A watercolor illustration of a winding river. The river is depicted with various shades of blue and white, suggesting depth and movement. The banks are rendered in warm, earthy tones of brown and tan. Scattered throughout the water are numerous small, black chemical structures, representing pharmaceuticals. The overall style is artistic and illustrative.

An integrated assessment of pharmaceuticals in water systems

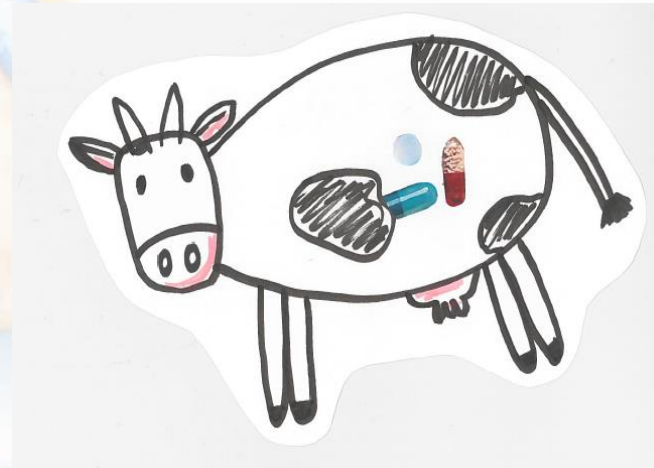
Lara Wöhler

06.04.2023

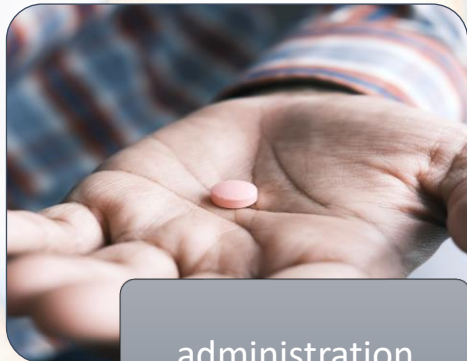


RQ1: How can pharmaceutical pollution from diverse sources and its impacts be quantitatively assessed at different geographical levels?

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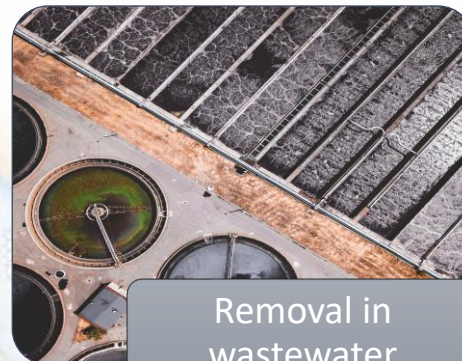
Human pharmaceuticals entering the environment



