Modeling the photochemical removal of pharmaceutical compounds in planted constructed wetlands

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Introduction: PPCPs

- Pharmaceutical and personal care products (PPCPs) that end up in water systems pose environmental, and health risk.
- Most wastewater treatment plants lack the money and technology to specifically target these compounds using advanced treatment to achieve high level of removal.
- Research work has explored the use of post-polishing of conventional wastewater treatment effluent using various types of constructed wetlands to provide removal beyond conventional removal of PPCPs.

Figure 1: Pharmaceutical and personal care products (PPCPs)

Introduction: Constructed Wetlands

- Constructed wetlands combine multiple mechanisms to transform and remove PPCPs.
  - Direct and *indirect photolysis*
  - Biological removal
  - Adsorption based removal
  - Plant uptake (in case of planted wetlands)
**Figure 2: Schematics depicting photochemical based processes in constructed wetlands**
# Modeling Aspects to Consider

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<th>PPCPs Compound Specific</th>
<th>Wastewater Quality Changes</th>
<th>Reactive Oxygen Species Formation</th>
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Arcata Wastewater Treatment Facility

- For this presentation we focus on the DOC transformation happening within the treatment train as that helps us identify the unique role of planted constructed wetlands
  - Determine how the DOC transformation affects the indirect ROS generation focusing on hydroxyl radicals

Figure 3: Wastewater flow path through the AWWTF
Site Details

- Oxidation pond effluent (OX 4-2)
- Treatment wetland effluent (TW 8-2)
- Chlorination effluent/Enhancement wetland influent (EW 11 influent)
- Enhancement wetland effluents (EW 12, EW 14, and EW 15)

Figure 4: Satellite photo of AWWTF with sampling locations
Some results

Figure 5: BOD$_5$ and DOC concentrations throughout the AWWTF

Figure 6: Dissolved nitrate and phosphate concentrations throughout the AWWTF
Some Results

Figure 7: EEMS throughout the AWWTF. Z axis (color bar) is intensity in cps
Some Results

\[ TA + \cdot OH \rightarrow 2HTA \]

- We saw an interesting effect of the treatment wetland on the hydroxyl radical formation
- Method details in Marty King’s Poster
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<th>Organization of Research</th>
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<tr>
<td>Claire Ingvoldsen</td>
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<td>- DOC Characterization and Modeling Using Fluorescence</td>
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<td>Angel Cortez Ramirez</td>
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<td>- Water quality analysis and process modeling</td>
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<td>Marty King</td>
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<td>- ROS formation experiments</td>
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Acknowledgements and Questions
Acknowledgements

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References:


Environmental Services Department, Andre, et al.. (2020). Arcata Wastewater Treatment Facility Upgrades Project - PROPOSED MITIGATED NEGATIVE DECLARATION AND INITIAL STUDY, City of Arcata, Arcata, CA.


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