

Comparing Effects of Chemical Amendments on 1,4-Dioxane Biodegradation

Florida State University

Yi Xiong,

Ashlee Hubert,

Gang Chen,

Olivia U Mason,

Youneng Tang (presenter)

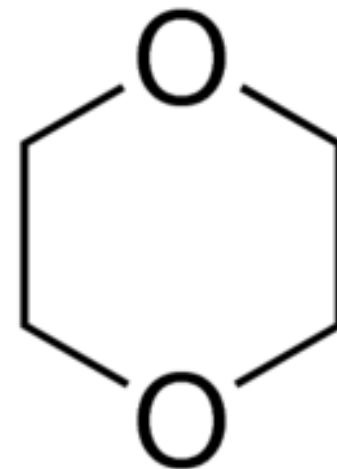


Geosyntec Consultants

Chao Zhou



Use of 1,4-dioxane (C₄H₈O₂)



- **Stabilizer of chlorinated solvents:**



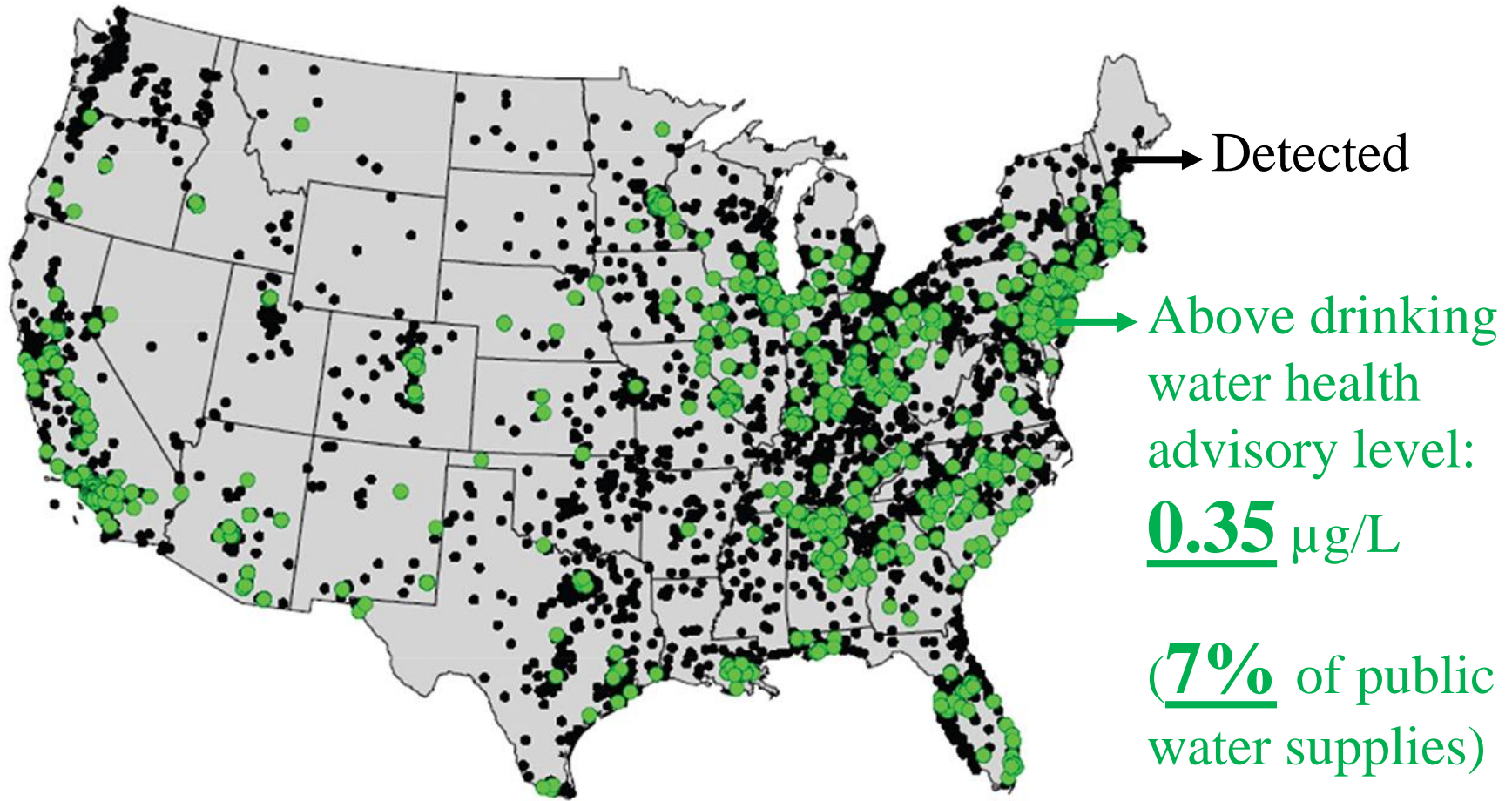
e.g., Trichloroethane
(TCA)