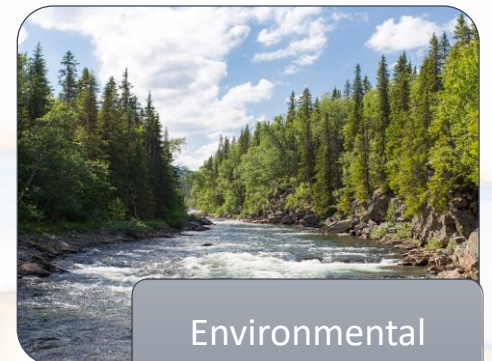
administration



excretion

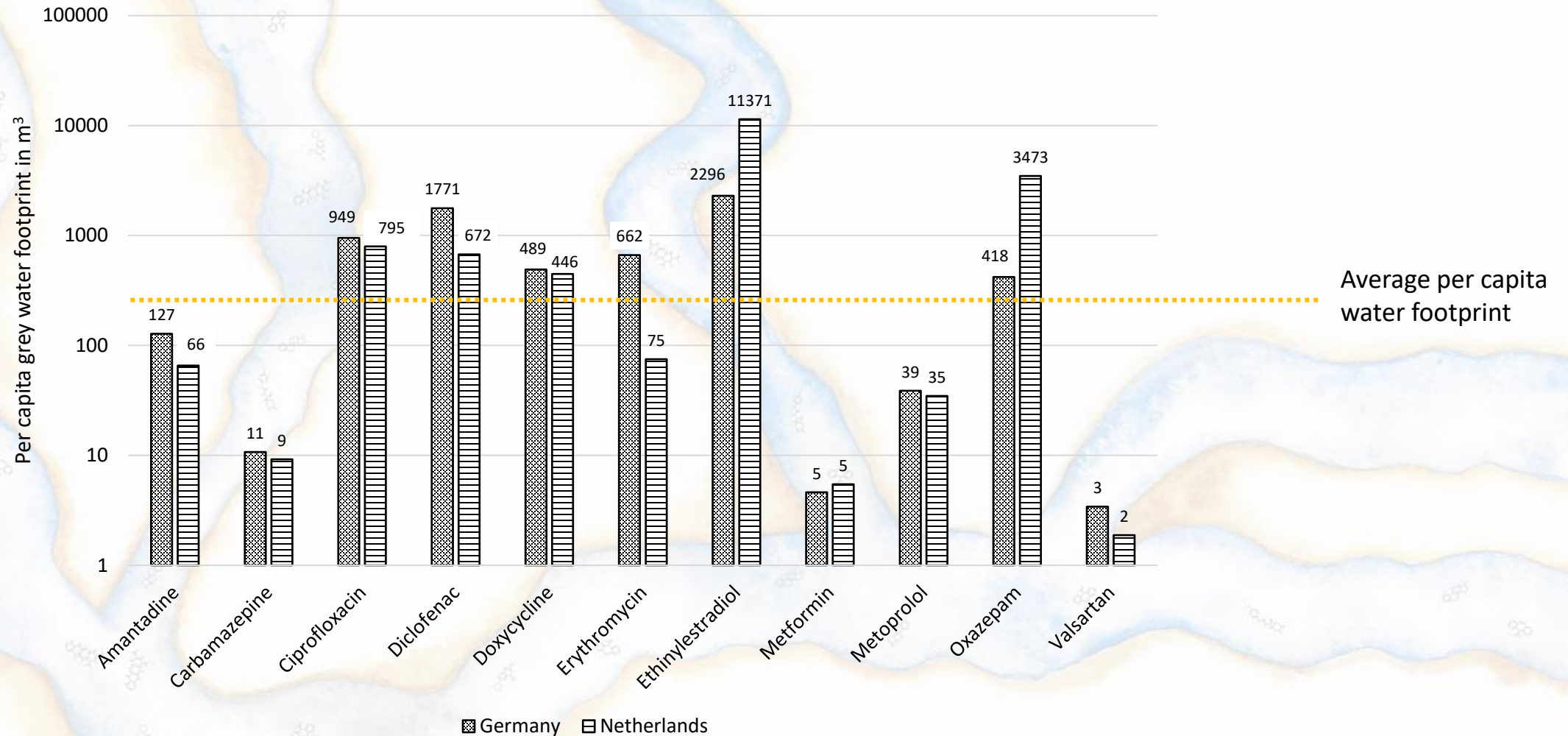


Removal in
wastewater
treatment



Environmental
discharge

Human pharmaceuticals entering the environment



Source: Wöhler, L., Niebaum, G., Krol, M., Hoekstra, A. (2020): The grey water footprint of human and veterinary pharmaceuticals. Water Research X, 7, 100044.

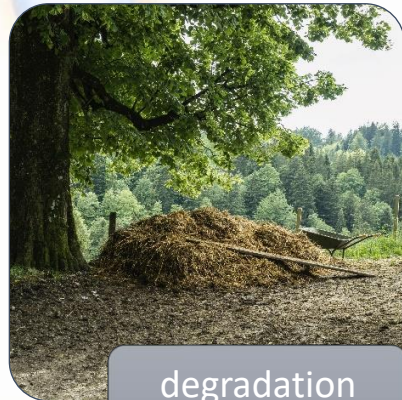
Veterinary pharmaceuticals entering the environment



