Antibiotics and Antibiotic Resistance in the Environment:

A One Health Perspective

One Health One Planet Symposium
One Health and the Future of Food
3/14/19
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Environment

Pharmaceuticals

Personal Care Products

Human Hormones

Nanomaterials

Microplastics

Antibiotics

(and resistance genes)

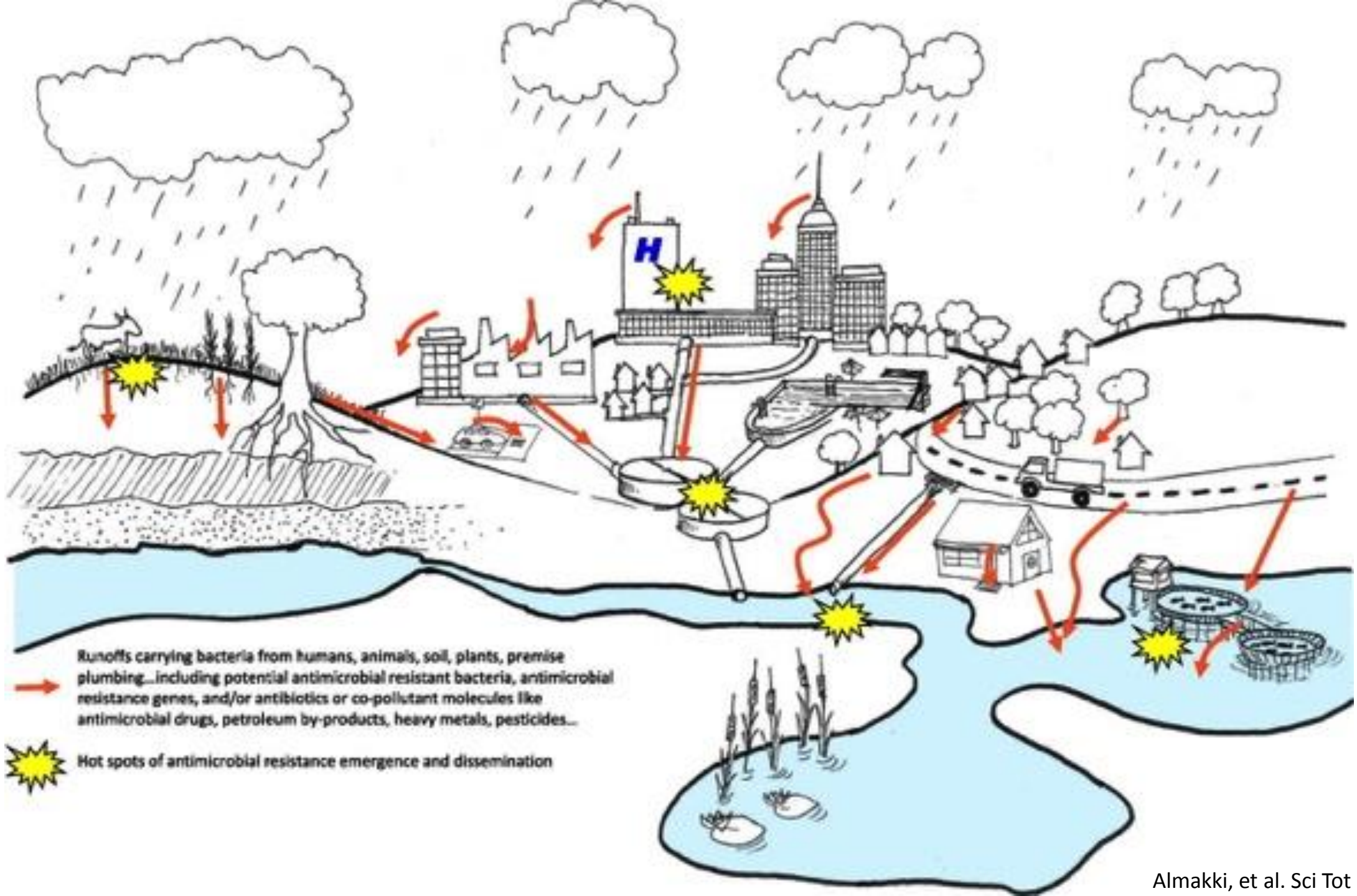
Pesticides

Agricultural Chemicals

Industrial Chemicals

Two main types of contaminant sources for Antibiotics reaching the Environment

Point vs. Non-point

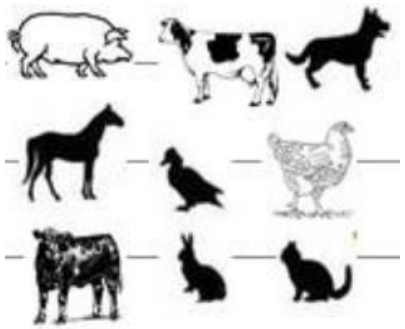


Almakki, et al. Sci Tot Enviro. 2019.

