



USEPA's Research for the Storm Water Management Model (SWMM)

Michelle Simon, Ph.D., P.E
United States Environmental Protection Agency
International Conference of Water Management Modeling

February 24, 2021



USEPA's Future Role for the Storm Water Management Model (SWMM)

Michelle Simon

United States Environmental Protection Agency
International Conference of Water Management Modeling
February 28, 2018



Disclaimer

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Introduction

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EPA Point of Contact for SWMM, since 2015

Worked with SWMM since 2010



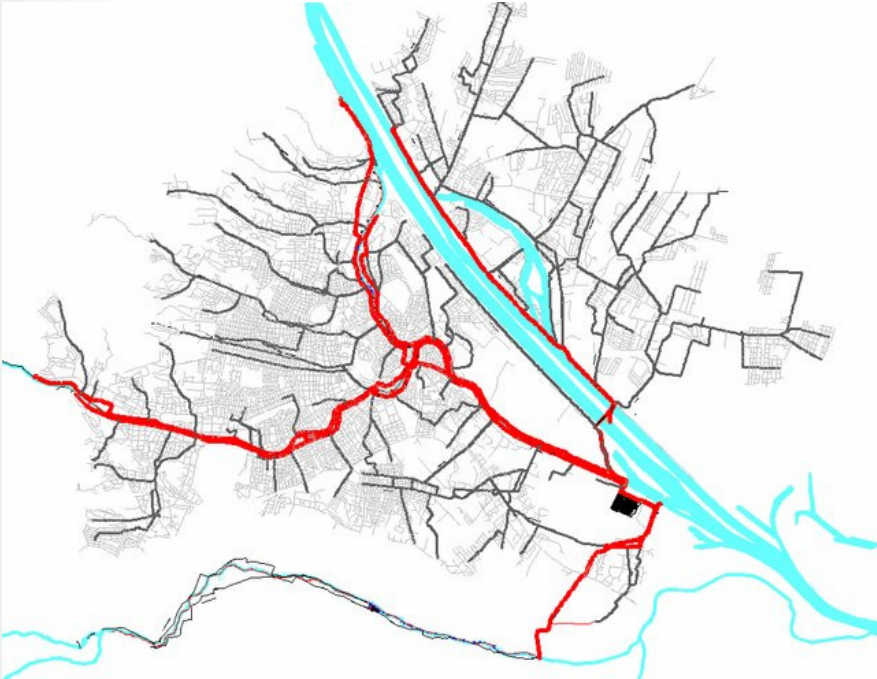


Figure: Fuchs, L. and T. Beeneken. (2004). Development and Implementation of Real-Time Control Strategy for the Sewer System of Vienna City. 6th International Conference on Urban Drainage Modeling – Volume 2

Introduction

Recent Changes EPA's Stormwater Management Model (SWMM)

