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Modeling the fate of down-the-drain chemicals at large geographic scales

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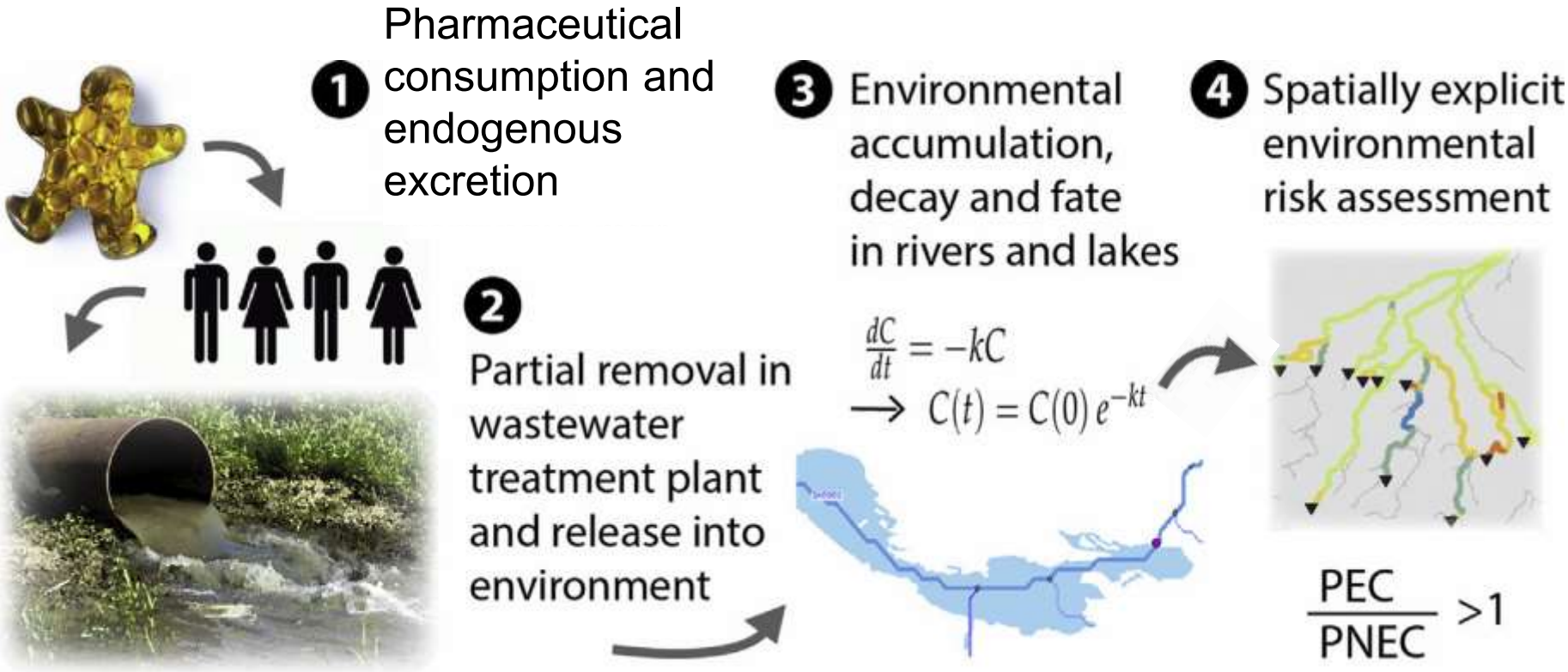
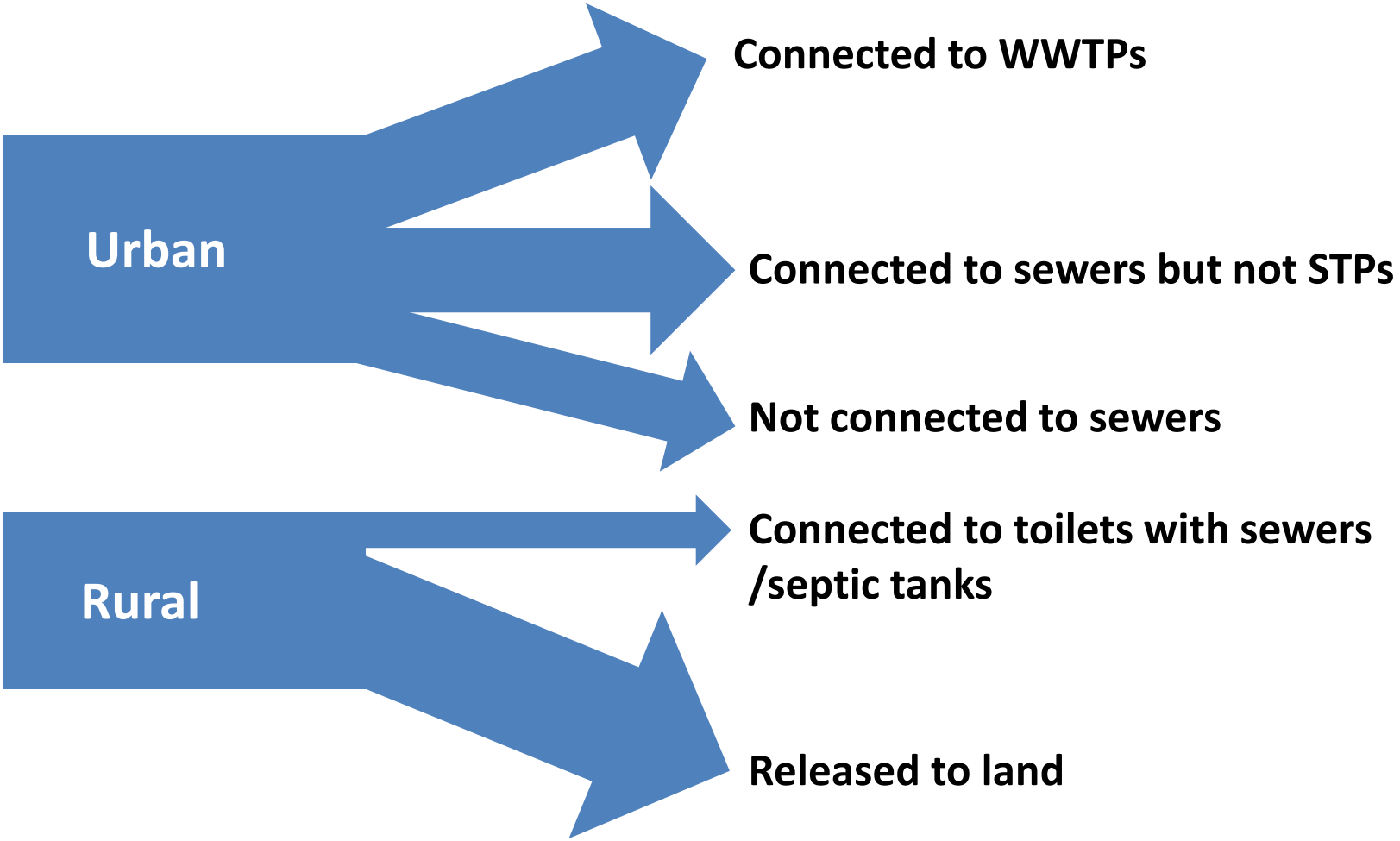
General Approach



