Ministry of Health, Welfare and Sport

# AMR in the environment

Research results and policy dilemma's in the Netherlands

One Health Network AMR

26 October 2018

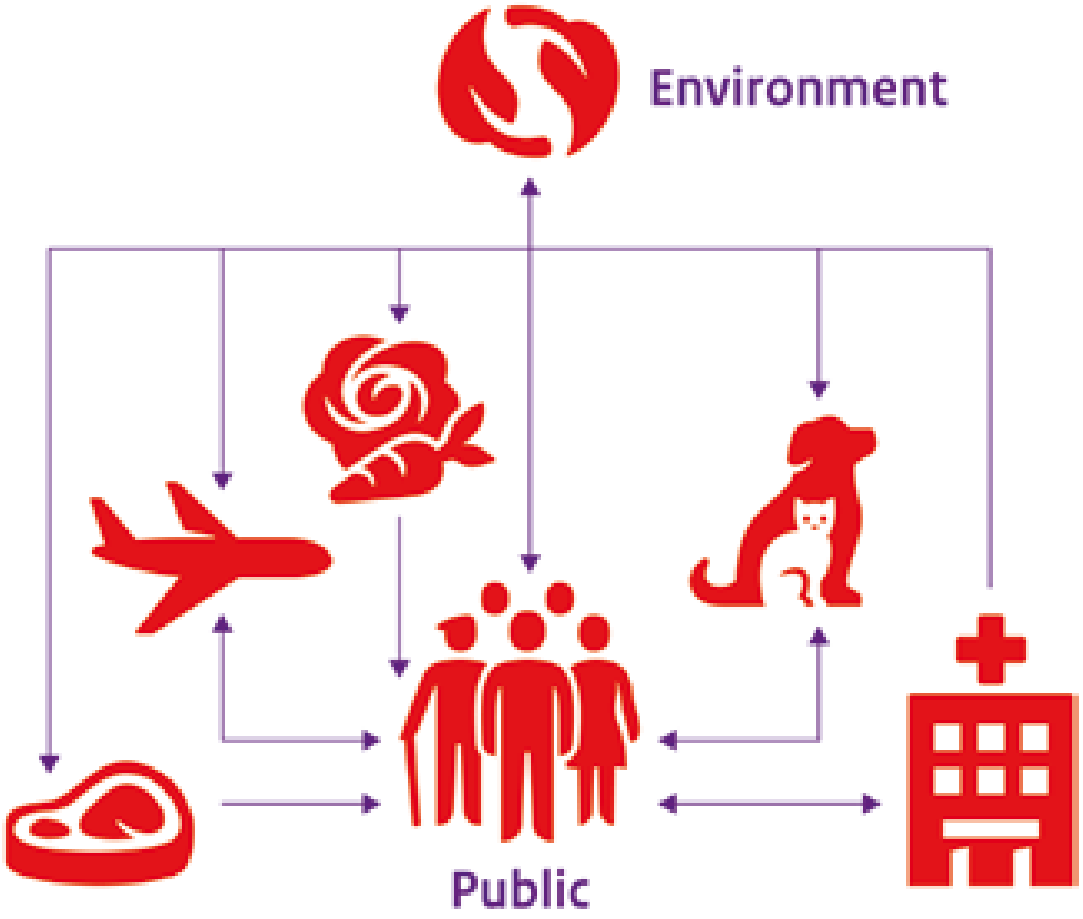
# Introduction

- NAP AMR 2015-2019

- actions in all domains

- research in domain environment largely finalised

# Spread of resistant bacteria



# Background

- <2015 policy advice reports highlight uncertainties

- Message ‘more research needed’ not desirable

- Therefore commisioned RIVM to:
  - Conduct baseline / ‘zero’ measurements in wastewater and manure
  - Advice on effective no-regret policy measures

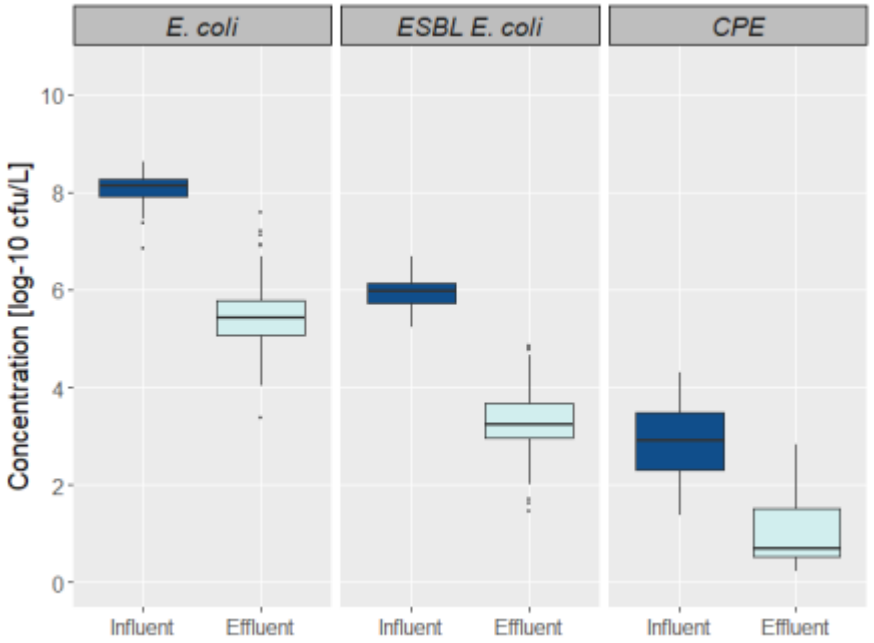
# Selection of Wastewater Treatment Plants


