

Overuse of antimicrobial household products: Environmental and human health effects

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Presenter Disclosures

Rolf Halden, PhD, PE

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

I am listed as an inventor on pending patent applications filed on behalf of Arizona State University for methods and systems suitable for removing antimicrobials from contaminated environments.


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Context

Some materials from this presentation previously were presented at:

- (1) Halden, RU: Congressional Briefing on Triclosan, Washington, DC, February 17, 2011
- (2) Halden, RU: 2011 Dr. Leroy E. Burney Lecture at the Johns Hopkins University on Johns Hopkins Bloomberg School of Public Health, March 3, 2011
- (3) Halden, RU: EPA Emerging Contaminant Group, Broadcasted on April 6, 2011




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Outline

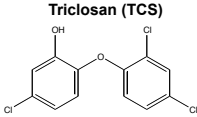
- A Case Study of An Antimicrobial's Life Cycle
- Nationwide Data on Antimicrobials
- Regulatory Challenges & Opportunities
- Conclusions



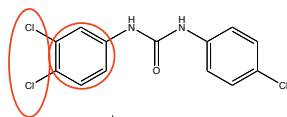
4

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Triclosan (TCS)



Triclocarban (TCC)



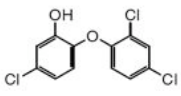
Name	Triclosan	Triclocarban
Year Introduced	1964	1957



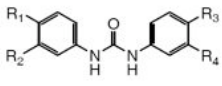
5

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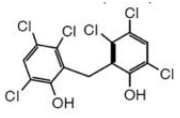
Persistent Antimicrobials



Triclosan (TCS)



NCC, Carbanilide (R₁=H, R₂=H, R₃=H, R₄=H)
 DCC, Dichlorocarbanilide (R₁=Cl, R₂=H, R₃=Cl, R₄=H)
 TCC, Trichlorocarbanilide, (R₁=Cl, R₂=Cl, R₃=Cl, R₄=H)
 TetCC, Tetrachlorocarbanilide, (R₁=Cl, R₂=Cl, R₃=Cl, R₄=Cl)

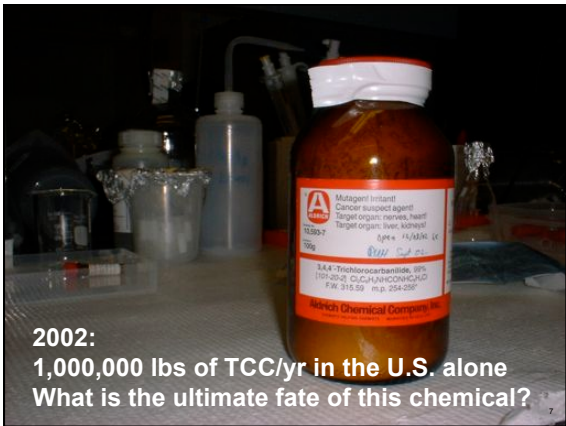


Banned in 1972

Hexachlorophene (HCP)

Heisler & Halden, J. Environ. Monit. 11:2207-2215 (2009)

6



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2002 Known / Potential Environmental and Human Health Risks of Triclocarban

Degradates

Impurities

Persistent Environmental Contaminant

?

Triclocarban

Endocrine Disruption

?

Cross-resistance to Antibiotics

?

Bioaccumulation

?

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2011 Known / Potential Environmental and Human Health Risks of Triclocarban

