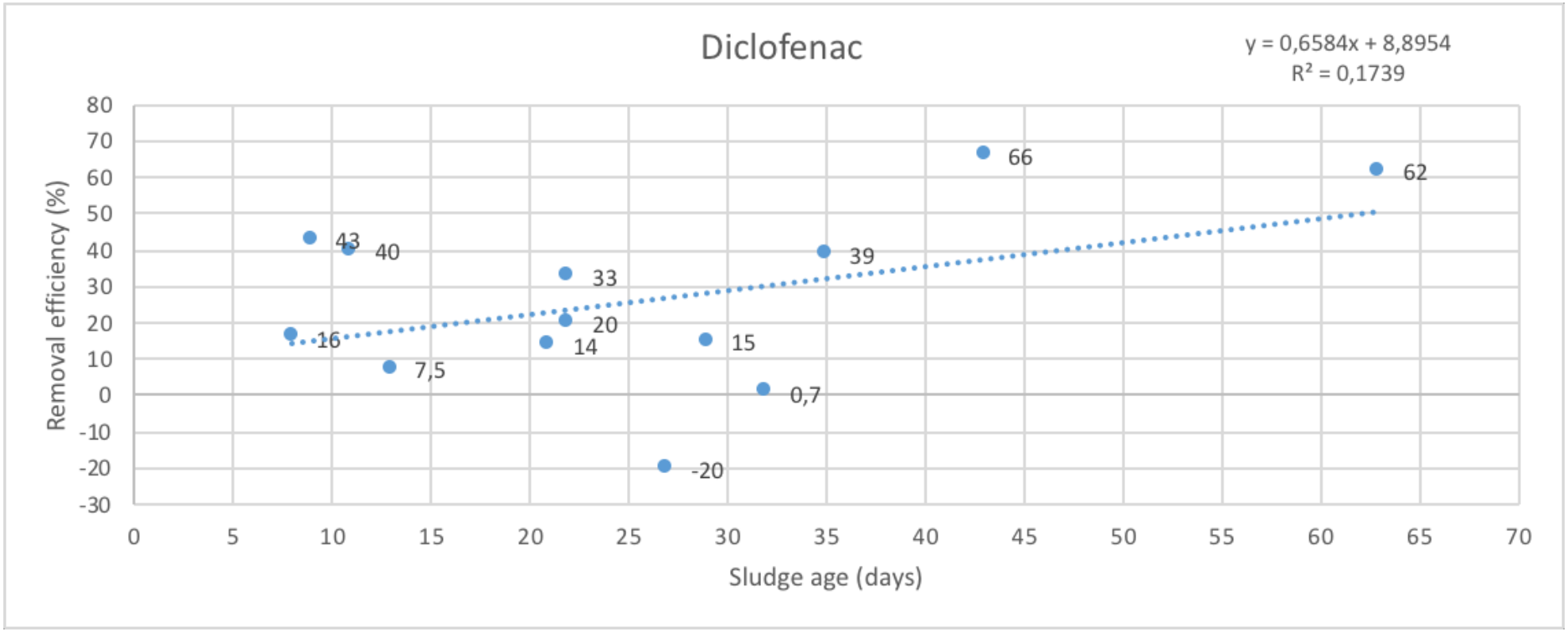




Removal efficiency vs. sludge age



Removal efficiency vs. sludge age



Removal efficiency vs. sludge age

main hint

There seem to be no strong relation between

REMOVAL EFFICIENCY and SLUDGE AGE

SUMMARY

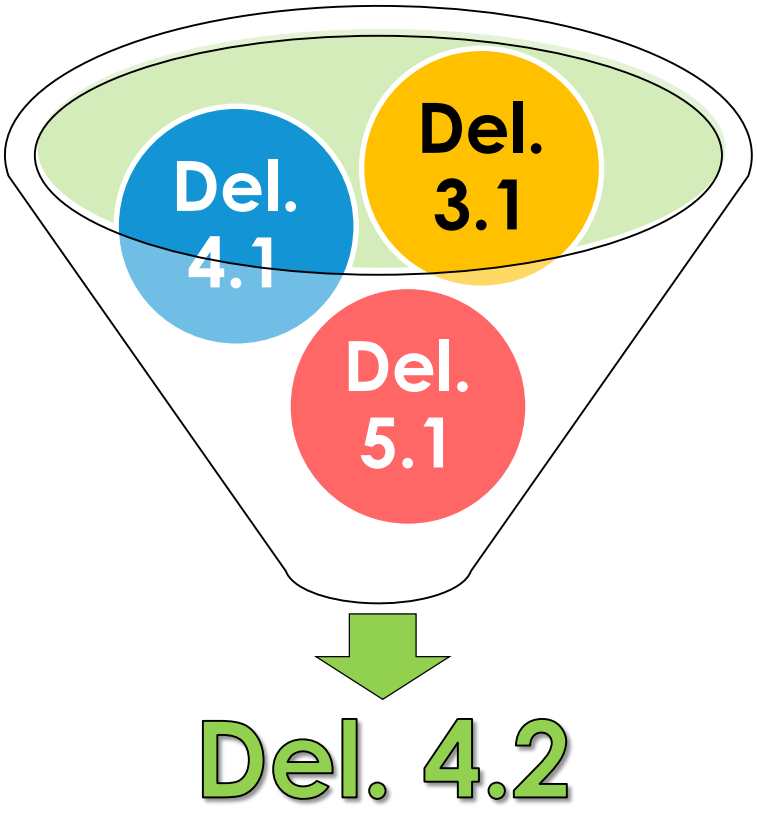
Based on the presented results **Carbamazepine** is a good candidate to be used as **predictor of expected chemical load** to a WWTP using consumption data in a certain region

Removal efficiency may corresponding to pharmaceutical load. In case of **Metoprolol**, it was observed, that removal efficiency is decreasing with the load increase.

