SWAT-CUP……. New Features

2011 International SWAT Conference, Toledo

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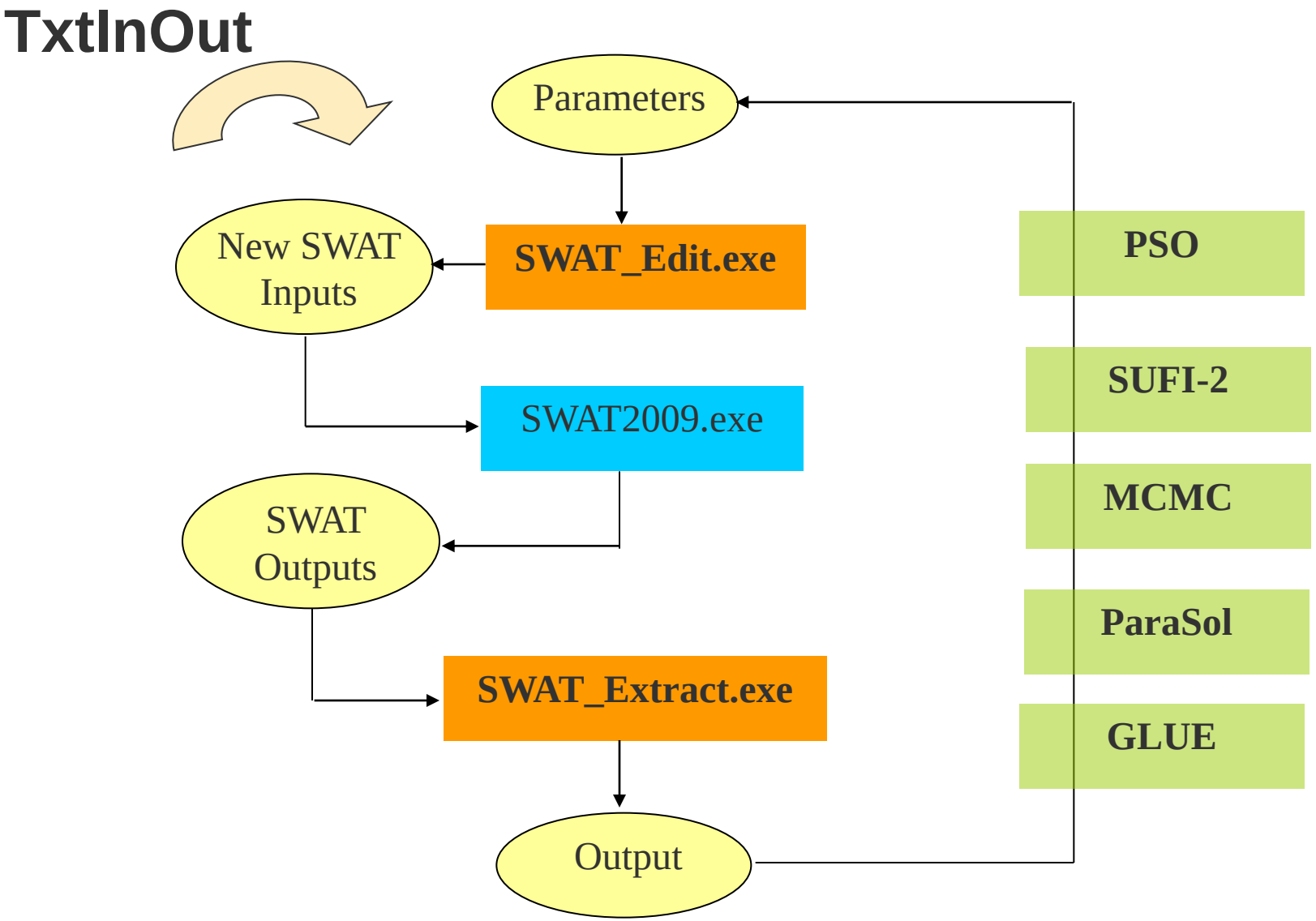
SWAT-CUP