- **Byproduct of personal care products:**



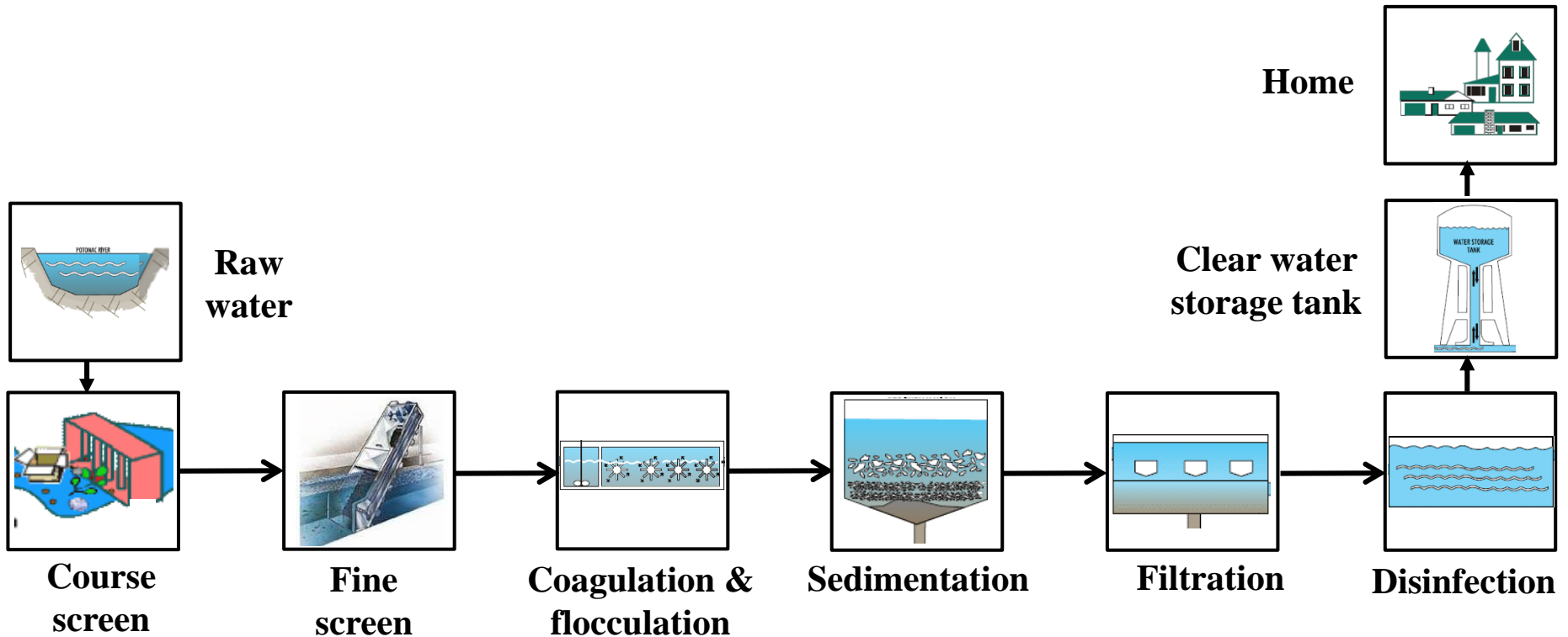
Personal care products

1,4-dioxane contamination in the US

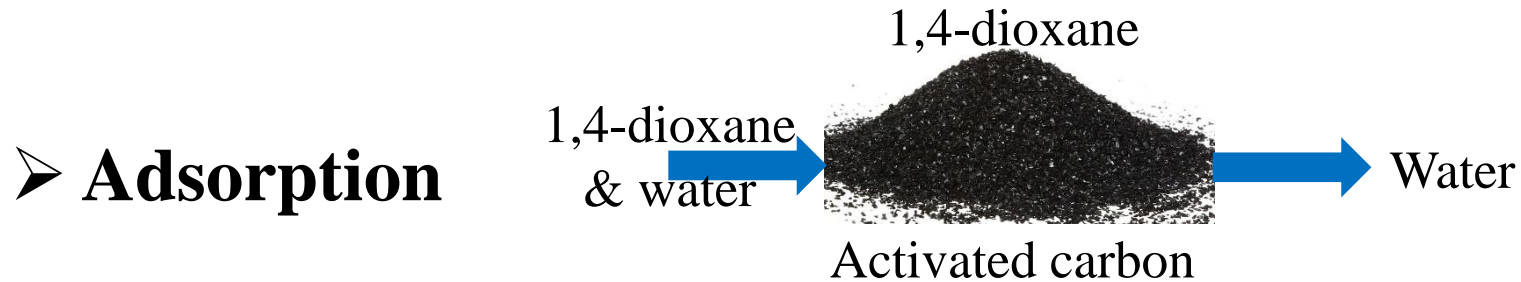


Reference: Suthersan, S.; Quinnan, J.; Horst, J.; Ross, I.; Kalve, E.; Bell, C; Pancras, T. Making strides in the management of “emerging contaminants”, *Groundwater Monitoring & Remediation*, 2016, 36(1), 15-25.

