IMPROVING THE RESULTS OF URBAN WATER MODELING IN DATA SCARCE AREA

Ngoc Huan Tran*, Quy Nhan Pham[1]
[1] Hanoi University of Natural Resources and Environment, Hanoi, Vietnam

HANOI UNIVERSITY OF NATURAL RESOURCES AND ENVIRONMENT, HANOI, VIETNAM

Contents

1 Introduction
2 Methodology
3 Study area
4 Results
5 Conclusion and recommendation

Introduction

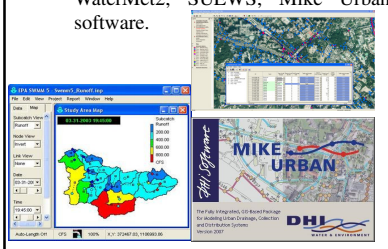
- Facing challenges in urban areas
- Simulating flood phenomenon to supply important information
- Numerical modeling in urban water resources is a crucial approach.

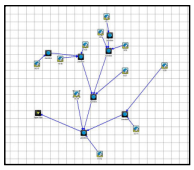
Urban flooding

Water pollution

Introduction

- Models help to solve the problems of urban drainage, environmental pollution or urban water supply: SWMM, WaterMet2, SUEWS, Mike Urban, SOBEK, MUSIC software.





MUSIC sotware

Introduction

- Roles of meteorology data in validating and verifying
- Lack of data (H, Q) in urban catchment
- Combine 1D and 2D flood modeling, compare different methods
- Invest servers to update and store satellite and ground observation data providing input data

→ Require a great investment in technology and knowledge. Need a new and more economical approach.

Methodology

- Urban water resources modeling requires hydro-meteorology, natural condition.
- Citizen Science (CS) is a process, in which local communities participate in scientific activities.
- CS provide terrain, drainage system parameters, water level and flooded area, current land use data.
- CS is a connection point for solving data scarce problem in urban areas

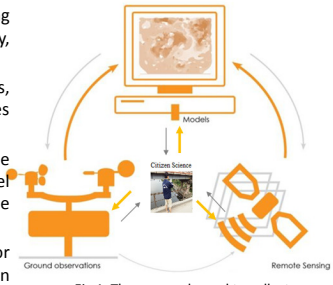


Fig 1. The approach used to collect data for urban water resources modeling

Study areas

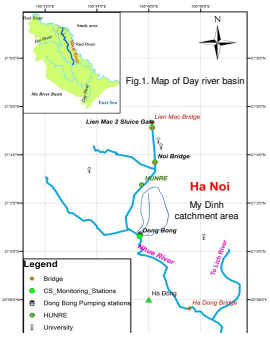


Fig. 2. Nhue river and SC monitoring locations

Fig. 3. Land-use locations

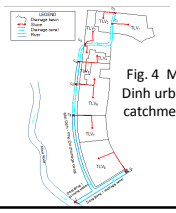


Fig. 4 My Dinh urban catchment

Study areas

- Location: North - Tu Liem District, Hanoi.
- Drainage system covers for 5 communes bordered by streets.
- Urban catchment: 1,55km^2.
- Left side of study area is Nguyen Co Thach St. and a canal named Mai Dich – Phu Do. (L=3.410m, B x h=(1.5 x 1.2) m)
- Outlet basin: Dong Bong pumping station (design capacity 8 m^3/s) into the Nhue River.