SWAT Calibration and Uncertainty Analysis Procedures

- Calibration,
- Validation,
- Sensitivity analysis (One-at-a-time and global),
- Uncertainty analysis,
- Visualize the watershed and outlet locations,
- Parallel processing

SWAT-CUP


TxtInOut
Parameters
New SWAT Inputs
SWAT_Edit.exe
SWAT2009.exe
SWAT Outputs
SWAT_Extract.exe
Output
PSO
SUFI-2
MCMC
ParaSol
GLUE

Issues w.r.t Calibration of Distributed Watershed Models

- Parameterization

(most important, difficult, and neglected aspect of calibration)

- Positioning observed outlets in SWAT

(causes the biggest headache in calibration)

- Time constraint

(makes some projects impossible to build and run)

- Objective function definition

(most surprising aspect of calibration)

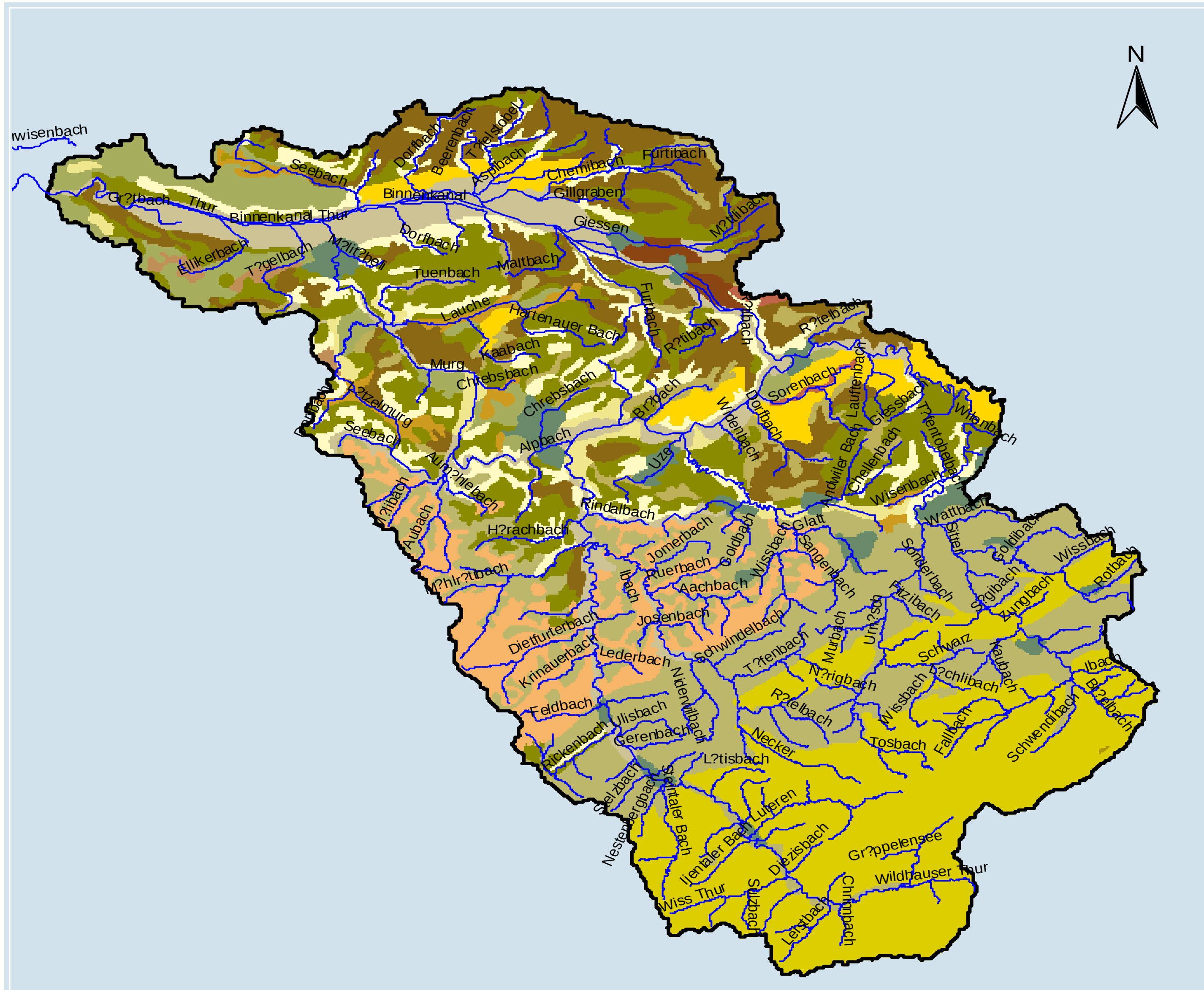
- Non-uniqueness (Uncertainty)