Existing water treatment plants cannot remove 1,4-dioxane

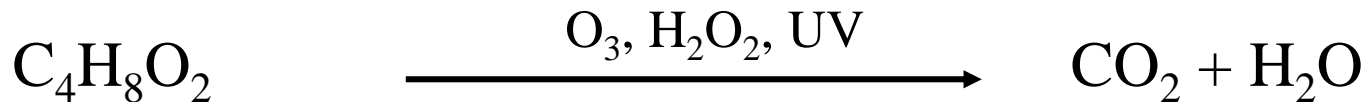


Three methods for removing 1,4-dioxane



Disadvantage: Frequent regeneration and disposal of carbon

➤ **Advanced Oxidation**



Disadvantage: Energy intensive

➤ **Biological Oxidation**



Disadvantage: Low degradation rate

Overall Research Objective: increase the degradation rate

Using a chemical amendment to enhance 1,4-dioxane removal

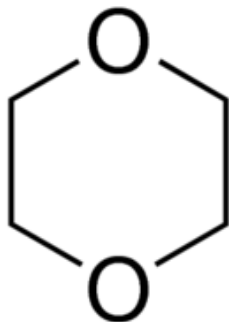
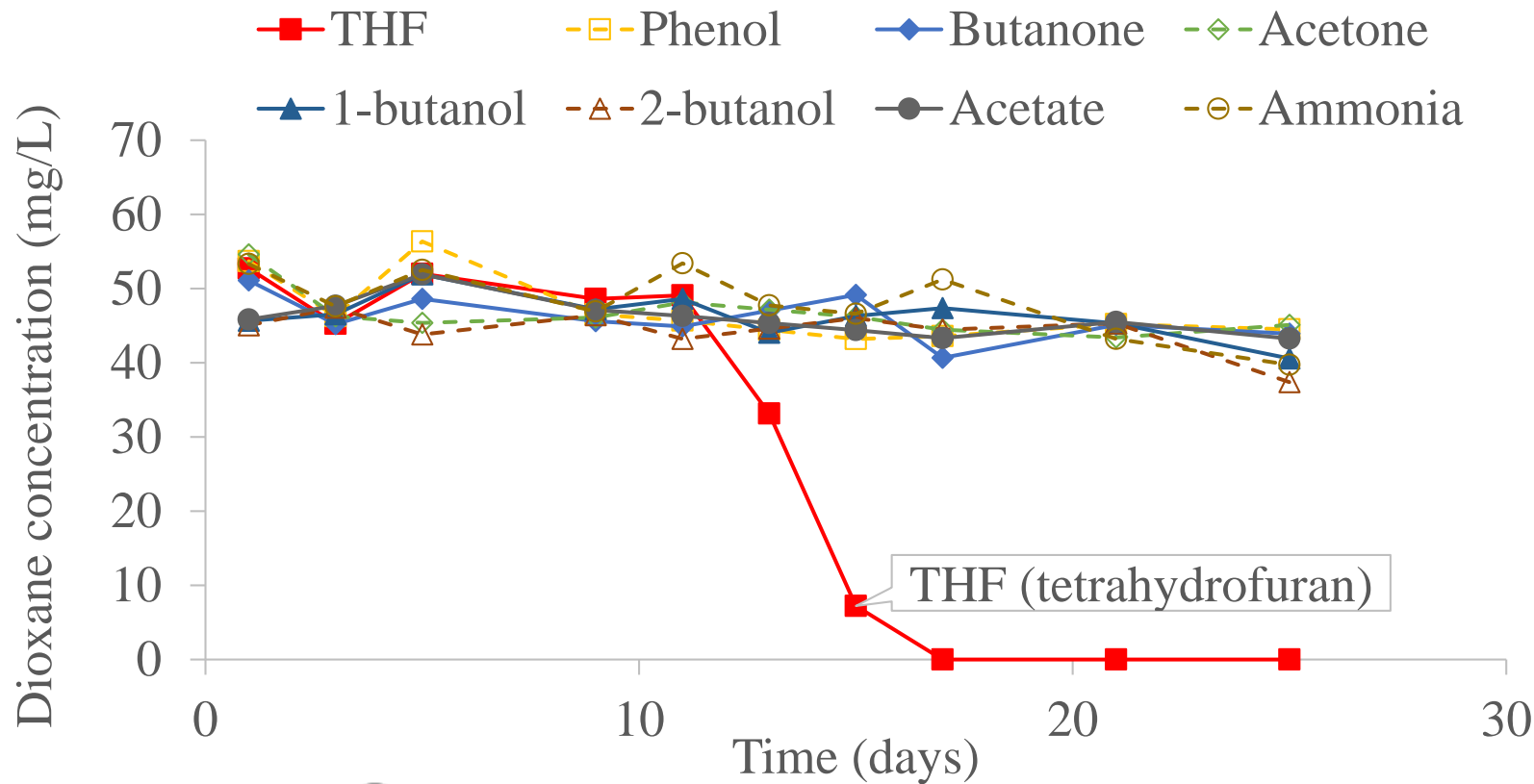
- **Q1:** Which amendment is the best?
- **Q2:** How should the best amendment be added?
- **Q3:** Why does the best amendment help?

