A spatially explicit framework was developed for global implementation of the iSTREEM® DdD aquatic exposure model. This framework was applied with case studies for China and Japan recently published. River flows for level-12 catchments at global scale were estimated using the USDA Curve Number approach. Here we discuss the application of the framework for Canada and Mexico, utilizing the level-12 catchments from HydroBASINS® and the river network from HydroRIVERS®. The model includes 74,000 level-12 catchments for Canada and 15,000 for Mexico, with catchments parameterized for:

- River flow for the entire hydrologic network was extracted from the Global Flow data.
- WWTP spatial locations and effluent flow – from publicly available country sources.
- Water use – from publicly available country sources.
- Population connected to WWTP – estimated from effluent volume and water use.
- Onsite discharge population – to account for people connected to septic systems.
- Direct discharge population – to account for all non-connected people.

**TREATMENT METHODS**

The model framework estimates DdD chemical removal from WWTPs, onsite or septic systems, or direct discharge to the environment. In-river removal is handled through a first order decay parameter. The population in catchments without WWTPs were assigned to onsite treatment and direct discharge based on statistics from WHO-JMP®.

**Canada**
- Per capita water use at census subdivisions (Figure 1) and WWTPs were accessed from the Wastewater Systems Effluent Regulations® (Figure 2).
- 81% of the population was estimated to be connected to WWTP infrastructure.
- Onsite treatment systems cover about 11%, and 8% of the population has direct discharge to receiving waters.

**Mexico**
- Per capita water use at province-level obtained from (Figure 3) and WWTPs were accessed from the National Water Information System® (Figure 4).
- 52% of the population was estimated to be connected to WWTP infrastructure.
- Onsite treatment systems cover about 33%, and 15% of the population has direct discharge to receiving waters.

**RESULTS AND DISCUSSION**

- For sensitivity analysis, a no–WWTP removal and no in–river decay scenario was considered the base scenario for comparison.
- In Canada, when onsite and direct discharge removal were varied from 50% to 90%, little impact was observed on river concentrations (Figure 5 a–d). If WWTP removal varied from 50% to 90%, a 3X decrease in river water concentration was observed (Figure 5a). This is due to catchments with 81% population connected to WWTP being significantly higher than catchments with 11% population for onsite and 8% population for direct discharge; thus, significantly greater impact when WWTP removal is varied. In-river decay had similar reduction as WWTP removal.
- In Mexico, when WWTP, onsite and direct discharge removal were varied from 50% to 90% (Figure 6 a–d), little impact was observed on river water concentrations. In-river discharge was varied from 50% to 90%, the decrease in river water concentration was minimal. This is due to the catchments with 52% population connected to WWTP was only slightly higher than catchment population of 33% with direct discharge. However, the variation of in-river decay rate from 1 to 10 day brought about a significant reduction in river concentration (Figure 6d).

**SUMMARY AND OUTLOOK**

- A spatially explicit modeling framework based on the iSTREEM® model was applied for Canada and Mexico. Serves as an important step towards developing broad scale environmental exposure models for DdD assessments across North America and the globe.
- Sensitivity analysis was performed to evaluate the impact of key model input parameters (% removal during treatment and in-river decay) – modeling results for Canada and Mexico show that for different chemicals, treatment removal and in-stream decay rates can vary the range of estimated river concentrations.
- This analysis provided insights into how country-specific parameterization for wastewater treatment types across the two countries can impact model results.
- Case studies of modeled results are currently being performed, and there is a need for DdD chemical monitoring data for model validation in Canada and Mexico.

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