GUI Interface

CIMM Solver

Open Community Development

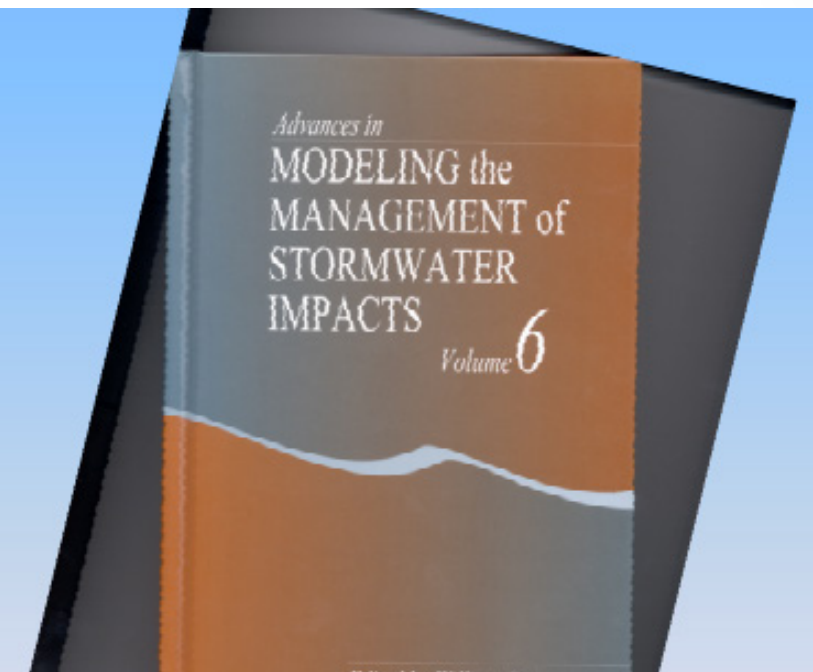
Documentation and Testing

Protocol for EPA Acceptance

Summary



People far more experienced than I



ECI CONFERENCE: FIFTY YEARS OF WATERSHED
MODELING; PAST, PRESENT AND FUTURE

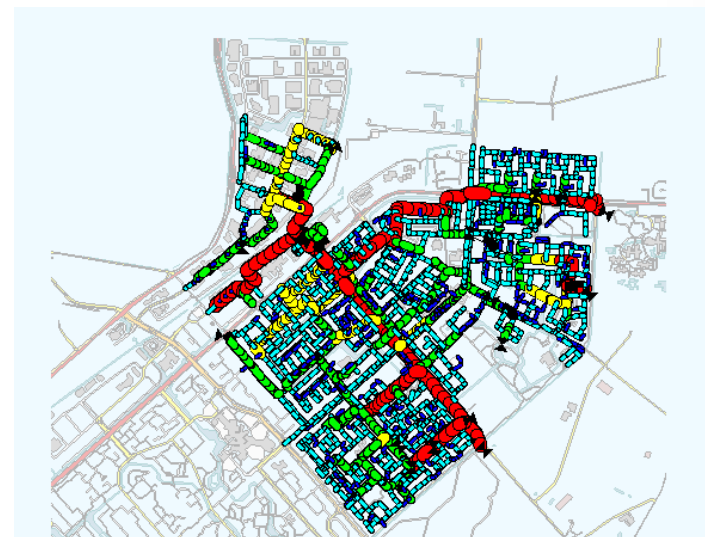
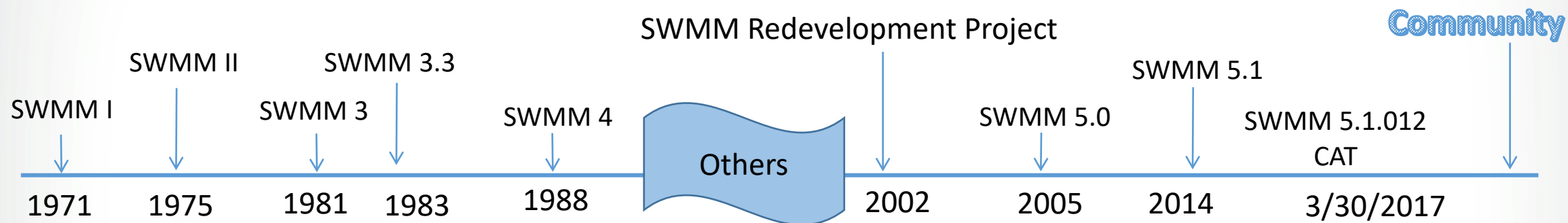
SEPTEMBER 24-26, 2012, BOULDER, CO
CONFERENCE PROGRAM WITH LINKS TO PRESENTATIONS

Bob Dickinson, Rob James, Mitch Heineman, Bill James, Lew Rossman, 2002





History of EPA and SWMM





Why EPA Needs SWMM – CSO, MS4, TMDL, NPDES

Design and sizing of drainage system

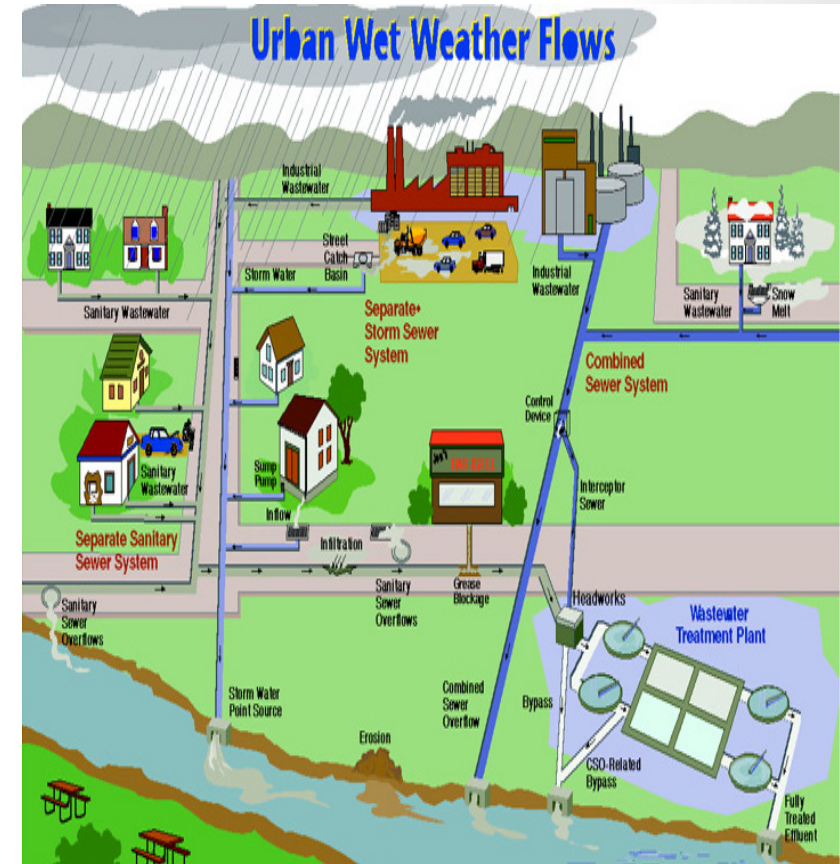
Control of combined and sanitary sewer overflows