Q1: Which amendment is the best?

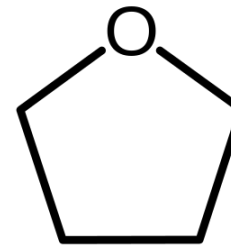


- Landfill leachate, 400 mg COD/L
- 1,4-dioxane, 50 mg/L
- Bacteria, 300 mg VSS/L
- Chemical amendment, 150 mg/L
 - tetrahydrofuran(THF)
 - butanone
 - acetone
 - 1-butanol
 - 2-butanol
 - phenol
 - acetate
 - ammonia

A1: THF is the best.

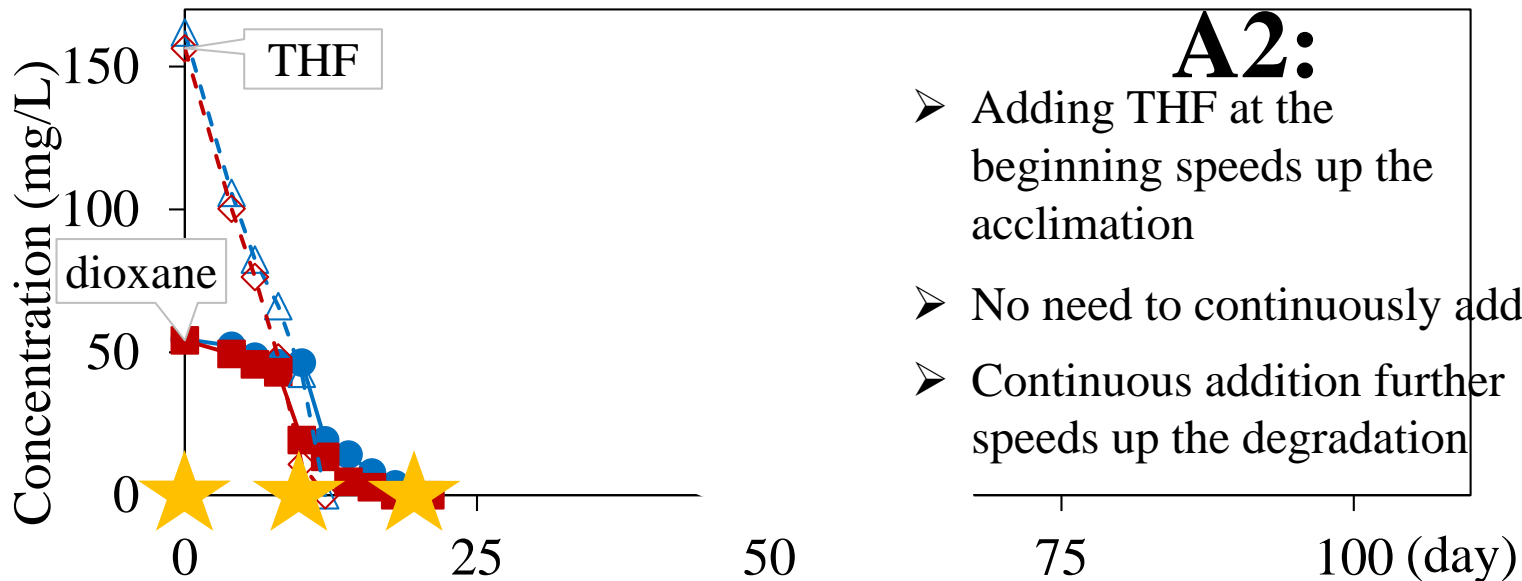
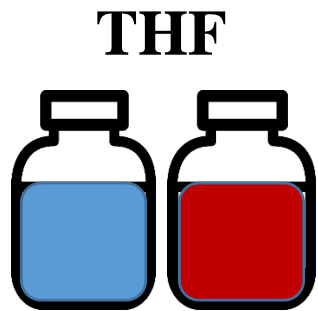
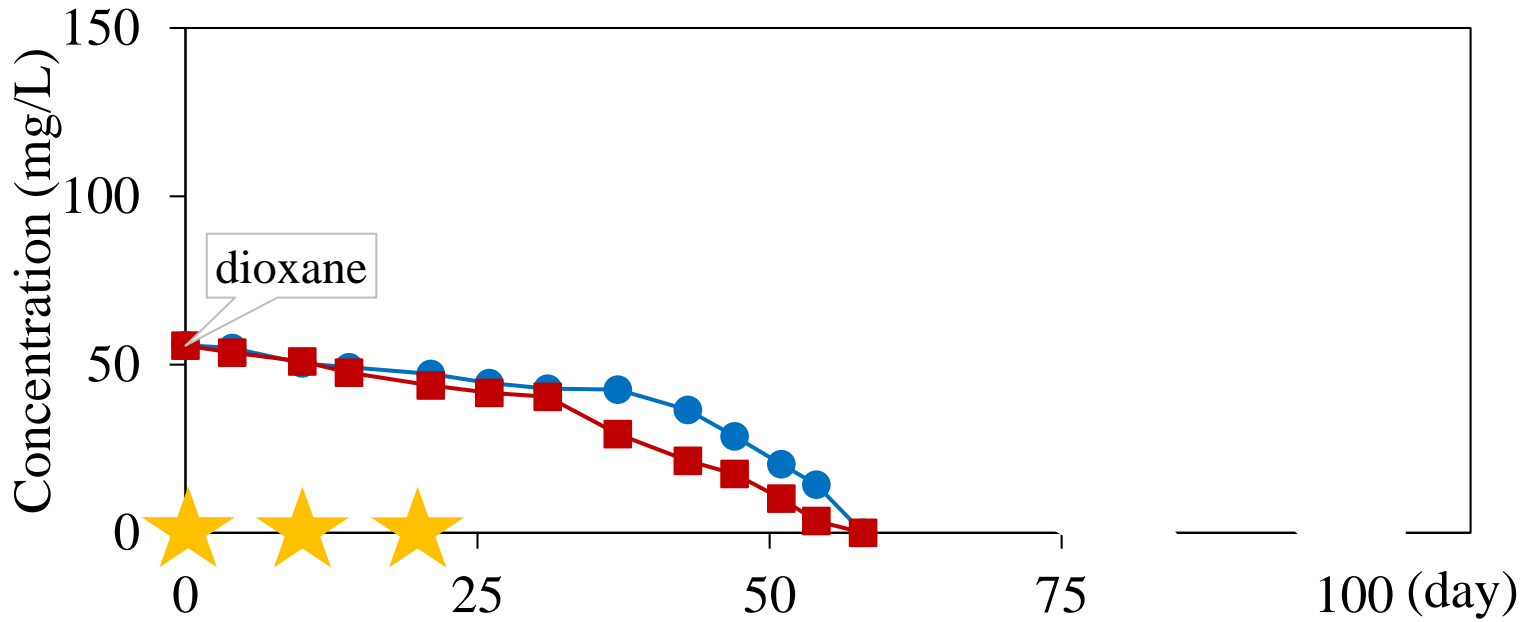


