

Sadržaj

- **UVOD – šta je EPA, SWMM...**
 - **MODELIRANJE i SWMM...**
 - **SWMM – Download, Literatura...**
 - **SWMM – Prednosti i mane**
 - **Drugi dostupan software**
 - **SWMM – Radno okruženje**
 - **Unos objekata i pokretanje simulacije**
-

EPA?

EPA - Environmental Protection Agency



<http://www.epa.gov/>

- Agencija se bavi problemima:
 - Zaštite vode, vazduha i zemljišta od zagađenja
 - Klimatskih promena
 - „Greener Living“
 - Otpada
- Aktivnosti Agencije podrazumevaju:
 - Razvijanje standarda i propisa
 - Finansiranje različitih projekata za rešavanje prethodno navedenih problema
 - Naučno istraživački rad



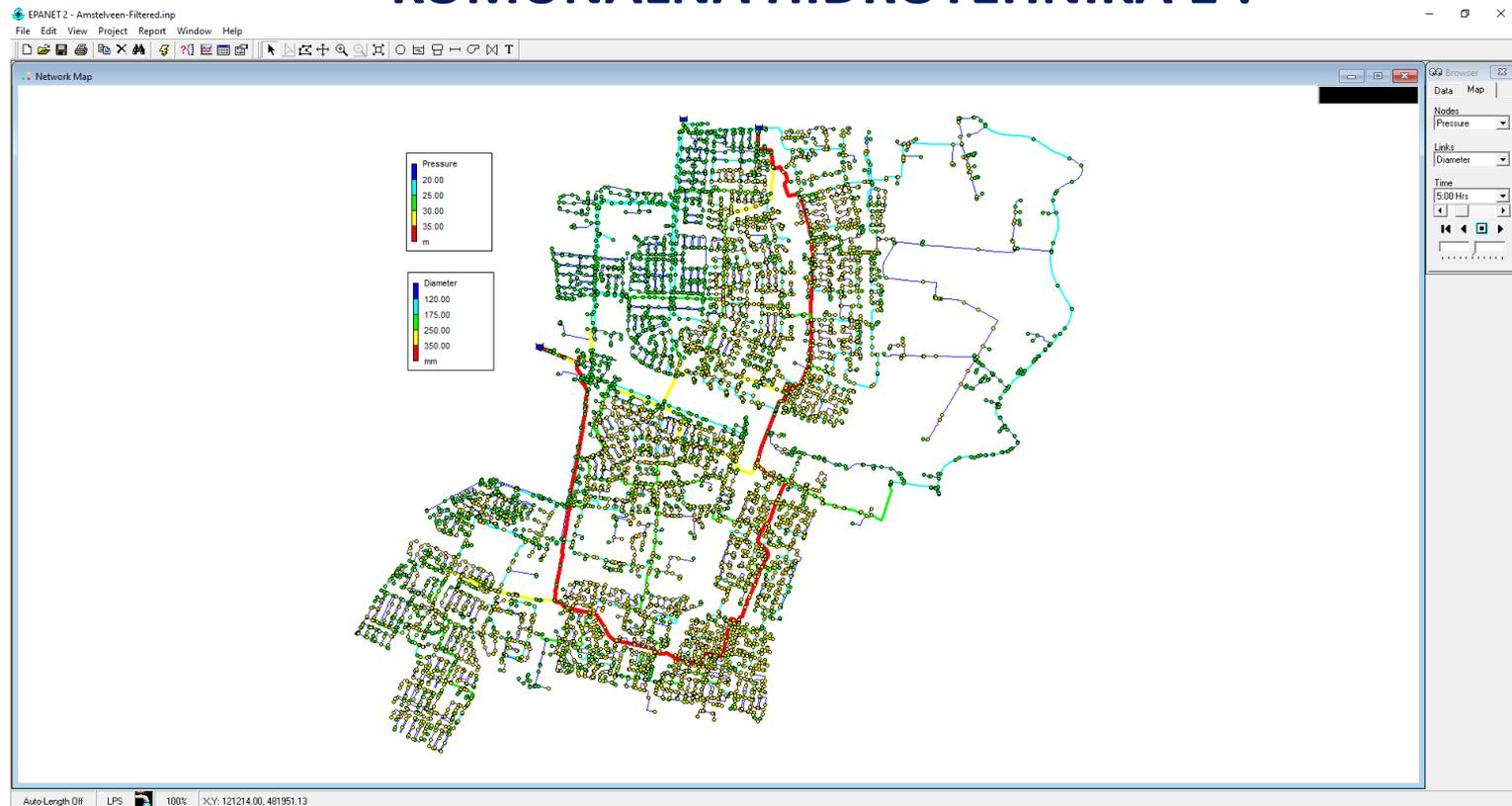
EPA...

- EPA – EPANET

Modelira distributivnu mrežu pod pritiskom

Hidrauličko modeliranje + Modeliranje kvaliteta vode

KOMUNALNA HIDROTEHNIKA 1 !



EPA SWMM 5.1?

SWMM (*Storm Water Management Model*) je **distributivni dinamički model** za simulaciju padavina i oticaja koji se koristi za pojedinačne epizode ili dugotrajne (kontinualne) simulacije **kvantiteta i kvaliteta oticaja**, pre svega u **urbanim sredinama**.