Modeling I&I in sanitary sewer systems

Generating non-point source pollutant loadings for waste load allocation studies

Evaluating green infrastructure

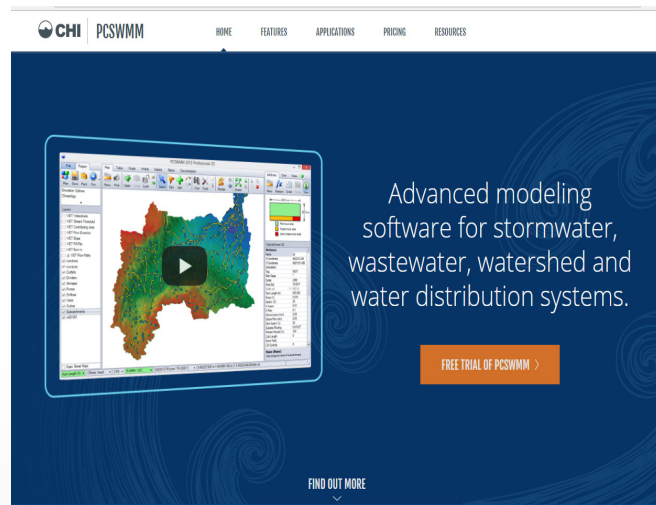
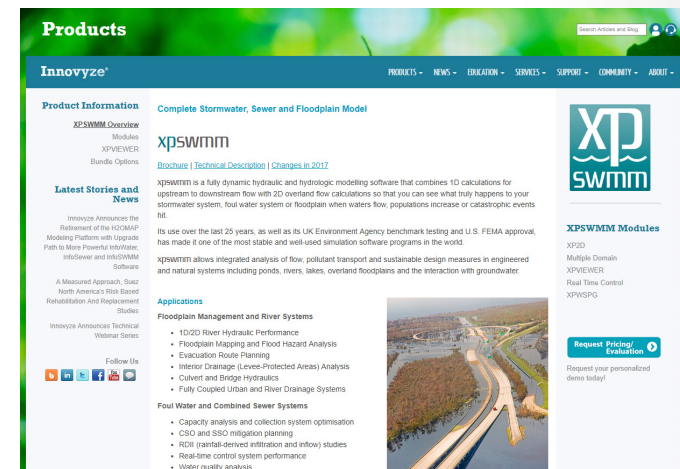
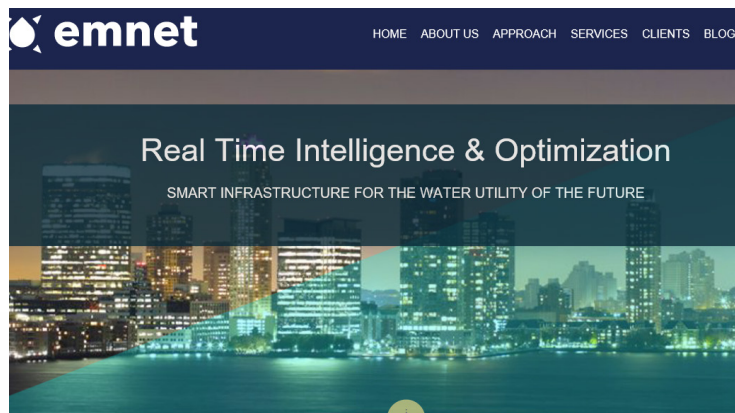
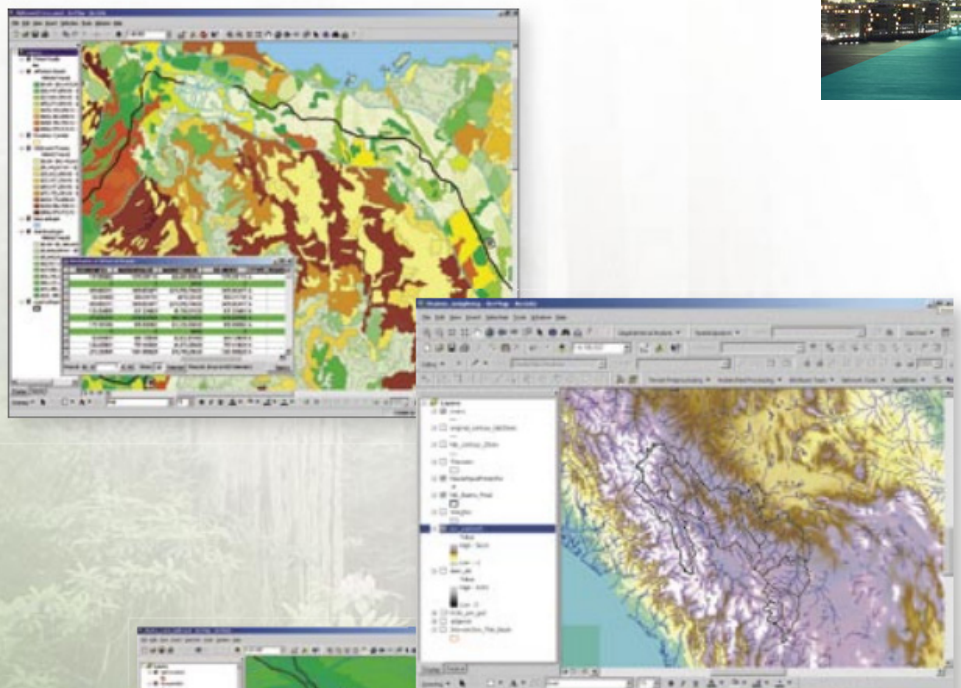
Flood plain mapping of natural channel systems





