UNESCO-IWRA ONLINE CONFERENCE
17-19 JANUARY 2023
3RD IN THE IWRA ONLINE CONFERENCE SERIES

Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

Analysis of Sunscreens and Antibiotics in Groundwater During COVID-19 Pandemic in the Riviera Maya, Mexico

Melissa E. Lenczewski

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unesco
Programme hydrologique intergouvernemental

IWRA International Water Resources Association

Introduction - Tourism

Tourism is important for economies

- 1.5 billion travelers in 2019
- Half of world travelers visit coastal locales

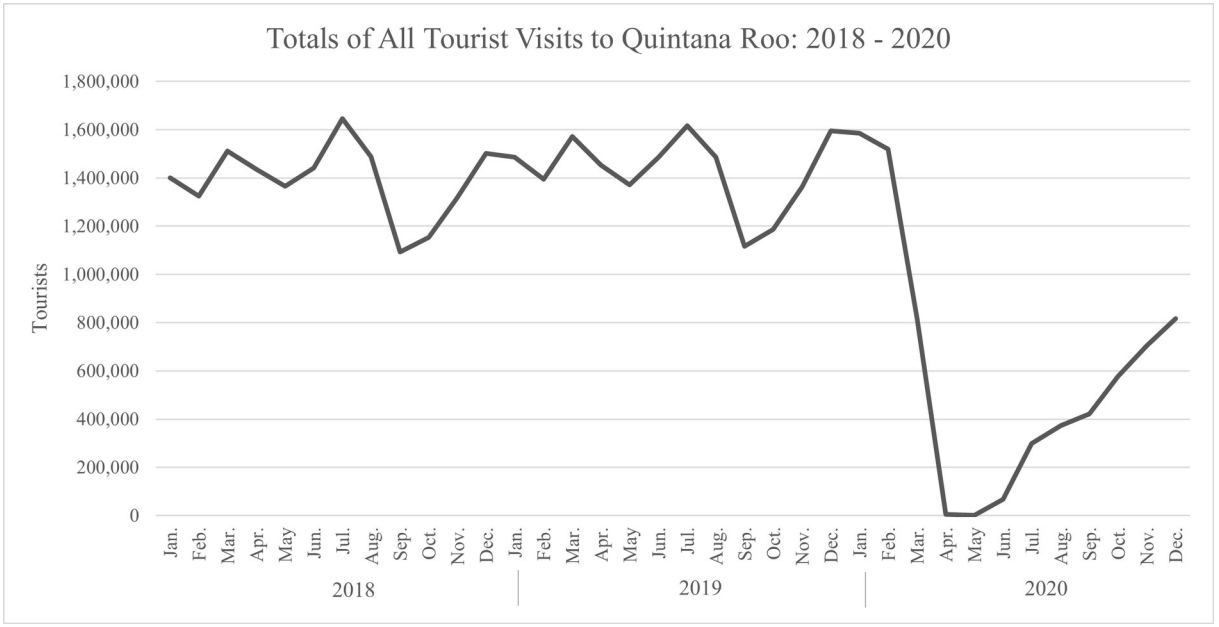
Tourism in Quintana Roo, Mexico

- 50% of tourists to Mexico visit Riviera Maya
- Cancún is an international transportation hub

Introduction – Water Quality

- Karst- easily contaminated
  - Tourist
  - Locals
- Wastewater and tourist activities

Introduction – COVID-19's Impact



Introduction – Filling the Gaps

Pandemic set up a natural experiment to test how much groundwater pollution is due to tourism.