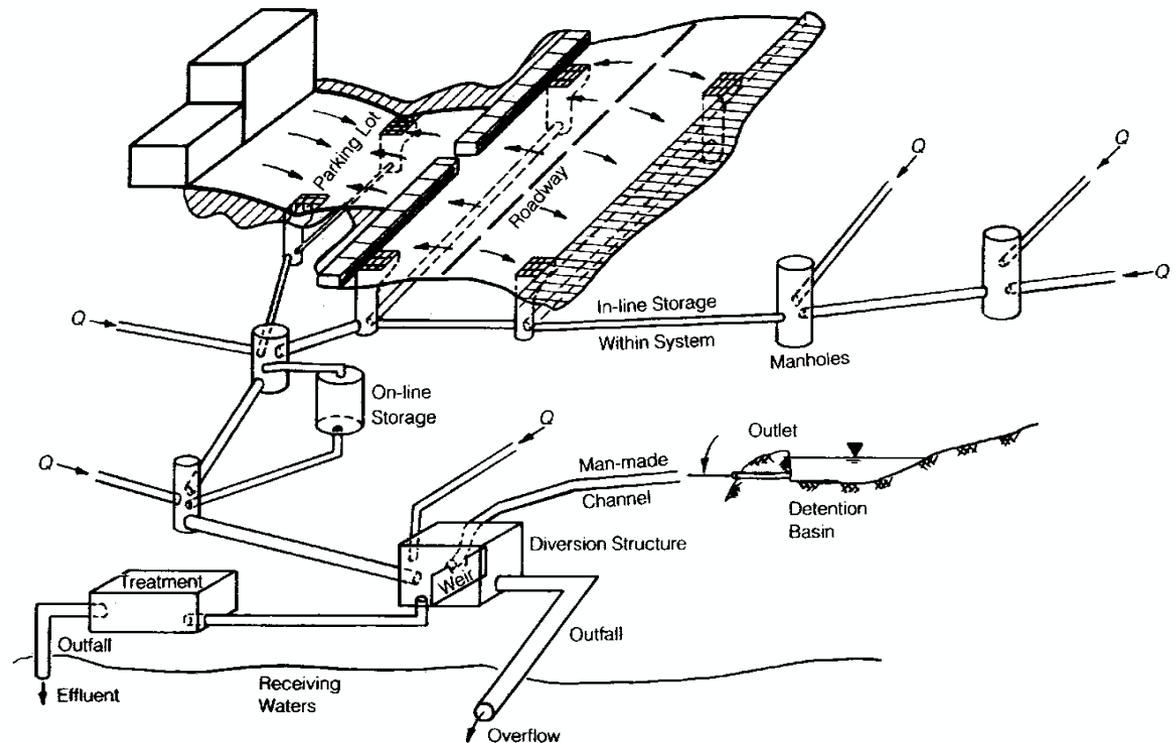
Hidrologija

+

Hidraulika

+

Kvalitet



Model?



model

Google Search

I'm Feeling Lucky

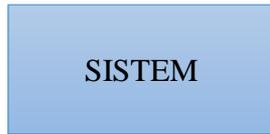


???

MODEL

Na predavanjima....

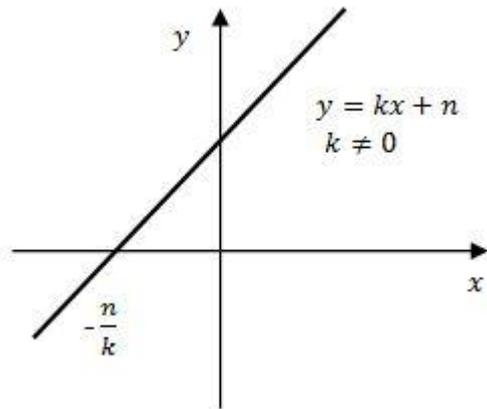
ULAZ



IZLAZ



1. Matematički modeli



2. Fizički modeli



Sources: npl.co.uk



Modeliranje i SWMM?

SWMM MODEL

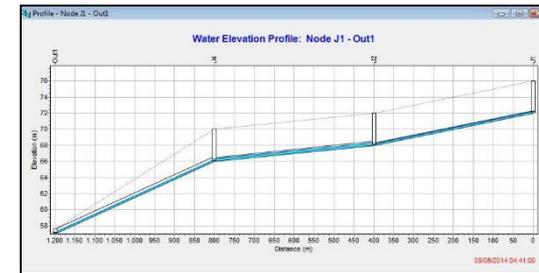
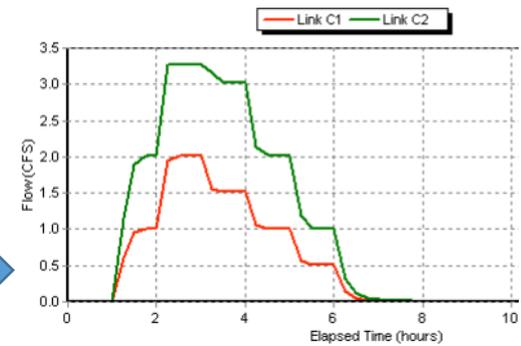
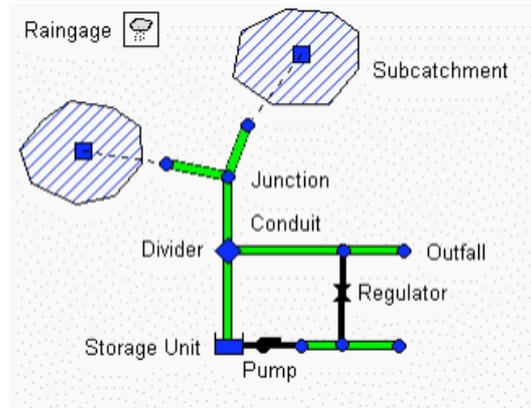
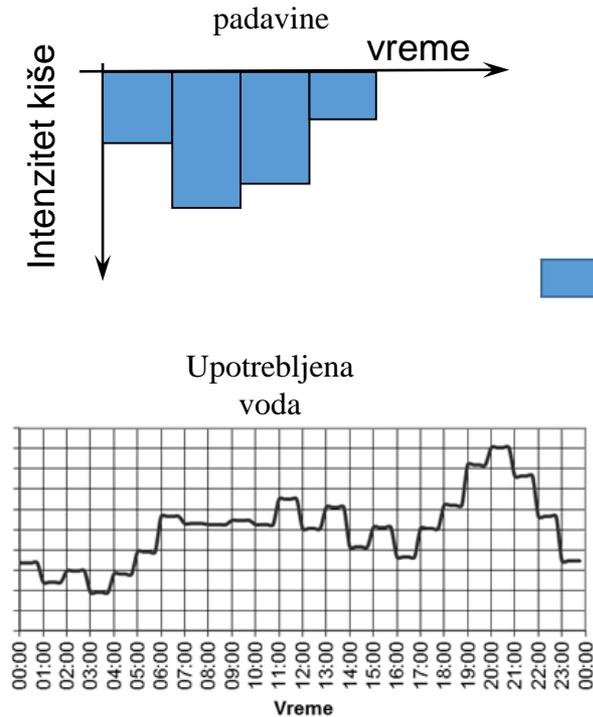
PADAVINE +
UPOTREBLJENA VODA
(ulaz)



MODEL
(Sliv+Kan.Mreža)



OTICAJ +
PROTOK U MREŽI
(izlaz)

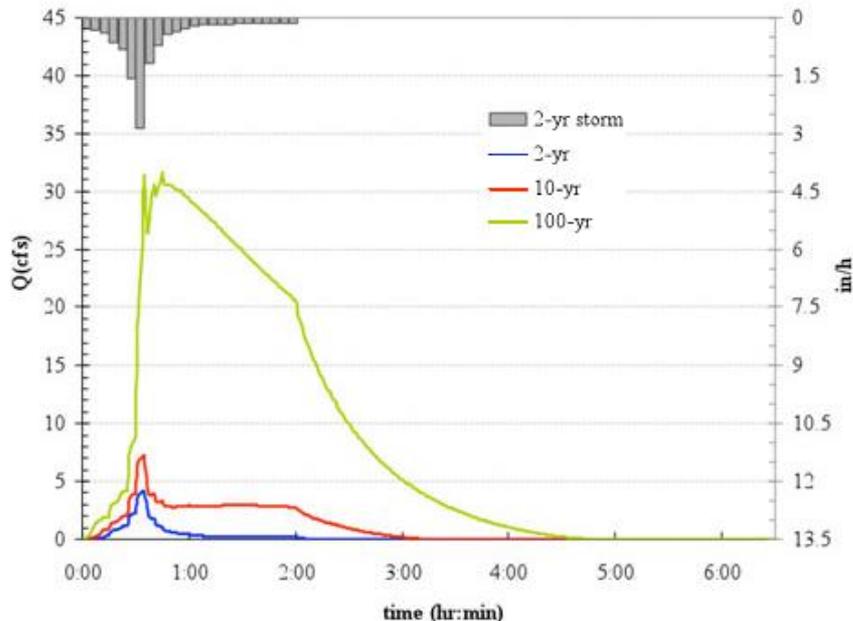


Modeliranje i SWMM...