1,4-dioxane ($C_4H_8O_2$)



Tetrahydrofuran (THF, C_4H_8O)

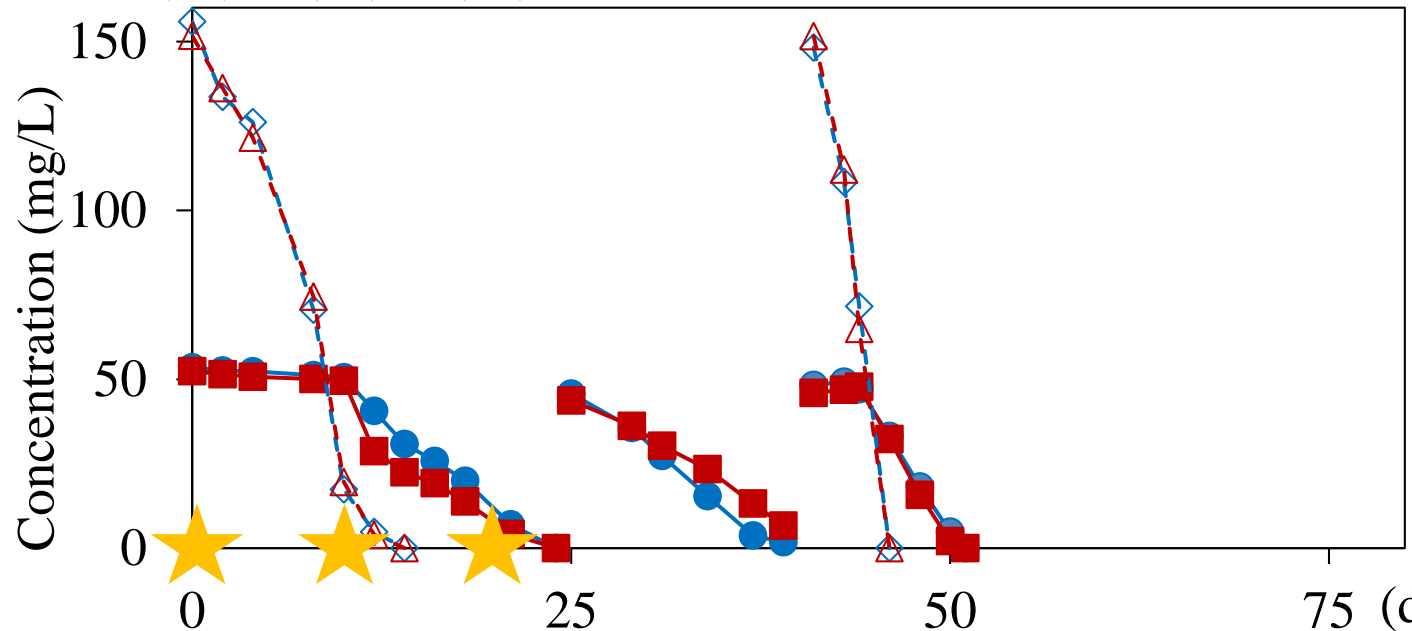
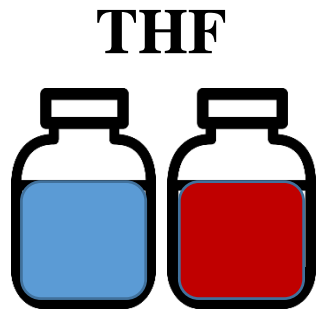
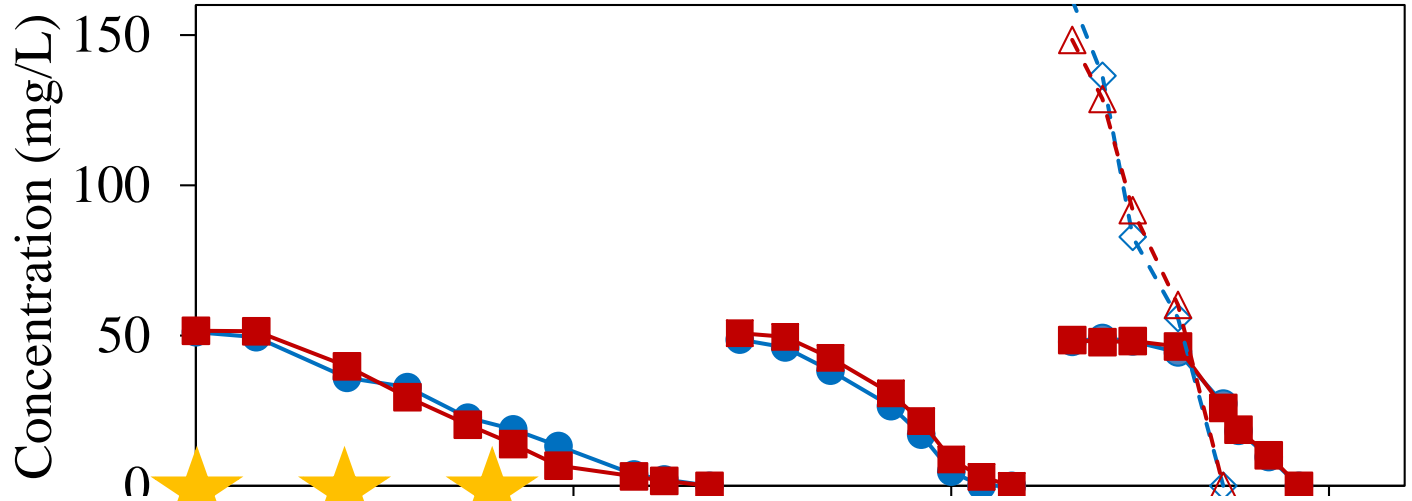
Q2: How should the best amendment be added? (leachate test)



A2:

- Adding THF at the beginning speeds up the acclimation
- No need to continuously add
- Continuous addition further speeds up the degradation