Grill et al., 2016

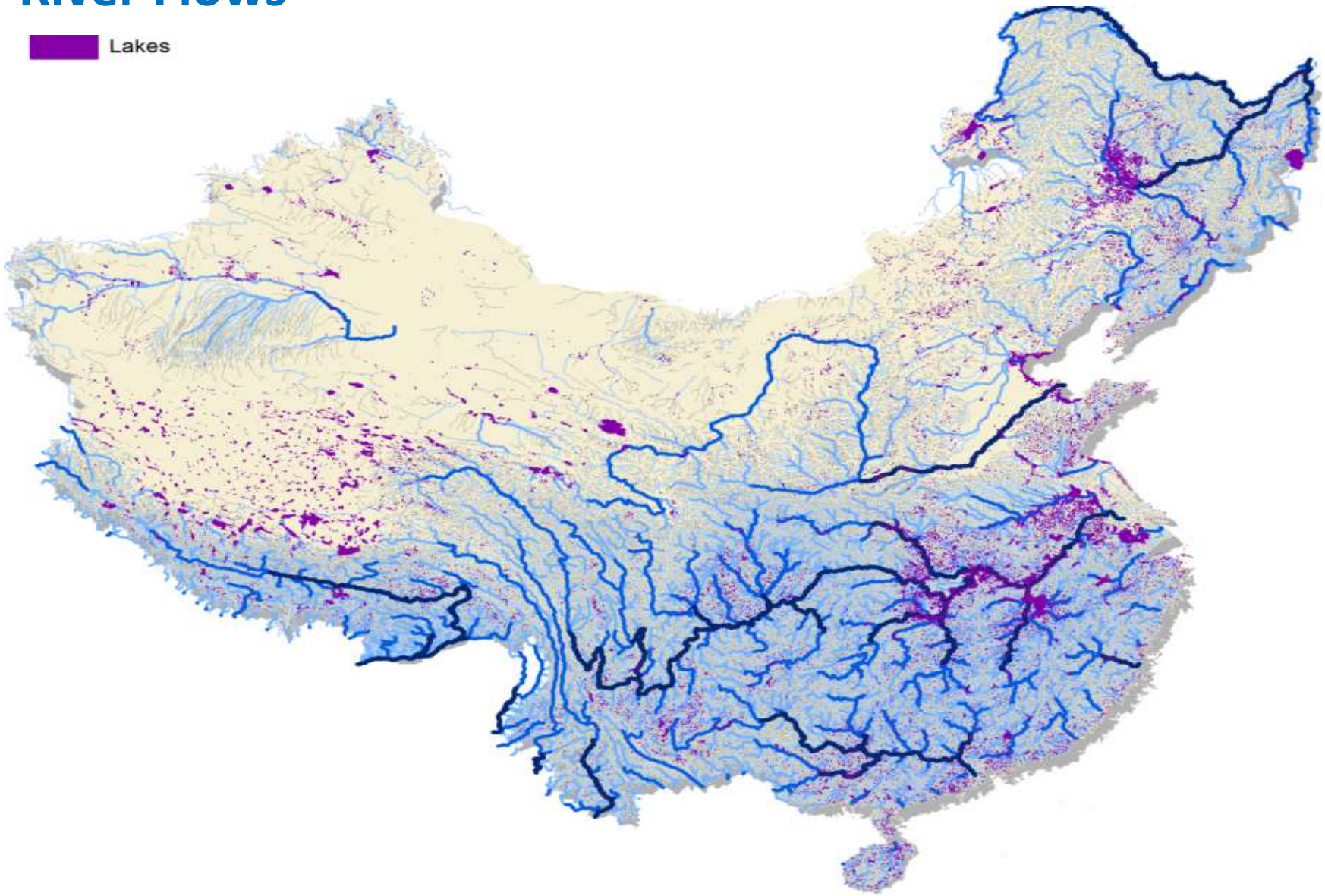
A Contaminant Fate Model for Mainland China