Zašto modelirati, odnosno zašto praviti model (kanalizacione mreže)?

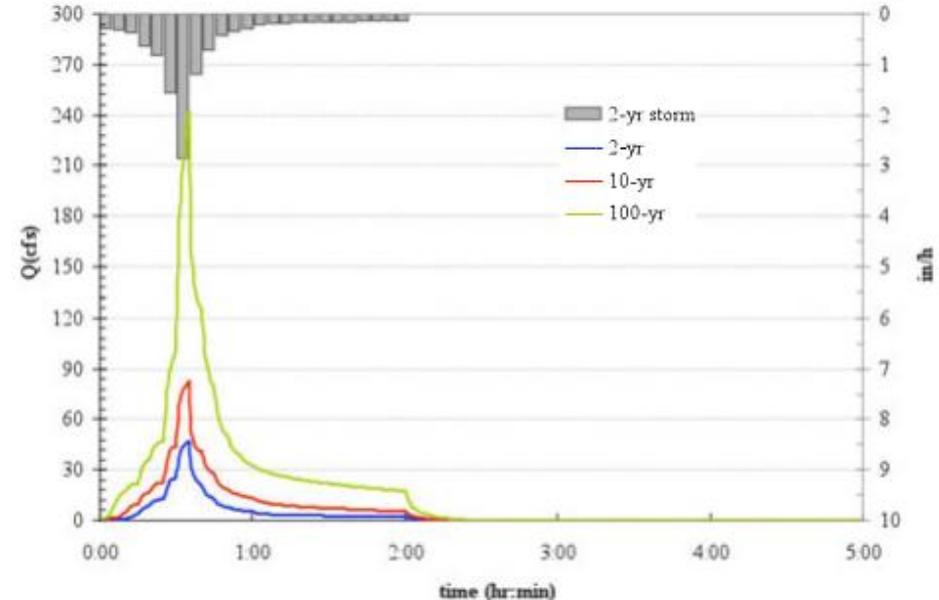
- Analiza stanja i rada postojećeg sistema
- Sagledavanje različitih uticaja na količinu i kvalitet oticaja
- Analiza različitih varijantnih rešenja prilikom projektovanja

Sliv pre urbanizacije



Sources: swmm spplications manual

Sliv nakon urbanizacije



Šema modeliranja u SWMM-u

Zona atmosfere

Padavine se izlučuju na površinu zemljišta.

Zona površine zemljišta

Modeliraju se važni hidrološki procesi. (Gubici vode pri padavinama, Površinski oticaj)

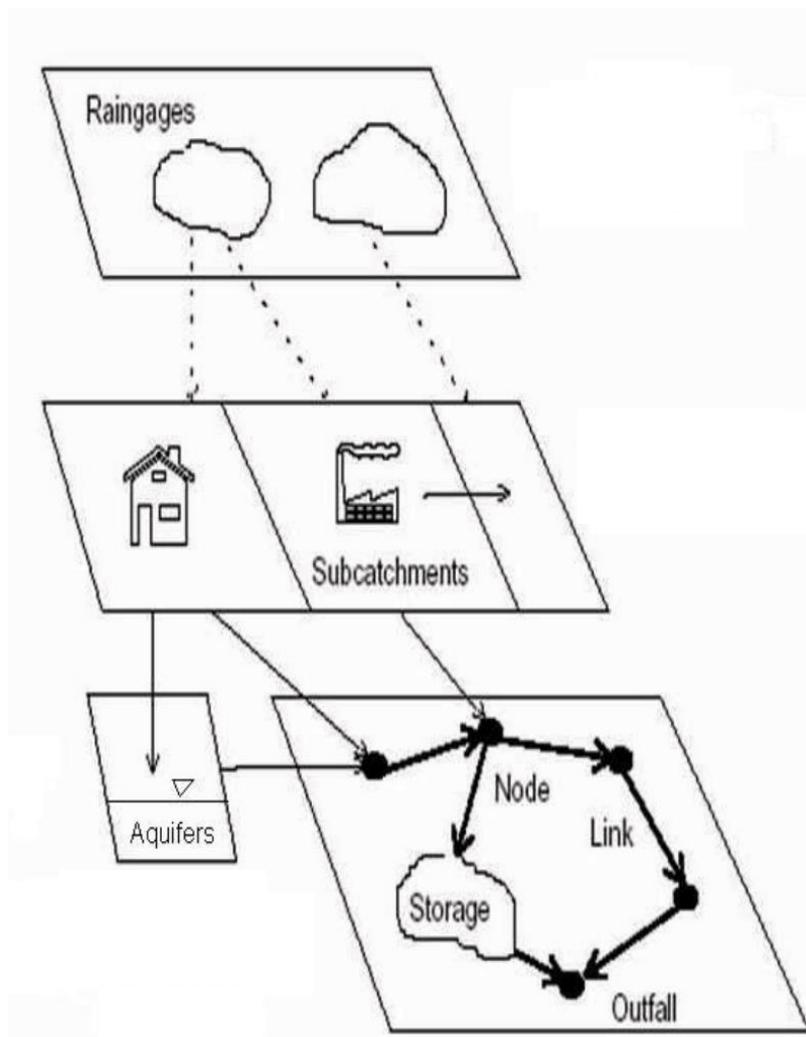
Zona podzemnih voda

Prima infiltriranu vodu iz zone površine zemljišta.