Fg 5. The map of drainage system of My Dinh urban basin

Citizen science in land use classification

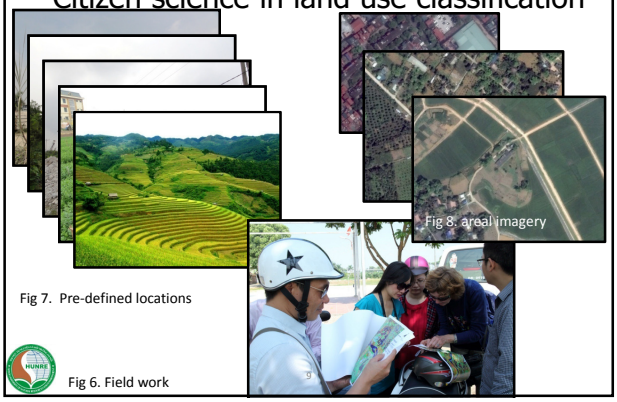


Fig 7. Pre-defined locations

Fig 6. Field work

Citizen science in land use classification

Matrices to estimate the accuracy of citizens

	OW	Rl	Rh	Ind	Ba	Mi	Fo	Shr	Gr	CC	Or	RC	We
OW	100	0	0	0	0	0	0	0	0	0	0	0	0
Rl	0	92.5	7.5	0	0	0	0	0	0	0	0	0	0
Rh	0	8.75	91.3	0	0	0	0	0	0	0	0	0	0
Ind	0	0	0	100	0	0	0	0	0	0	0	0	0
Ba	0	2.5	0	0	75	0	0	18.8	3.75	0	0	0	0
Mi	0	0	0	0	6.25	93.8	0	0	0	0	0	0	0
Fo	0	0	0	0	0	0	92.5	7.5	0	0	0	0	0
Shr	0	0	0	0	13.8	0	3.75	43.8	37.5	0	0	1.25	0
Gr	0	0	0	0	0	0	0	5	77.5	1.25	0	16.3	0
CC	0	0	0	0	0	0	0	0	6.25	83.8	0	8.75	1.25
Or	0	0	0	0	0	0	2.5	2.5	0	0	93.8	1.25	0
RC	0	0	0	0	0	0	0	0	5	6.25	2.5	86.3	0
We	21.3	0	0	0	0	0	0	0	1.25	1.25	0	0	76.3

Results

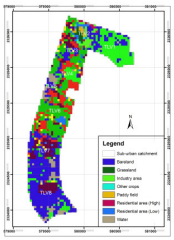


Fig 9. Map of land-use of My Dinh urban catchment in 2015

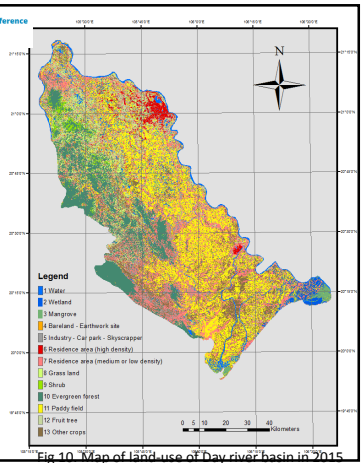


Fig 10. Map of land-use of Day river basin in 2015

Citizen science in water level monitoring

- Applied at the 3 locations (Lien Mac No.2 sluice, Noi Bridge and Dong Bong No.1 pumping station)
- Conducting several field trips to look for participants and to guide
- Most of the participants: 18 to 35 ages.

Fig11. Collecting data

Fig 12. Uploading data on the social network

(https://www.facebook.com/groups/233323730344680/).

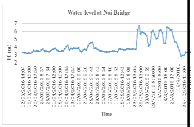
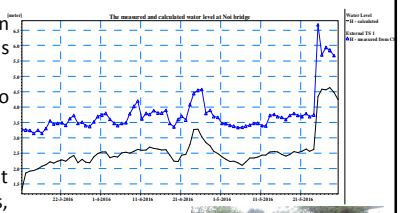


Fig 13. Water level at Noi Bridge on Nhue river derive from SC

Citizen science in water level monitoring

- Comparison between water level from citizens and the MIKE 11 model.
- Two line is offset due to different datum.
- $R^2 = 0.91$
- Based on water level at channel parameters, discharge of My Dinh urban catchment can be estimated



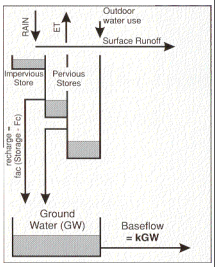
Manning's formula

$$Q = \frac{1}{n} A R^{\frac{2}{3}} \left(\frac{\partial h}{\partial x}\right)^{1/2}$$