Fate of Sewage in China

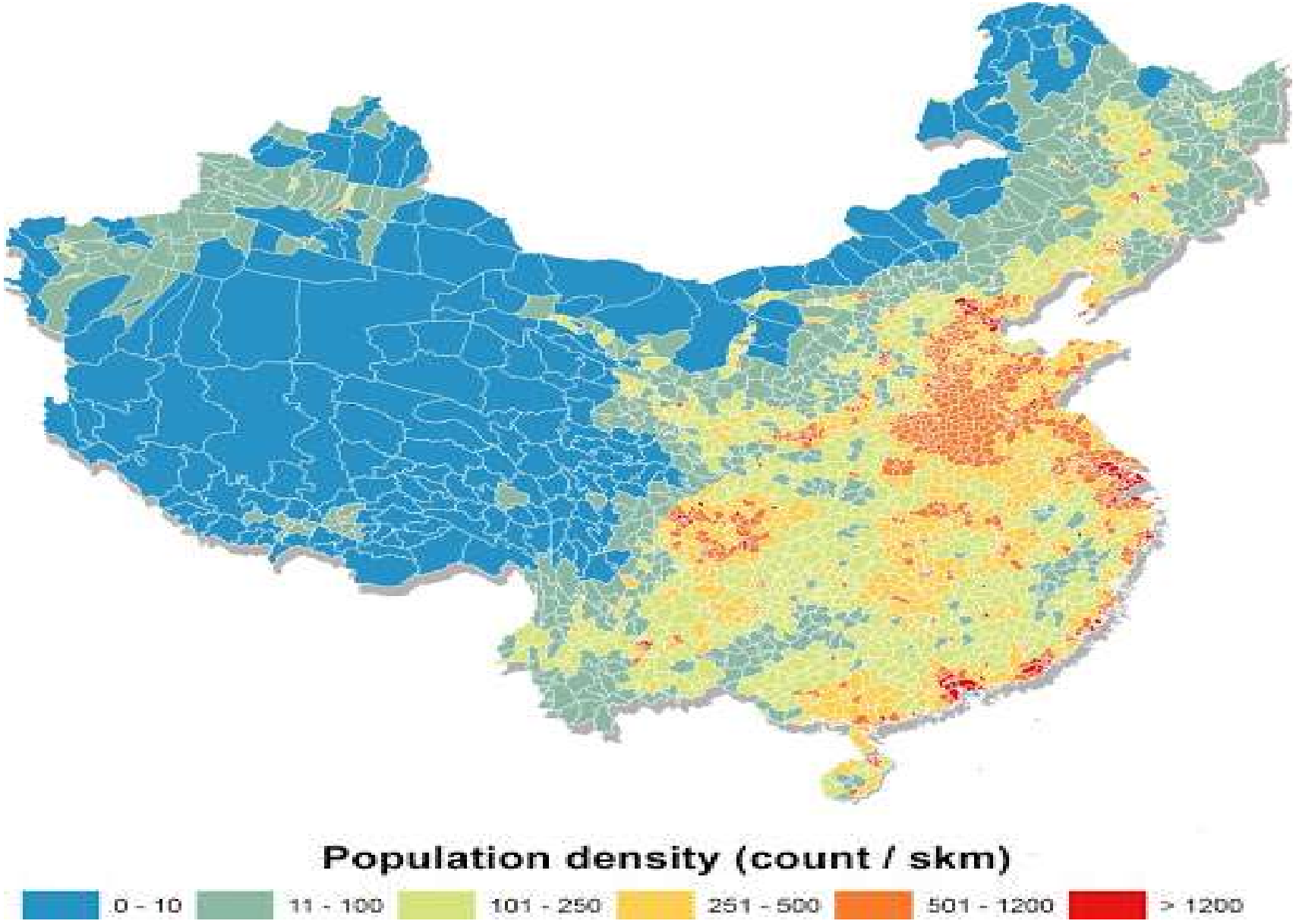


- Uncertainty in parametrization
- Un-treated components can represent a significant mass contribution
- Spatial allocation of non-point sources