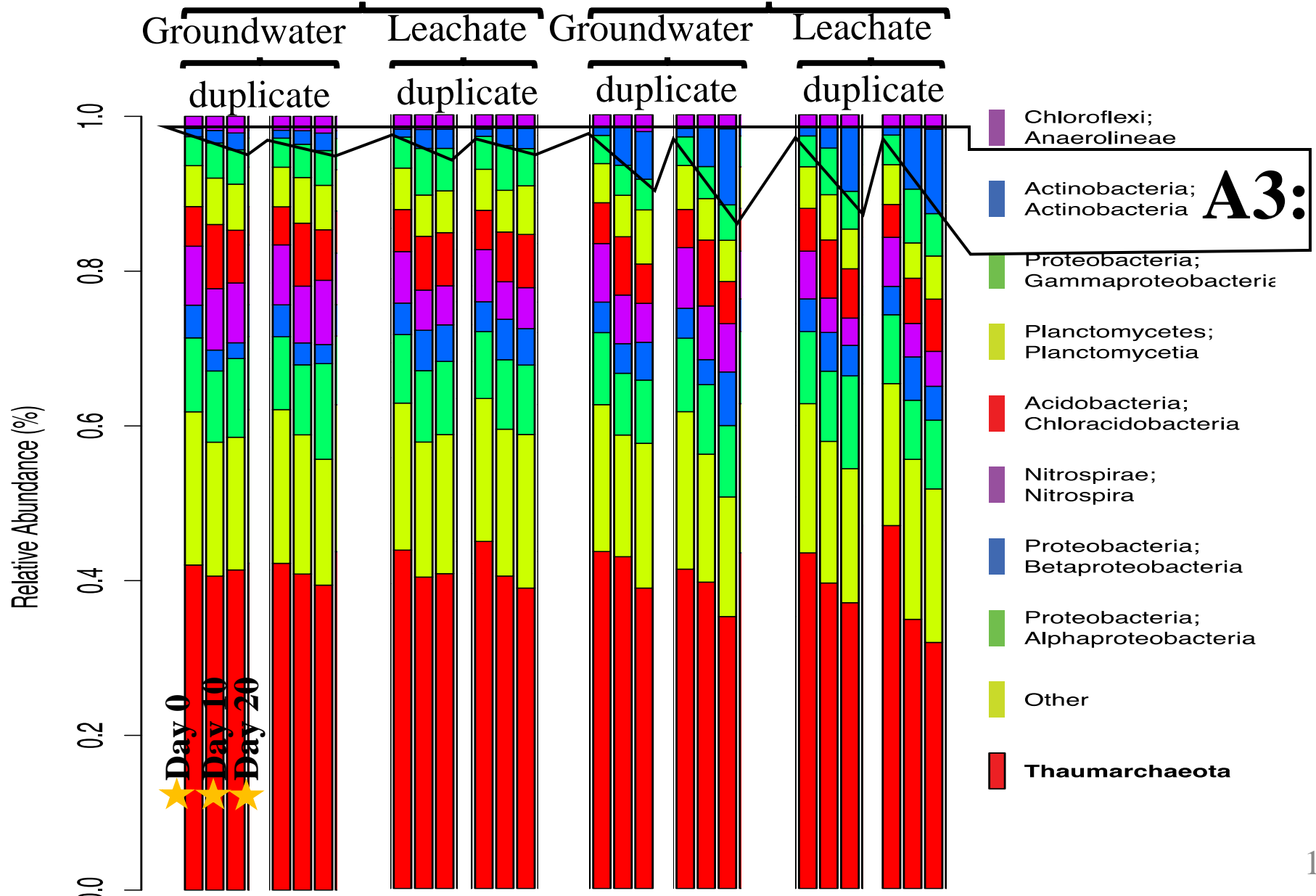
Q2: How should the best amendment be added? (groundwater test)