- Selection of 100 WWTP (approx. 1/3 of all Dutch WWTP)
- Inventory of water volumes across NL



Schmitt et al. 2017, RIVM report 2017-0058

# Concentrations of *E. coli*, ESBL and CPE




- log2 – log3 removal of bacteria
- No selection for ESBL or CPE

- CPE detected in 89% of the WWTP (87% of the influents, 55% of the effluents)



Schmitt et al. 2017, RIVM report 2017-0058

# Loads to the aquatic environment

Residues: around 900 kg/a for 4 most prevalent substances

| | Volume | ESBL E.coli | CRE | *ermB* | *sul1* |
|---|---|---|---|---|---|
| | [$10^6$ $m^3$/year] | Load [CFU / year] | | Load [copies / year] | |
| **WWTP** | 1900 | $3{,}2\times10^{15}$ | $1{,}8\times10^{13}$ | $1{,}9\times10^{19}$ | $2{,}4\times10^{20}$ |



Schmitt et al. 2017, RIVM report 2017-0058

# Other sources of resistant bacteria in surface water

- WWTP effluent
- Sewage overflows
- Separated sewers (rain to surface water, faulty connections: wastewater to surface water)
- Animal husbandry (manure, stables)

# Loads to the aquatic environment

Overflows and separate sewer systems possibly equally important

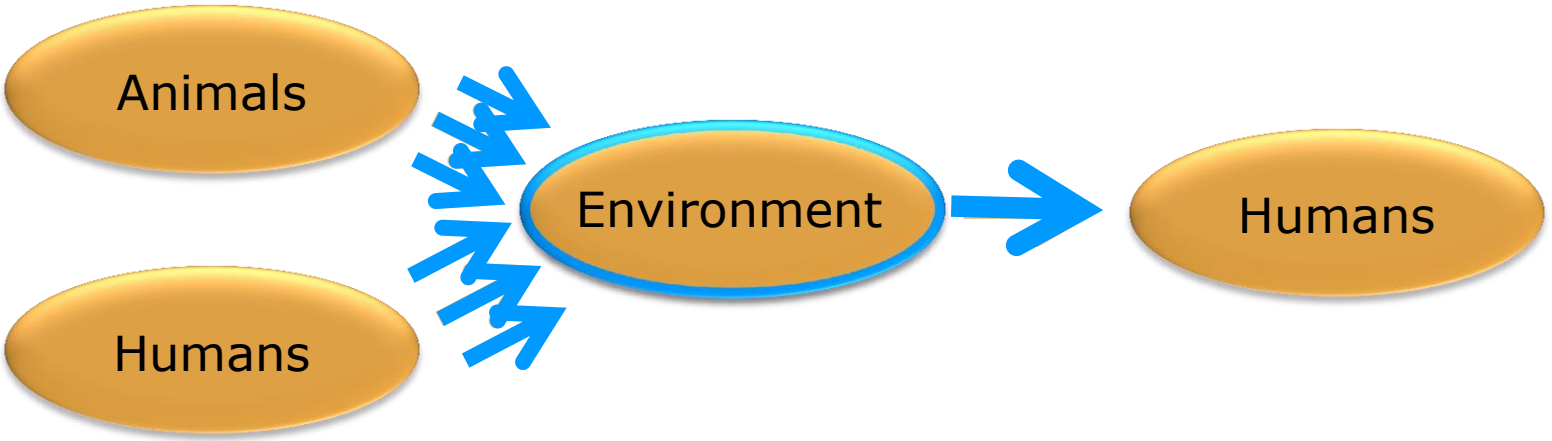
| | Volume | ESBL E.coli | CRE | *ermB* | *sul1* |
|---|---|---|---|---|---|
| | [$10^6$ $m^3$/year] | Load [CFU / year] | | Load [copies / year] | |
| **WWTP** | 1900 | $3x10^{15}$ ($8x10^{14}$ – $2x10^{16}$) | $1,8\times10^{13}$ | $1,9\times10^{19}$ | $2,4\times10^{20}$ |
| **Overflows** | 29 | $1x10^{15}$ ($1x10^{15}$ - $5x10^{15}$) | $2,8\times10^{11}$ – $1,4\times10^{14}$ | $2,9\times10^{17}$ – $9,2\times10^{19}$ | $3,7\times10^{18}$ – $2,9\times10^{20}$ |
| **Separate sewer systems** | 2,7 | $3x10^{15}$ ($1x10^{15}$ – $5x10^{15}$) | $1,3\times10^{13}$ | $8,5\times10^{18}$ | $2,7\times10^{19}$ |

