Antimicrobial Resistance and Environmental Hotspots

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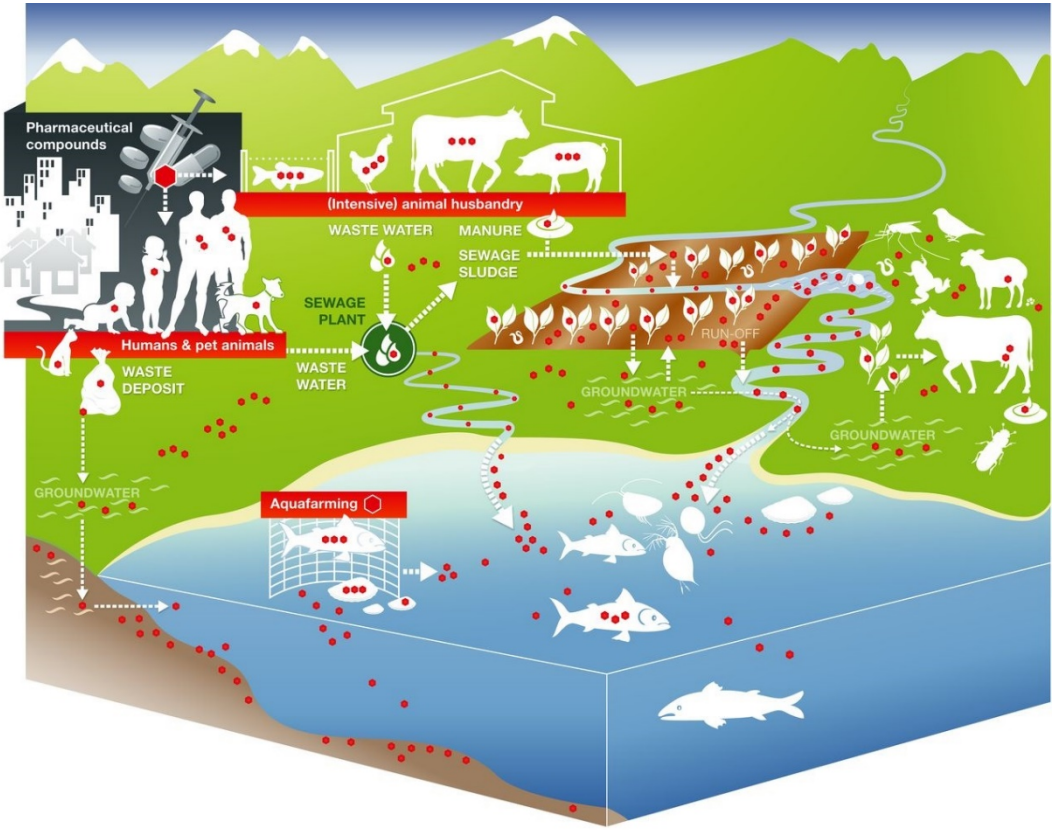
PACCARB Public Meeting, February 27, 2020

AMU and AMR - One Health in Action



"The life cycle of pharmaceutically used antibiotics does not simply end when a patient swallows a pill or when livestock are treated."

Berkner et al., EMBO Reports, 2014

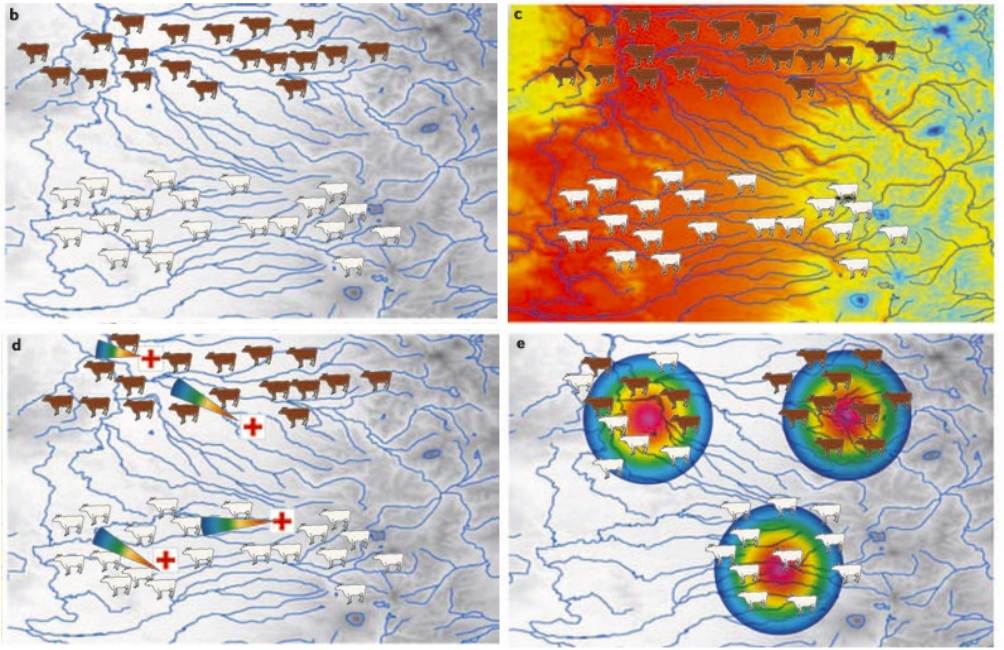
Landscape Ecology and AMR

OPINION

Can landscape ecology untangle the complexity of antibiotic resistance?