administration



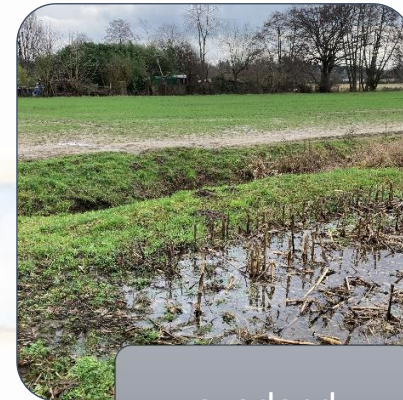
excretion



degradation
during manure
storage

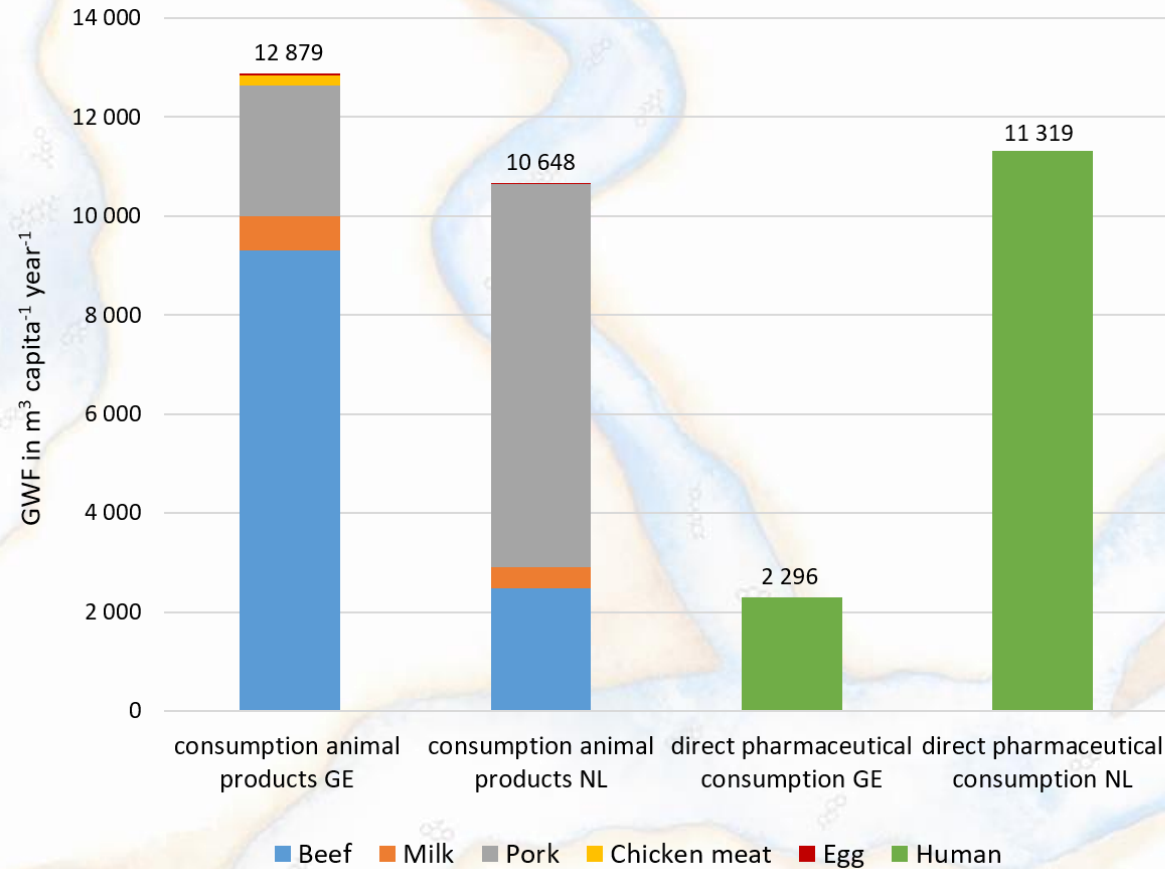


fate in soil



overland
transport

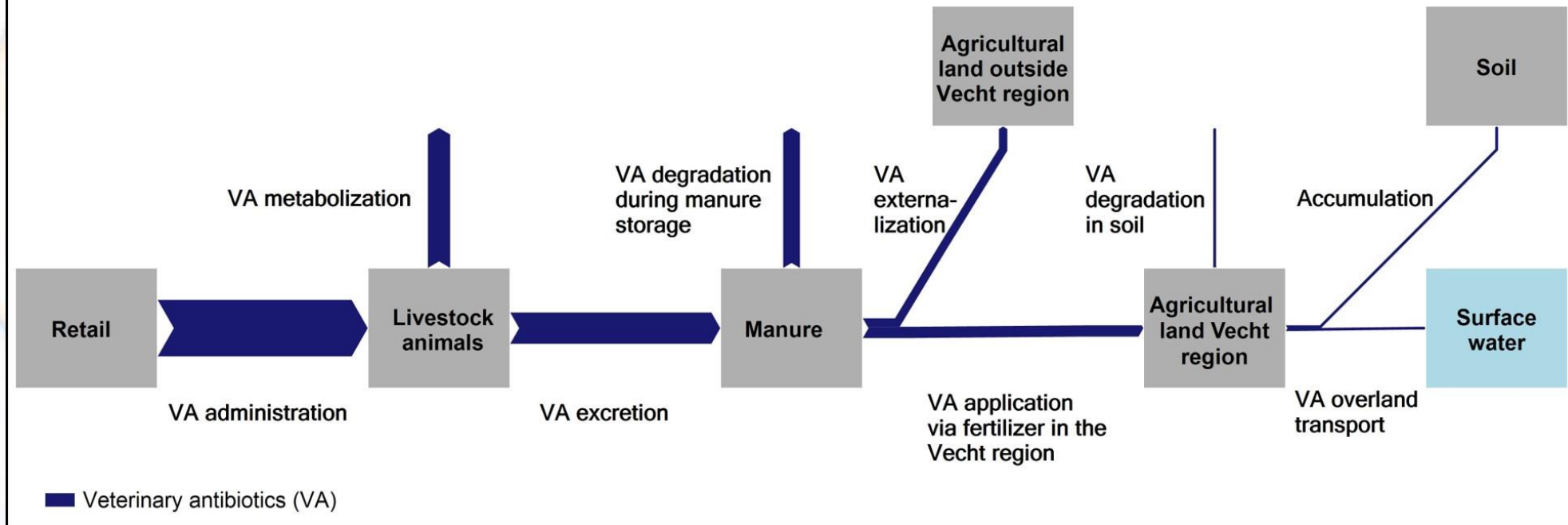
Veterinary pharmaceuticals entering the environment