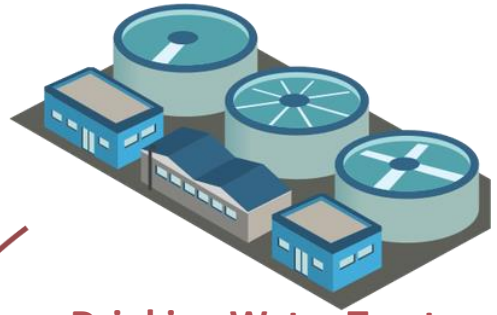
Water is Cyclical:

Concentrations of antibiotics in environment (ng/L- µg/L)

Antibiotic Sources



Drinking Water
Low ng/L



Drinking Water Treatment

Surface Water
1 ng/L – 1 µg/L

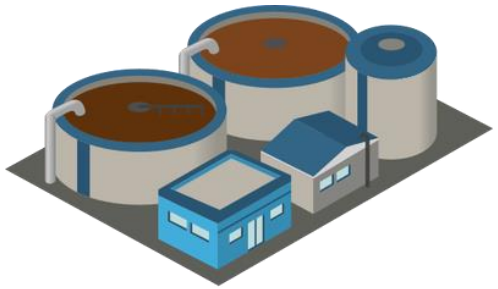
Ground Water
o.1 ng/L – 100 ng/L

Plant Uptake
ng/kg - ug/kg

Soil
ng/kg - mg/kg

WWTP Influent
ng/L - µg/L

Manure
mg/kg



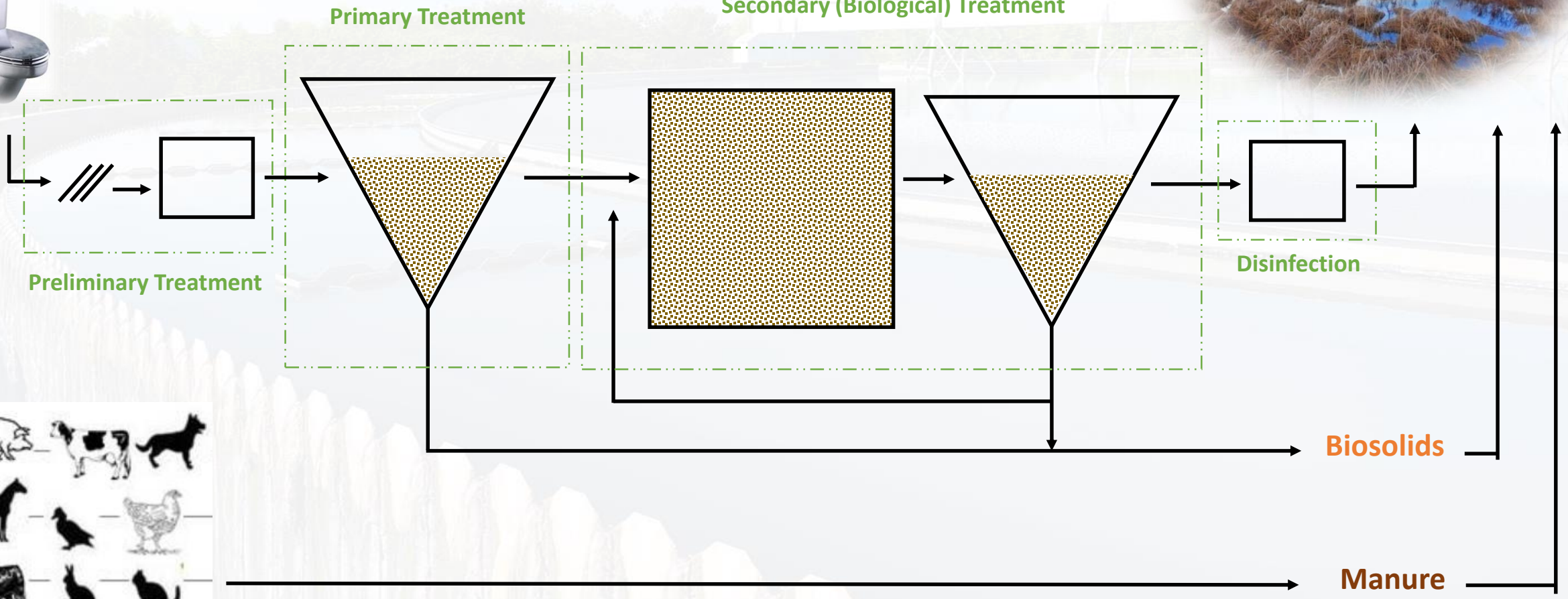
Point and Non-Point Sources

WWTP Effluent
ng/L – ug/L

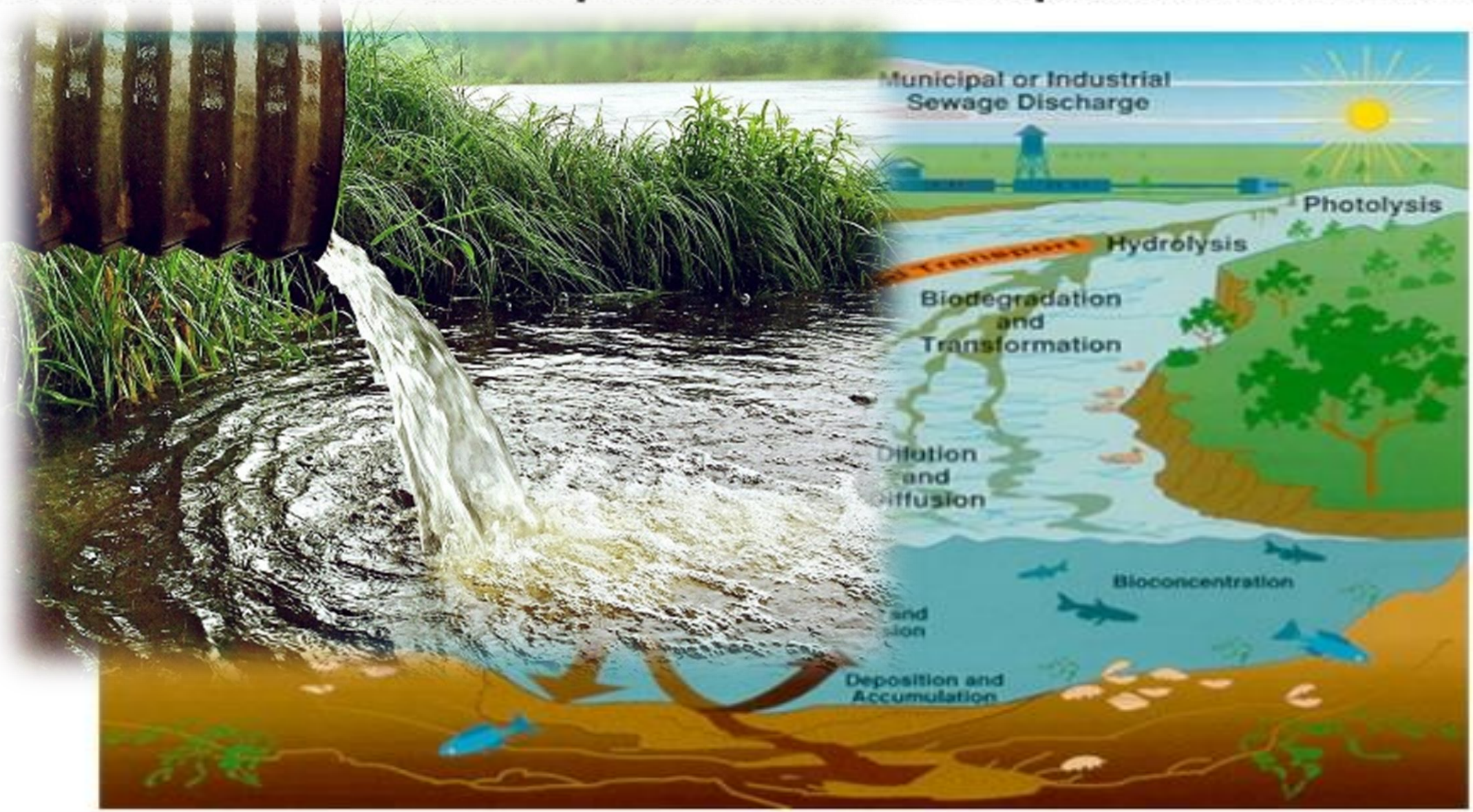
Manure
mg/kg

What happens once treated wastewater, biosolids, and untreated manure are released into the Environment?