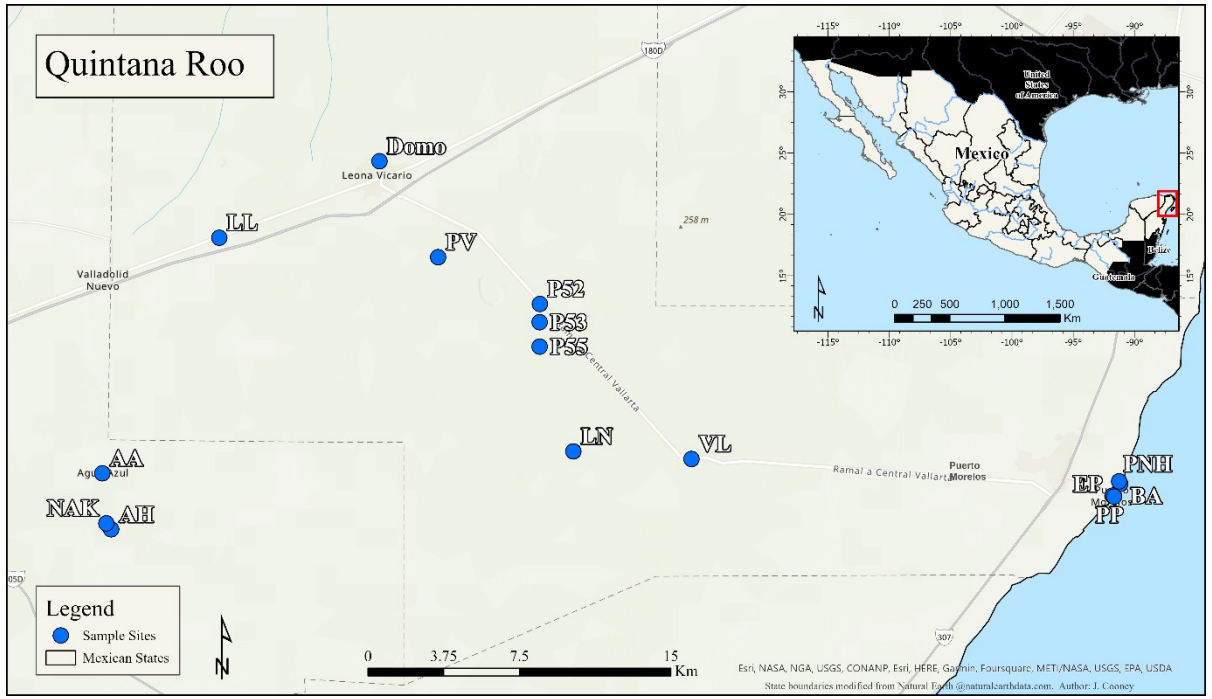
- Used sunscreens and antibiotics as proxies to estimate human presence
- Previous research looked at other indicators during tourism seasons

Introduction – Filling the Gaps

Evaluate new drainage system installed in Puerto Morelos

- New connections to wastewater treatment plant replaces septic systems

Study Area- Location



Site Abbreviation	Site Description	Use
Domo	Cenote	Not In Use
EP	Well	Private Well
LL	Cenote	Limited Tourism
BA	Well	Beach
PP	Beach	Recreation/Tourism
PV	Cenote	Recreation/Tourism
VL	Cenote	Recreation/Tourism
AA	Cenote	Not In Use
AH	Cenote	Limited Tourism
LN	Cenote	Recreation/Tourism
NAK	Cenote	Limited Tourism
P52	Well	Public Well
P53	Well	Public Well
P55	Well	Public Well
PNH	Well	Private Well

Methods

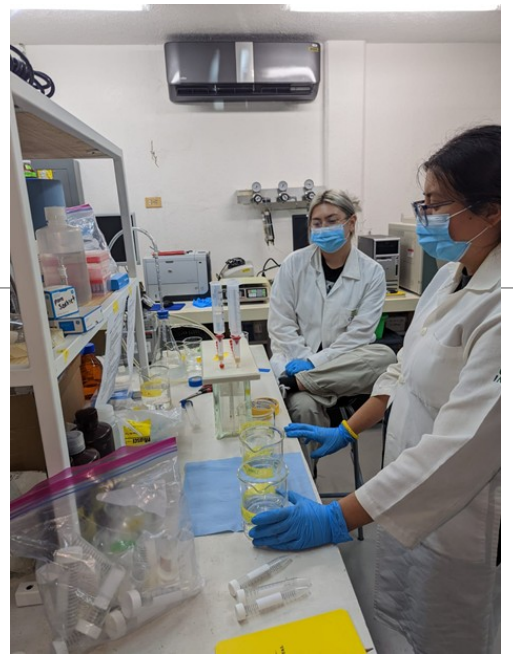
Sunscreens and antibiotics- LC/MS

Water grab samples were collected between March 2020 to July 2021

- March 2020 – June 2021: Dr. Rosa María Leal-Bautista from CICY
- July 2021: NSF Research Experience for Undergraduates