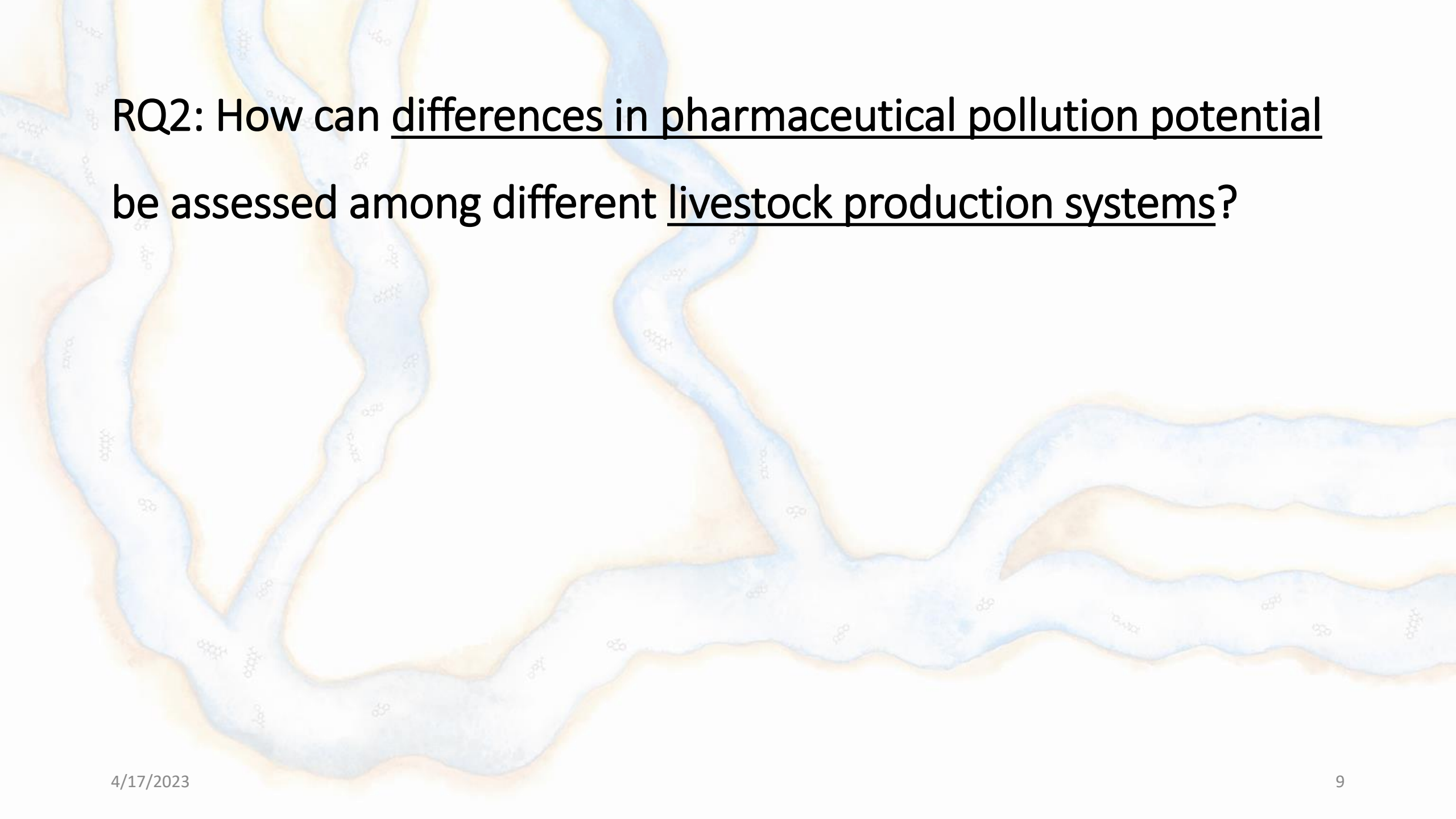
Source: Wöhler, L., Niebaum, G., Krol, M., Hoekstra, A. (2020): The grey water footprint of human and veterinary pharmaceuticals. Water Research X, 7, 100044.