Stakeholders - >30,000 annual downloads

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**Environmental and
Natural Resources**



Regulators
Communities,
Utilities,
Private industry,
Consultants,
Academia



Recent Changes to SWMM

Epaswmm5_updates.txt

<https://www.openswmm.org/Code>

1. SWMM 5.1.013
Preissman slot
2. SWMM 5.1.014 – significant bug fixes
E.g., soil moisture deficit ignored,
Program crashing when LIDs are present but
no subcatchment
3. SWMM 5.1.015 – features added
Individual Subcatchment Infiltration
Grouped frequency table of routing steps
Delphi 10.3

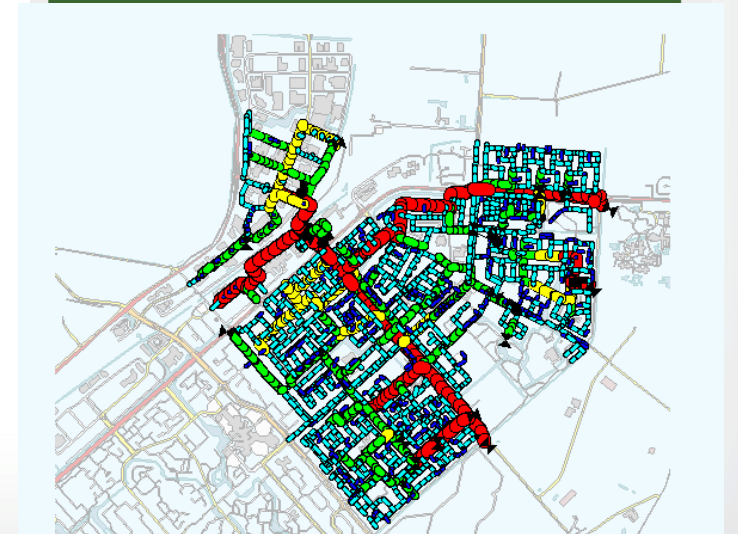
Compare code

EPA SWMM 5.1.015

VS

EPA SWMM 5.1.013

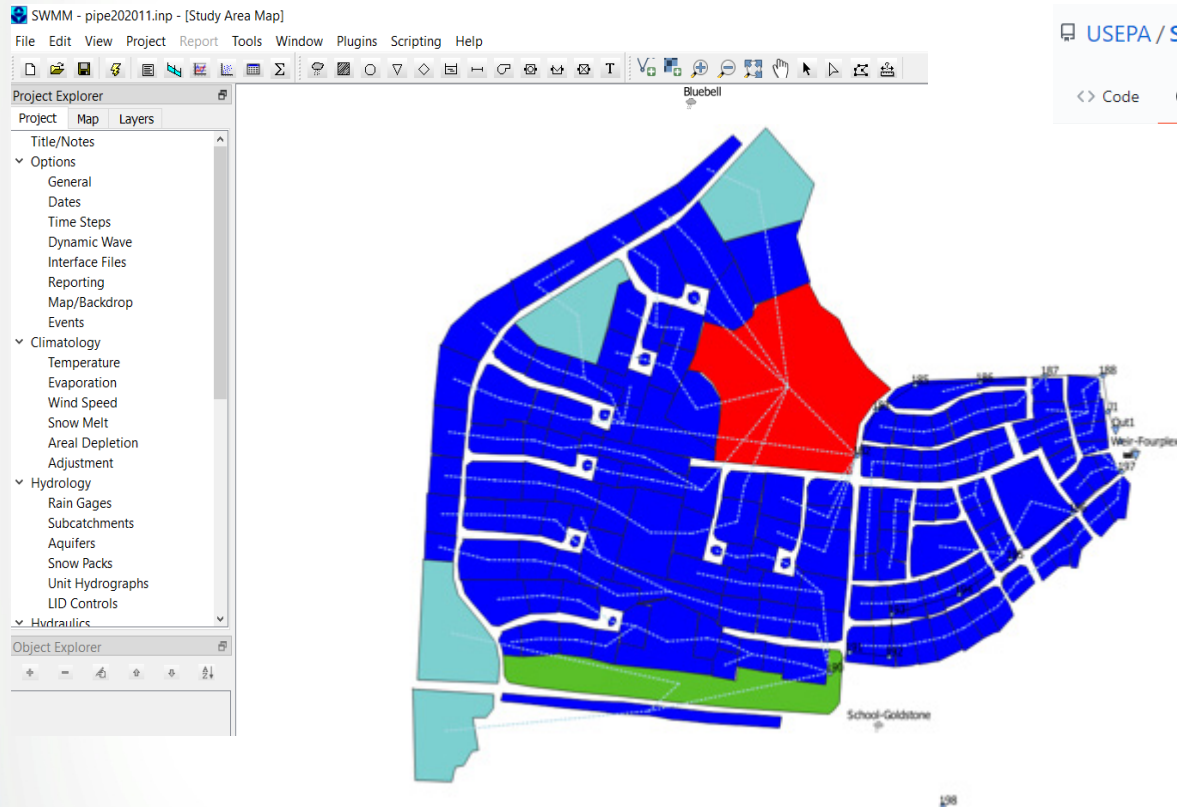
Compare





SWMM GUI

https://github.com/USEPA/SWMM-EPANET_User_Interface



USEPA / SWMM-EPANET_User_Interface

<> Code ⓘ Issues 19 🔗 Pull requests 1 🔄 Actions 📁 Projects 📖 Wiki 🛡 Security 📊 Insights

Filters 🔽 🔍 is:issue is:open

☐ ⓘ 19 Open ✓ 333 Closed

Author ▾

☐ ⓘ Handle SWMM simulation error more smoothly

#410 opened on Mar 11, 2020 by barrc

☐ ⓘ It is not clear how to add SWMM-CAT and SSOAP Tools

#406 opened on Mar 2, 2020 by michelleannesimon

☐ ⓘ Path information for recently opened files enhancement

#401 opened on Feb 26, 2020 by MitchHeineman

