Olga Ogburn Background

Graduate Student
The University of Alabama (Tuscaloosa, AL, US)

- Focus: Environmental Engineering
- Partial support is funded by NSF
- Was research assistant and teaching assistant in various classes since Jan. 2007
- Worked as an engineer in various organizations.
- M.S. in Thermal Power Engineering. Moscow Power Engineering Institute (Technical University). (Moscow, Russia) (Feb. 1997)
  - with the specialization "Technology of Water and Fuel at Thermal Electric Power Stations"

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The Goal

- The purpose of this study was to investigate heavy metal releases from different pipe, gutter, and storage tank materials under a wide range of environmental conditions.
- The influence of pH, salinity, and time of contact were examined.
- This presentation will cover rate of metal release at different water conditions.

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Literature Review

- Rooftop and pipe material contribute to the runoff water quality.
- Environmental parameters of the water have an effect on the concentrations of the contaminants leaching into the storm water.

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Experimental Design

- Two series of long term-leaching laboratory tests were conducted.
  - Eight gutter and pipe materials
- First series of experiments were conducted to investigate the heavy metal releases under controlled pH conditions.
  - Roof runoff and parking lot runoff were collected in the city of Tuscaloosa and adjusted to pH 5 and pH 8 values.
  - Disodium phosphate dehydrate and potassium phosphate monobasic (Na_2HPO_4 * $2H_2O$ and KH_2PO_4) were used to create buffers.
  - Waters had high phosphate and high conductivity values.

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Experimental Design

- During the second testing stage, materials were immersed into un-buffered waters from Mobile Bay (saline) and the Black Warrior River.
- These experiments were performed to investigate the metal releases under natural pH conditions with varying salinity values associated with natural brackish bay water and river water.

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Gutter and Pipe Materials:

- Gutter Materials: vinyl, aluminum, copper, and galvanized steel.
- Pipe Materials: concrete, HDPE, PVC, and galvanized steel.
- New materials
- Concrete pipes - 15 cm long
- The rest of pipes - 30 cm long

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Experimental Design

- Sampling times:
  - First testing stage: time zero (buffered water without pipes), 0.5 hr, 1 hr, 27 hr, 1 mo, 2 mo, 3 mo
  - Second testing stage: time zero (unbuffered water without pipes), 1 hr, 27 hr, 1 week, 1 mo, 2 mo, 3 mo
- Measured Parameters:
  - Metals (cadmium, chromium, lead, copper, zinc, aluminum, and iron)
  - Toxicity (Microtox)
  - pH, conductivity, Eh
  - Nutrients (ammonia nitrogen, total nitrogen, nitrate) and COD

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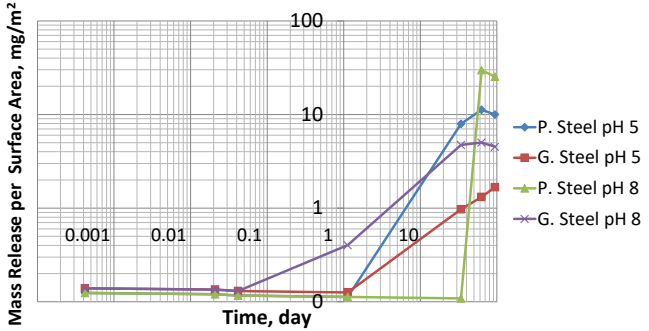
Lead Mass Release per Surface Area of a Pipe/Gutter in Containers with pH 5 and pH 8



- Galvanized steel materials were the only the source of lead release during both short and long exposure times.
- The loss of lead was higher for samples under pH 8 conditions compared to samples under pH 5 conditions.
- The greatest lead release was observed for galvanized steel pipe under pH 8 conditions and reached as high as 0.628-0.710 mg/L (corresponds to 25– 30 mg/m^2).