(most difficult part to quantify and communicate)

- Parameter conditionality

(most disappointing aspect of calibration)

Parameterization



Parameterization

x__<parname>.<ext>__<hydrogrp>__<soltext>__<landuse>__<subbsn>__Slope

Where x=

v__ means the existing parameter value is replaced by a given value,

a__ means the given value is added to the existing parameter value, and

r__ means the existing parameter value is multiplied by (1+the given value);

Parameterization

Soil parameters

Parameter identifiers	Description
r__SOL_K().sol	K of all soil layers in all HRUs
r__SOL_K(1).sol	K of Layer 1 of all HRUs
r__SOL_K(1).sol____FSL	K of layer 1 in HRUs with soil texture FSL
r__SOL_K(1).sol____FSL__PAST	K of layer 1 of HRUs with soil texture FSL and landuse PAST
r__SOL_K(1).sol_____PAST__1-15	K of layer 1 of subbasin 1 to 15 in HRUs with landuse PAST
v__SOL_K(1).sol_____0-10	K of layer 1 for HRUs with slope 0-10

Parameterization

Management parameters

Parameter identifiers	Description
v__HEAT_UNITS{rotation no,operation no}	Management parameters that are subject to operation/rotation must have both specified
v__CNOP{[],1}.mgt	change an operation's parameters in all rotations [] means every rotation that has the specified operation.
v__CNOP{2,1,plant_id=33}.mgt v__CNOP{[],1,plant_id=33}.mgt	Operation filters could be applied as shown The changes are applied to crop 33 only
v__CNOP{[],1,plant_id=33}.000010001.mgt	To modify just one file, it could be given as shown

Parameterization

Rainfall parameters

Parameter identifiers	Description
v__precipitation(1){1977300}.pcp1.pcp	(1) means column number 1 in the pcp file {1977300} specifies year and day
v__precipitation(1-3){1977300}.pcp1.pcp	(1-3) means column 1, 2, and3 {1977300} specifies year and day
v__precipitation( ){1977300,1977301}.pcp	( ) means all columns (all stations) {1977300,1977301} means 1977 days 300 and 301
v__precipitation( ){1977001-1977361,1978001-1978365,1979003}.pcp	( ) means all columns from day 1 to day 361 of 1977, and from day 1 to day 365 of 1978, and day 3 of 1979

Parameterization

par_inf.txt

r__CN2.mgt	0.5	0.9
v__ALPHA_BF.gw	0.4	1.4
v__GW_DELAY.gw	0.0	100.0
v__GWQMN.gw	0.0	0.0
v__GW_REVAP.gw	0.02	0.1
v__ESCO.hru	0.02	0.1
v__OV_N.hru	0.02	0.1
v__SLSUBBSN.hru	1.0	8.0
v__HRU_SLP.hru	0.3	0.8
v__CH_N2.rte	0.01	0.1
v__CH_K2.rte	29.5	96.7
v__ALPHA_BNK.rte	0.38	1.16
r__SOL_AWC(1).sol	-0.1	0.02
r__SOL_K(1).sol	-0.8	0.8