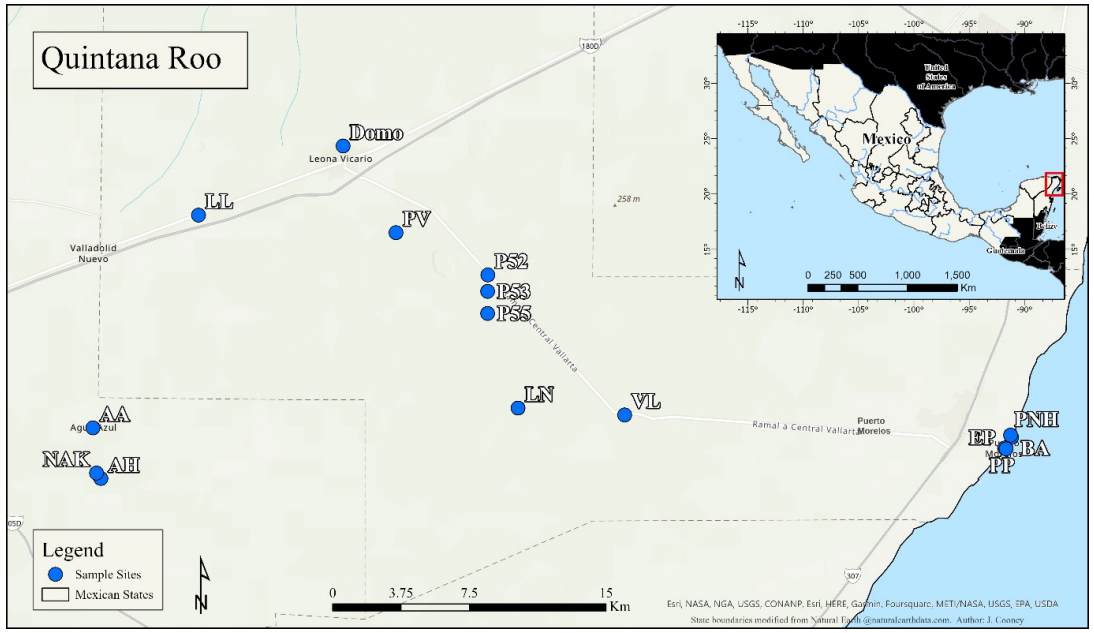
Cenotes, beaches, public and private wells, and showers at recreational areas

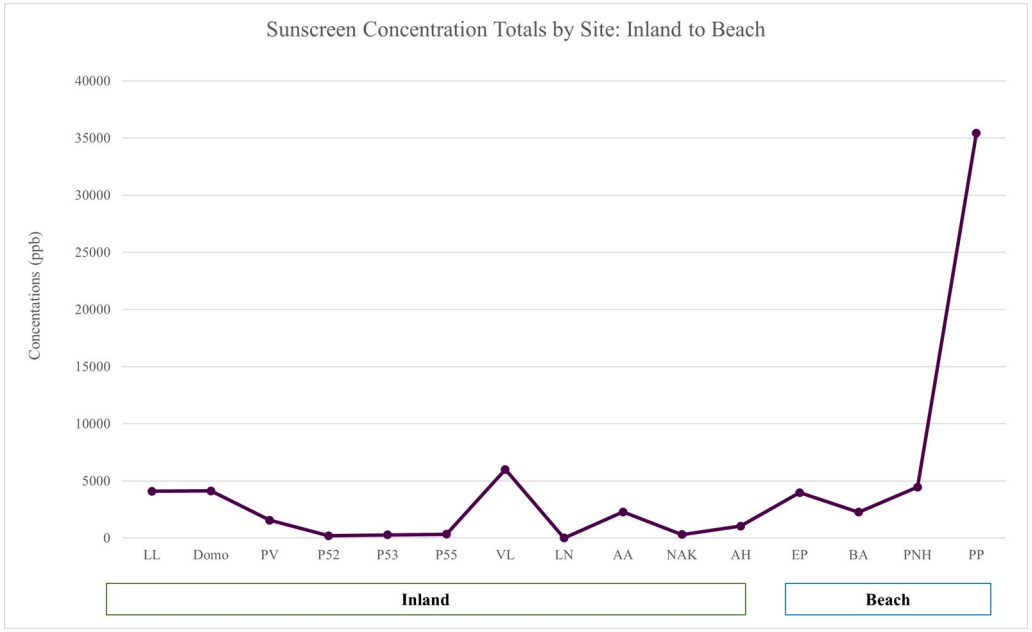
- Subject to availability due to the pandemic