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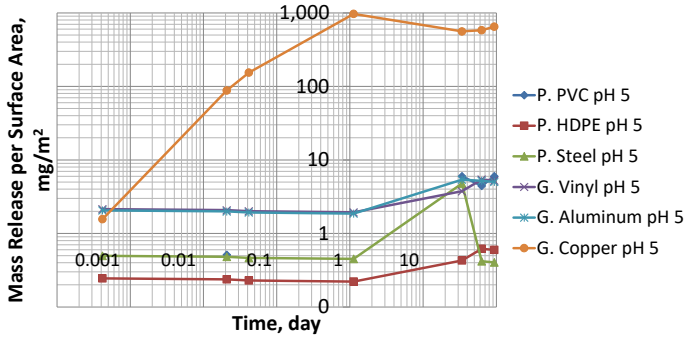
Copper Mass Release per Surface Area of a Pipe/Gutter for Containers with pH 5



- The greatest copper release was detected in containers with copper materials. 27 hr exposure resulted in copper release exceeding 6 mg/L (up to 970 mg/m^2).
- Copper release was also found in containers with other materials but in much lower concentrations.

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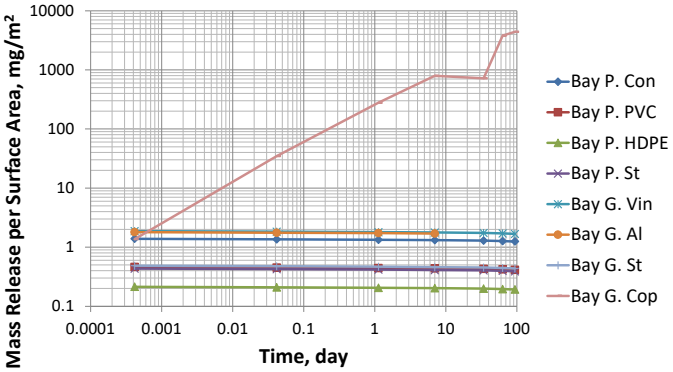
Copper Mass Release per Surface Area of a Pipe/Gutter for Containers with Bay Water



- Copper materials released very the high copper concentrations.
- After 3 months of exposure copper concentrations reached 35.90 mg/L (corresponds to 4420.34mg/m^2)
- The highest copper concentrations were detected in bay water samples compared to other water conditions.

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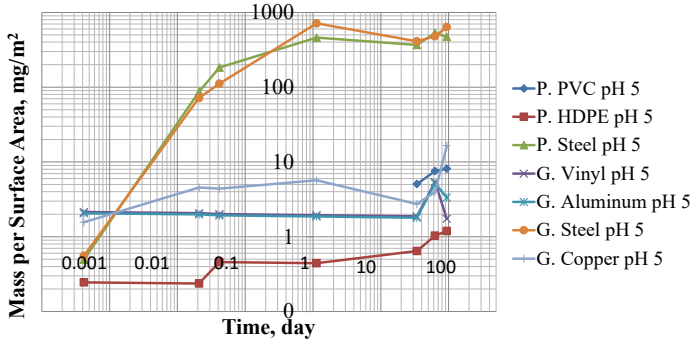
Zinc Mass Release per Surface Area of a Pipe/Gutter in the Containers with pH 5



- The greatest zinc losses were detected for galvanized steel materials
- Copper materials were the second highest source of zinc loss
  - -Reached 0.13 mg/L (16 mg/m^2) after long time exposure
  - -Higher losses at pH 5 compared to pH 8 conditions
- Concrete and Plastic materials were the lowest source of zinc

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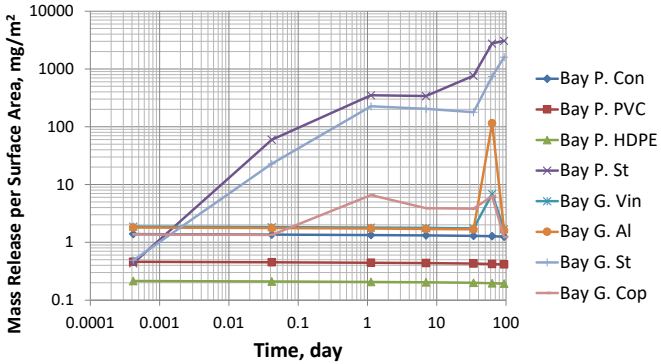
Zinc Mass Release per Surface Area of a Pipe/Gutter for Containers with Bay Water



- Galvanized steel materials had the highest zinc release
  - After 3 months of exposure the zinc concentrations exceeded 78 mg/L (corresponds to 3072.52 mg/m^2).
- Zinc losses were greater under bay water conditions compared to controlled pH 5 conditions.