☐ ⓘ Edit | Copy and Edit | Find Object menu items and tools missing

#375 opened on Feb 5, 2020 by MitchHeineman

☐ ⓘ Some quotation symbols stripped from comment lines

#373 opened on Feb 5, 2020 by MitchHeineman

☐ ⓘ No common general file enhancement swmm

#312 opened on Sep 19, 2019 by michelleannesimon

☐ ⓘ Cannot right-click on elements and adjust properties enhancement swmm

#307 opened on Sep 9, 2019 by michelleannesimon

☐ ⓘ Add ability to customize landing screen enhancement swmm

#302 opened on Sep 9, 2019 by michelleannesimon

<https://www.cimm.org/>



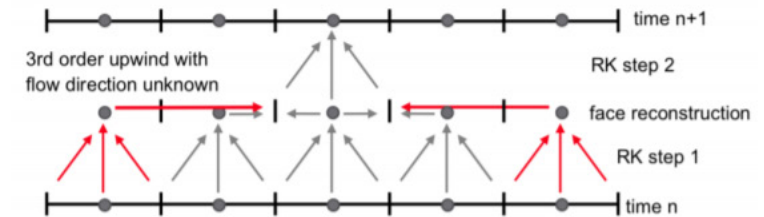
Center for Infrastructure Modeling and Management

FULL SITE COMING SOON!

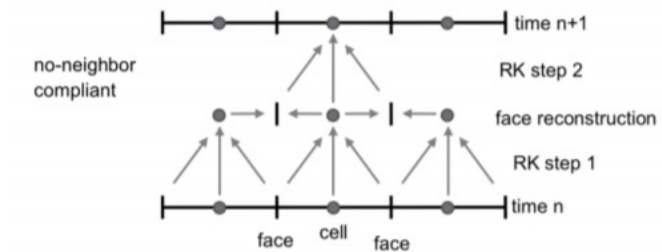
[Learn More About CIMM and NCIMM](#)

More cells require more data communication

3rd order
with
RK2



2nd order
with
RK2





<https://github.com/OpenWaterAnalytics/Stormwater-Management-Model>

OpenWaterAnalytics / Stormwater-Management-Model

forked from USEPA/Stormwater-Management-Model

Unwatch

<> Code ⓘ Issues 46 🔗 Pull requests 4 ⌂ Actions 📁 Projects 4 📖 Wiki 🛡 Security 📊 Insights

develop 16 branches 17 tags

Go to file

Add file

Code

This branch is 1000 commits ahead, 171 commits behind USEPA:develop.