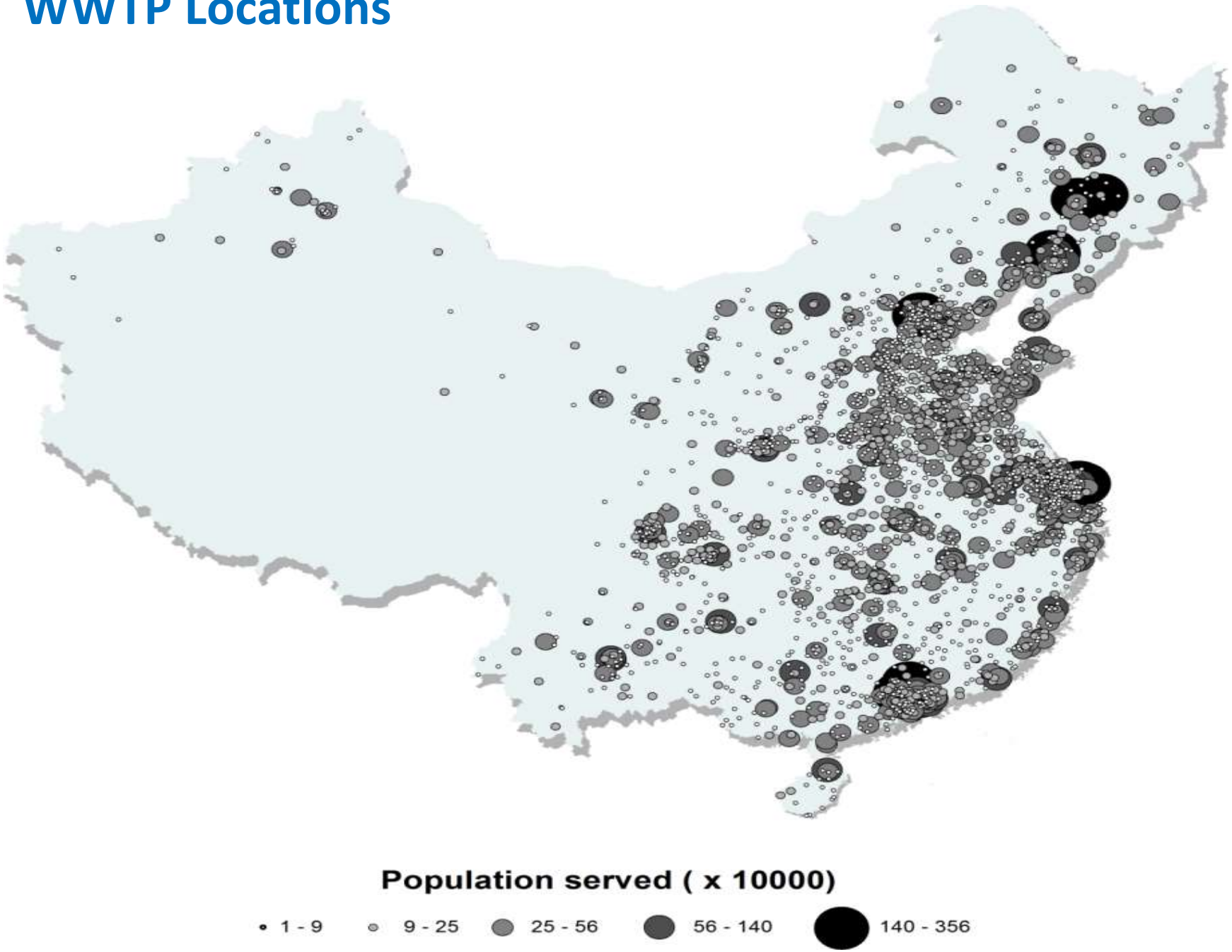
River Flows


Lakes
Long-term average discharge (m3/s)
1 - 10
11 - 100
101 - 1000
1001 - 10000
> 10000