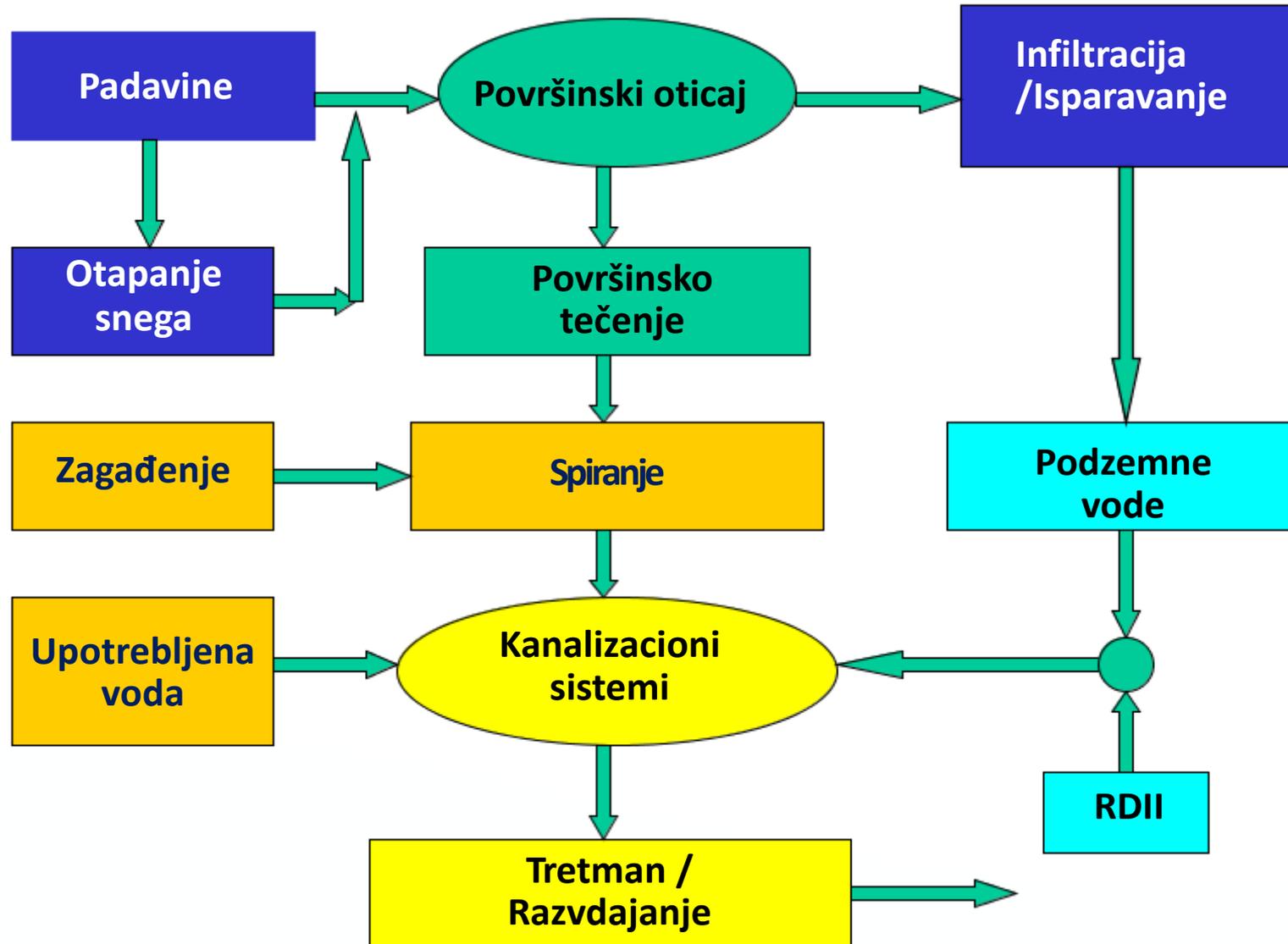
Zona transporta

Mreža povezanih elemenata: kanala, cevi, šahtova...

Koristi čvorove i mreže u poretku u kome su prikazani u mreži.



Procesi koji se modeliraju u SWMM-u



EPA SWMM 5.1 – download

Svi materijali na linku:

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

An official website of the United States government.

We've made some changes to EPA.gov. If the information you are looking for is not here, you may be able to find it on the EPA Web Archive or the January 19, 2017 Web Snapshot. [Close](#) X

EPA United States Environmental Protection Agency

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Storm Water Management Model (SWMM)

Helps predict runoff quantity and quality from drainage systems

EPA's Stormwater Management Model (SWMM) is used throughout the world for planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems. It can be used to evaluate gray infrastructure stormwater control strategies, such as pipes and storm drains, and is a useful tool for creating cost-effective green/gray hybrid stormwater control solutions. SWMM was developed to help support local, state, and national stormwater management objectives to reduce runoff through infiltration and retention, and help to reduce discharges that cause impairment of waterbodies.



Fact Sheet: [Storm Water Management Model](#)

Software and Compatibility Capabilities Applications LID Controls Technical Support Resources

Software, Compatibility, and User's Guides and other Documents

SWMM is a Windows-based desktop program. It is open source public software and is free for use worldwide. SWMM 5 was produced in a joint development effort with CDM, Inc., a global consulting, engineering, construction, and operations firm.

Date	Description
08/09/2018	Self-Extracting Installation Program for SWMM 5.1.013 (EXE) (31 MB)
12/11/2014	SWMM-CAT Download Version 1 (4 MB)
05/25/2005	Utility for converting SWMM 4 data files to SWMM 5 files (EXE) Version 1.2 (2 MB)

EPA SWMM 5.1 – download

Svi materijali na linku:

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Fact Sheet: Storm Water Management Model

Software and Compatibility

Capabilities

Applications

LID Controls

Technical Support

Resources

Software, Compatibility, and User's Guides and Other Documents

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EPA SWMM 5.1 – download...

Software, Compatibility, and User's Guides and other Documents

1	08/09/2018	Self-Extracting Installation Program for SWMM 5.1.013 (EXE) (31 MB)
2	09/30/2015	SWMM 5.1 User's Manual
3	09/07/2016	SWMM Applications Manual (ZIP) (7 MB)

1. Instalacioni fajl ...
 2. Uputstvo za upotrebu sa jednostavnim primerom (PDF)
 3. Realni primeri - uticaj urbanizacije, različiti nivoi detaljnsti, dimenzionisanje retenzije, BMPs, LIDs... – (PDF i potrebni fajlovi)
-