Pull request Compare

michaeltryby Merge pull request #317 from OpenWaterAnalytics/master ✓ 84f2994 on Dec 22, 2020 1,053 commits

.github/workflows	Update build-test.yml	last month
ci-tools @ a3d6d55	Updating ci-tools	last month
docs	Work in progress	2 months ago
extern	Refactoring build system	7 months ago
src	swmm-output rolling back void * pointer to handle	2 months ago
tests	Updating header notes	last month
.gitignore	Updating	7 months ago
.gitmodules	Migrating submodule to OWA/ci-tools	7 months ago
AUTHORS	Update authors email	last month
CMakeLists.txt	Add LICENSE and AUTHORS to install	last month
LICENSE	Updating LICENSE file	last month
README.md	Trigger build and test	last month
ReleaseNotes.md	Updating header notes	last month

About

Open Water Analytics Stormwater Management Model repository

toolkit modeling hydrology hydraulics stormwater swmm5

Readme

View license

Releases 17

OWA SWMM v5.1.13 Latest 10 days ago

+ 16 releases

Packages

No packages published

Languages

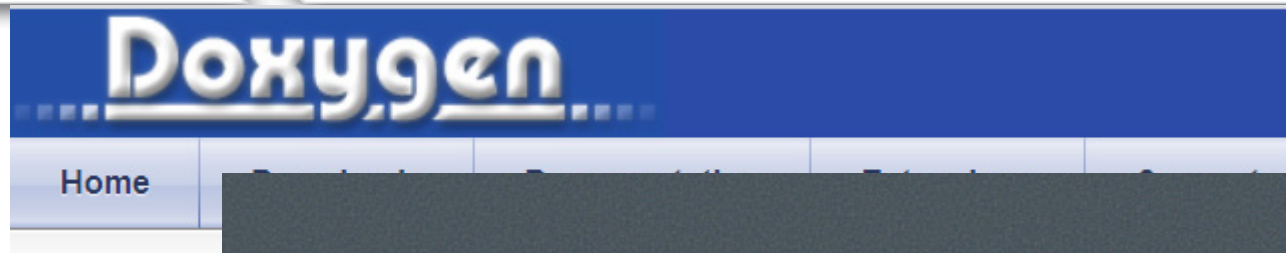
C 84.4% C++ 15.0% Other 0.6%

Tryby.michael@epa.gov



Documentation

Doxygen



Read the docs



Read the Docs

Create, host, and browse documentation.