Wastewater Treatment Plant



Movement and fate of pollutants in the aquatic environment



Mills, University of Portsmouth, UK, 2014

Antibiotics and Antibiotic Resistance in Aquatic Environments

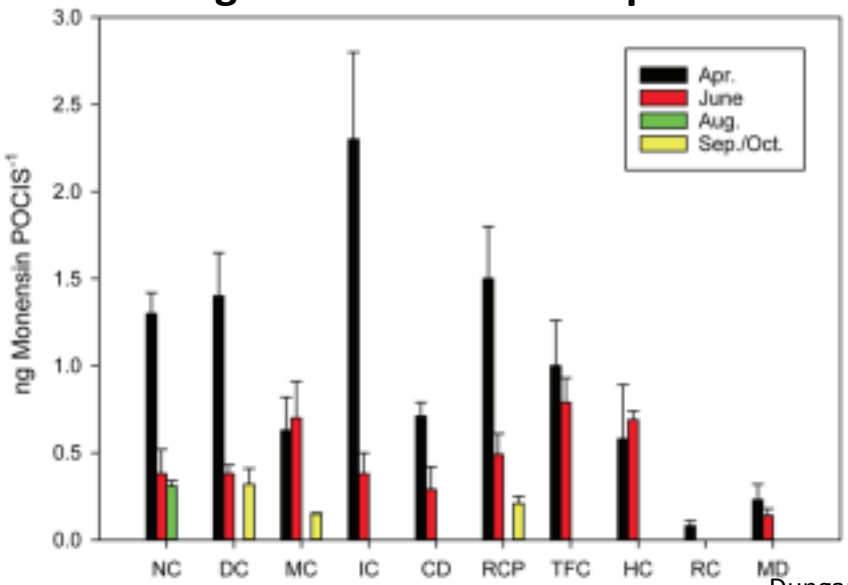
Antibiotic Contamination

WWTP Effluent

Site Location	Tetracyclines (ng L^{-1})	Sulfonamides (ng L^{-1})	Quinolones (ng L^{-1})
WWTP influent	1615.8	2263.0	3664.0
WWTP effluent	195.0	2001.0	3866.0
Upstream	265.2	648.1	728.8
Downstream	345.1	1111.0	2769.0
Removal efficiency	**87.9%**	**11.6%**	**Increased[a]**

