



A First-Approximation Mass Balance Model for Mercury in the Willamette River Basin

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INTRODUCTION

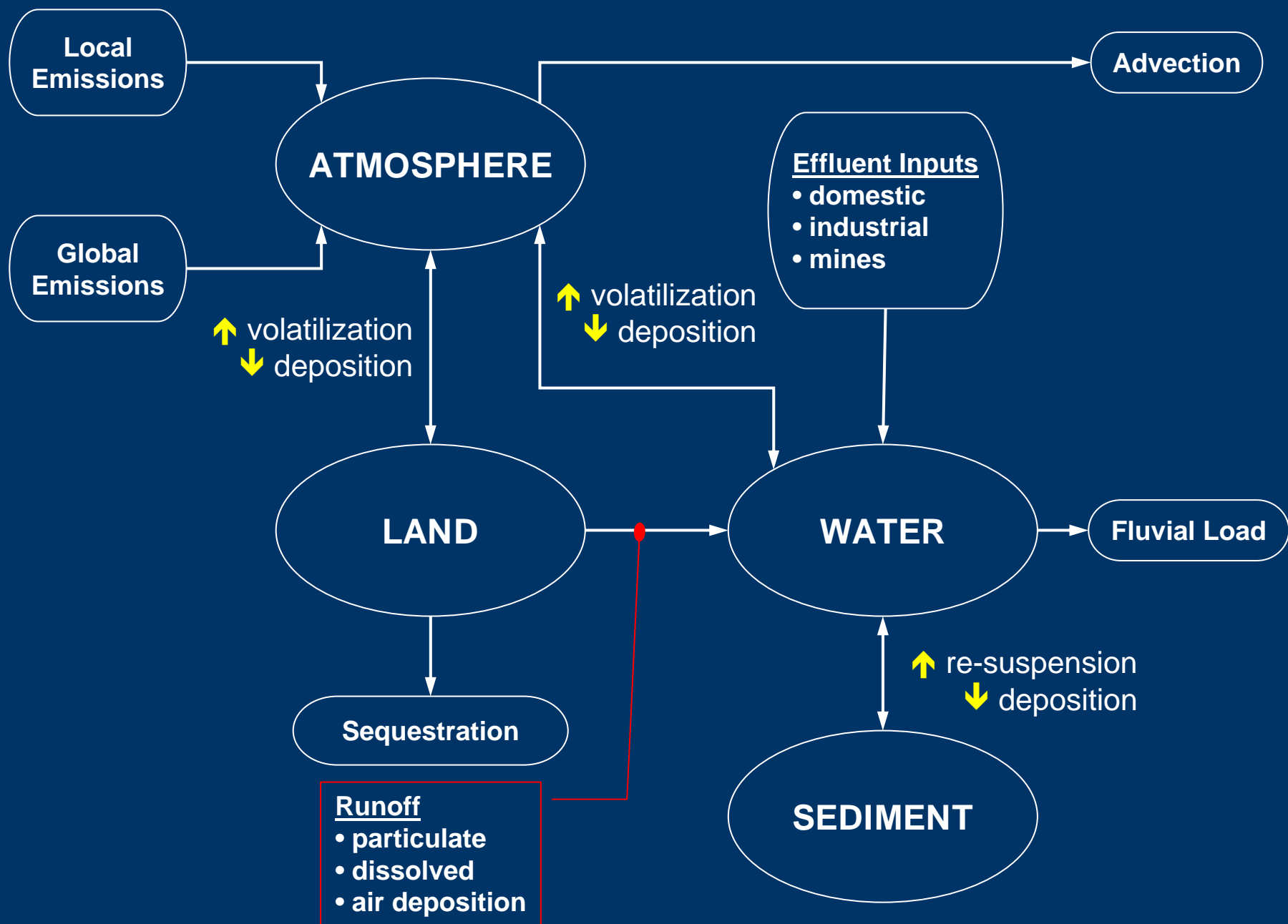
❖ Problem

- Elevated fish tissue Hg levels ⇒ basin-wide fish advisory
- Fish advisory ⇒ TMDL process
- TMDL process ⇒ better understand Hg in the Basin

❖ Questions

- What are the relationships between mercury in fish tissue and in the water column?
- What are the relationships between THg and MeHg in water and sediment?
- What are the sources for, and amounts of, mercury entering and leaving the Basin?