Veterinary pharmaceuticals entering the environment

Veterinary antibiotics mass flow



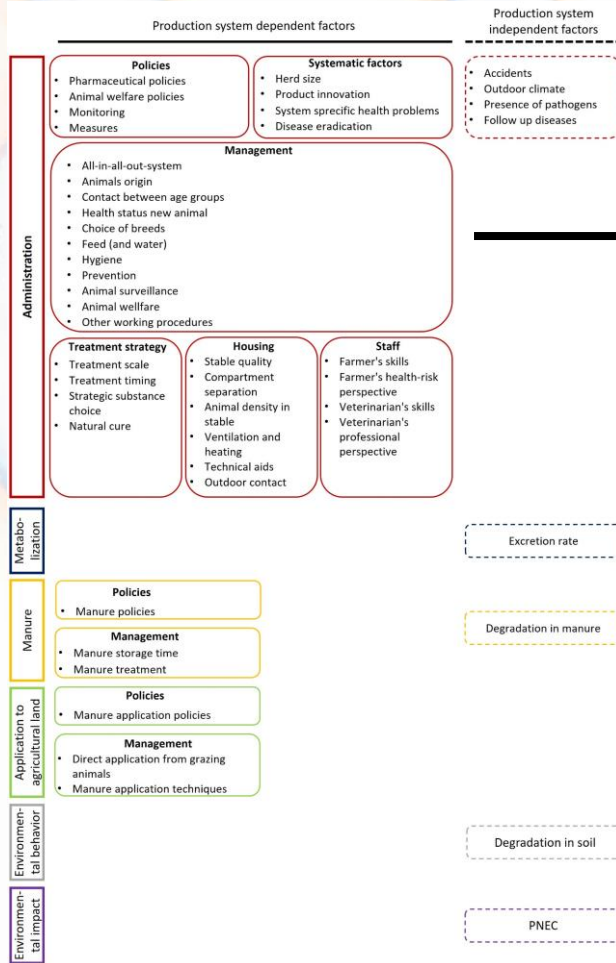
Source: Wöhler, L., Brouwer, P., Augustijn, D. C. M., Hoekstra, A. Y., Hogeboom, R. J., Irvine, B., Lämmchen, V., Niebaum, G. & Krol, M. S. (2021): An integrated modelling approach to derive the grey water footprint of veterinary antibiotics. *Environmental Pollution*, 288, 117746.



RQ2: How can differences in pharmaceutical pollution potential
be assessed among different livestock production systems?