Barancheshme & Munir, 2018

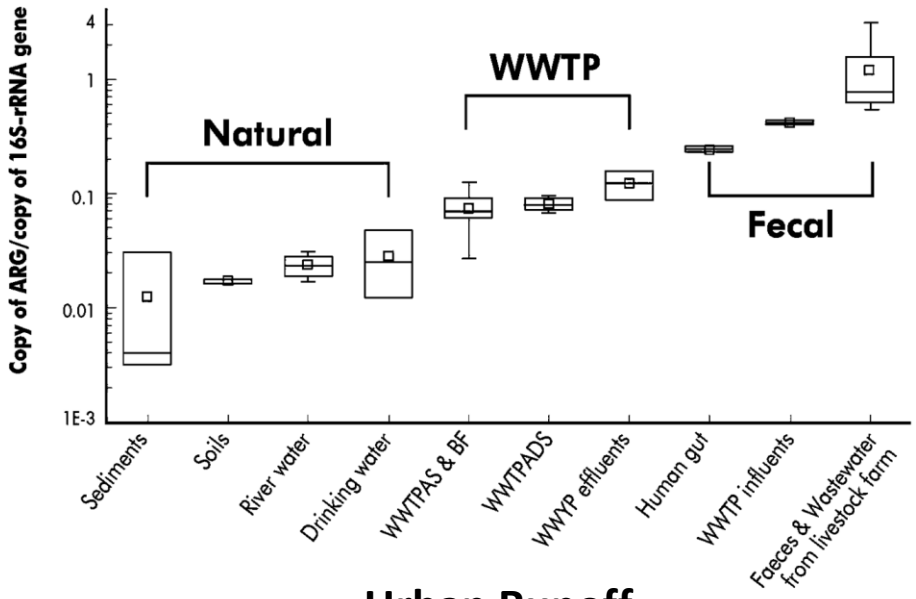
Agricultural Runoff Impacts



Dungan, et al., 2017

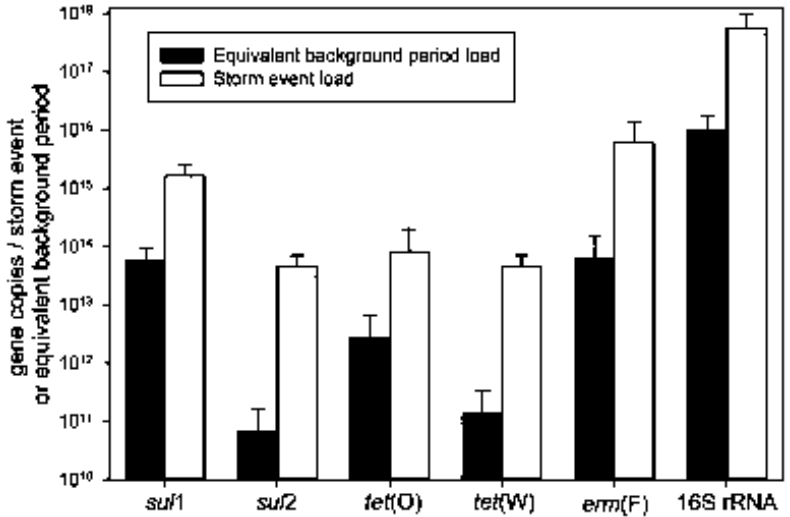
Presence of Antibiotic Resistance