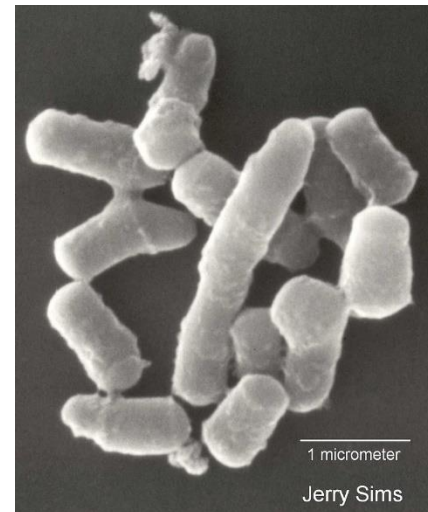
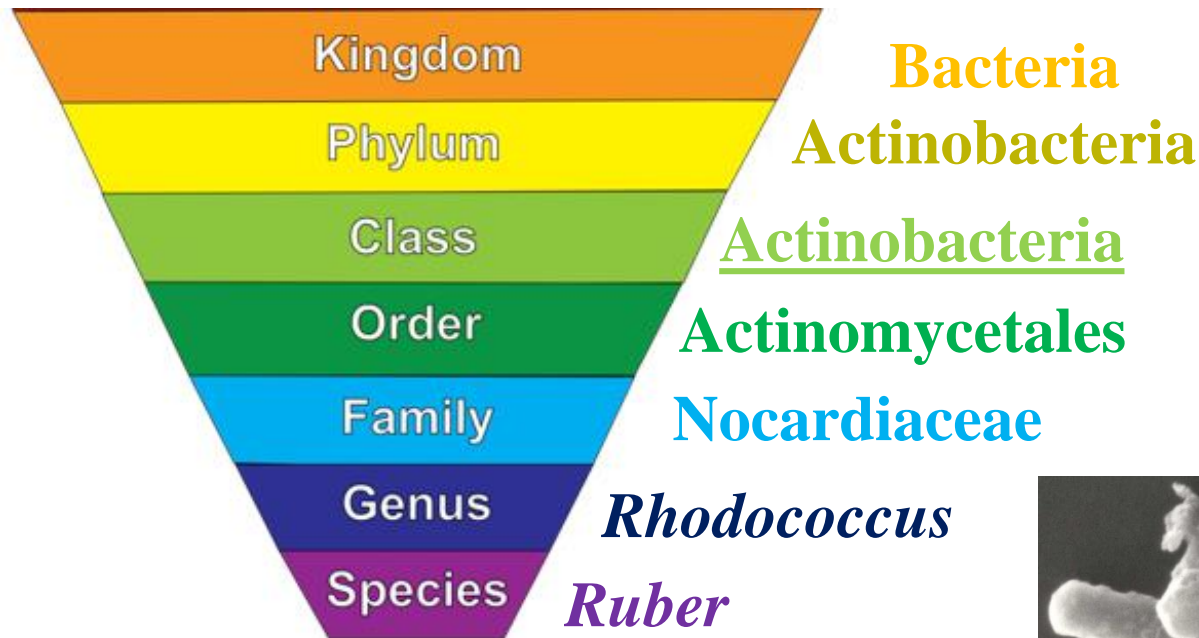
Q3: Why does the best amendment help?