The number of **connected inhabitants** and **sludge age** have **no visible effect** on reduction efficiency of the selected 4 pharmaceuticals

MORE INTERESTED?

Please see:

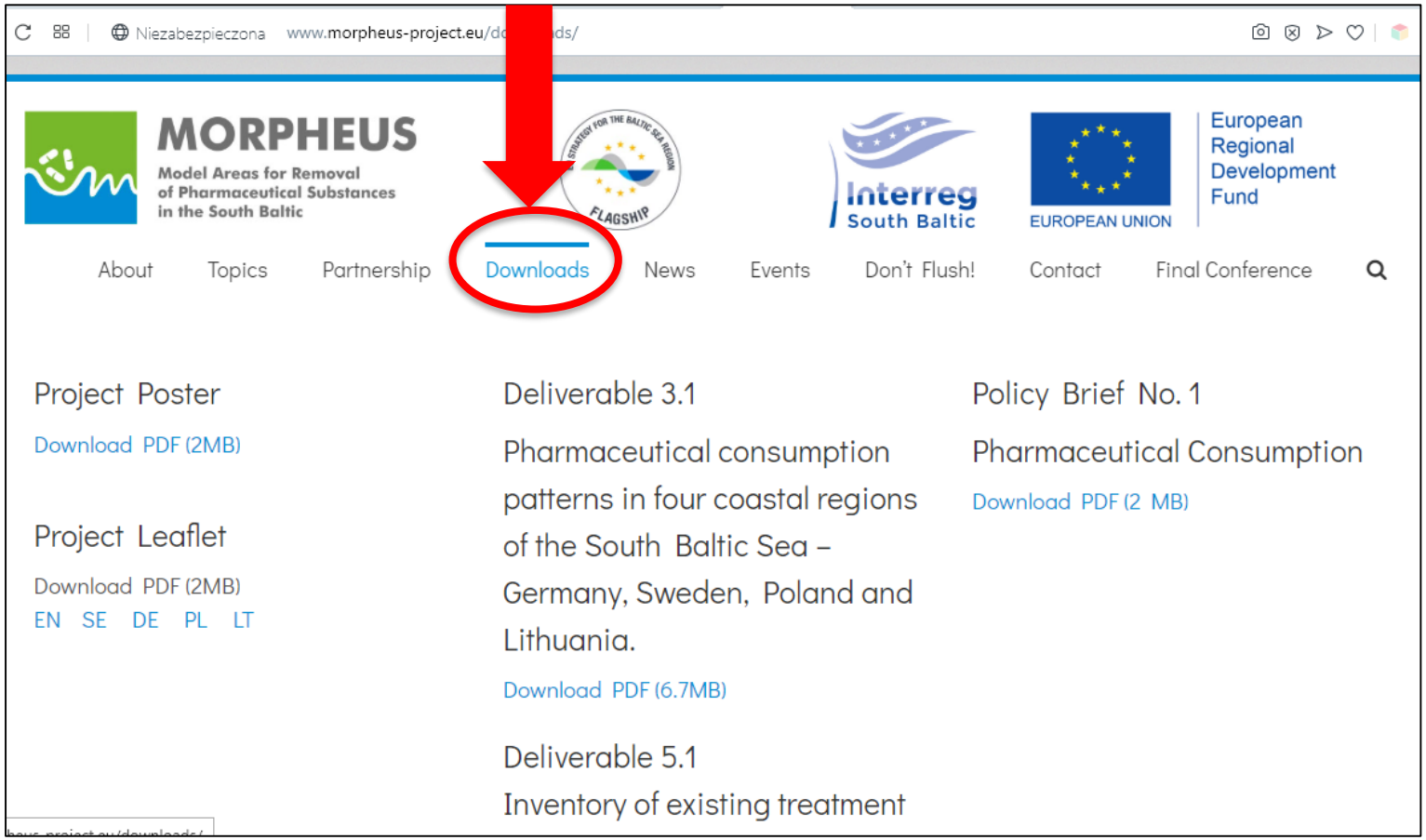


- **Deliverable 3.1** (regional consumption per inhabitant in 2015)
- **Deliverable 4.1** (pharmaceutical inflow loads of model WWTPs and pharmaceutical removal rates of model WWTPs) – **comming soon**
- **Deliverable 5.1** (model WWTPs characteristics)
- **excretion rates** of pharmaceuticals (literature)

- **Deliverable 4.2** Relation between pharmaceutical consumption, environmental pharmaceutical burdens and current treatment technologies – **comming soon**

MORE INTERESTED?

Please see



Authors of the presented work - MORPHEUS team