MASS BALANCE CONCEPTUAL MODEL





Role of land use

- ❖ **Cycling processes are a function (in part) of how land is used**
- ❖ **Agricultural (22.7%)**
- ❖ **Transitional (43.9%)**
 - < 20% Tree Cover
- ❖ **Forested (26.3%)**
 - ≥ 20% Tree Cover
- ❖ **Urban (6.4%)**
- ❖ **Open Water (1.2%)**



Land

all fluxes in kg yr⁻¹

❖ INPUTS

❖ **Wet deposition** **425**

- $\approx 8 \mu\text{g m}^{-2} \text{yr}^{-1}$
- $\approx 4 \mu\text{g m}^{-2} \text{yr}^{-1}$ {global}

❖ **Dry deposition** **162**

- $\approx 3 \mu\text{g m}^{-2} \text{yr}^{-1}$

❖ **NET** **587**

❖ OUTPUTS

❖ **Volatilization** **350**

❖ **Air dep. runoff** **57**

- Delivery ratio of 5-20%

❖ **Particulate runoff** **76**

❖ **Dissolved runoff** **33**

❖ **Mine discharges** **1**

- Amount past dams

❖ **NET** **517**

- net gain to land



Air

all fluxes in kg yr⁻¹

❖ INPUTS

- ❖ Volatilization (L) 350
- ❖ Volatilization (W) 2
- ❖ Local emissions 360
- ❖ Global sources 390
 - Wet deposition 228
 - Dry deposition 162
 - Hg(II), Hg(P)

❖ NET 1103

❖ OUTPUTS

- ❖ Deposition (L) 587
- ❖ Deposition (W) 4
- ❖ Advection 512
 - ~47% of inputs
 - Hg(0)