Differences in pharmaceutical pollution from different production systems

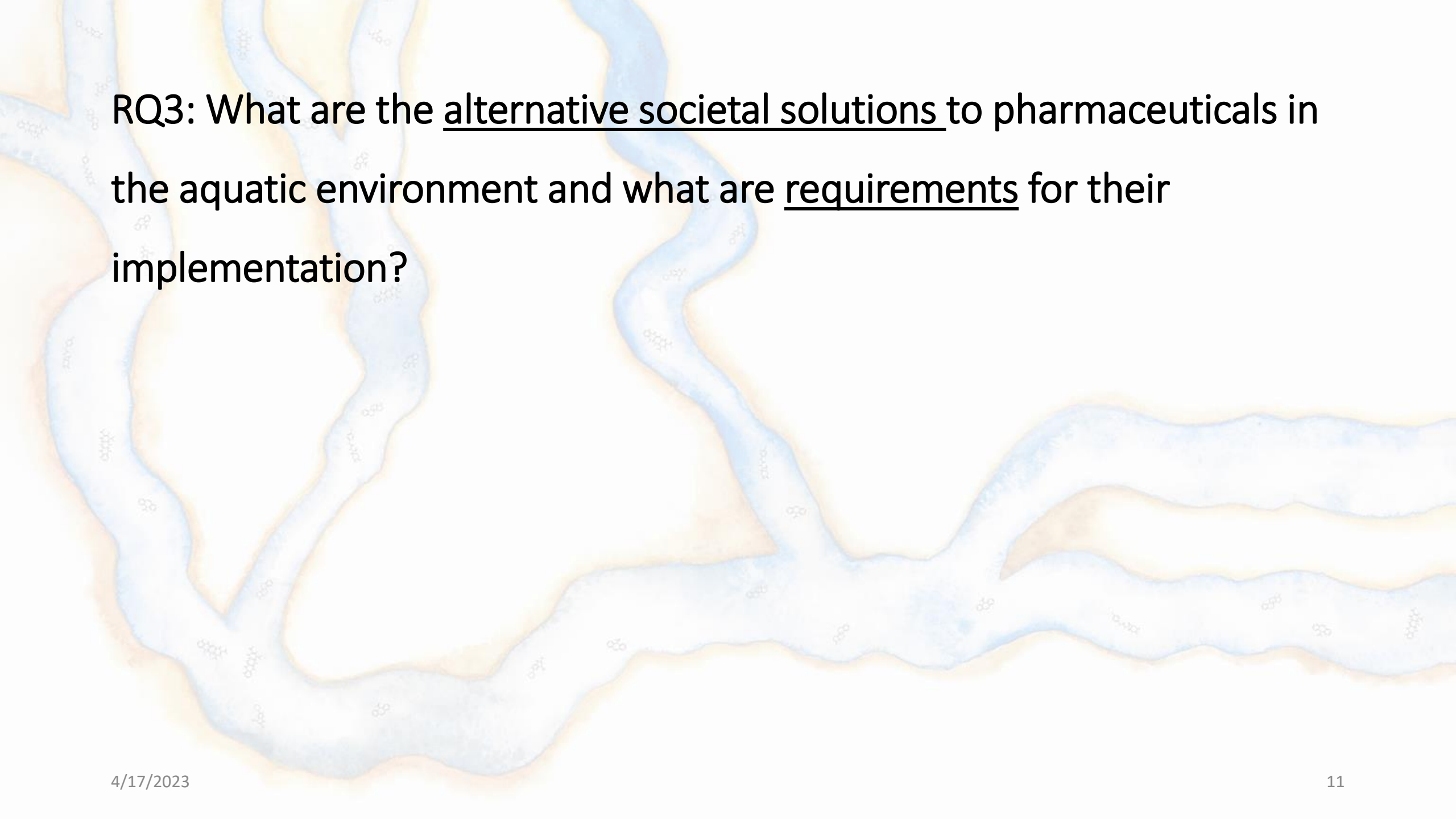
Framework



Pilot assessment

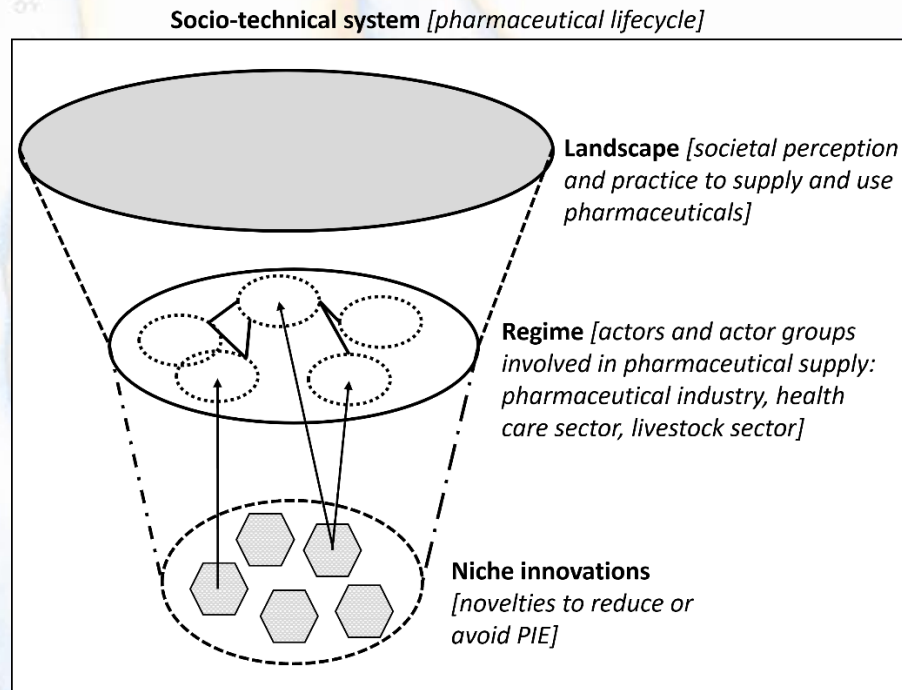
Management	C	O
All-in-all-out-system		
Animals origin		
Contact between age groups		
Health status new animal		
Choice of breeds	Red	Green
Feed (and water)	Blue	Blue
Hygiene	Green	Red
Prevention	Red	Green
Animal surveillance	Blue	Blue
Animal welfare	Blue	Blue
Other working procedures		