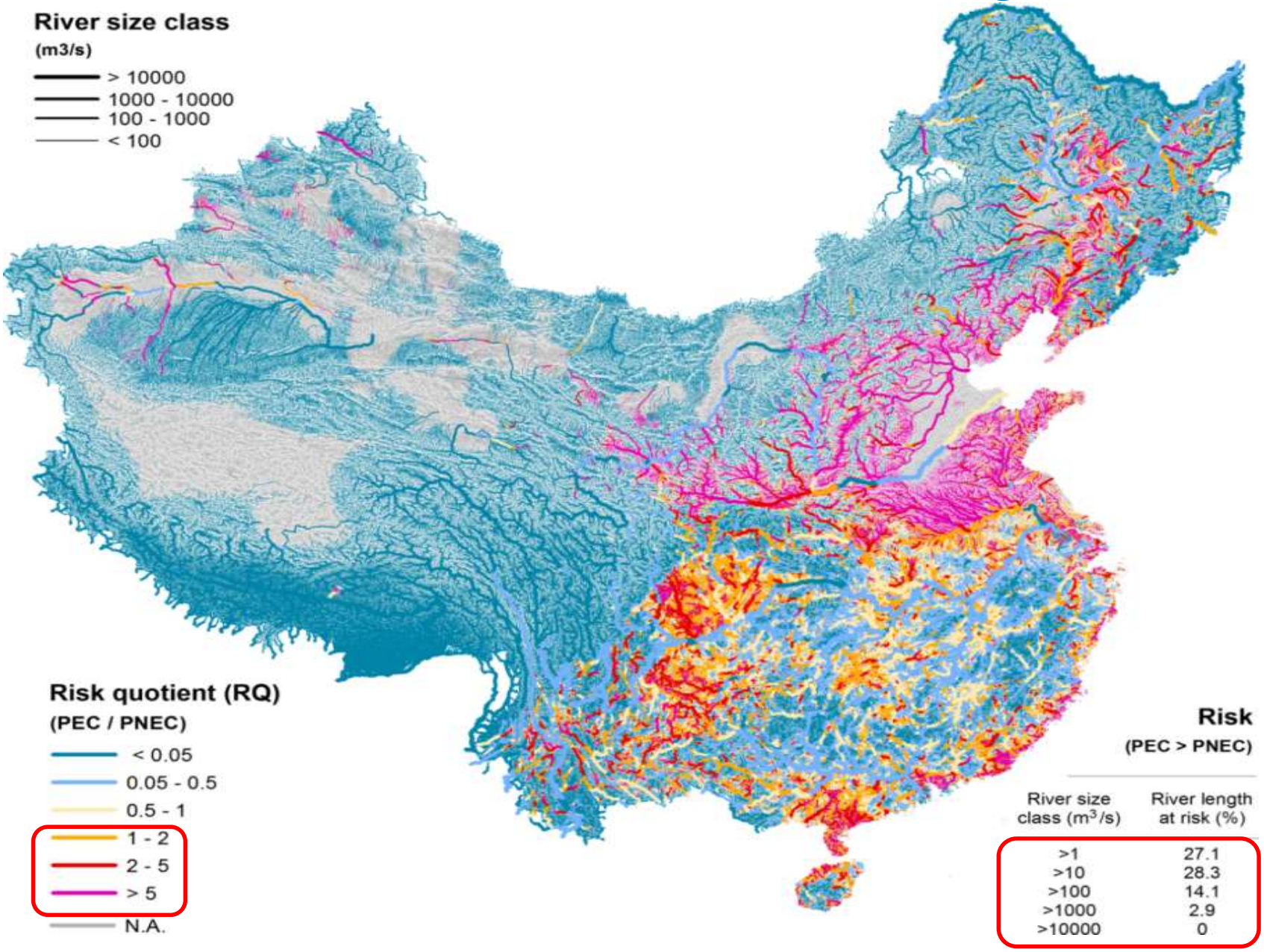
Population


Population density (count / skm)
0 - 10
11 - 100
101 - 250
251 - 500
501 - 1200
> 1200