EPA SWMM 5.1 – literatura

Građevinski fakultet Univerziteta u Beogradu

**PRIMENA PROGRAMSKOG PAKETA SWMM
ZA MODELIRANJE OTICAJA
SA URBANIH SLIVOVA**

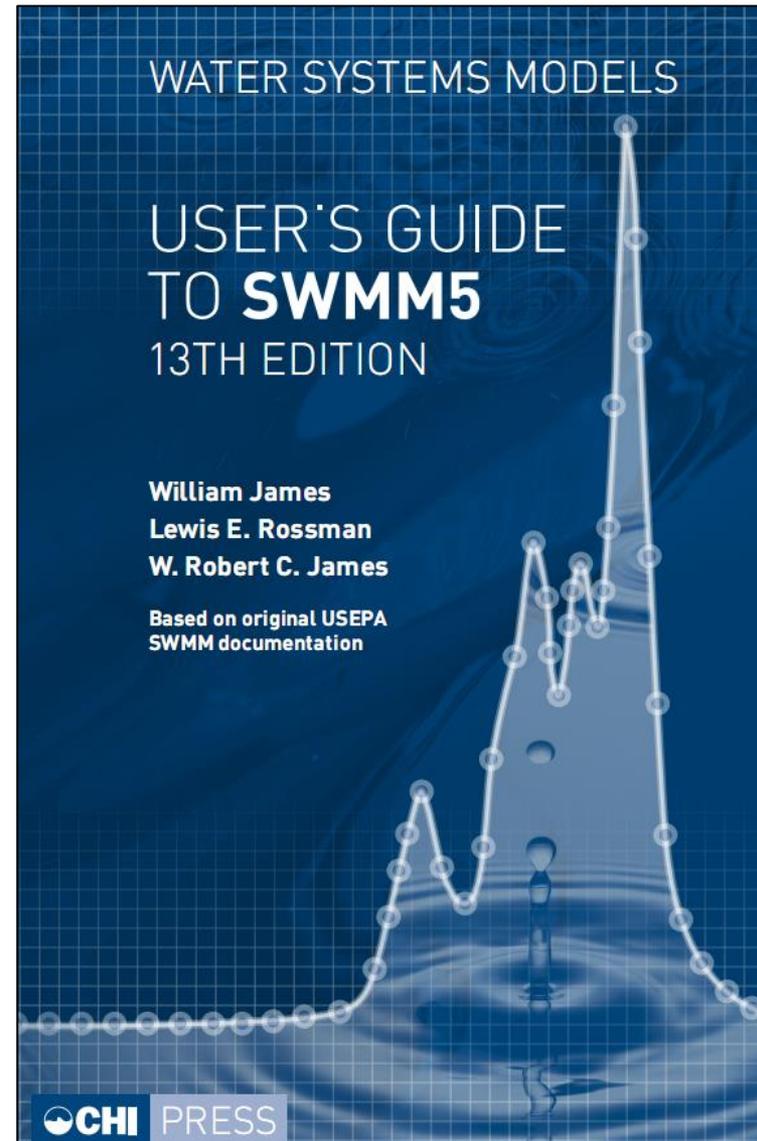
seminarski rad
iz predmeta

PARAMETARSKA HIDROLOGIJA

autor:
Ana Mijić

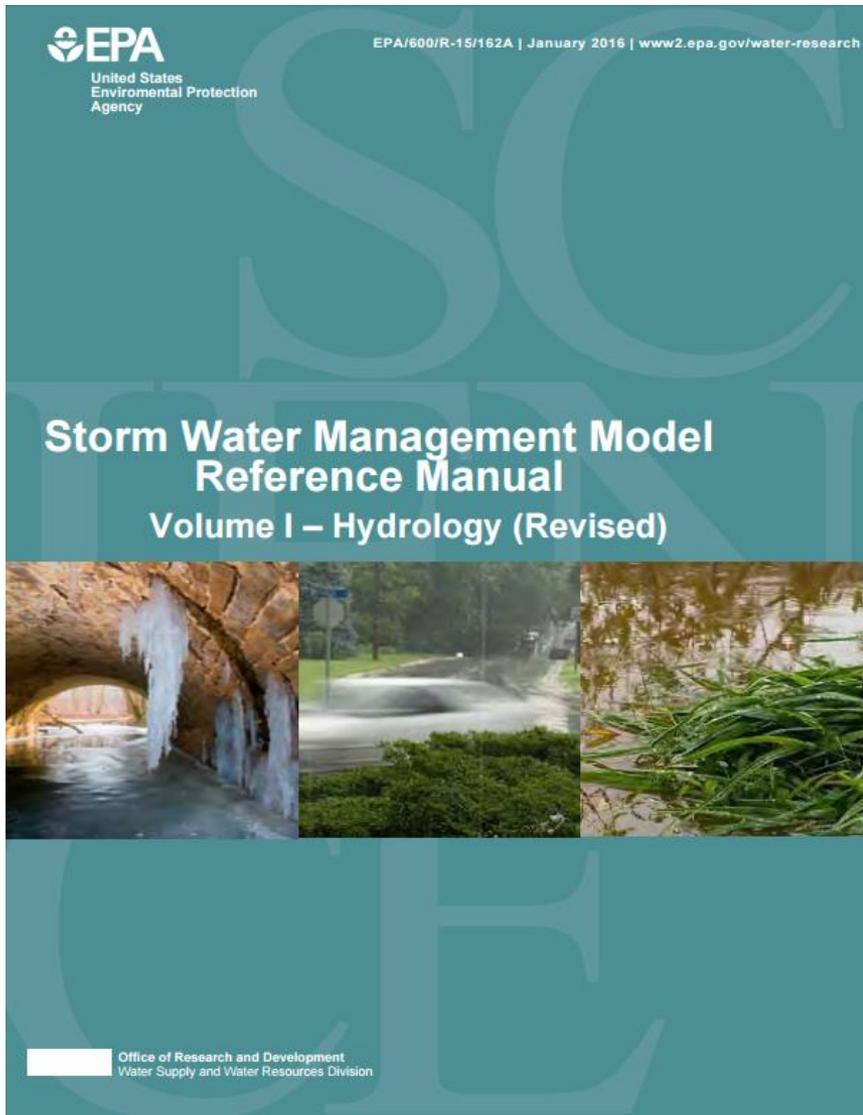
predmetni nastavnik:
Doc. dr Zoran Radić

Beograd, april 2006. godine



EPA SWMM 5.1 – literatura

01/29/2016 [Storm Water Management Model Reference Manual Volume 1 - Hydrology \(PDF\)](#) (235 pp, 3.8 MB) January 2016
Revised, EPA No. 600/R-15/162A.



EPA/600/R-15/162A
Revised January 2016

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

By:

Lewis A. Rossman
National Risk Management Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

and

Wayne C. Huber
School of Civil and Construction Engineering
Oregon State University
Corvallis, OR 97331

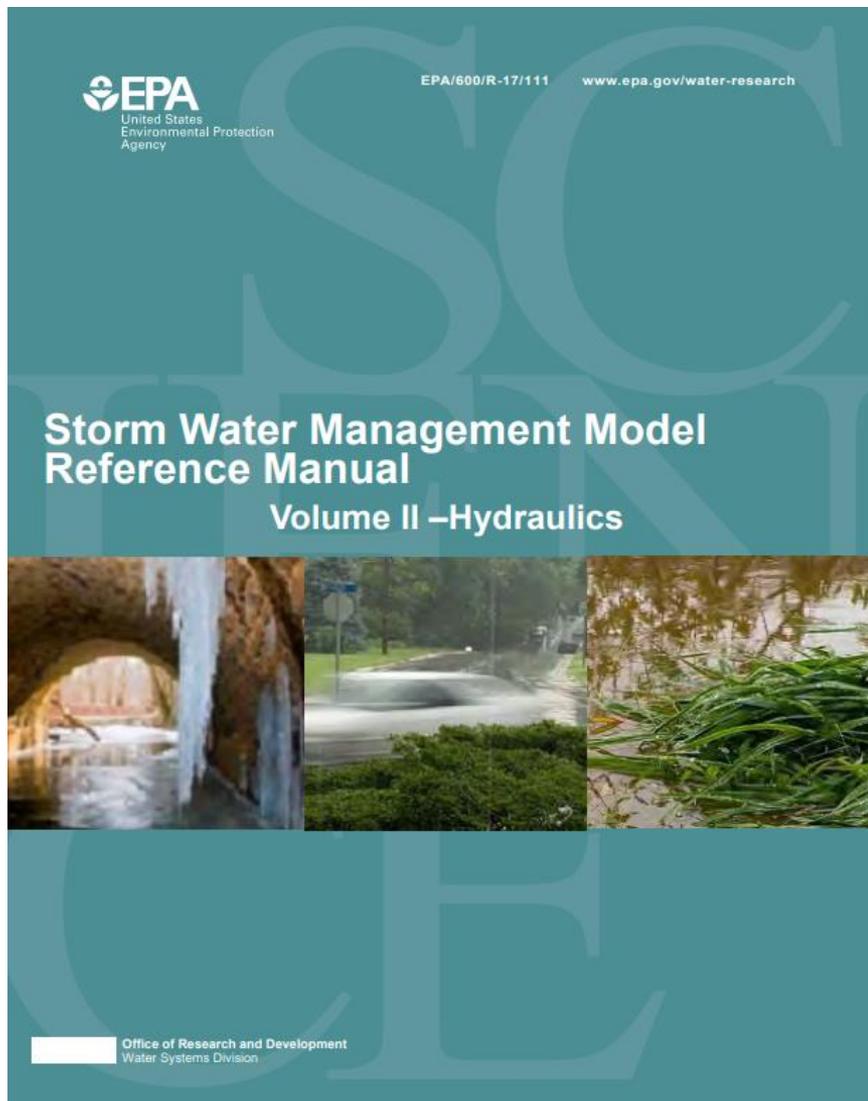
National Risk Management Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
26 Martin Luther King Drive
Cincinnati, OH 45268