Global parameterization

Parameterization

par_inf.txt

```
r__CN2.mgt_____AGRR__12,13,19,21      -0.1    0.1
r__CN2.mgt_____FRST__12,13,19,21      -0.2    - 0.1
.....

r__SOL_BD().sol_____12,13,19,21       -0.02    0.01
r__SOL_AWC().sol_____12,13,19,21      -0.04    0.1
......

v__EPCO.hru          0.18     0.32
v__ESCO.hru          0.4      0.6
v__SLSUBBSN.hru      3.8      120
.....

r__CN2.mgt_____AGRR__1-11,14-18,20,22,23      -0.26    -0.1
r__CN2.mgt_____FRST__1-11,14-18,20,22,23      -0.3      0.2
r__SOL_BD().sol_____1-11,14-18,20,22,23      -0.04     0.05
r__SOL_AWC().sol_____1-11,14-18,20,22,231    -0.5     -0.3
```

15-12-66.Sufi2 - SWAT-CUP

Home | Parallel Processing | Layout

Paste | Cut | Copy | Delete | Undo | Redo | Select All | Save | Save All — Edit

Calibrate... | Save Iteration | Validate... — Calibration - Validation

Print Preview Print | Advanced Writing Tools | Close All Window | Help | About | License and Activation — Help