❖ NET 1103



Water

all fluxes in kg yr⁻¹

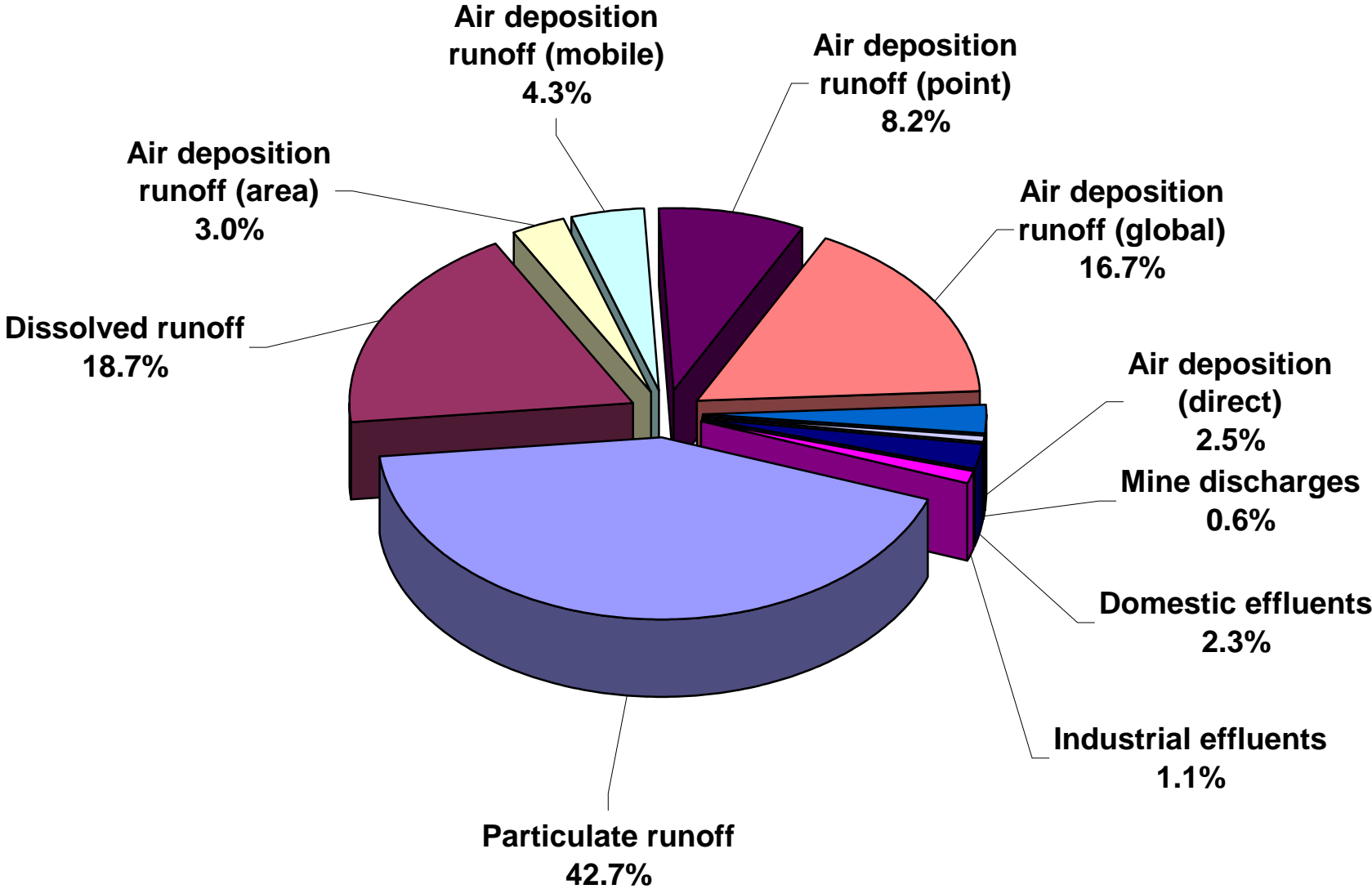
❖ INPUTS

| | |
|-----------------------|-----|
| ❖ Particulate runoff | 76 |
| ❖ Dissolved runoff | 33 |
| ❖ Air dep. runoff | 57 |
| ❖ Mine discharges | 1 |
| ❖ Air deposition | 4 |
| ❖ Domestic | 4 |
| ❖ Industrial | 2 |
| ❖ Re-suspension | 0 |
| • From sediment | |
| • Seasonal influences | |
| ❖ NET | 177 |