January 2016

EPA SWMM 5.1 – literatura

08/07/2017

[SWMM Reference Manual Volume II—Hydraulics](#)



EPA/600/R-17/111
May 2017

Storm Water Management Model Reference Manual Volume II – Hydraulics

By:

Lewis A. Rossman
Office of Research and Development
National Risk Management Laboratory
Cincinnati, OH 45268

National Risk Management Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
26 Martin Luther King Drive
Cincinnati, OH 45268

May 2017

EPA SWMM 5.1 – literatura

09/08/2016

[Storm Water Management Model Reference Manual Volume III – Water Quality \(PDF\)](#) (161 pp, 1.6 MB) July 2016, EPA No. 600/R-16/093



EPA/600/R-16/093 | July 2016 | www.epa.gov/water-research

EPA/600/R-16/093
July 2016

Storm Water Management Model Reference Manual Volume III – Water Quality



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Cincinnati, OH 45268

July 2016

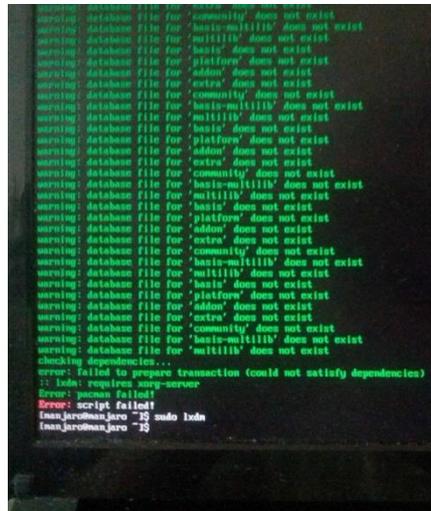
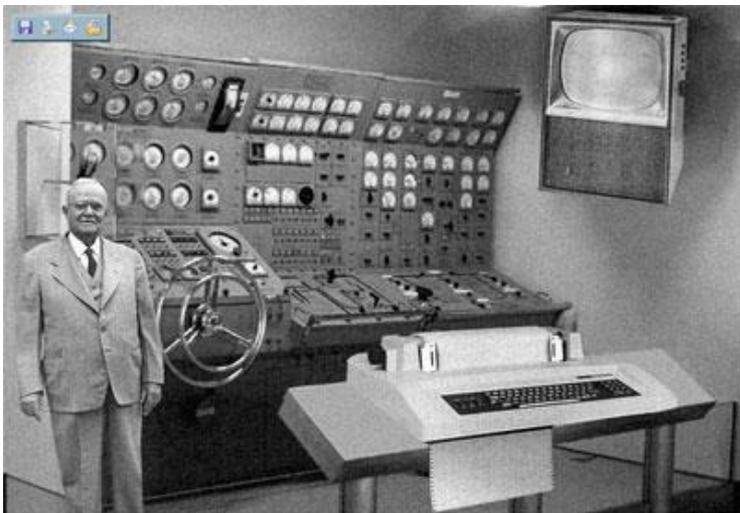
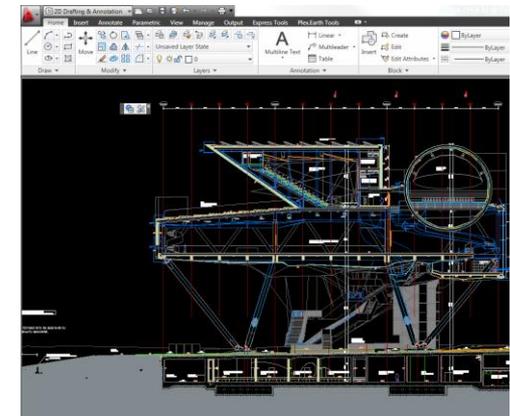
EPA SWMM – verzijje

- 1971 - SWMM 1 (M&E, UF, WRE)
- 1975 - SWMM 2 (UF)
- 1981 - SWMM 3 (UF & CDM)
- 1983 - SWMM 3.3 (PC Version)
- 1988 - SWMM 4 (UF & CDM & OSU)
- 2004 – SWMM 5 (EPA & CDM)

GUI

LIFE BEFORE THE COMPUTER

- * Memory was something that you lost with age
- * An application was for employment
- * A program was a TV show
- * A cursor used profanity
- * A keyboard was a piano
- * A web was a spider's home
- * A virus was the flu
- * A CD was a bank account
- * A hard drive was a long trip on the road
- * A mouse pad was where a mouse lived