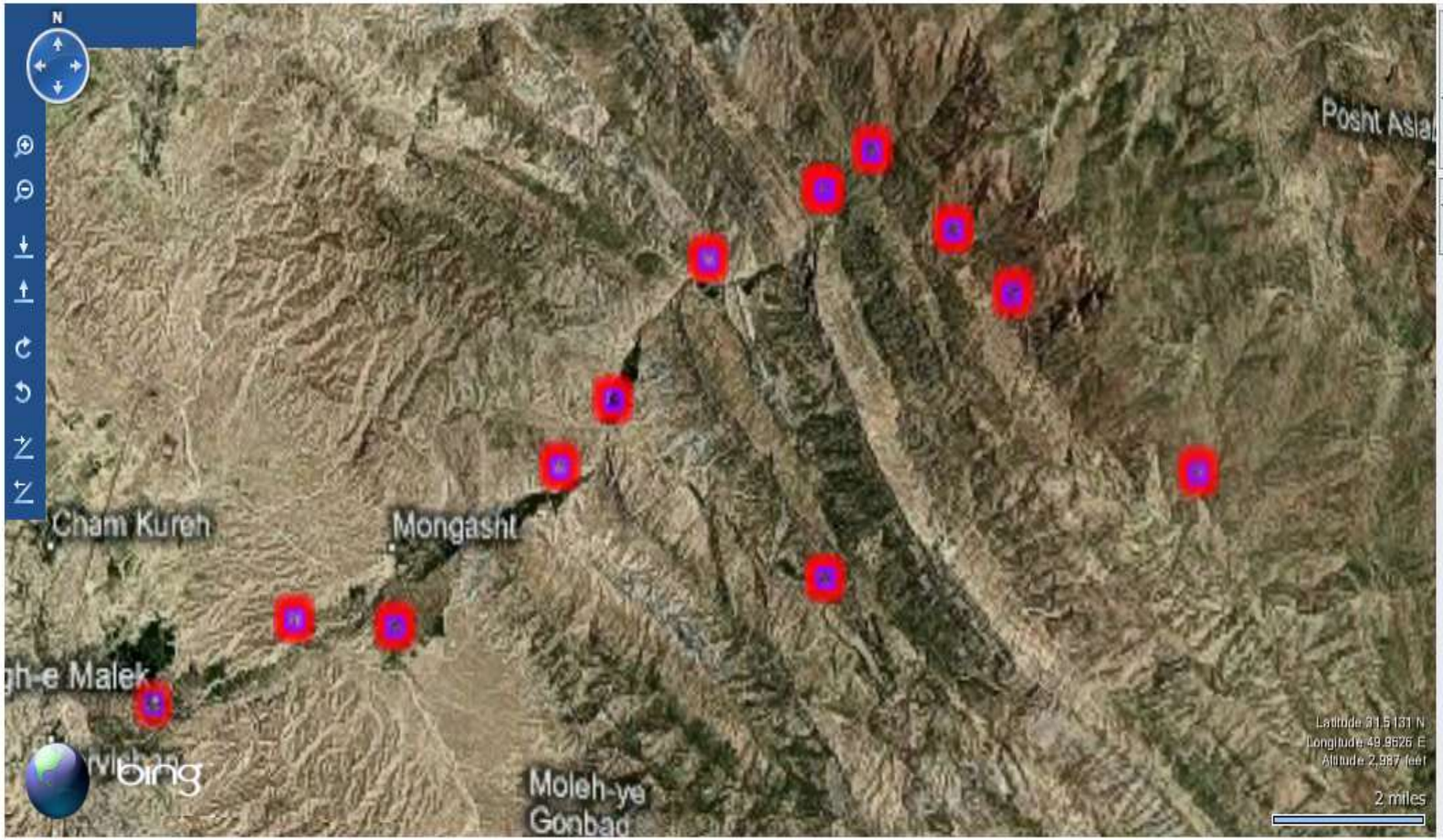
Project Explorer

- 15-12-66
  - Calibration Inputs
  - Executable Files
  - Calibration Outputs
  - Maps
    - Outlet Map
  - Iteration History

Outlet Map

Outlet Map

Help...



Outlet Properties | Layers

SWAT_web.doc - Microsoft Word

100%

start | Windows Task ... | 2 Microsoft ... | SWAT_web.do... | 5 Windows E... | 2 Microsoft ... | YouTube - Istik... | 15-12-66.Sufi2... | Windows Medi... | DE | 9:16 PM

1.Sufi2 - SWAT-CUP

Home | Parallel Processing | Layout

Paste | Cut | Copy | Delete | Undo | Redo | Select All | Save | Save All — Edit

Calibrate... | Save Iteration | Validate... — Calibration - Validation

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Project Explorer

- 1
  - Calibration Inputs
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  - Maps
    - Outlet Map
  - Iteration History

Outlet Map

Observed Outlet Positioning

The biggest calibration headache!

example.Sufi2 - SWAT-CUP

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Project Explorer

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Outlet Map

example.Sufi2 - SWAT-CUP

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Project Explorer

- example
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  - Iteration History

Outlet Map

Outlet Map

Help...

Time Constraint

Calibration takes a long time!