WWTP & Fecal Contamination



Zhang, 2016

Urban Runoff



Garner et al., 2017

Antibiotics in the Soil

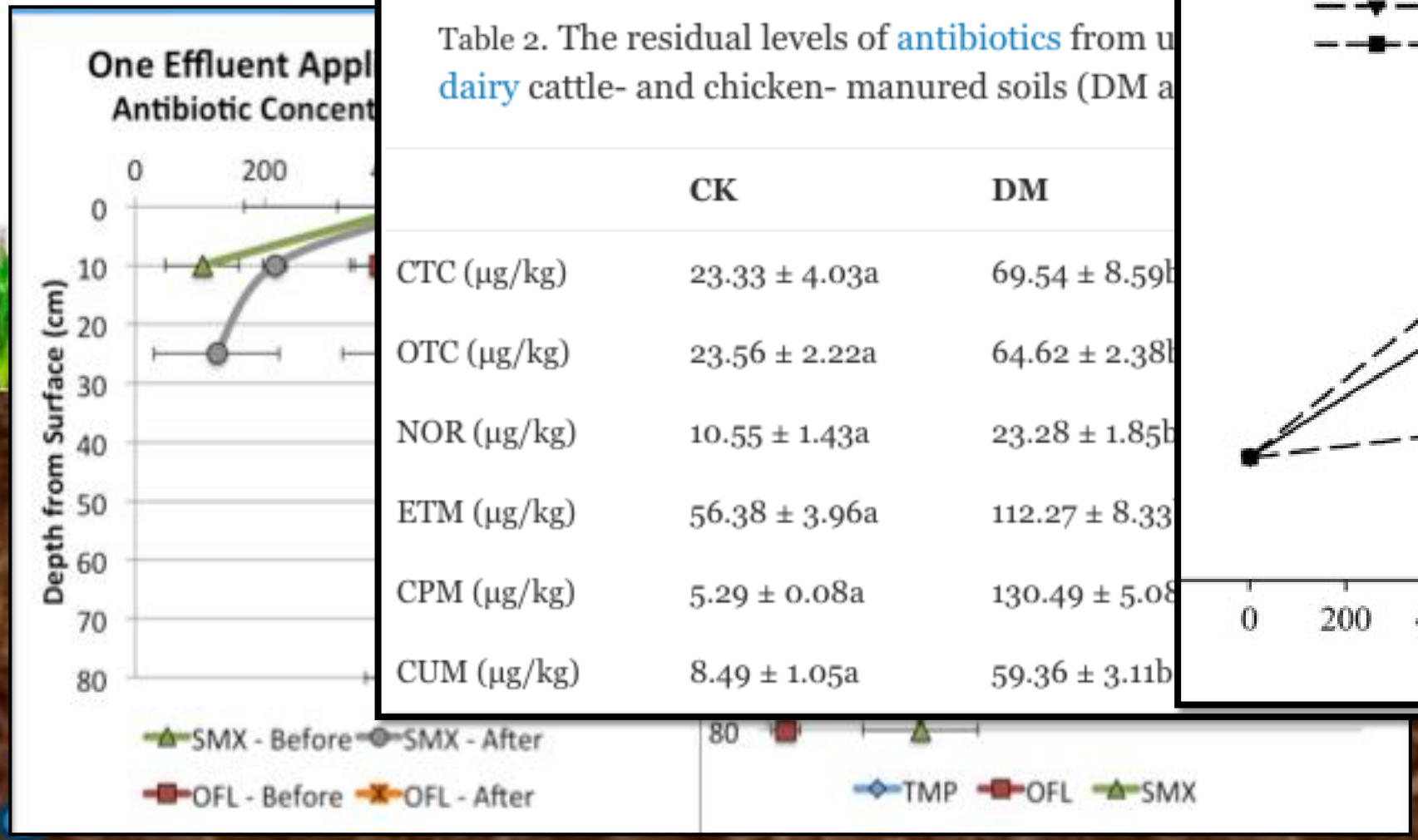
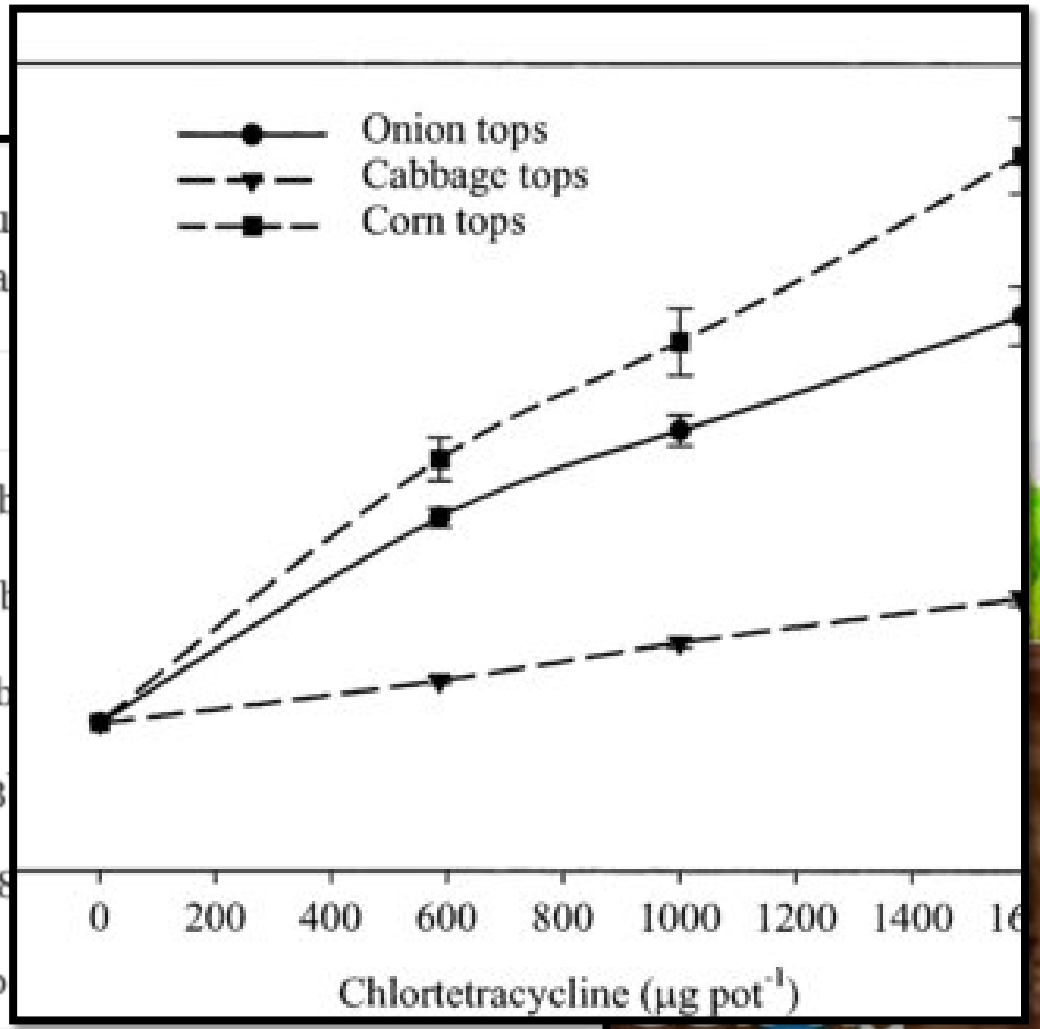