No THF

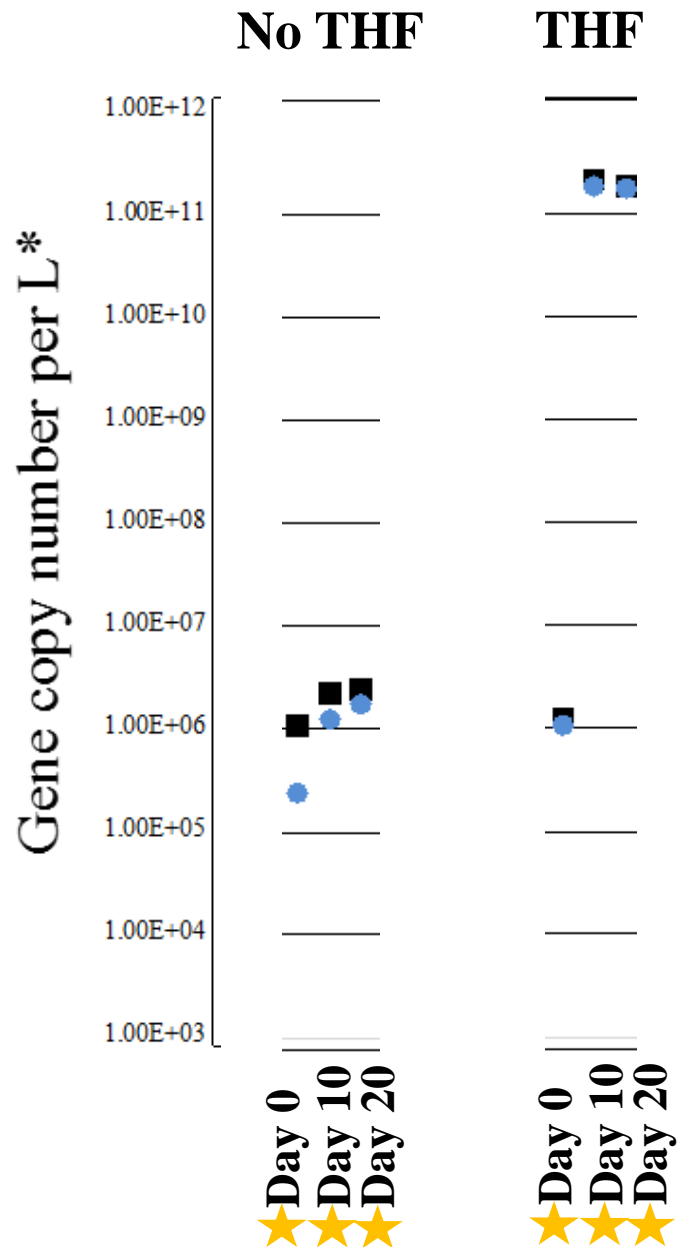
THF



Which kind of bacterium degraded 1,4-dioxane?



Q3: Why does the best amendment help?



A3:

- DXMO
(dioxane monooxygenase)
- ALDH
(aldehyde dehydrogenase)

Reference: Gedalanga, P.B.; Pornwongthong, P.; Mora, R.; Chiang, S.Y.D.; Baldwin, B.; Oglesd, D.; Mahendra, S. Identification of biomarker genes to predict biodegradation of 1,4-dioxane. *Appl Environ Microbiol.*, 2014, 80(10), 3209-3218.

Conclusions

- **Q1:** Which amendment is the best?
A1: tetrahydrofuran (THF)
- **Q2:** How should the best amendment be added?
A2: 1) Initial addition speeds up the acclimation;
2) Continuous addition further speeds up removal.
- **Q3:** Why does the best amendment help?
A3: 1) more *Rhodococcus ruber*;
2) more DXMO & ALDH.

Acknowledgement



engineers | scientists | innovators

Contact

Youneng Tang, Ph.D., Assistant Professor
Department of Civil & Environmental Engineering
FAMU-FSU College of Engineering
Florida State University
ytang2@fsu.edu