Build projects with coarser resolution

- Not run enough times to properly calibrate or do uncertainty analysis

- Grid computing

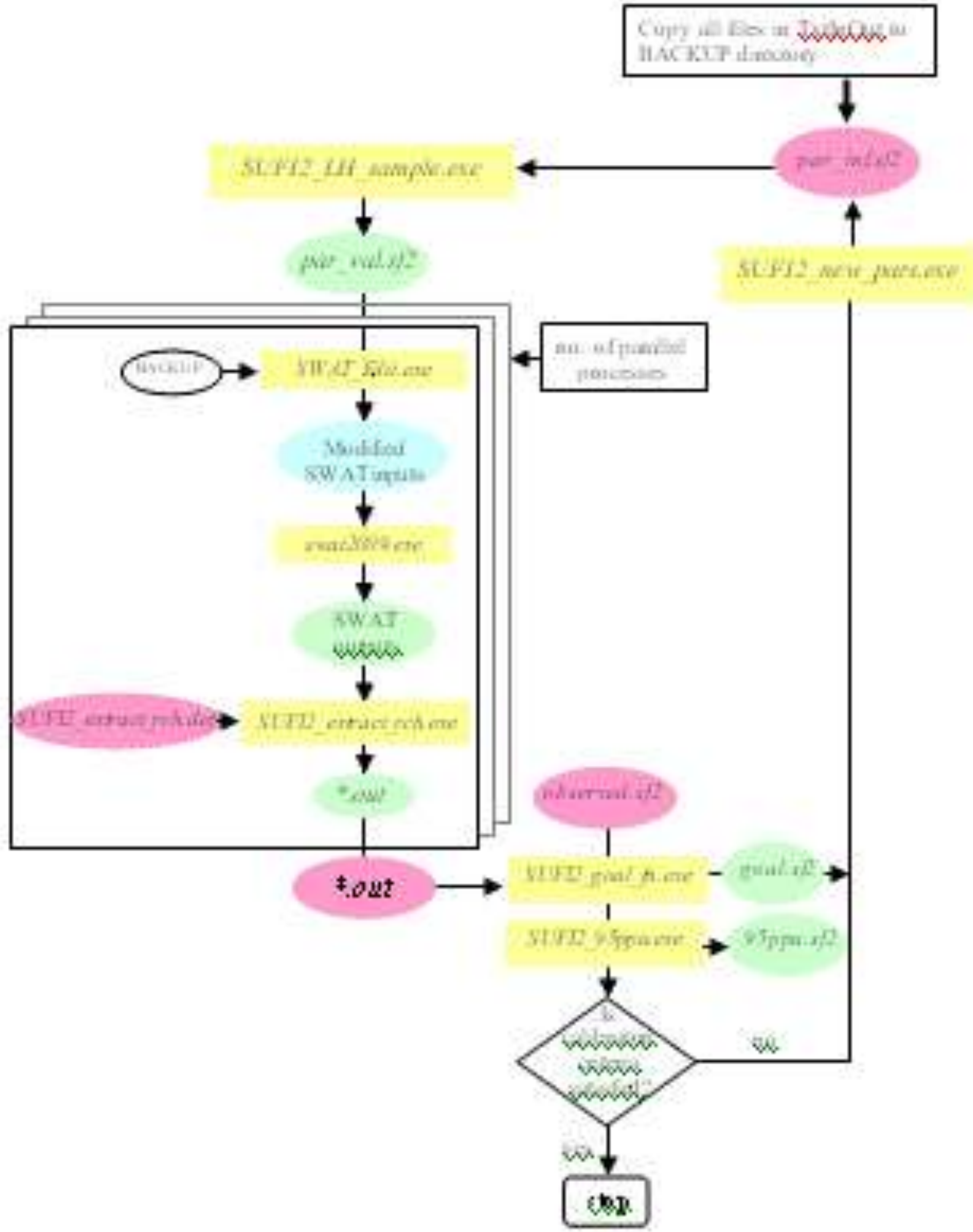
- Cloud computing

- Parallel processing

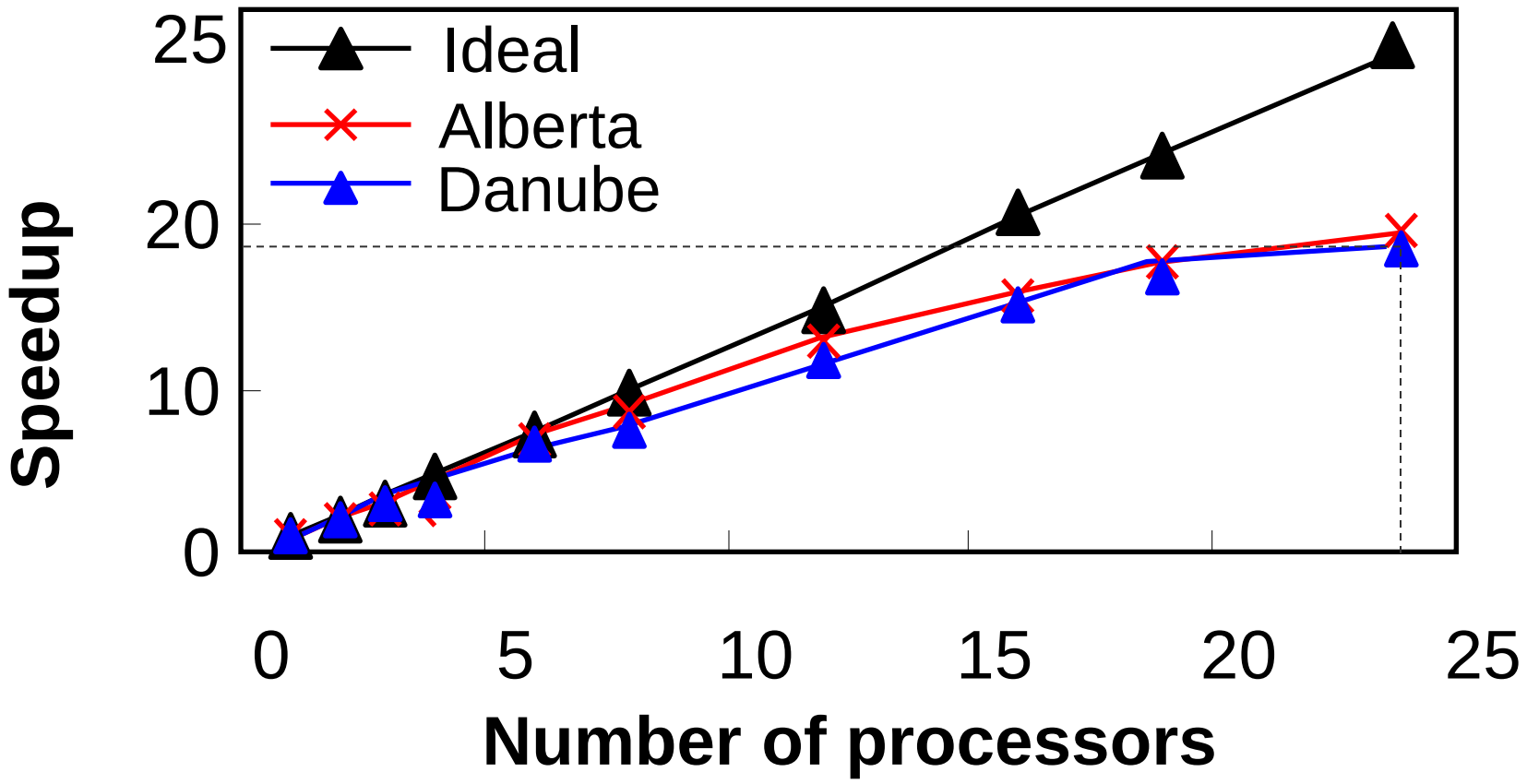
Rouholahnejad, Elham et al.

Parallelizing SWAT Calibration in Windows using SUFI2 Program

Environmental Modelling and Software, March 2011


Copy all files in TxtInOut to BACKUP directory
par_inf.sf2
SUFI2_LH_sample.exe
par_val.sf2
SUFI2_new_pars.exe
no. of parallel processes
BACKUP
SWAT_Edit.exe
Modified SWAT inputs
swat2009.exe
SWAT
SUFI2_extract_rch.def
SUFI2_extract_rch.exe
*.out
observed.sf2
*.out
SUFI2_goal_fn.exe
goal.sf2
SUFI2_95ppu.exe
95ppu.sf2