Source: <http://victoriagosse.weebly.com/>

EPA SWMM – prednosti

Topic	Item	Model		
		SWMM 5.0	MOUSE / MIKE URBAN	INFOWORKS CS
Hydraulics	Flow Routing	Dynamic Wave	Dynamic Wave	Dynamic Wave
	Routing Engine	Explicit numerical engine can have stability issues if the model not constructed and reviewed carefully.	Implicit numerical engine, a stable and fast hydraulic engine. Though it is considered to be a slightly slower engine than InfoWorks.	Implicit numerical engine. Generally considered the fastest and most stable fully dynamic engine.
	Inlet Control	No	No	Yes
	Detention Storage	Yes	Yes	Yes
	RTC	Yes	Yes	Yes
	Pumps	Yes	Yes	Yes
	Irregular XS	Yes	Yes	Yes
Hydrology	Surface Runoff	Utilizes a non-linear reservoir model to simulate runoff.	Provides a number of surface runoff models, such as a time area method and a Kinematic wave model (Non Linear Reservoir Model). This model behaves exactly the same as the SWMM non-linear reservoir model	Provides a number of surface runoff models, including the SWMM non-linear reservoir model.
	Infiltration	Provides three infiltration options, Curve Number, Horton's Equation and Green Ampt.	In addition to the RDII model (see below) MOUSE utilizes the Horton's Equation or SCS Curve Number to simulate infiltration.	Fixed PR Model (simple percentage) Green Ampt Model Horton Infiltration Model New UK PR Model Wallingford Procedure Model Constant Infiltration Model US SCS Model
	RDII	Provides either unit hydrographs to simulate RDII or a groundwater infiltration module to simulate the influence of groundwater table on infiltration flow.	MOUSE employs a complex RDII model.	Provides either unit hydrographs to simulate RDII or a groundwater infiltration module to simulate the influence of groundwater table on infiltration flow. As per SWMM.
	Continuous Simulation	Yes	Yes	Yes
Water Quality	Pollutant Build Up / Washoff	Yes	Yes	Yes
	Pollutants Modeled	Yes	Yes	Yes
	Treatment	Yes	Yes	Yes
Miscellaneous	LTS - Job List	No	Yes - MOUSE provides a job list file which allows a selected number of events to be run by the HD model.	No
	Statistics	Yes	Yes	Yes
Use Ability	User Interface	Basic user interface.	Good user interface.	Sophisticated user interface.
	Data Management	None	Reasonable data management with the scenario manager.	Excellent data management.
	Result Display	Reasonable	Good	Excellent
	Support	No formal support, A SWMM Users List server, allows subscribers to ask questions and exchange information.	Comprehensive	Comprehensive
Price	Purchase Cost	Free	~\$15k to \$40k dependant on pipe limitation and modules selected.	~\$30k to \$60k dependant on node limitation selected.
	Maintenance Cost	Free	~10% of the purchase price	~15% of the purchase price

EPA SWMM – ograničenja

- To je hidrološko-hidraulički alat za analizu, **a ne za automatsko projektovanje**
- Nema direktnog povezivanja sa **GIS**-om
- Nema transporta sedimenata, ni prostiranja erozije
- Nema proračuna kretanja zagađivača u vodotocima (influentima), niti u podzemnim vodama

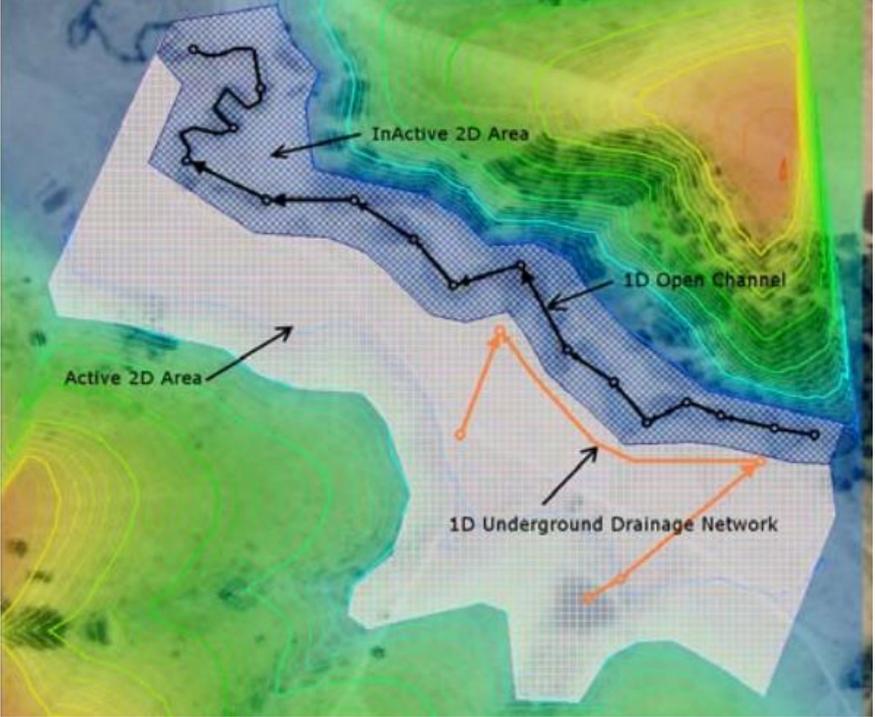
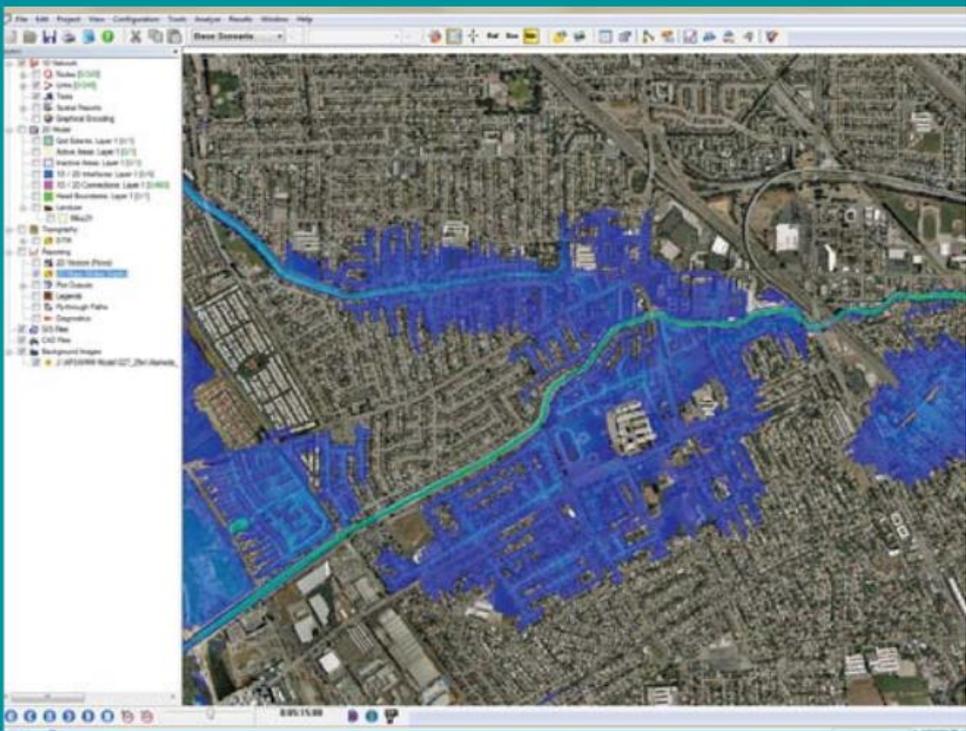


SWMM wrappers

- komercijalni software koji koriste SWMM engine
- Određena unapređenja – GIS, 2D tečenje po terenu
- **InfoSWMM - MWH Soft (www.mwhsoft.com)**
- **PC SWMM – CHI (www.computationalhydraulics.com)**
- **XP SWMM – XP Software (www.xpsoftware.com)**



EPA SWMM – alternative ...