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2^2 Factorial Analysis

- During the first testing stage to estimate the effects of
  - Exposure time (short and long)
  - pH value (5 and 8)
- During the second testing stage to evaluate the effects of
  - Exposure time (short and long)
  - Salinity (high and low)

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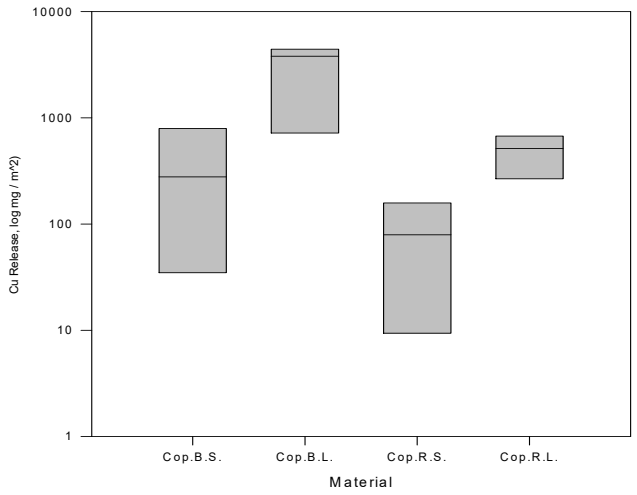
Copper Release. Bay and River Waters



- Long term exposure increases copper loss.

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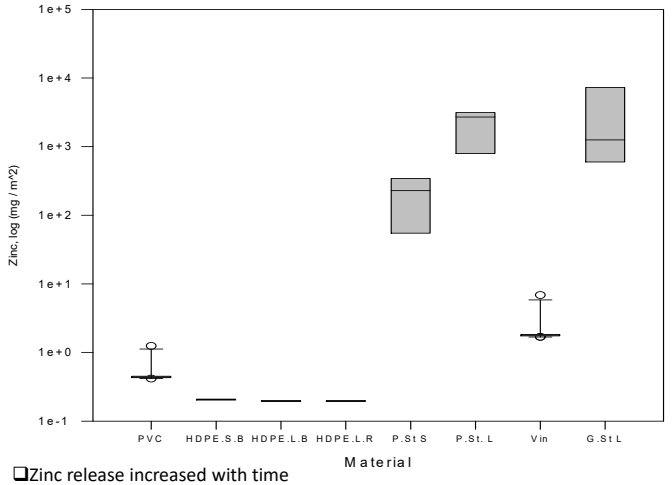
Zinc Release. Bay and River Waters



- Zinc release increased with time
- HDPE pipes were the lowest source of zinc
- No zinc release was detected from concrete pipes

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Regression Analysis

- Regression Analysis was performed to obtain a regression equations to predict the metal release from the exposure time of the material.
- Time series plots of metal releases per pipe surface area vs. time were used.
  - The data was log transformed.
- First Order Polynomial was fitted to the data.

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Conclusions

- Galvanized materials resulted in the highest concentrations of zinc, while copper materials were the highest source of copper.
- Galvanized materials were the only source of lead releases.
- Zinc and lead releases were detected during both short and long exposure.
- During short exposure time copper releases were detected only for copper materials under all water conditions.
- Copper releases from copper gutters increased as pH decreased during the first series of the experiments. During the second series f the experiments copper losses were greater in bay water samples compared to river samples.
- Increase in zinc concentrations was detected during the first day of exposure under all water conditions.
- During short exposure time, zinc releases from galvanized materials were lower in river water samples compared to the bay water samples, however, during long time exposure, zinc concentrations in the river water samples exceeded those in the bay water samples.

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Acknowledgements

- NSF EPSCoR and U.S. Environmental Protection Agency (U.S. EPA)

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