Server1

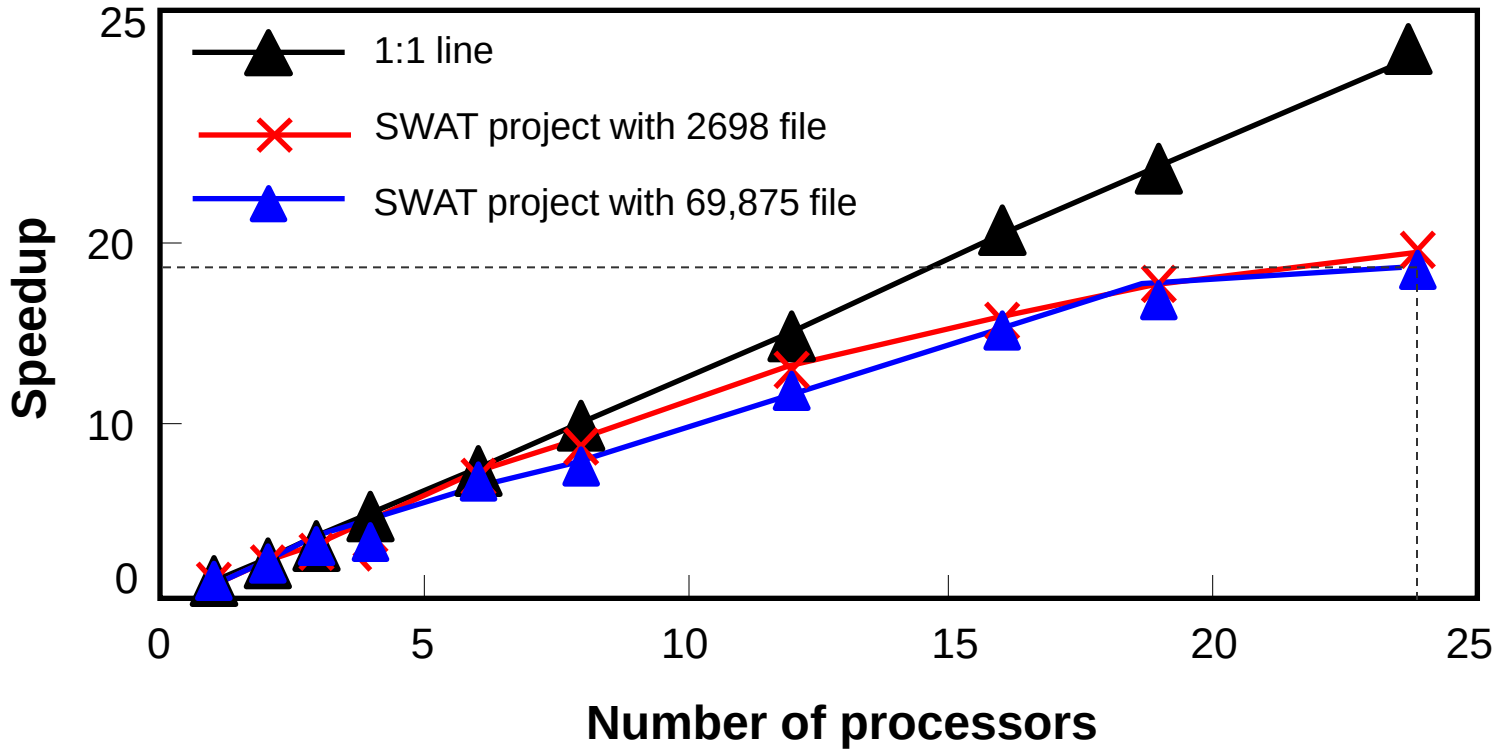


24 CPU

16 GB RAM

Danube 69,875

Alberta 2,698


25
20
10
0
Speedup
1:1 line
SWAT project with 2698 file
SWAT project with 69,875 file
0
5
10
15
20
25
Number of processors

Future Development

- Parallel Processing on GPU!
- More visualization
- More optimization algorithms
- More features as requested by users…….