# Manure – loads to the terrestrial environment

- Less precise estimates
- All, volumes, concentrations and prevalence matters
- Overall similar to wastewater (but: human exposure to manured soil?)

| | Volume | ESBL *E.coli* |
|---|---|---|
| | [$10^6$ $m^3$/year] | load [CFU / year] |
| Dairy cattle | 44.9 | $10^{15}$ (± 1 log) |
| Veal calves | 3.9 | $10^{15}$ (± 1 log) |
| Pork | 10 | $10^{15}$ (± 1 log) |
| Layers / broilers | 0.15 | $10^{14}$ (± 1 log) |

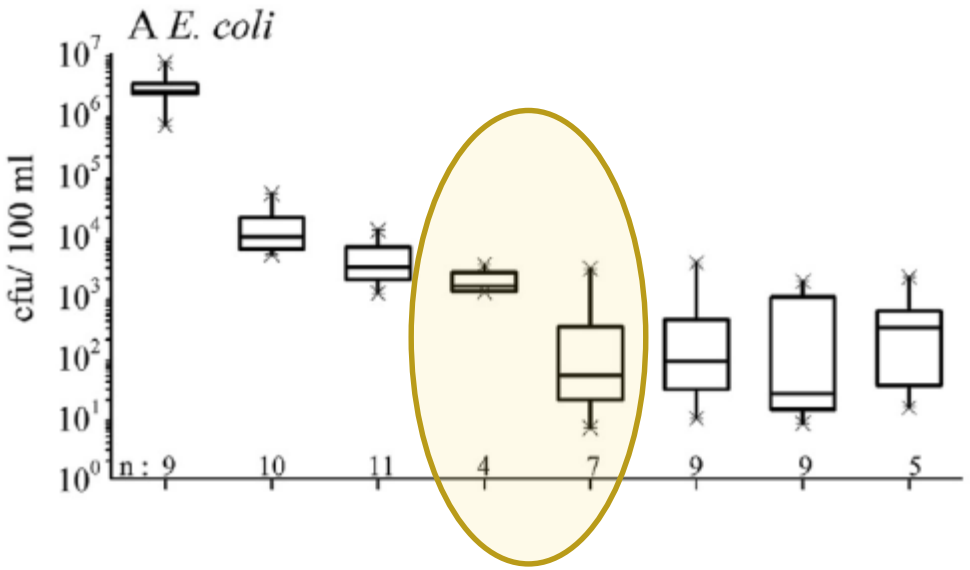
# Knowledge gaps?




- Environmental exposure to AMR and health outcomes
- Efficiency management options
- Horizontal gene transfer and selection of resistance traits

# Possible interventions – Advanced treatment processes and ABR

- Less data on AMR removal than on removal of pharmaceuticals
- Efficiency of treatment in lab studies > pilot / field
- Techniques that are currently considered for removal of pharmaceuticals differ in their removal efficiency for bacteria (GAC lower than $O_3$)






Lüddeke et al. Water Research 2015

# ABR in hospital wastewater

- Separated treatment of hospital wastewater?
- 7 (4) hospital / WWTP pairs, 3-4 samplings
- Contribution of hospital wastewater to ESBL and CPE mostly <10%

| | E. coli | ESBL E. coli | CPE E. coli totaal | Non OXA-48 CPE E. coli |
|---|---|---|---|---|
| C | 1.9 | 5.3 | **10.8** | **11.4** |
| C | 0.5 | 9.1 | 3.4 | 3.0 |
| C | 0.4 | 9.6 | 7.1 | 7.0 |
| C | 1.9 | 7.6 | **14.7** | **15.9** |
| Da | 0.4 | 0.4 | 5.5 | **10.6** |
| Da | 0.0 | 0.0 | <0.1 | <0.1 |
| Da | 0.6 | 1.8 | 3.3 | 1.0 |
| Da | 0.1 | 0.5 | 1.0 | 0.4 |
| Db | 0.3 | 0.6 | <0.1 | <0.1 |
| Db | 0.1 | 0.8 | <0.1 | <0.1 |
| E | 0.4 | 0.3 | 4.7 | 4.9 |
| E | 1.0 | 0.8 | 7.0 | **11.2** |
| E | 0.7 | 1.0 | **16.9** | **26.3** |
| E | 1.8 | 5.8 | **18.8** | **34.8** |
| G | 1.4 | 14.0 | <0.1 | <0.1 |
| G | 0.6 | 8.3 | 8.5 | 1.1 |
| G | 1.5 | 10.4 | 1.8 | **34.9** |