❖ OUTPUTS

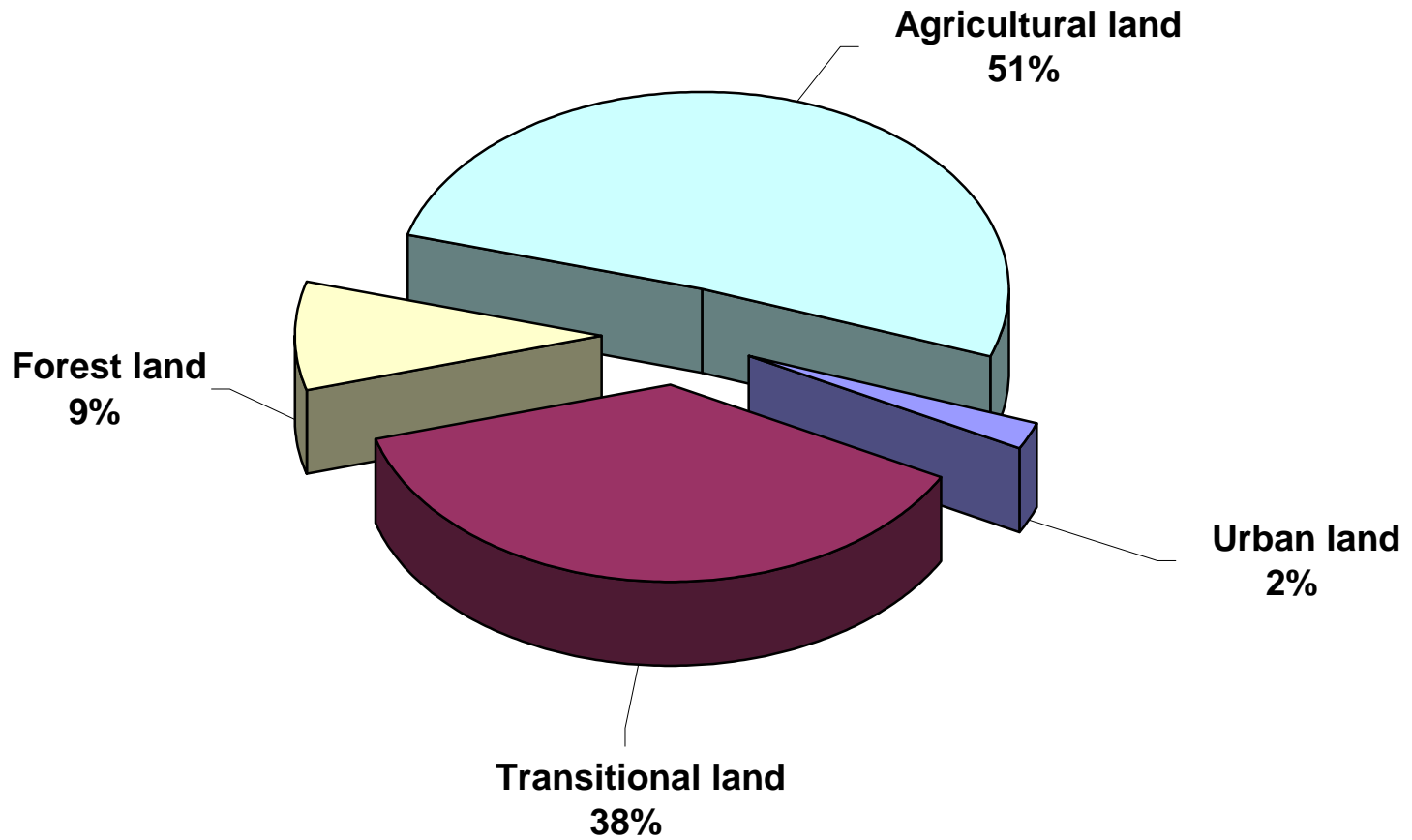
| | |
|-----------------------|-----|
| ❖ Volatilization | 2 |
| ❖ Fluvial load | 112 |
| • At RM 7.0 | |
| • 76% of input | |
| ❖ Deposition | 63 |
| • To sediment | |
| • Seasonal influences | |
| ❖ NET | 177 |