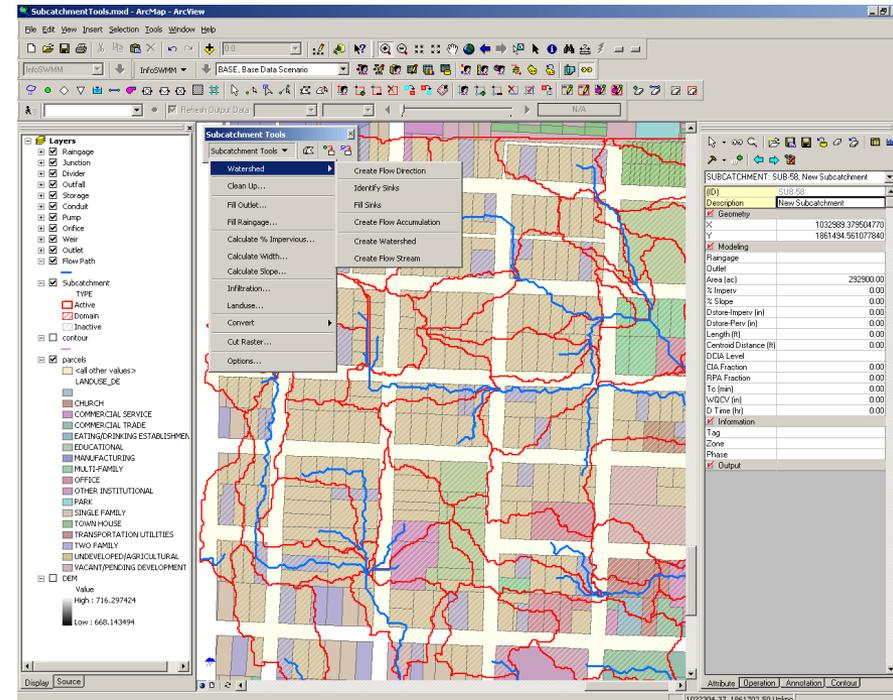
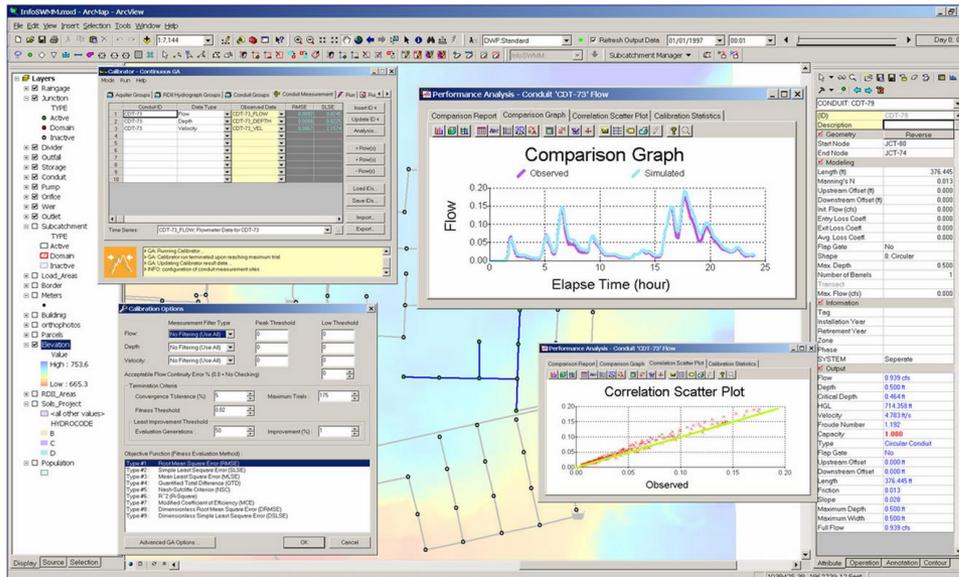


Source: xpsolutions.com

EPA SWMM – alternative ...



- ArcGIS integracija (5god I 5k cevi ≈40 000\$)



Designer - Advanced Messy GA

Mode Run Page Help

Result Time Stamp: 14:48:40, Tuesday, December 27, 2005

Solution	Total Cost	Design Cost	Penalty Cost
1	48,737,825.38	670,100.00	48,067,725.38
2	52,269,673.27	676,440.00	51,593,233.27
3	60,326,341.33	1,993,890.00	58,332,451.33
4	68,804,392.42	385,152.00	68,419,240.42
5	73,998,998.94	386,242.00	73,612,756.94
6	77,227,544.97	376,442.00	76,851,102.97
7	85,880,438.17	651,900.00	85,228,538.17
8	100,118,907.25	256,170.00	99,862,737.25
9	113,198,291.65	670,920.00	112,528,371.65
10	135,929,445.02	645,390.00	135,284,055.02

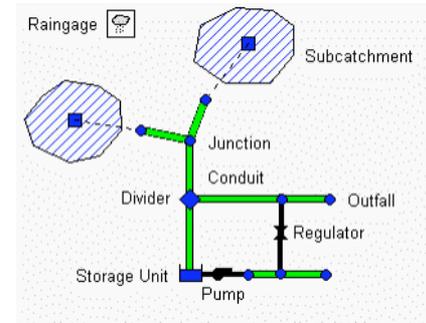
INFO: optimal network design evolution information.
 GA: Running Designer ...
 GA: Designer completion. GA optimization completed: maximum trial reached
 INFO: solution summary.

Source: <http://www.innovyze.com/>

Osnovni koraci u razvoju SWMM projekta

- Definirati opcije i zajedničke parametre objekata (jedinice mere, ofsete, ...)
- Uneti šemu sliva ili mreže koristeći vizuelne objekte
- Izmeniti attribute objekata tako da odgovaraju Vašem projektu
- Izabrati niz modela za simulaciju
- Pokrenuti simulaciju
- Pregledati rezultate simulacije

Defaults



+

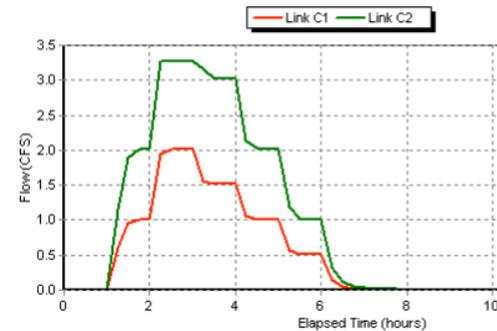
$$X = \text{Inputs}$$

+

$$f(\text{inputs})$$



=



EPA SWMM 5.1 – Radno okruženje

STUDY AREA MAP
-unošenje vizuelnih objekata

PROJECT BROWSER
-izbor i editovanje vizuelnih i nevizuelnih objekata

Auto-Length: Off | Offsets: Depth | Flow Units: CMS | Zoom Level: 100% | X,Y: -714.286, 7521.515

Korisni sajтови

- **USEPA** - SWMM 5 instalacija, QA, test primeri, nove verzije...
www.epa.gov/ednnrml/swmm
- **Oregon State University** - SWMM 4 instalacija i dokumentacija
[etc. ftp://ftp.engr.orst.edu/pub/swmm/pc/](ftp://ftp.engr.orst.edu/pub/swmm/pc/)
- **NOAA NCDC** - National Climatic Data Center – meteorološki podaci - www.ncdc.noaa.gov

FORUMI

- <http://swmm2000.com/>
 - <http://swmm5.org/>
 - <https://www.openswmm.org>
-