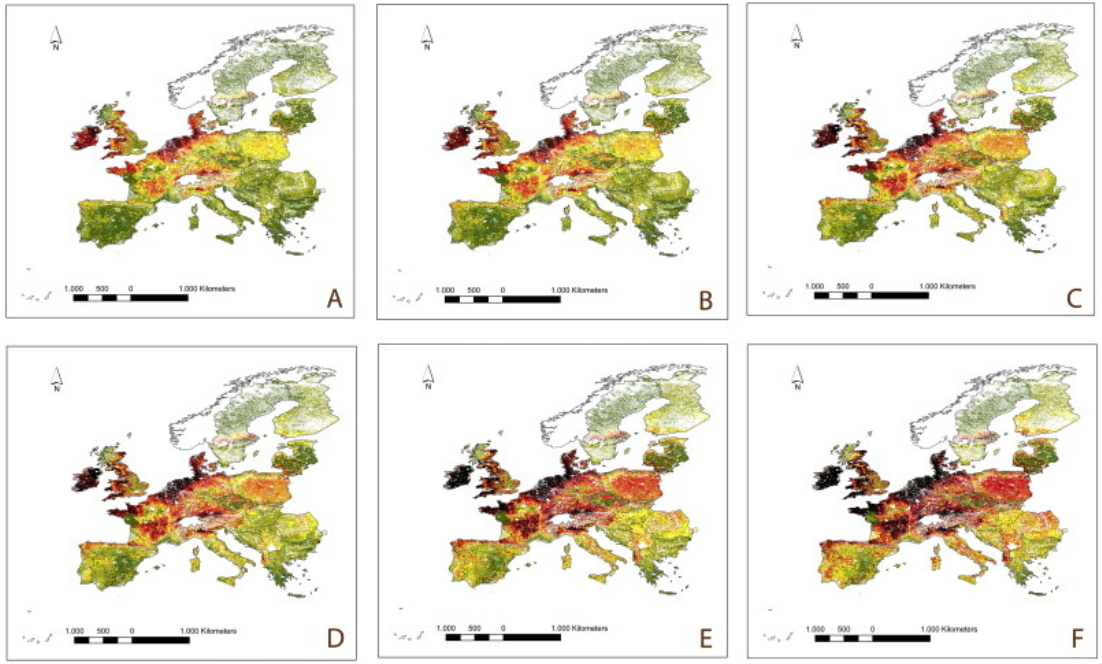
Randall S. Singer, Michael P. Ward and George Maldonado

"In studies involving complex environments with many potential causes, the ability to quantify the causal relationship accurately becomes extremely difficult."



Singer et al., Nat Rev Microbiol, 2006

Antimicrobials and Soil Vulnerability



A. Sulfachlorpyridazine, florfenicol, lincomycin.
B. Sulfamethazine.
C. Amoxicillin.
D. Sulfadimethoxine
E. Oxytetracycline, tetracycline, chlortetracycline, tylosin, sulfodiazine
F. Enrofloxacin

"A risk assessment was carried out to measure soil vulnerability to antibiotic contamination. The assessment comprised four steps: release assessment, exposure assessment, consequence assessment and risk estimation."

De la Torre et al., Sci Tot Environ, 2012

Mapping Minnesota's Antibiotic Footprint

- Overarching Hypothesis
  - A spatial model of Minnesota can predict areas of highest AMR risk in the natural environment and ultimately provide a basis for risk-based surveillance to guide targeted interventions for risk mitigation
- Objectives
  - Estimate the quantity and location of antimicrobial usage in Minnesota's healthcare and veterinary sectors
  - Develop an 'antibiotic footprint' geospatial model
  - Quantify concentrations of antimicrobials and antimicrobial resistance genes at sites impacted by anthropogenic activities

Minnesota ONE HEALTH Antibiotic Stewardship Collaborative
WORKING TOGETHER TO PROTECT HEALTH & PRESERVE ANTIBIOTICS

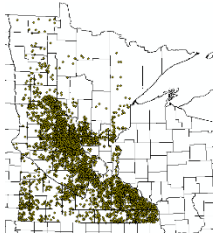
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