CONTRIBUTIONS TO MAIN STEM BY SOURCE



WITH LOCAL EMISSIONS

CONTRIBUTIONS TO PARTICULATE RUNOFF



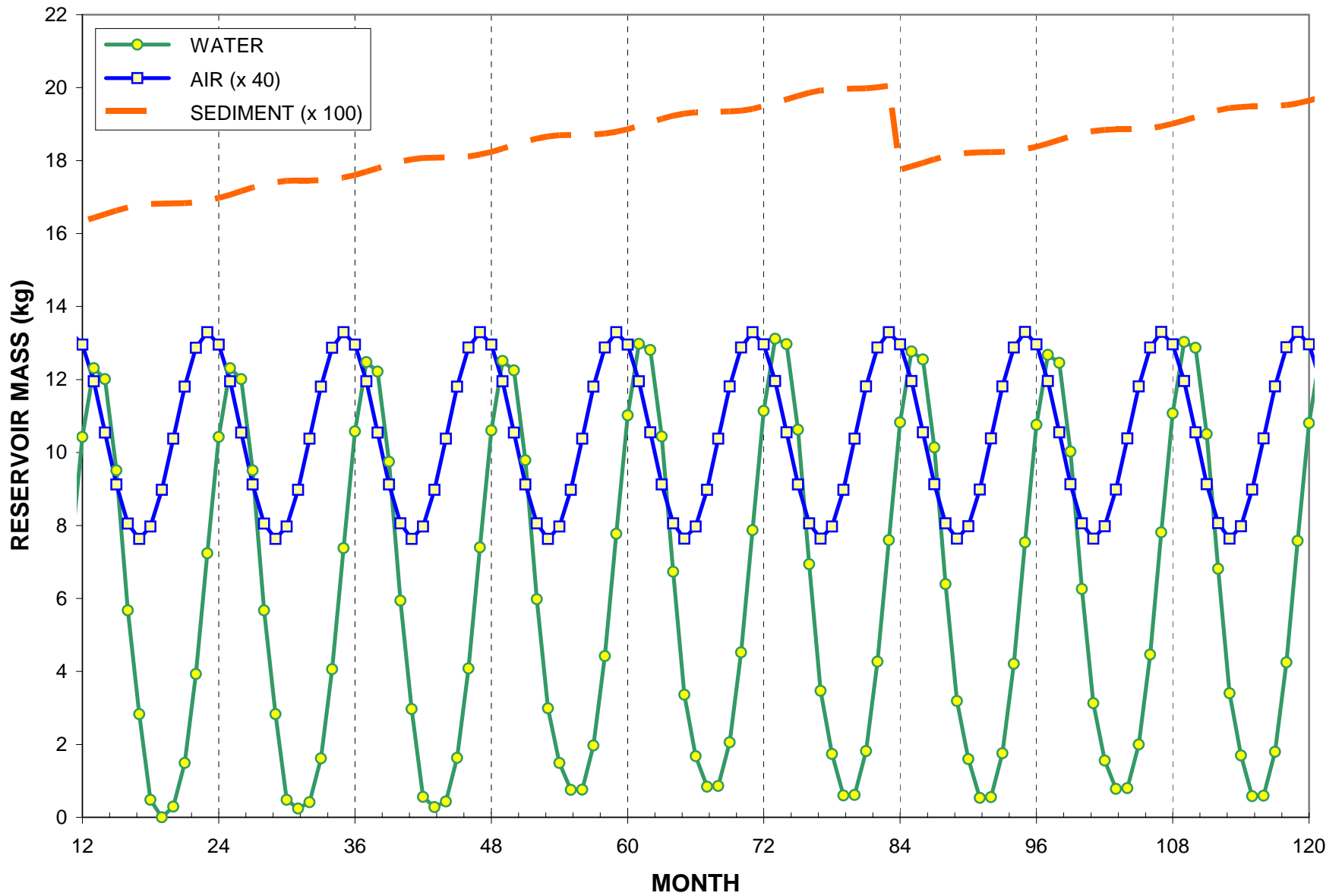
WITH LOCAL EMISSIONS



What if ?- no local sources

- ❖ **Load to Main Stem decreases**
 - $177 \text{ kg yr}^{-1} \Rightarrow 147 \text{ kg yr}^{-1}$
- ❖ **Total deposition decreases**
 - $\approx 11 \mu\text{g m}^{-2} \text{ yr}^{-1} \Rightarrow \approx 7 \mu\text{g m}^{-2} \text{ yr}^{-1}$ (global background)
 - Dry deposition rate assumed constant, but maybe not?
- ❖ **Land: net gain becomes net loss**
 - $+70 \text{ kg yr}^{-1}$ becomes -104 kg yr^{-1} (natural loss processes)
- ❖ **Sediment deposition decreases**
 - $63 \text{ kg yr}^{-1} \Rightarrow 32 \text{ kg yr}^{-1}$
- ❖ **Native soil remains primary source**
 - $\approx 42\% \Rightarrow \approx 51\%$

SEASONAL VARIATION PLAYS A MAJOR ROLE





Discussion

- ❖ **Global, local air emissions high & similar**
 - ↓ local emissions, ↓ (but not stop) Main Stem loading
 - But local sources ⇒ localized deposition
 - Anthropogenic effluents not major contributors
- ❖ **↑ Management native soil erosion, ↓ THg loading**
- ❖ **Seasonality could confound detecting THg Δ**
- ❖ **Continuing issue of THg ⇒ MeHg**
 - Is THg really a MeHg production limiting factor?
 - Role of wetlands in MeHg production?