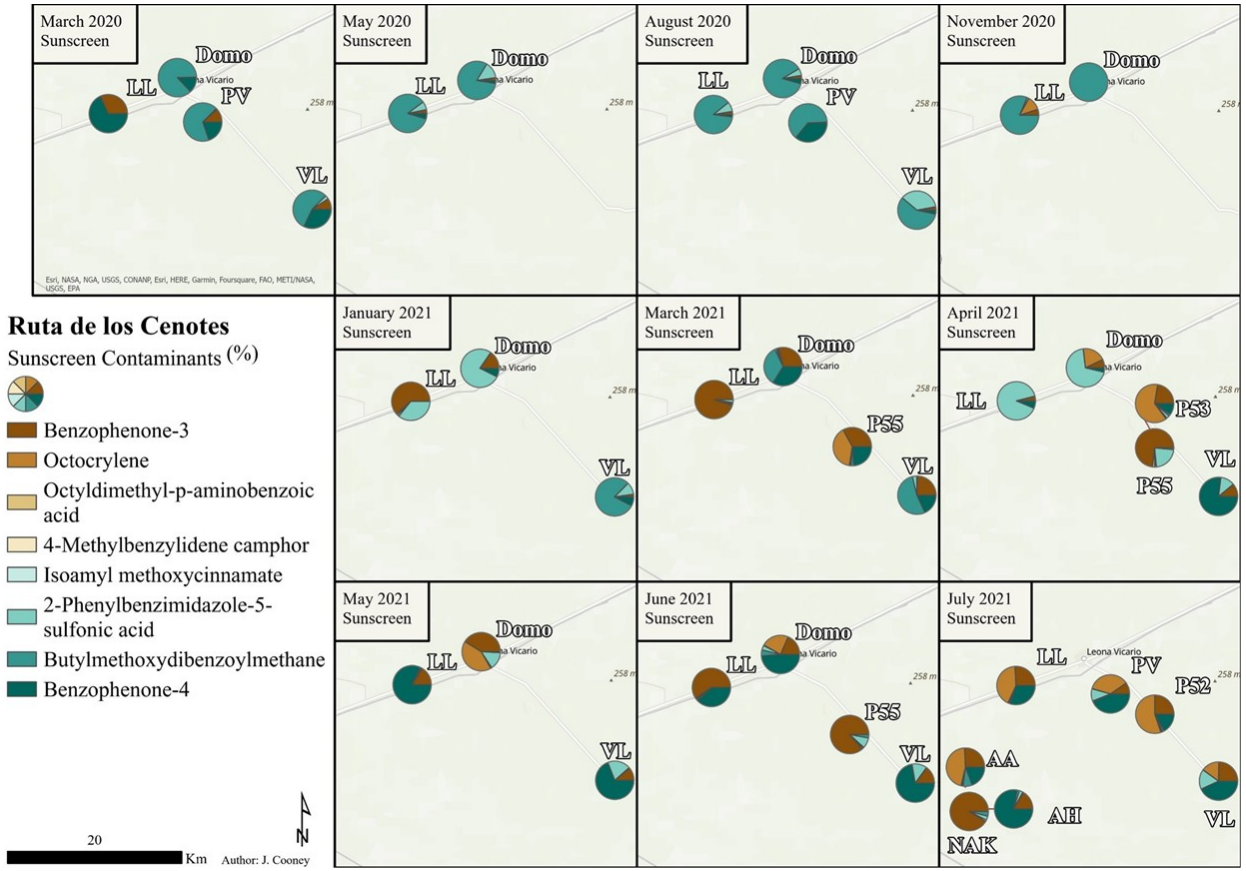
Antibiotic	CAS #	Prescribed Uses	Sunscreen Active Ingredient	CAS #	Banned In	Abbreviations
Penicillin G	61-33-6 or 113-98-4	Treats severe infections requring quick and potent antibiotics such as severe pnemonia septicemia, endocarditis, pericarditis, meningitis	Benzophenone-3	131-57-7	Banned in Palau, City of Key West, FL., Hawaii. Regulated in Australia	BP-3
Ampicillin	69-53-4	Treats respiratory, gastrointestinal and urinary tracts, and meningitis infections	Octocrylene	6197-30-4	Banned in Palau and Hawaii. Regulated in Australia.	OC
Cephalexin	15686-71-2	Treats respiratory, genitourinary, ear, skin, and bone infections	Octyldimethyl-p-aminobenzoic acid	58817-05-3	Banned in Palau	OCPABA
Oxytetracycline	79-57-2, 6153-64-6, 7179-50-2, 13303-91-8	Treats respiratory and gastrointestinal illnesses	4-Methylbenzylidene camphor	36861-47-9 or 95342-41-9	Banned in Palau. Regulated in Australia.	4MBC
Tetracycline	60-54-8	Treats respiratory, tick-borne, and sexually transmitted illnesses and acne. Substitute for penicillin.	Isoamyl methoxycinnamate	71617-10-2	Banned in Palau. Regulated in Australia.	IMC
Erythromycin	643-22-1, 114-07-8, 82343-12-2, 215031-94-0, 7540-22-9	Treats respiratory, GI, skin, genital, sextually transmitted infections. Substitute for penicillin	2-Phenylbenzimidazole-5-sulfonic acid	27503-81-7	Banned in Palau. Regulated in Australia.	PBSA
Tylosin	1401-69-0 or 1405-54-5	Veterinary treatment	Butylmethoxydibenzoylmethane	70356-09-1	Banned in Palau and Hawaii. Regulated in Australia.	BMDM
Sulfamethoxazole	723-46-6, 144930-01-8, 144993-89-5	Used with Trimethoprim for treatment of respiratory, GI, ear, and urinary tract infections.	Benzophenone-4	4065-45-6	Banned in Palau. Regulated in Australia.	BP-4
Trimethoprim	738-70-5	Treats urinary and eye infections. Combined with sulfamethoxazole, treats urinary, respiratory, and GI infections.				