Fig 13. Water level at Dong Bong No1 channel in Apirl 1st, 2017

Numerical modeling (MUSIC) to simulate stormwater of My Dinh suburban, in Hanoi

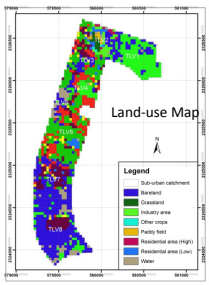
- Cooperative Research Centre (CRC) for Catchment Hydrology, Australia developed the Model for Urban Stormwater Improvement Conceptualisation (MUSIC)
- MUSIC simulates the rainfall-runoff process in urban catchment, It operates by continuously accounting for of the impervious area and two soil moisture storages.
- The majority of stormwater runoff in urban catchments is generated from the impervious surfaces.
- Baseflow, influenced by sub-surface soil moisture and groundwater levels, is less dominant in urban catchments as evident by the "flashy" nature of urban stormwater hydrographs.
- Runoff routing through the catchment is undertaken using the Muskingum-Cunge flood routing algorithm.



Conceptual Rainfall-Runoff Model adopted for MUSIC

Data used

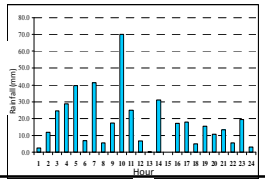
- Meteorology station: Ha Dong station
- Drainage system of My Dinh urban catchment
  + Schematic drainage system, designed parameters (cannel, sluice, pumping station)
  + Soil characteristics
  + Land-use



Tab 1. Pervious and impervious area

Sub-urban	Area (ha)	% Pervious	% Impervious
TLV1	21.83	1	99
TLV2	9.952	45	55
TLV3	21.22	21	79
TLV4	5.85	8	92
TLV5	5.00	0	100
TLV6	35.49	11	89
TLV7	20.41	32	68

Rainfall

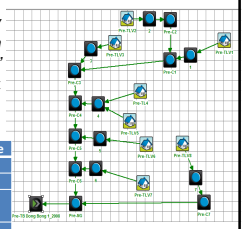


Set-up MUSIC model

- Rainfall – Runoff Parameters
- Soil characteristic obtained from *"Sydney Catchment Authority _Using MUSIC in Sydney's Drinking Water Catchment"* (Macleod 2008), local reports, experiment physical reports.

Tab 2. Model parameters

No	Parameters	Unit	Value
1	Rainfall Threshold	(mm/day)	1.00
2	Soil Storage Capacity	(mm)	97
3	Initial Storage	(% of Capacity)	25
4	Field Capacity	(mm)	79
5	Infiltration Capacity Coefficient - a	-	250
6	Infiltration Capacity Exponent - b	-	1.3
7	Initial Depth	(mm)	10
8	Daily Recharge Rate	(%)	60
9	Daily Baseflow Rate	(%)	45
10	Daily Deep Seepage Rate	(%)	0



The drainage schematic of My Dinh urban catchment from the MUSIC model

Pilot simulations

- The MUSIC model simulated historical flood in May, 2003 (from 24th to 25th) and in Nov, 2008 (from 4th to 10th).

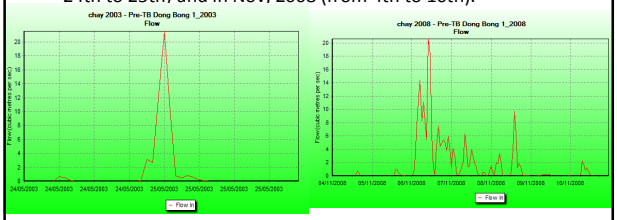


Fig. 6. Flood hydrography in 2003, 2008 at Dong Bong No 1 pumping station

Conclusion and Recommendation

- Data availability is a challenge for many researchers
- Framework for accessing and collecting data to modeling established, with a central approach to citizen science.
- Citizen science helps to collect data on current land use and water level and flooded area.
- Urban water resource models can use indirect measurement data as input data for the model such as the determination of impervious area by using the land use map through satellite imagery after calibrating ground data from citizen science.
- Data from the citizen science model is consistent, ensuring reliability compared to the numerical modeling and statistical analysis.

Conclusion and Recommendation

- The Citizen Science model is still a new potential trend in water resources field, especially in urban areas. Therefore
  - Need to expand the number a participant
  - Increase the awareness of people and vulnerability
  - Promote their enthusiasm
- Data collected by citizens should be stored by a smart phone app like AKVO flow
- Further research will gather data from CS, ground observation to conduct study in the same time

Thank for your kindness attendance!

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