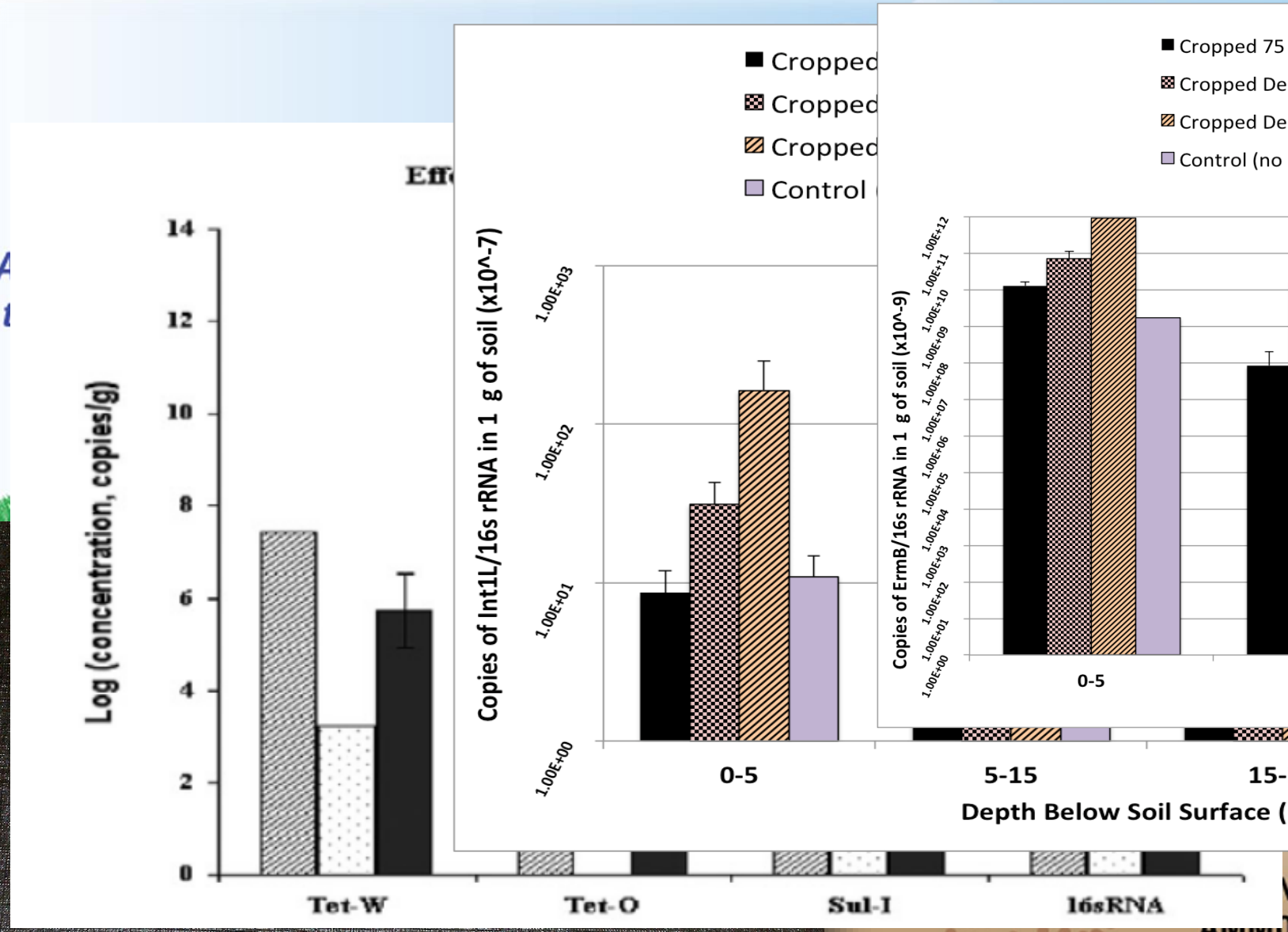
Table 2. The residual levels of antibiotics from u
dairy cattle- and chicken- manured soils (DM a

	CK	DM
CTC (μg/kg)	23.33 ± 4.03a	69.54 ± 8.59b
OTC (μg/kg)	23.56 ± 2.22a	64.62 ± 2.38b
NOR (μg/kg)	10.55 ± 1.43a	23.28 ± 1.85b
ETM (μg/kg)	56.38 ± 3.96a	112.27 ± 8.33
CPM (μg/kg)	5.29 ± 0.08a	130.49 ± 5.08
CUM (μg/kg)	8.49 ± 1.05a	59.36 ± 3.11b



Carter et al.., 2014; Franklin et al., 2018; Li et al., 2017; Kumar et al., 2005.