Results- Sunscreens

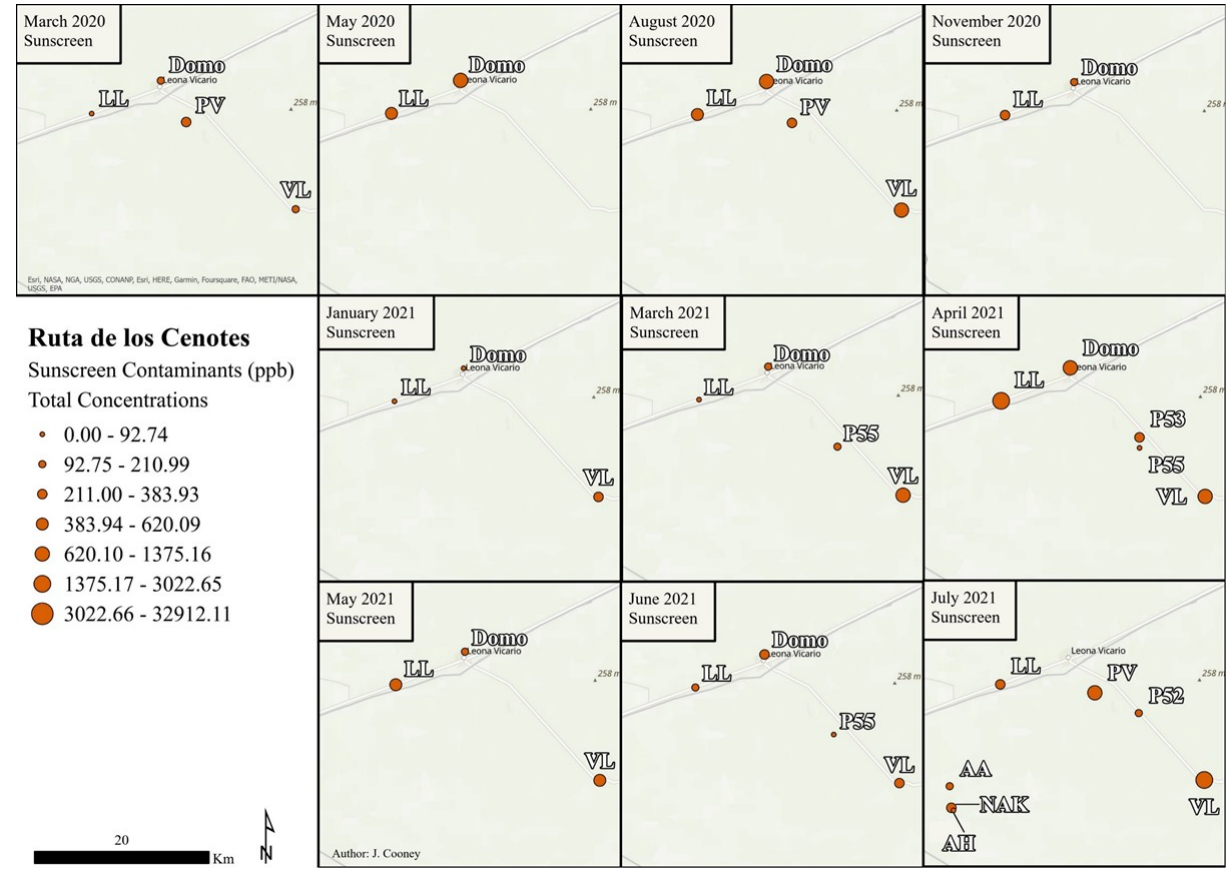




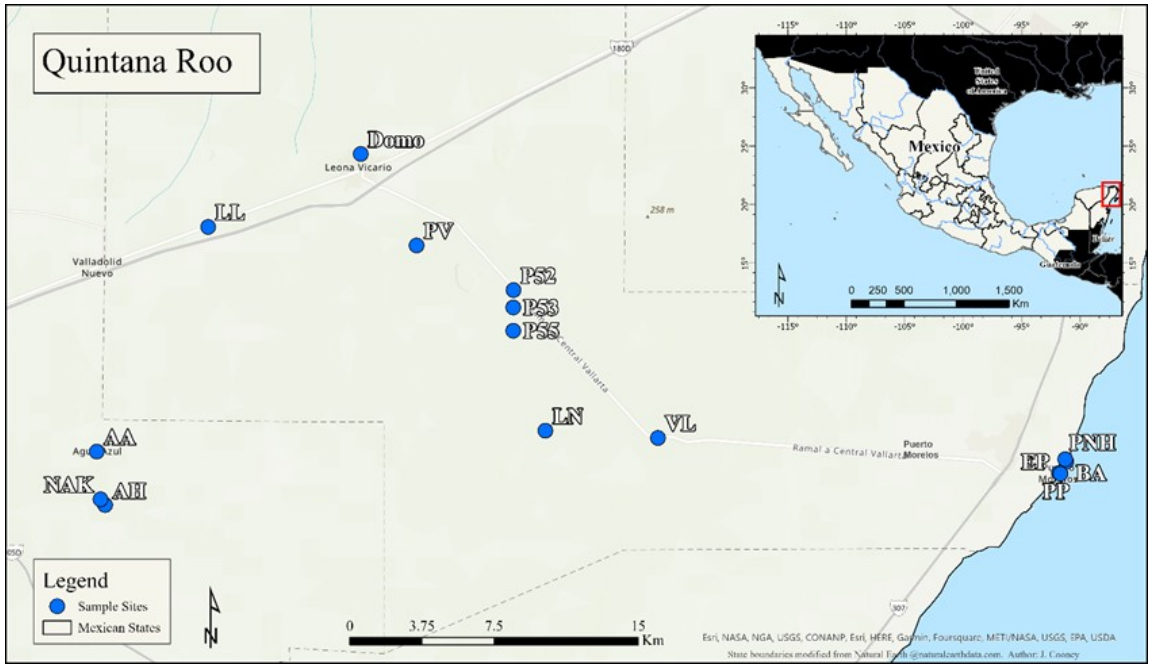
PERCENTAGES OF SUNSCREENS

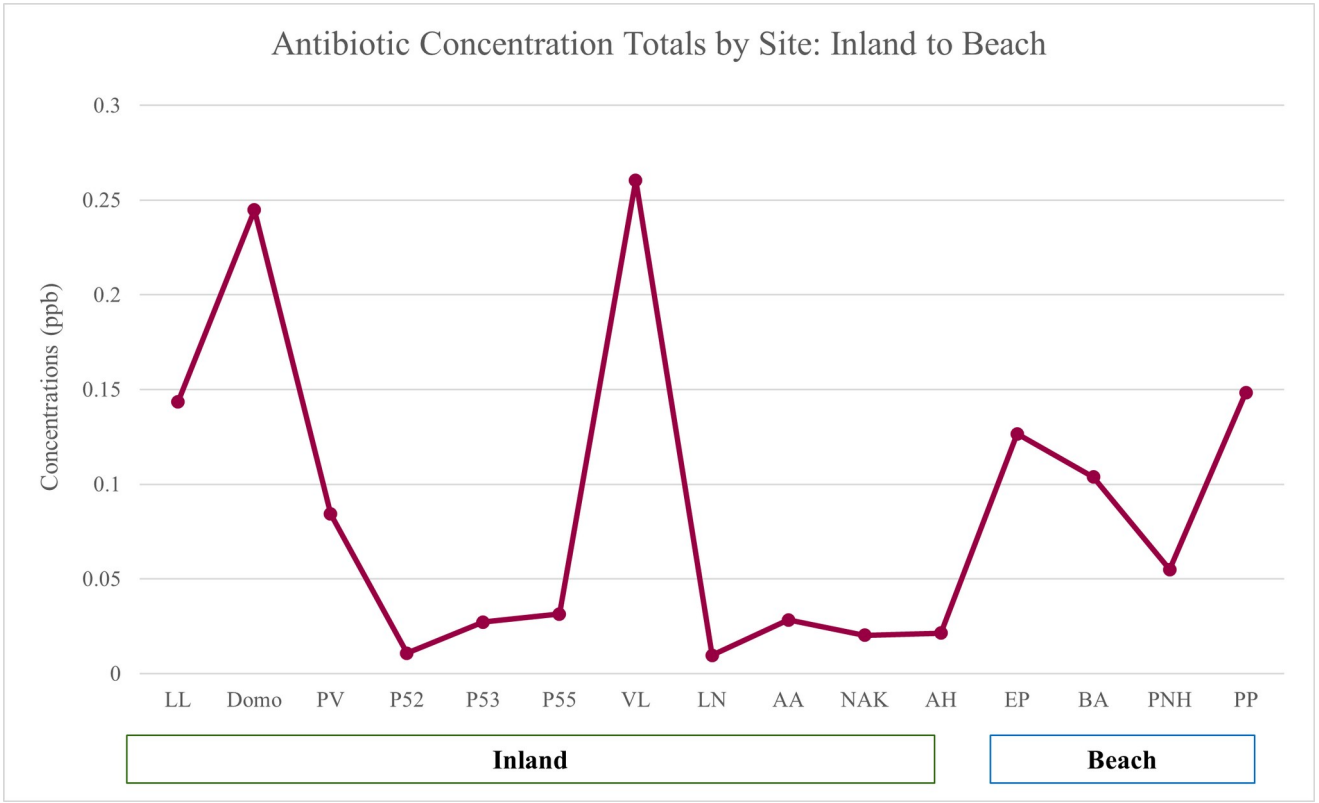


SUNSCREEN TOTAL CONCENTRATIONS

