**Water Quality Modelling Paper Proposal**

**Larger Goal: *In one sentence describe the overarching goal of this paper. This is not what you will do in the paper, but rather what your vision as a research is.***

* Use real-time control to transform watersheds into a distributed water treatment plants to improve watershed water quality.

**Specific Objective(s) of the Paper: *What exactly will you do in this paper that works towards your larger goal.***

* Build a Python toolbox that works seamlessly with SWMM that offers a flexible, simple way to model any water quality pollutant using any treatment method (PFR, CSTR, etc.) in urban drainage systems.
* Provide several case studies that demonstrate ease of use and the range of modelling possibilities.

**Audience: *Which journal will you submit to? Get a link to their style files now.***

* Environmental Modelling & Software: https://www.elsevier.com/journals/environmental-modelling-and-software/1364-8152/guide-for-authors

**Specific Contribution: *On a scale across (1) “never been done before”, (2) “doing things better”, to (3) “repeating prior work”, where does your paper stand? Be very clear and justify why this paper is important to the boarder advancement of knowledge.***

* ***(1) “never been done before”,*** This toolbox essentially lets one extend SWMM’s capabilities to model pollutant transformations.
* We can model water quality in SWMM, but with limited functionalities. One is currently limited in the types of treatment, build-up, and wash-off equations you can use. In addition, you have to set everything in the SWMM input file and then run it in PySWMM.
* Our Python toolbox provides the ability to run any water quality equation. It computes concentrations for each subcatchment, node, etc. and then sets the new concentration each time step and uses SWMM to route the pollutants. This toolbox is needed to move the research field forward in order to more accurately model water quality with the ultimate goal of improving water quality.
* We are not just contributing the ability to model pollutants; we will show how Python numerical solvers can be used to solve process equations. Hence, enabling researchers to use an ASM-like approach to formulate treatment equations as differential equations, which can then be extended to control as well.

**Potential Paper Titles:**

* An open-source toolbox for modelling water quality in urban drainage systems
* Beyond SWMM: An open-source toolbox for modelling water quality

**Paper Sections:**

* Abstract
* Keywords: open-source toolbox, Python, water quality, real-time control, urban drainage systems
* Introduction
* Structure of WQ Toolbox
* WQ Toolbox Functionalities
* Example Applications
  + Show it can replicate a previous study and then a new application
    - Abhi’s nitrogen model for detention pond (CSTR) (w/ control)
  + Show new applications
    - TSS model w/ resuspension and erosion for detention pond (w/ control)
    - Phosphorus model (from my master’s thesis) for BRC (PFR)(no control)
* Conclusions & Future Work
* Acknowledgments
* References

**List of Figures:**

* Toolbox Configuration

A screenshot of a cell phone

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* WQ algorithm

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* Nitrogen Results: comparing Abhi’s results w/ our toolbox results
* TSS Results: our toolbox results
* Phosphorus Results: our toolbox results

**List of Tables:**

* WQ getters and setters for PySWMM
* WQ other functionalities

**Timeline:**

* WQ Python Toolbox Development – due Jan 31st
  + Pollutant creation, land-use, buildup/washoff set in SWMM for now
  + Determine how it will work
    - Import modules
    - Setup how pollutants will be transformed
      * Treatment
      * Erosion
    - Select solver? Also have default?
    - Set if you want a pollutant tracked
    - Step through the simulation
  + Determine solvers to implement
  + Build library
  + Write up library explanation
* Build/run/test Nitrogen example – due Feb 14th
  + Determine which N species to include
  + Determine if including DO
  + Build based on Abhi’s Matlab model
  + Run/test model for uncontrolled/controlled, compare results with Abhi’s results
  + Write up results
  + Create figure
* Build/run/test TSS example – due Feb 28th
  + Run/test model, compare results from HIC abstract
  + Determine how to model erosion (thinking Universal Soil Loss Equation)
  + Add erosion to model
  + Run/test model for uncontrolled/controlled
  + Write up results
  + Create figure
* Build/run/test Phosphorus example – due March 13th
  + Build based on my master’s thesis model
  + Run/test model and compare results with my previous results
  + Write up results
  + Create figure
* Write draft – due April 10th
  + Write introduction
  + Write conclusions
  + Write abstract
  + Submit to BK, Abhi for feedback
* Submit publication – due May 30th

**Papers to Model My Paper After:**

* Ask Abhi for the ones he found
* Leveraging open source software and parallel computing. For model predictive control of urban drainage systems using EPA-SWMM5 (Sadler et al 2019)

Papers to Cite:

* SWMM as Digital Twin Layer for evaluating control performance with the desired accuracy – used to obtain quality variable estimations at locations where on sensors are available. My toolbox helps with this part. (Real-time control of urban water cycle under cyber-physical systems framework. Sun et al. 2020)
* This also positions hydroinformatics as a cross-cutting field of study that underpins the transition of water authorities and utilities from reactive to proactive by leveraging technological advances to achieve to the so-called Water 4.0 state (also named DigitalWater orWater Informatics) delivering sustainable and resilient water management. (Urban hydroinformatics: past, present, and future. Makropoulos and Savic, 2019)
  + ﻿This is because as urbanization continues to accelerate concentrating ever increasing demands for water services in cities and megacities around the world [7], and as urban water infrastructure is ageing and related investments are lagging behind [8], it is argued that the urban environment urgently needs smarter solutions based on hydroinformatics more than any other domain.