WWTP Locations



Eco-tox Risk Assessment for Steroidal Estrogens

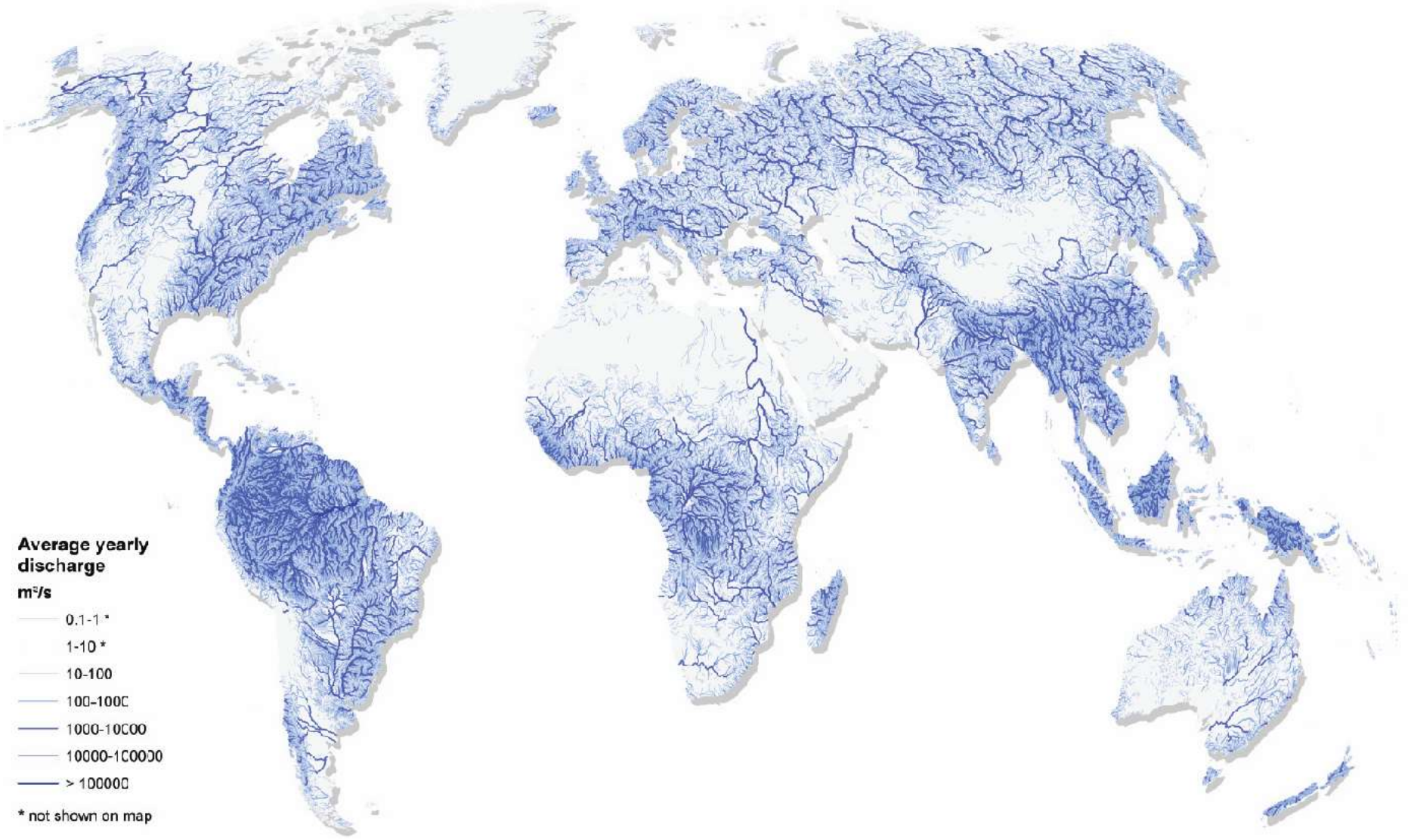


Validation

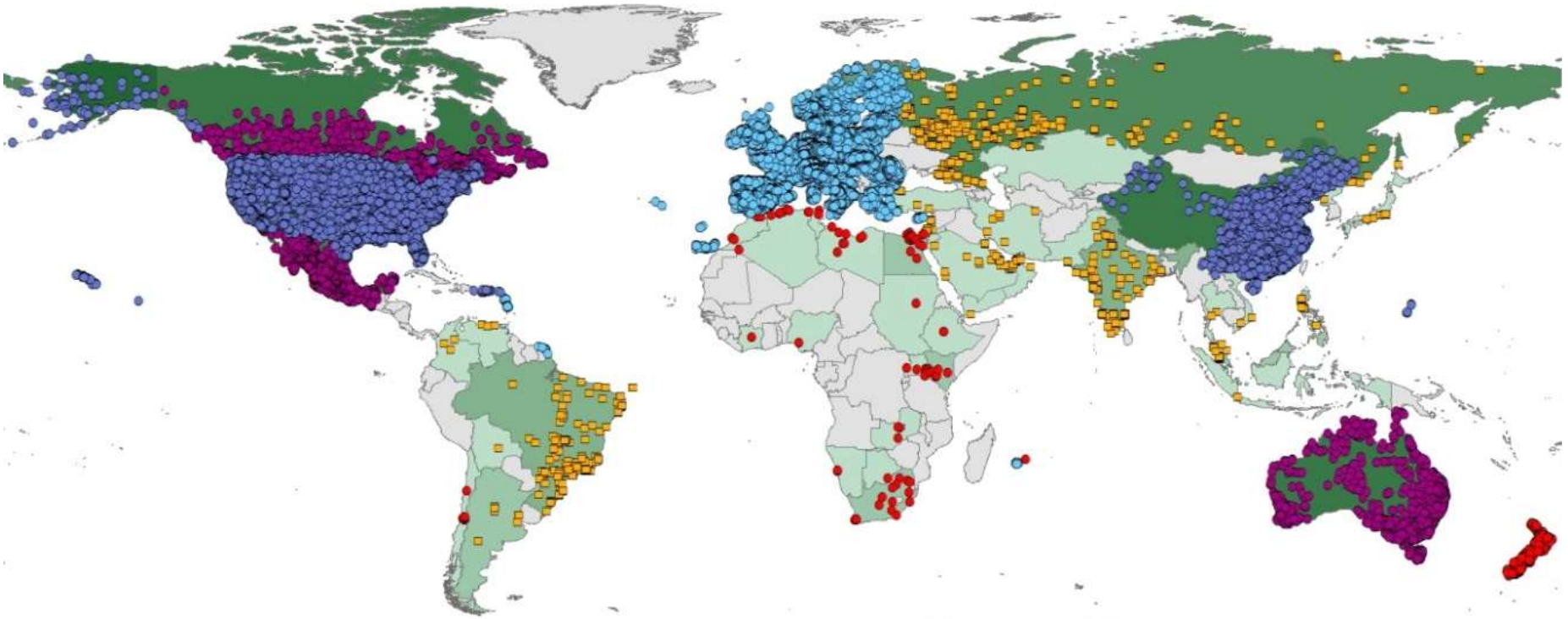
Site	E1 (ng/L)			E2 (ng/L)			E3 (ng/L)		
	obs.	pred.	factor diff.	obs.	pred.	factor diff.	obs.	pred.	factor diff.
S6	1.53	1.67	1.1	0.25	0.32	1.3	n.a.	n.a.	n.a.
S7	0.96	2.0	2.1	0.34	0.38	1.1	n.a.	n.a.	n.a.
S8	0.87	0.5	1.7	0.31	0.1	3.1	n.a.	n.a.	n.a.
S9	1.08	10.05	9.3	0.55	1.5	2.7	4.4	2.78	1.6
S10	1.93	0.15	12.9	0.71	0.02	35.5	3.9	0.014	281.4
S11	2.37	10.09	4.3	0.58	1.53	2.6	4.2	3.42	1.2
S14	2.98	6.34	2.1	1.51	0.75	2.0	2.6	0.38	6.8

Obs. = observed data (Jiang et al., 2012); pred. = predicted

Developing a Global Database of WWTPs


Average yearly discharge
m³/s
0.1-1 *
1-10 *
10-100
100-1000
1000-10000
10000-100000
> 100000
* not shown on map

Location and Attribute Information of WWTP Database (n = 52,225)



Available WWTP Attributes

- Population served & Wastewater volume & Treatment level
- Wastewater volume & Treatment level
- Capacity proxy & Treatment level
- No attributes but confimed location
- No attributes and unconfirmed location

Number of WWTPs per Country