Degradates

Impurities

Persistent Environmental Contaminant

✓

Triclocarban

Endocrine Disruption

✓

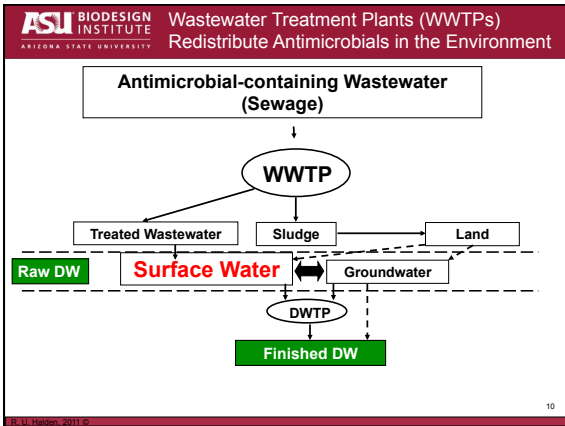
Cross-resistance to Antibiotics

✓

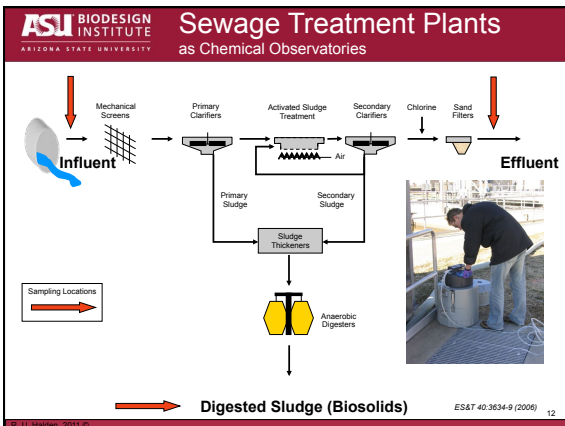
Bioaccumulation

✓

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Behavioral Impacts

Used by consumers Sequestered in sludge Applied onto soils



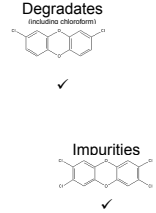
16
ES&T 40(11) 3634-39, (2008)
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Known Environmental & Human Health Risks of Triclosan at a Glance

Triclosan

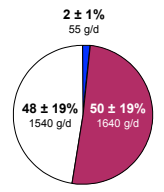
- Degradates (includes chlorotam) ✓
- Impurities ✓
- Persistent Environmental Contaminant ✓
- Bioaccumulation ✓
- Endocrine Disruption ✓
- Cross-resistance to Antibiotics ✓



17
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Fate of Triclosan in Activated Sludge WWTP

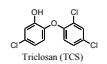


2 ± 1%
55 g/d

48 ± 19%
1540 g/d

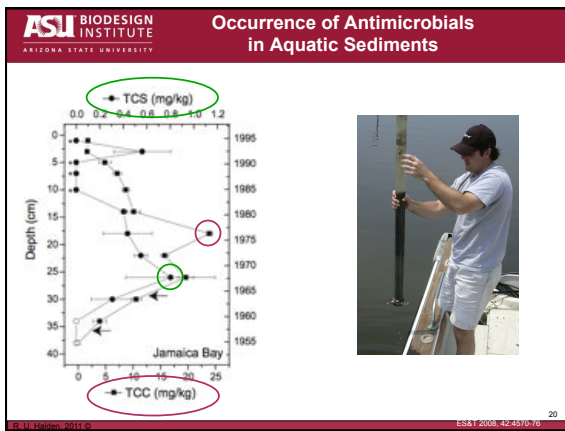
50 ± 19%
1640 g/d

- Mass in effluent
- Mass in sludge
- Mass transformed/lost



18
Chemosphere 66(2):362-8 (2007)
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Nationwide Assessment of Pharmaceuticals and Personal Care Products in U.S. Biosolids Collected by the U.S. EPA in 2001

Kristin McClellan, Rolf U. Halden
Ira A. Fulton School of Engineering
The Biodesign Institute at Arizona State University


- 72 Target Compounds
- 94 Wastewater Treatment Plants
- 24 U.S. States

McClellan & Halden, Water Res. 44: 626-636 (2010) 21

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Study approach

- 72 PPCPs
 - Antimicrobials
 - Antibiotics
 - OTC drugs
- HPLC MS/MS
 - EPA method 1694

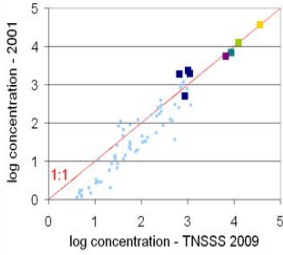


McClellan & Halden, Water Res. 44: 626-636 (2010) 22

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Chemistry of 2001 vs. 2007

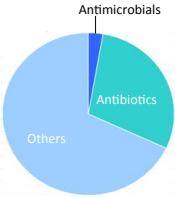
	2007	2001 EPA TNSSS
	Mean concentration [ppm]	
Triclocarban	36	39
Triclosan	12	16
Ciprofloxacin	7	10
Ofloxacin	5	8
Cimetidine, 4-Epitetracycline, Miconazole, Tetracycline	0.5 – 2.5	1 - 2