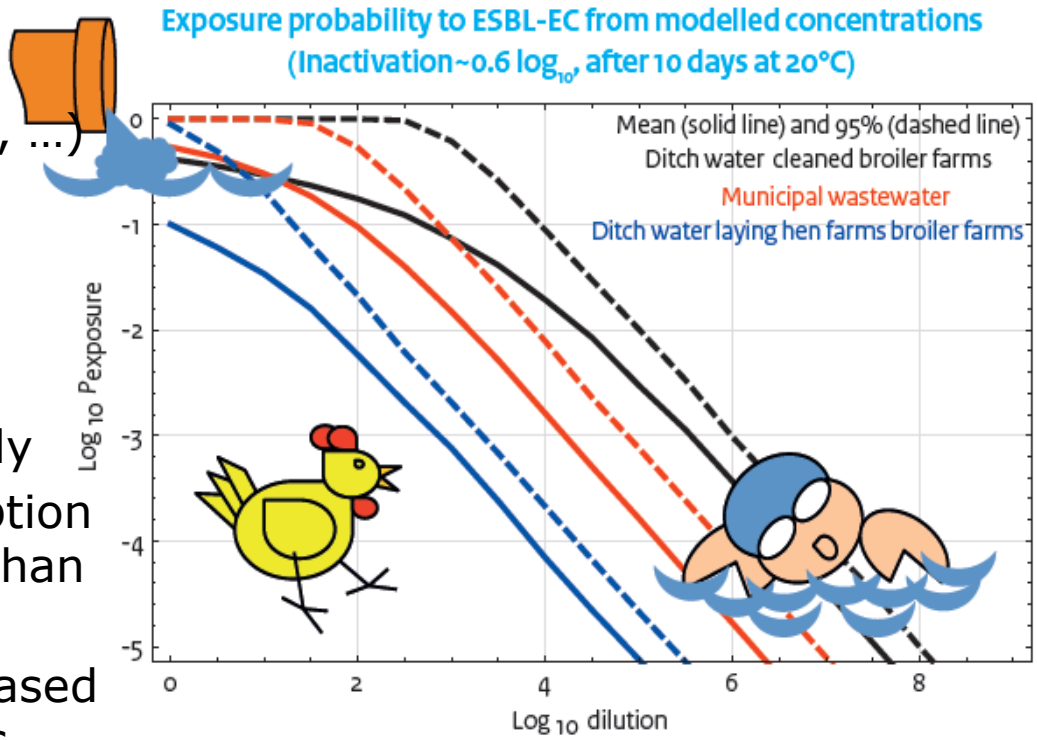
# Exposure to ABR through the environment

Possible transmission routes

- Recreation (swimming, surfing, …)
- Occupational exposures

Estimates of ESBL E. coli uptake (NL):

- Uptake through swimming likely
- Uptake through meat consumption and swimming possibly lower than direct human-human contact
- UK: 3GC-resistant E. coli increased in surfers (9%) versus controls (3%, n=140)






Schijven et al. EST 2015, Rapport ESBLAT 2018

# Current studies NL

JPI AWARE-WWTP (2017-2020)

ESBL *E. coli* in WWTP workers as compared to controls

"Zwemmersstudie" (2017-2019)

ESBL E. coli in participants of city swims before / after participation (n=300)

# Conclusions

- Prevalence of resistant bacteria and antibiotic residue in wastewater and manure is now known
  - In contradiction to what we expected, hospitals do not contribute more than residential areas
  - AMR loads in wastewater and manure are equal

- Effective measures are possible
  - Certain techniques to treat wastewater and manure are more effective than those currently applied
  - Manure is not often treated, and if treated has another purpose
  - Possible measures are expensive and for manure even not realistic

# Dilemma's

- End of current NAP
  - decide on policy development environmental domain
  - is it necessary and realistic to reduce spread of AMR via the environment?

- On the one hand
  - Exposure of humans to AMR in the environment likely occurs
  - precautionary principle
  - international attention AMR in the environment

- On the other hand:
  - NL takes extensive measures at source (health care and veterinary domain)
  - disease burden probably low
  - exposure to specific resistant pathogens largely unquantified
  - no clear indication where to start (wastewater or manure)
  - measures are expensive
  - responsibility of others than Ministry of Health