No data | 1 - 10 | 11 - 50 | 51 - 200 | 201 - 500 | 501 - 1000 | 1001 - 5000 | >5000

Summary of Data Availability for WWTP Database (n = 52,225)

Country/region	WWTP location	Population served	Treatment level	Wastewater volume
Canada	✓	×	✓	✓
United States of America	✓	✓	✓	✓
Mexico	✓	×	✓	✓
Europe	✓	×	✓	+
Australia	✓	×	✓	✓
New Zealand	✓	×	×	×
China	✓	✓	✓	✓
Asia (other than China)	✓	×	×	×
Africa	✓	×	×	×
South America	✓	×	×	×
Total number of countries	93	2	37	5✓ and 32+

✓ Data available

× Data not available

\+ Capacity of WWTP reported as population-equivalent

Conclusions & Next Steps

Conclusions & Next Steps

- The described large-scale contaminant model is capable of identifying river reaches that represent an environmental risk
- The case study of mainland China revealed that contaminant releases from untreated wastewater can dominate the contribution to overall risk
- Database of 52,225 WWTPs in 93 countries have been obtained, yet with a strong bias towards North America, Europe, China, and Australia
- Next steps (*pending further funding*): Upscaling to larger regions. Sub-continental India model is under construction, plans to extend to continental application