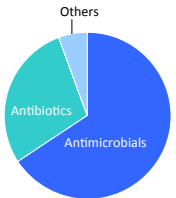
McClellan & Halden, Water Res. 44: 626-636 (2010) 23

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TCS & TCC: Key Sludge Pollutants



TCS and TCC are only two of 72 drugs monitored by EPA Method 1694




Yet, these two antimicrobials account for >60% of the mass of all drugs detectable in sewage sludge

McClellan & Halden, Water Res. 44: 626-636 (2010) 24

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Contaminated Land



Approximately **92,000-114,000 lbs/yr** of **Triclosan** and **264,000- 330,000 lbs/yr** of **Triclocarban** are applied inadvertently on U.S. agricultural land as a result of sewage sludge disposal

<http://photos.state.gov/libraries/az/>

This presents a pathway for contamination of food with antimicrobials and drug-resistant microbes


McClellan & Halden, Water Res. 44: 626-636 (2010)

ASU, Hayden, 2011 ©

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Other Known Impacts

- Bioaccumulation
 - Algae
 - Crustacea
 - Fish
 - Dolphins
 - Worms
- Endocrine disruption
- Other Impacts
 - Behavioral changes
 - Immuno-toxic effects
 - Growth impairment




Source: <http://www.dolphin.com/images/Dolphin.jpg>

26

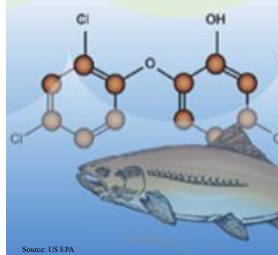
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Contact Time



5 - 10 Seconds
(ineffective)

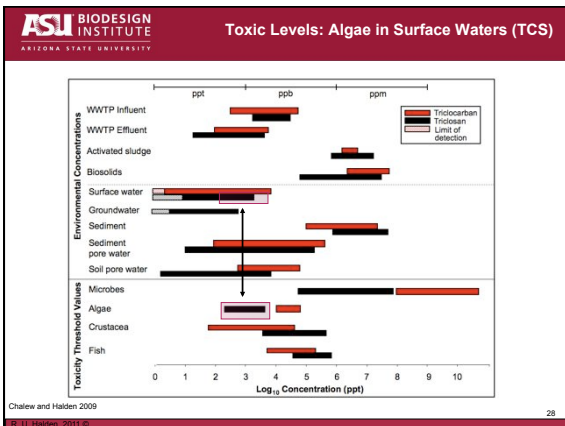


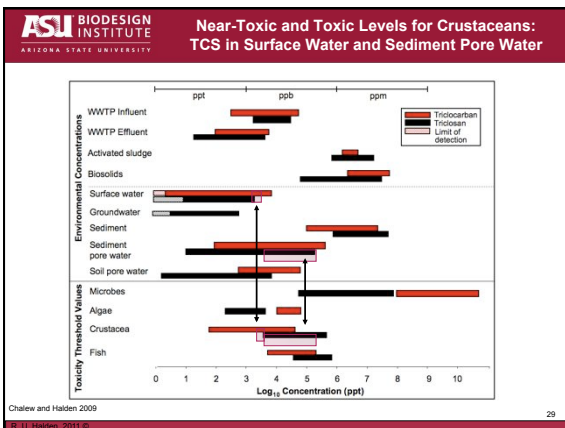
Lifetime exposure in aquatic organisms
(toxic)