Source: Wöhler, L., Hogeboom, R. J., Berger, M., Krol, M. S. (2023): Water pollution from pharmaceutical use in livestock farming: Assessing differences between livestock types and production systems. Integrated Environmental Assessment and Management



RQ3: What are the alternative societal solutions to pharmaceuticals in the aquatic environment and what are requirements for their implementation?

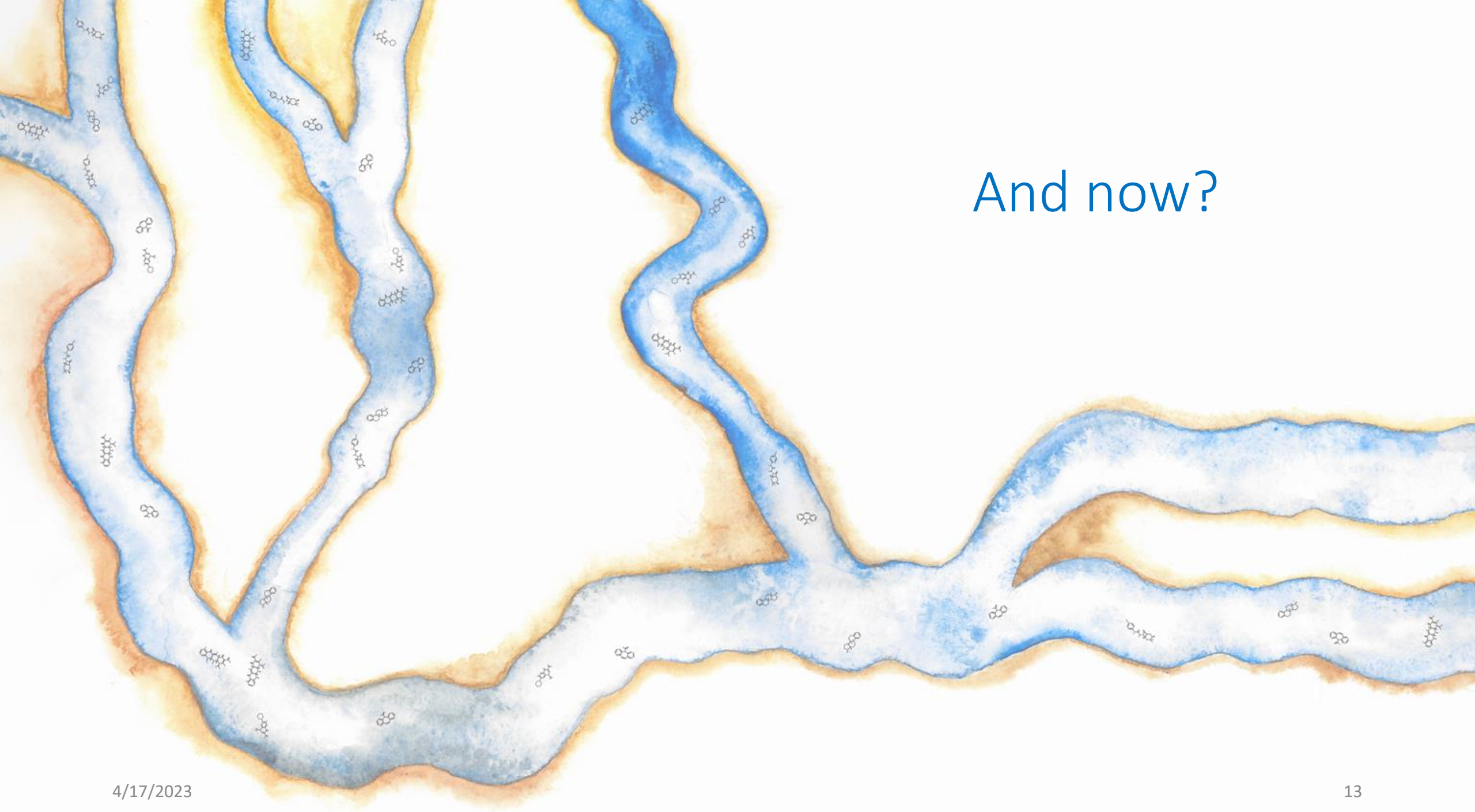
Societal solutions to pharmaceuticals in the environment