UNIVERSITY OF MINNESOTA

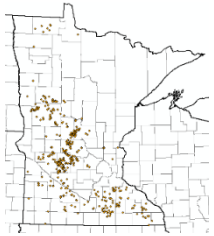
Geospatial Model Development

Antimicrobial Loading

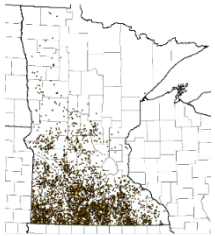
Dairy



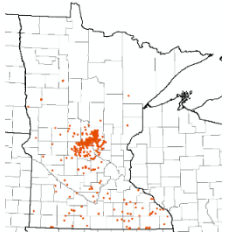
Turkey



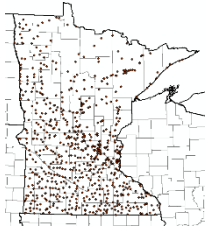
Swine



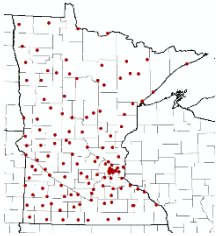
Chicken



Hospitals

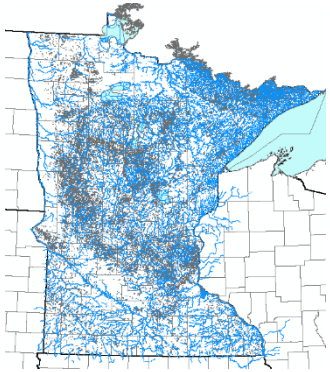


WWTP

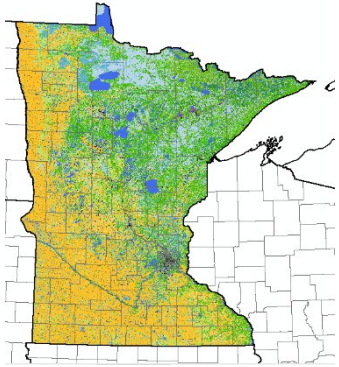


Geospatial Attributes

Surface Water

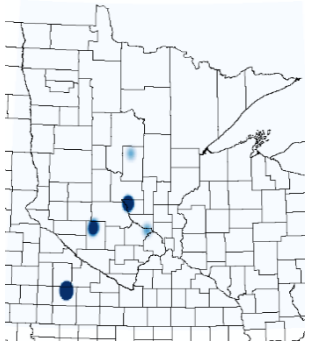


Land Cover

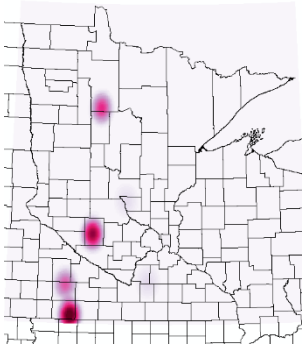


Environmental Concentrations

Enrofloxacin



Sulfadimethoxine



Antibiotic 'Footprint'

'Antibiotic footprint' as a communication tool to aid reduction of antibiotic consumption

Direk Limmathurotsakul [1–3]*, Jonathan A. T. Sandoe[4,5], David C. Barrett[6], Michael Corley[5], Li Yang Hsu[7,8], Marc Mendelson[9,10], Peter Collignon[11,12], Ramanan Laxminarayan[13,14], Sharon J. Peacock [15] and Philip Howard[4,5]

Data to be Gathered for Major Antibiotic Classes

Examples of Direct and Indirect Influence on Antibiotic Footprint

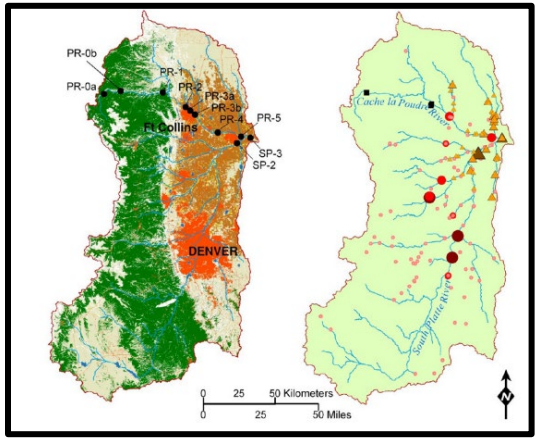
- **Clinical uses in humans and animals**
  - → Clinical importance to treating infections
- **Adverse impacts on individual human and animal patients**
  - → Adverse antibiotic events, *C. difficile* infection, risk of colonization/infection with multidrug-resistant organisms
- **Impact on individual patient microbiome**
  - → Known and unknown risks to patient and close contacts
- **Antibiotic stewardship implications**
  - → Effect of improving use of antibiotic class on reducing resistance, improving outcomes
- **Antibiotic elimination (human and animal PK/PD)**
  - → Potential contribution to environmental contamination
- **Environmental implications**
  - → Persistence, environmental resistance genes, wildlife impacts