User Manuals and
Reference Manuals

**Storm Water Management Model
Reference Manual**
Volume I – Hydrology (Revised)



GitHub Actions

Unit Testing

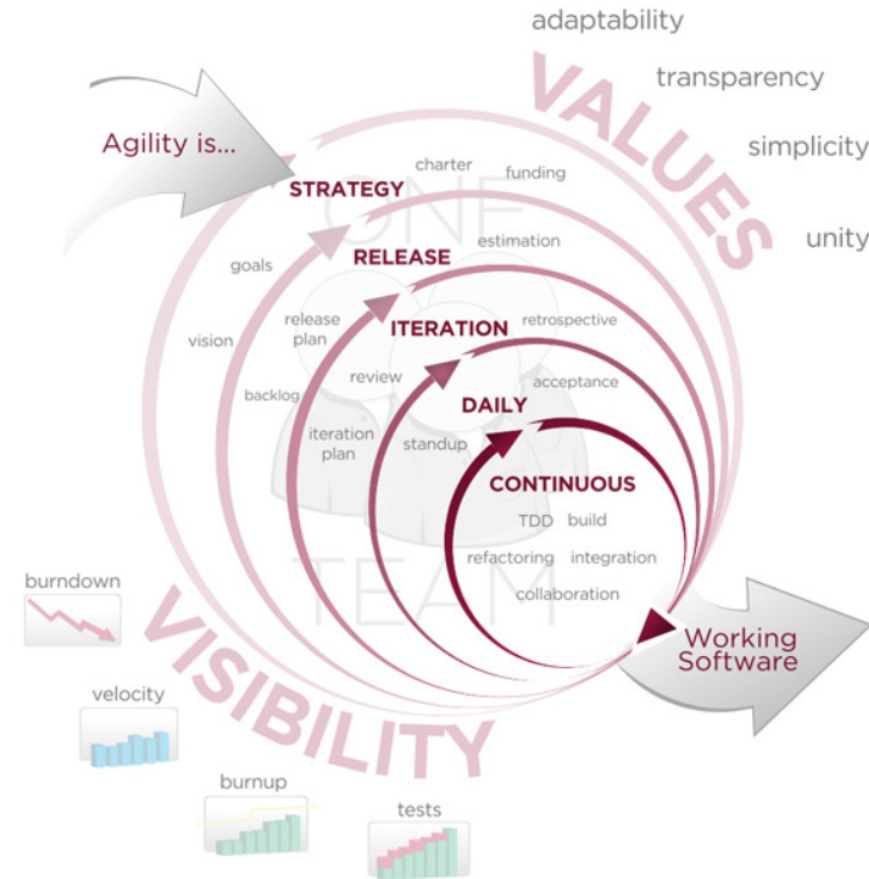
Regression Testing

EPA Internal Testing

CHI Water Testing

Metamorphic Testing

<https://agileinsights.wordpress.com/tag/agile-development/>





USEPA GitHub Action

<https://github.com/USEPA/Stormwater-Management-Model/actions>

USEPA / Stormwater-Management-Model

Watch

<> Code

! Issues 24

🔗 Pull requests

▶ Actions

📁 Projects

📖 Wiki

🛡 Security

📊 Insights

Workflows

All workflows

🔗 Build and Test

All workflows

Filter workflows

83 results

Event

Status

Branch

Actor

✓ Merge pull request #64 from SWMM-Project/epa-devel...
Build and Test #72: Commit 3596f5e pushed by michaeltryby

develop

📅 5 months ago
🕒 5m 12s

...

✓ Merging develop <-- master
Build and Test #71: Pull request #64 opened by michaeltryby

SWMM-Project:epa-develop

📅 5 months ago
🕒 5m 12s

...

✓ Processing update swmm v5.1.15 (#61) In addition to im...
Build and Test #70: Commit afbb518 pushed by michaeltryby

master

📅 5 months ago
🕒 4m 49s

...

tryby.michael@epa.gov

Discovering Metamorphic Relations from OpenSWMM

Xuanyi Lin¹ (linx7@mail.uc.edu), Michelle Simon²,
Zedong Peng¹, Nan Niu¹



Department of
Electrical Engineering
& Computer Science

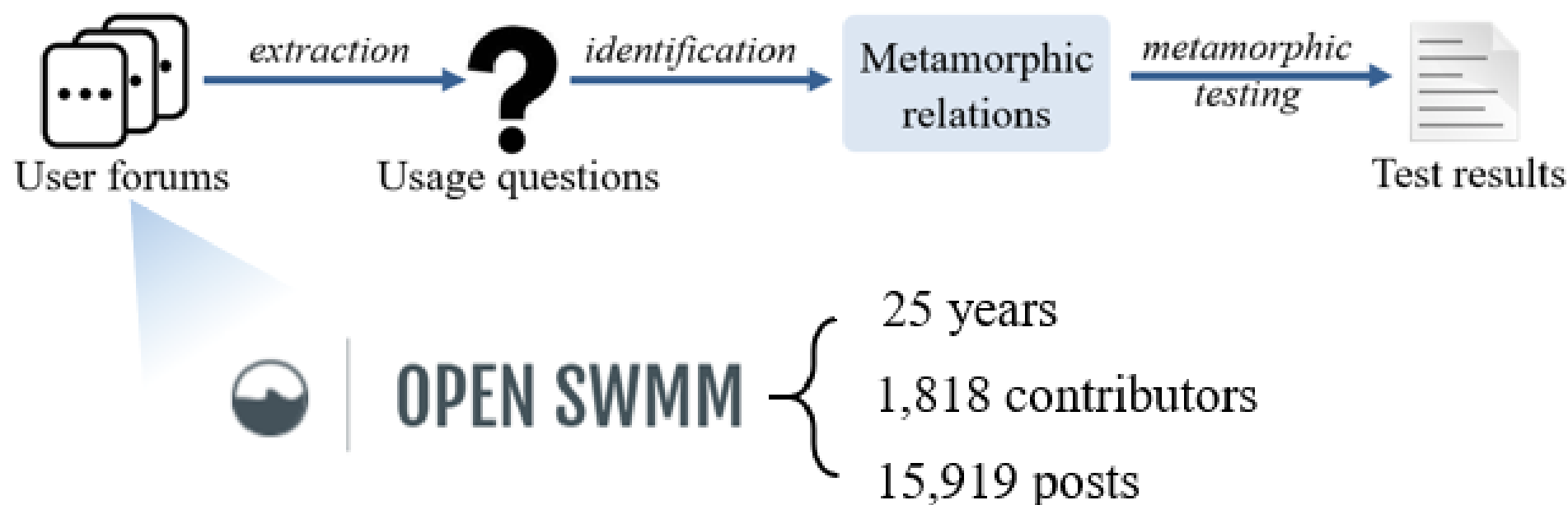


Water
Infrastructure
Division

February 25, 2020

User forum analysis

- Use the user forums as sources and explore the identification of metamorphic relations from them.