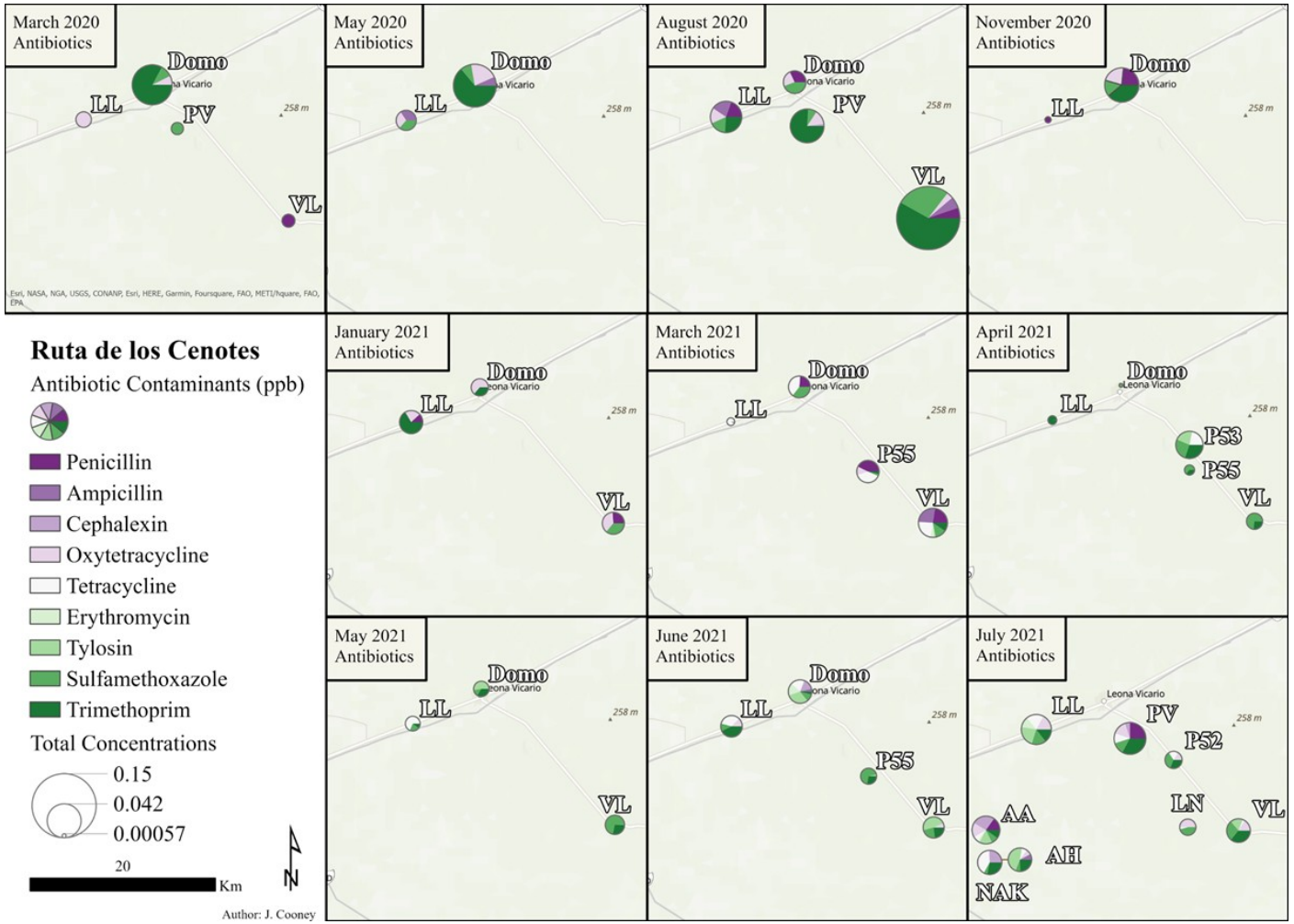


Results- Antibiotics

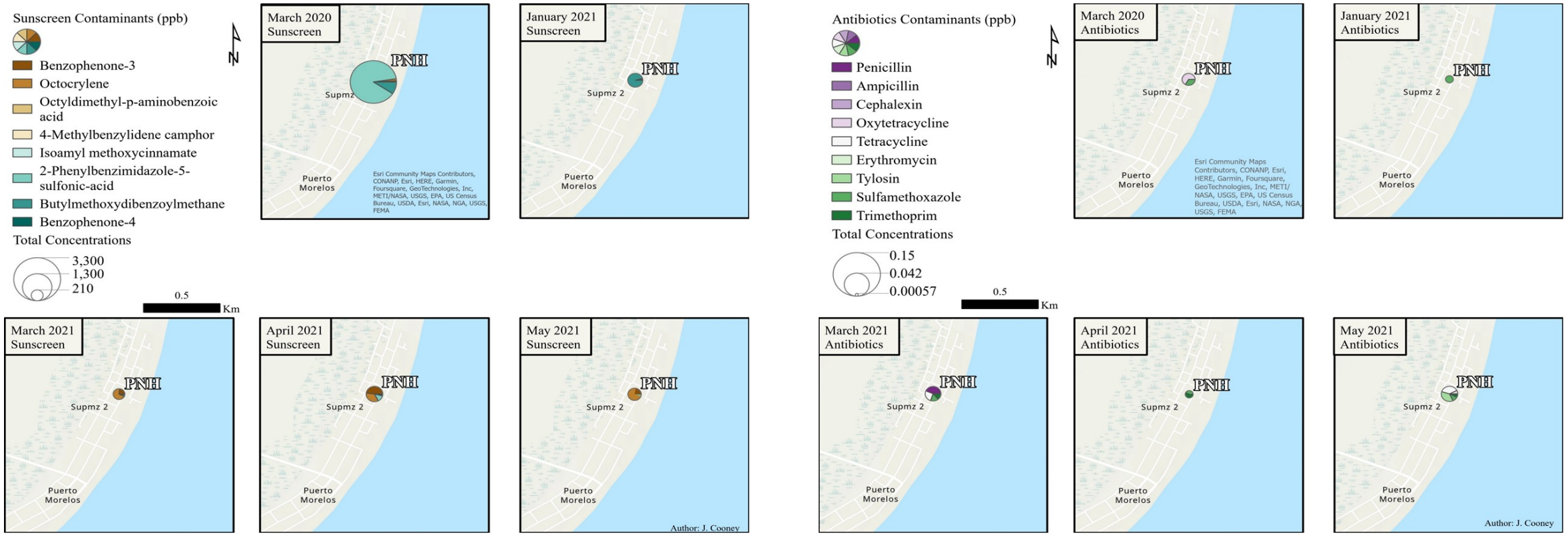




ANTIBIOTIC PERCENTAGES AND TOTAL CONCENTRATIONS



DRAINAGE CONNECTION EFFICACY



Key Findings

- Tourists contribute to the diversity of contaminants in groundwater.
  - Pandemic antibiotic diversity from residents
- Residents are major contributors of total concentration of contaminants, but not diversity.
- New drainage program in Puerto Morelos, QR, effectively reduces contamination in groundwater.
- Next steps: 2022 data, time and location in cenote

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Thank you

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