Limmathurtsakul et al., J Antimicrob Chemother, 2019

Other Geospatial Studies

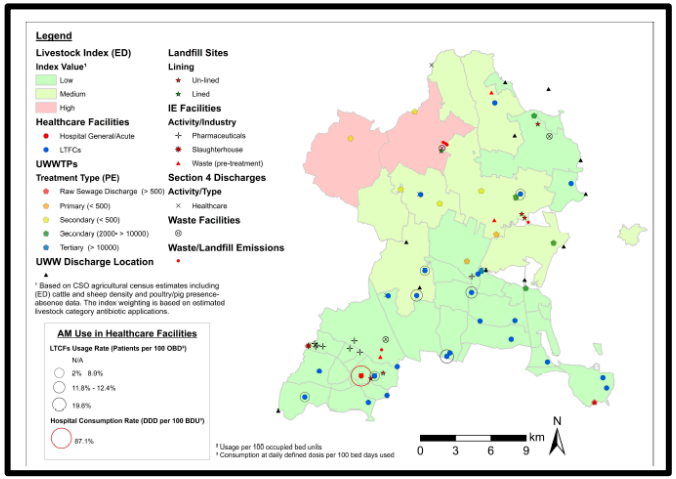
Correlation Between Upstream Human Activities and Riverine Antibiotic Resistance Genes

Amy Pruden,*[†,‡,§] Mazdak Arabi,[‡,§] and Heather N. Storteboom[‡]



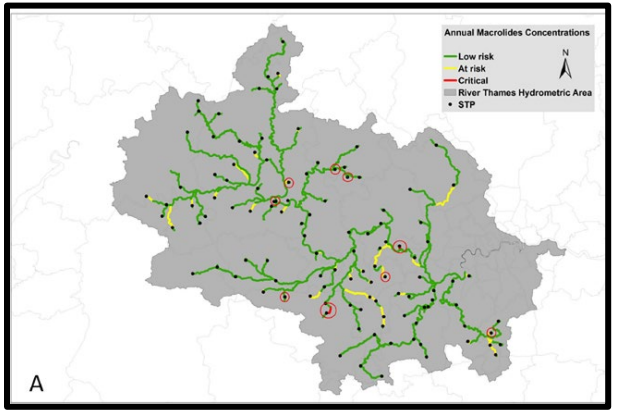
Mapping and Analysing Potential Sources and Transmission Routes of Antimicrobial Resistant Organisms in the Environment using Geographic Information Systems—An Exploratory Study

Carlos Chique [1], John Cullinan [1,*], Brigid Hooban [2] and Dearbhaile Morris [2]



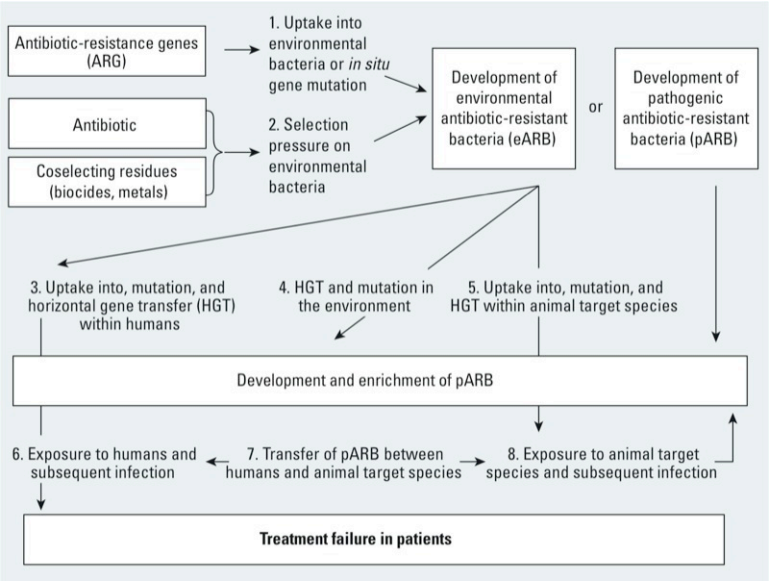
Translating antibiotic prescribing into antibiotic resistance in the environment: A hazard characterisation case study

Andrew C. Singer [1]*, Qiuying Xu [1,2], Virginie D. J. Keller [1]



Conclusions

- Predicting concentrations in the natural environment is affected by many factors
  - Spatial scale, environmental parameters, seasonality, multiple possible input sources, paucity of good data
- Major knowledge gap is ability to predict health impacts from environmental AMR



Ashbolt et al., Environ Health Perspect, 2013

Acknowledgments

Geospatial Team

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Footprint Team

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