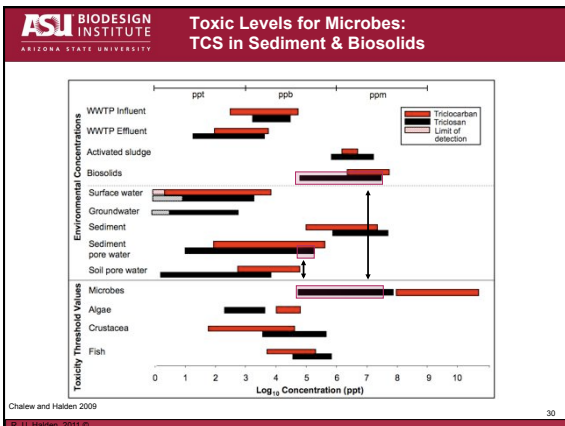
Source: US EPA

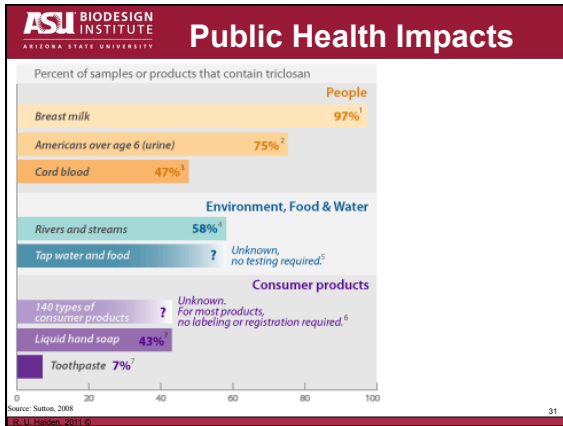
27

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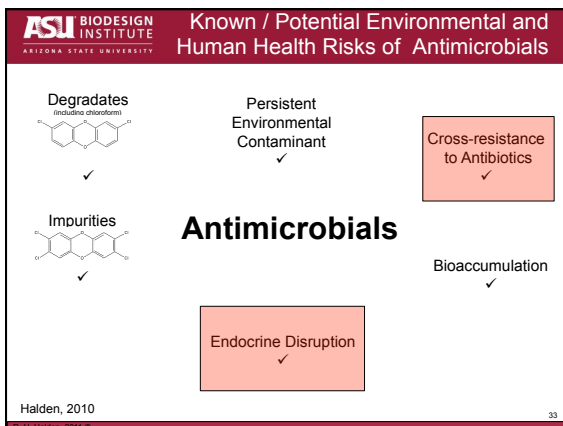








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- ### Timeline of TCS Regulation by FDA
- 1974** Tentative Final Monograph (TFM)
Evidence lacking for Triclosan safety and effectiveness
 - 1978** Meeting to discuss effectiveness testing
Claims may be misleading to consumers
 - 1994** Removal of antibacterial soaps from drug category
Proliferation is not a problem
 - 1997** Recommended surveillance system for drug resistance
 - 2005** FDA meeting to finalize "tentative final monograph"
 - 2011** Congressional briefing on TCS (Halden, Aiello, Vikesland)
No proven benefit / Known human health & env. risks
 - Now** After 37 years, TFM still not finalized *Modified from: AE Aiello, 2011*
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ASU BIODESIGN INSTITUTE Summary
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- *sterilizing our homes and bodies is the fiction of marketing*
- *proper hygiene is essential but can be attained by using **regular soap and water**, thereby avoiding environmental pollution*
- *most antimicrobial products are ineffective for non-clinical uses (FDA Expert Panel, 2005)*
- *unwarranted use of antimicrobial products can pose risks to humans and the environment*



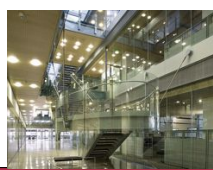
34


ASU BIODESIGN INSTITUTE Conclusions
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- Antimicrobials persist in the environment
- Ubiquitous contamination threatens some biota
- Current use of antimicrobials is unsustainable
- Cutting back on antimicrobials is feasible (e.g., hexachlorophene)
- Opportunity: removal of TCS/TCC from market would reduce burden of PPCPs in agricultural soils by >60%
- Antimicrobial drug resistance needs more study
- Endocrine disruption and multi-drug resistance drive risk
- Antimicrobials need to be managed/regulated more effectively

35

ASU BIODESIGN INSTITUTE Acknowledgements
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Todd Miller	Livable Future	
Steven Chillrud		
Jerry Ritchie		
Amelia DeLaquill		
Jana Mihalic		
Richard Bopp		
Randhir Deo		


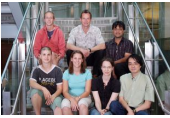


36

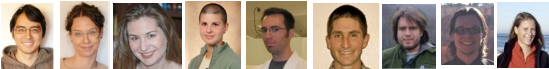

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