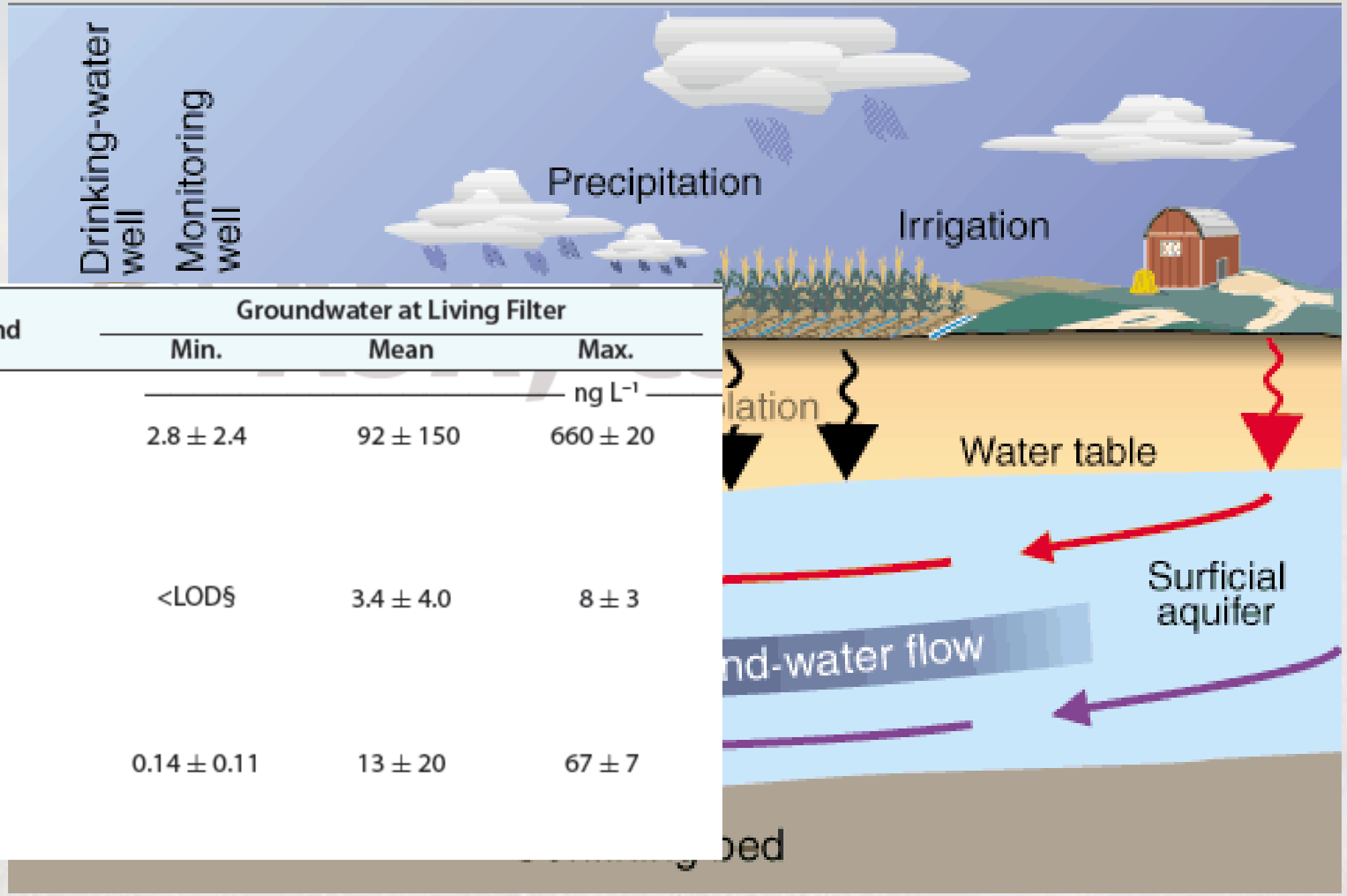
Effects in Soil Organisms



https://toxics.usgs.gov/highlights/antibiotics_gw/

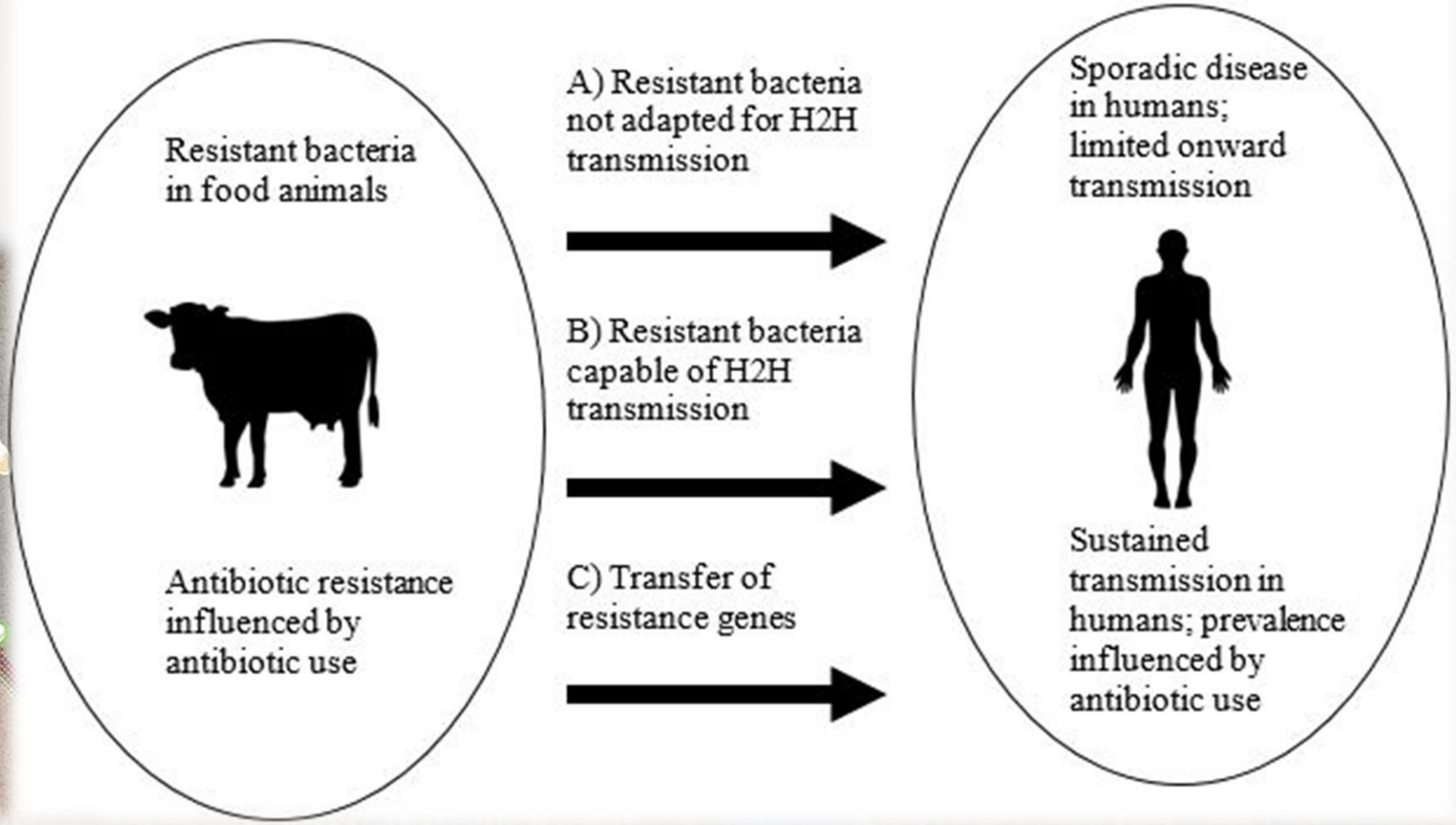
Munir & Xagoraraki, 2010

Compound	Groundwater at Living Filter		
	Min.	Mean	Max.
	ng L^{-1}		
SMX	2.8 ± 2.4	92 ± 150	660 ± 20
TMP‡	<LOD§	3.4 ± 4.0	8 ± 3
OFL	0.14 ± 0.11	13 ± 20	67 ± 7