References for UC Work

- Xuanyi. Lin, Michelle Simon, Zedong Peng, and Nan Niu. (2021). Discovering Metamorphic Relations for Scientific Software from User Forums.” *Computing in Science and Engineering*
- Zedong Peng, Xuanyi. Lin, Michelle Simon, and Nan Niu. (2020). “Unit and Regression Tests of Scientific Software: A Study on SWMM?” invited paper submitted to a special issue of *Journal of Computational Science*.
- Xuanyi. Lin, Michelle Simon, and Nan Niu. (2020). “Scientific Software Testing Goes Serverless: Creating and Invoking Metamorphic Functions.” Xuanyi Lin, Michelle Simon, Nan Niu submitted to a special issue of *IEEE Software*.
- Xuanyi Lin, Michelle Simon, Nan Niu (2018). “Exploratory Metamorphic Testing for Scientific Software.” [*Computing in Science and Engineering*](#). DOI: [10.1109/MCSE.2018.2880577](https://doi.org/10.1109/MCSE.2018.2880577)
- Xuanyi Lin, Michelle Simon, Nan Niu (2018). “Hierarchical Metamorphic Relations for Testing Scientific Software.” *Journal of the ACM*, 1(1) Article 1.



CHI Report

Compare SWMM5 results from different engine

SWMM5 input files (11):

- G:\Model list\Sample\2D Model.inp
- G:\Model list\Sample\Ellenvale_MD.inp
- G:\Model list\Sample\Mine Control Rules.inp
- G:\Model list\Sample\Mississauga Road with LIDs.inp
- G:\Model list\Sample\OldsCollege.inp
- G:\Model list\Sample\Sandlundlu River.inp
- G:\Model list\Sample\Valleyfield to be water quality.inp
- G:\Model list\Sample\Valleyfield to-be - 5 year.inp
- G:\Model list\Sample\Valleyfield to-be dual system .inp
- G:\Model list\Sample\Valleyfield to-be pond.inp
- G:\Model list\Sample\Valleyfield_sanitary.inp

Add files... Add folder... Remove

Compare SWMM 5.1.013 with SWMM 5.1.014

☒ Compare SWMM5 report file

Time limits for SWMM5 run: 5 minutes

Temp folder: G:\Model list\Sample Browse...

- Same results
- Different report
- Different output
- Both different
- Over limits
- Error to run
- File not found
- Unknown



Protocol for Acceptance

1. Developer debugging and testing

2. GitHub PR Actions

3. Documentation

4. EPA Testing

6. CHI Testing

7. <https://www.epa.gov/water-research/storm-water-management-model-swmm>

USEPA / Stormwater-Management-Model

<> Code 24 Issues Pull requests Actions Projects Wiki Security Insights

develop 5 branches 16 tags Go to file Add file Code

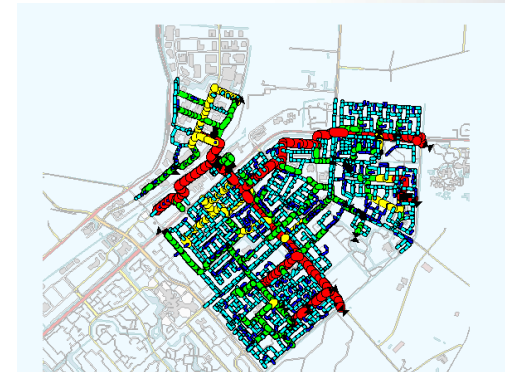
michaeltryby Merge pull request #64 from SWMM-Project/epa-develop 3596f5e on Sep 10, 2020 224 commits

.github/workflows	Processing update swmm v5.1.15 (#61)	5 months ago
bindings	Work in progress	11 months ago
extern	Work in progress	8 months ago
src	Merging develop <-- master	5 months ago
tests	Processing update swmm v5.1.15 (#61)	5 months ago
.gitignore	Work in progress	8 months ago
Build.md	Processing update swmm v5.1.15 (#61)	5 months ago
CMakeLists.txt	Processing update swmm v5.1.15 (#61)	5 months ago
README.md	Update README.md	8 months ago
ReleaseNotes.txt	Processing update swmm v5.1.15 (#61)	5 months ago



EPA – Curator of SWMM Code

- Contribute to improving scientific aspects of SWMM
- Cooperative Agreement with CIMM
- Work with Stakeholder community
- Assist where possible with testing and ground-truthing of SWMM's numerical models and other software
- Publish an Official Version of SWMM



<https://www.epa.gov/water-research/storm-water-management-model-swmm>



Thank-you

<https://github.com/USEPA/Stormwater-Management-Model>



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simon.michelle@epa.gov

<https://www.epa.gov/water-research/storm-water-management-model-swmm>



<https://www.openswmm.org/>

 OPEN SWMM

KNOWLEDGECODERESEARCHRESOURCES





Expand your knowledge of SWMM with the people who know it best: its users, developers and innovators.

Find and share solutions.

SWMM KNOWLEDGE BASE >

An easy-to-search knowledge center for EPA SWMM users that has 25 years of shared knowledge, more than 1,500 contributors and over 13,000 posts.

Understand your engine.

SWMM CODE VIEWER >

Browse the SWMM source code in an engineer-friendly way. View and share comments, solutions, modifications and suggestions for improvement.

View and share research.

RESEARCH PROJECTS >

Announce your project and engage the community in your research. Explore ongoing research projects and join in discussions with project teams.

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