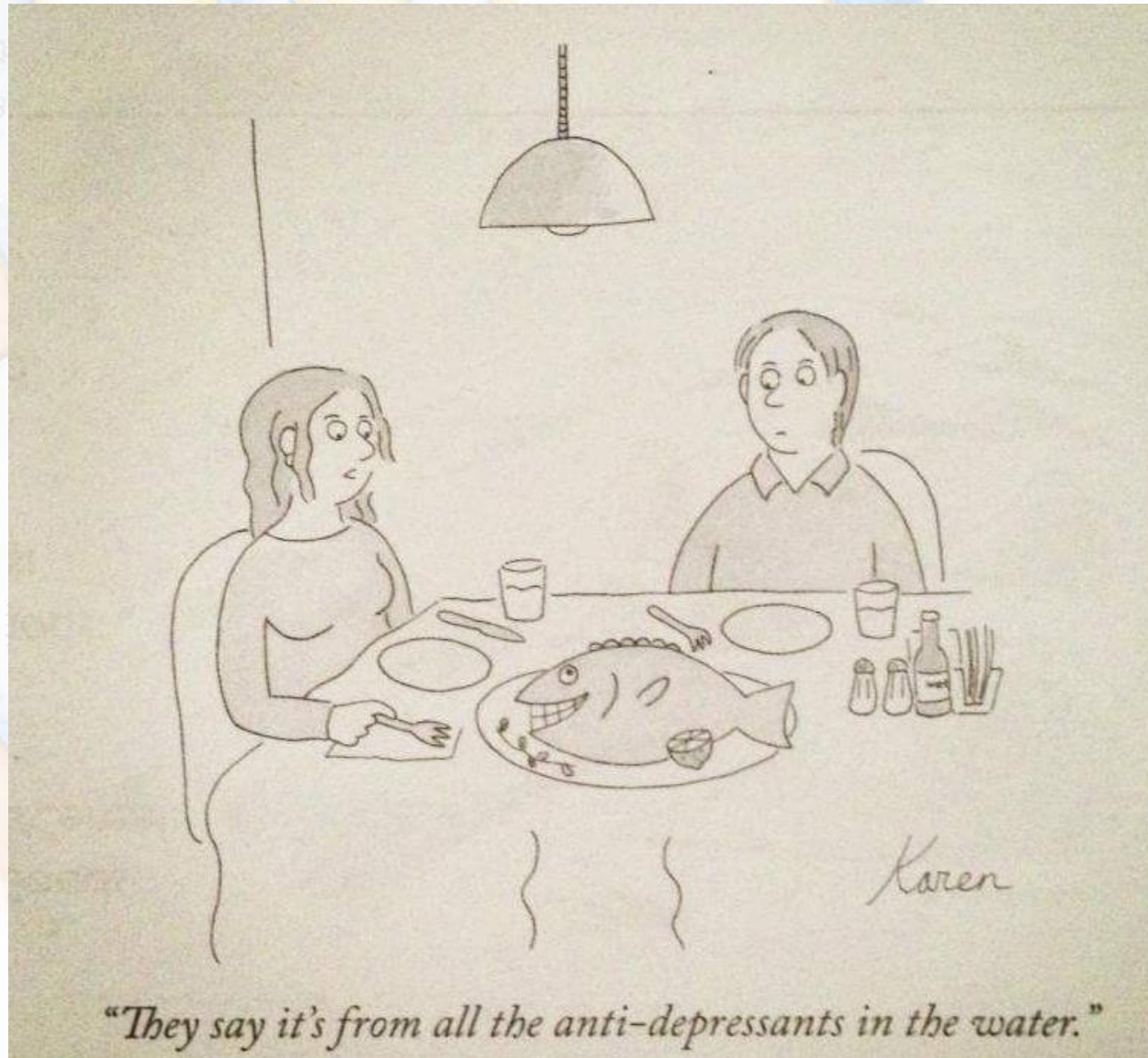
3 solutions:

- 1) Accepting pharmaceuticals in the environment → reproduction of the current regime
- 2) Reconfiguration of the current regime by implementing niche innovations
- 3) System change where environmental health is valued higher than animal (and human) health

Source: Wöhler, L., Hoekstra, A. Y., Hogeboom, R. J., Brugnach, M. & Krol, M. S. 2020. Alternative societal solutions to pharmaceuticals in the aquatic environment. Journal of Cleaner Production, 124350



And now?



Thank you
for your
attention!