Franklin et al. 2018

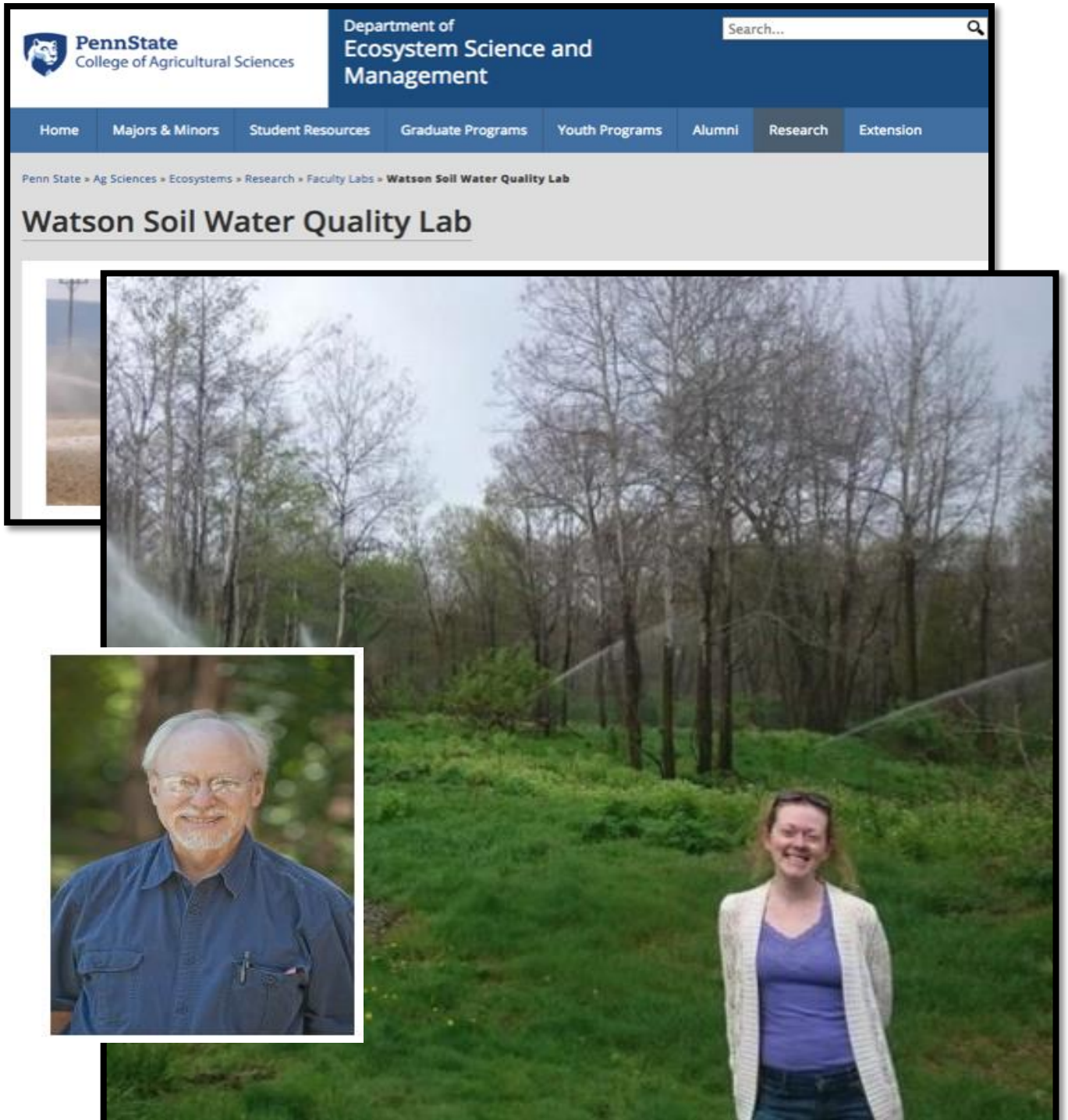
Effects in Humans and Mammals



Beyene, 2018 (Figure adapted from Chang et al., 2015)

THANK YOU!

And I'll answer questions during the panel discussion.



Soil Water Quality Laboratory at Penn State

- Emerging contaminants in soil and water
  - Carbamazepine
  - Estrogens
  - **Antibiotics**
  - **Antibiotic Resistance Genes**
  - **Toxicological Impacts**
- People:
  - Jack Watson – PI
    - Professor of Soil Physics
  - Alison Franklin
    - PhD Student, Soil Science & Biogeochemistry
    - MS – Soil Science
    - BS - Toxicology
- Research Site: The Living Filter
  - Long term irrigation site

Most antibiotics (and pharmaceuticals) make their way into wastewater, biosolids, and manure via human and animal **ingestion**