



ERASMUS MUNDUS
MASTER OF SCIENCE IN ECOHYDROLOGY

UNESCO-IHE
Institute for Water Education



Adapting SWAT for the Modeling of Pesticide Transport for a Tile-drained River Basin

by

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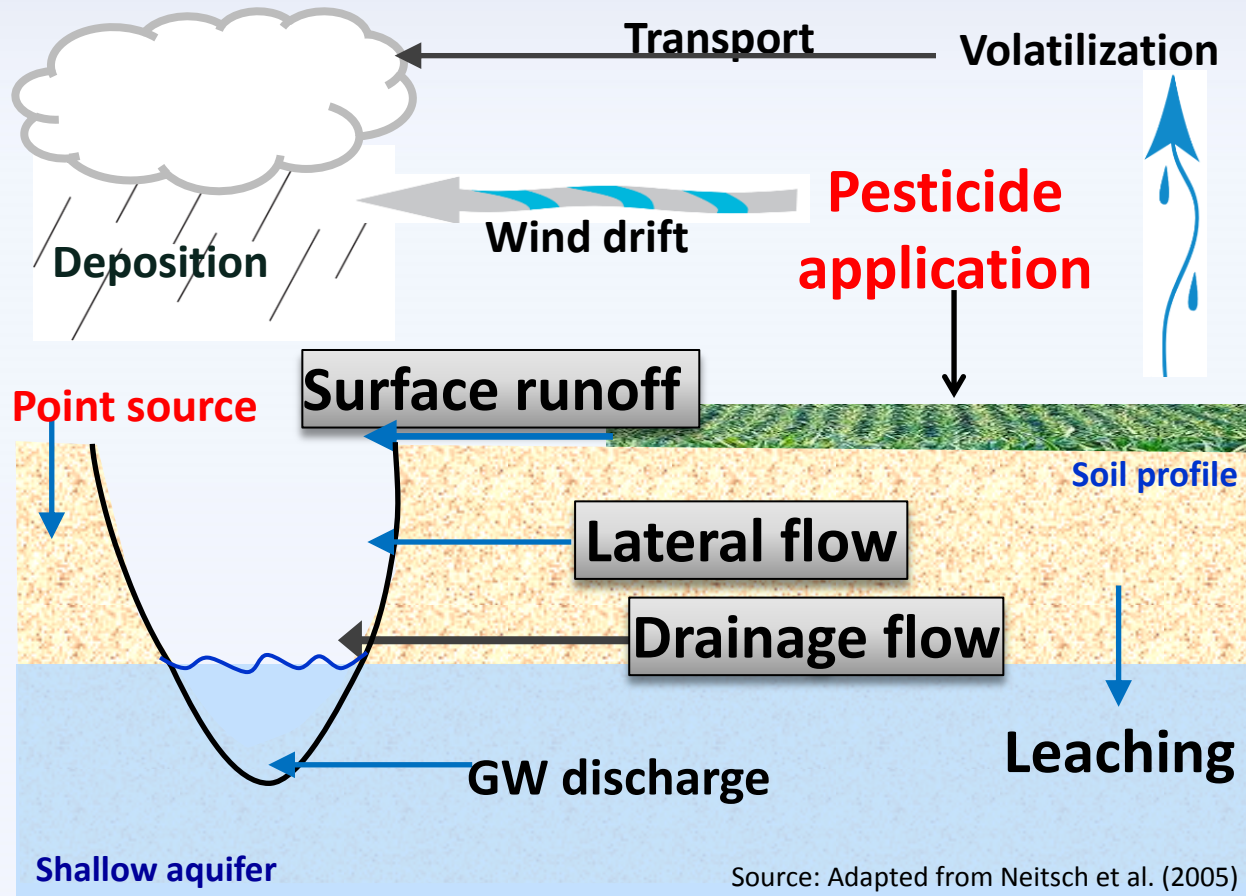
Presented by **Ting Tang**



19-Jul-13 @Toulouse, France – 2013 SWAT conference



Background



Agricultural pesticide loss in surface water:

<1% (Carter 2000)

Most important pathways

- Surface runoff
- **Drainage flow (if present)**



Background

- Ⓢ Realistic quantification of pesticide fluxes in subsurface drainage flow at the **basin scale** remains a challenge.
- Ⓢ SWAT is believed to be a promising tool for pesticide transport and flux modeling.
- Ⓢ **SWAT does not simulate pesticide transport in tile flow.**

Adaptations to SWAT model





Methodology: SWAT adaptations

Ad.1 – For detailed mass balance analysis

- I. Print out intermediate outputs
- II. Outputs treated with MATLAB to generate MB

Outputs	Source file modified	Outputs	Source file modified
Total application	<u><i>apply.f</i></u>	Storage in soil	<u><i>pesty.f</i></u>
Effective application	<u><i>apply.f</i></u>	Leaching	<u><i>pestlch.f</i></u>
Decay on foliage	<u><i>decay.f</i></u>	Channel load (SR_soluble)	<u><i>sumv.f</i></u>
Decay in soil	<u><i>decay.f</i></u>	Channel load (SR_sorbed)	<u><i>sumv.f</i></u>
Storage on plant	<u><i>decay.f</i></u>	Channel load (lateral flow)	<u><i>sumv.f</i></u>



Methodology: SWAT adaptations

Ad.2 – To incorporate pesticide transport in tiles

- I. Introduce a new variable 'fqtile (ly, j)' in percmmain.f
- II. Compute pesticide loss through tile flow in pestlch.f with

$$pst_{tile,ly} = conc_{pst,flow} * Q_{tile,ly}$$

Where: $pst_{tile,ly}$: amount of pesticide removed in tile flow from the layer tile located (ly) in kg pst/ha;

$conc_{pst,flow}$: concentration of pesticide in the mobile water for the given layer, in kg pst/mm H₂O;

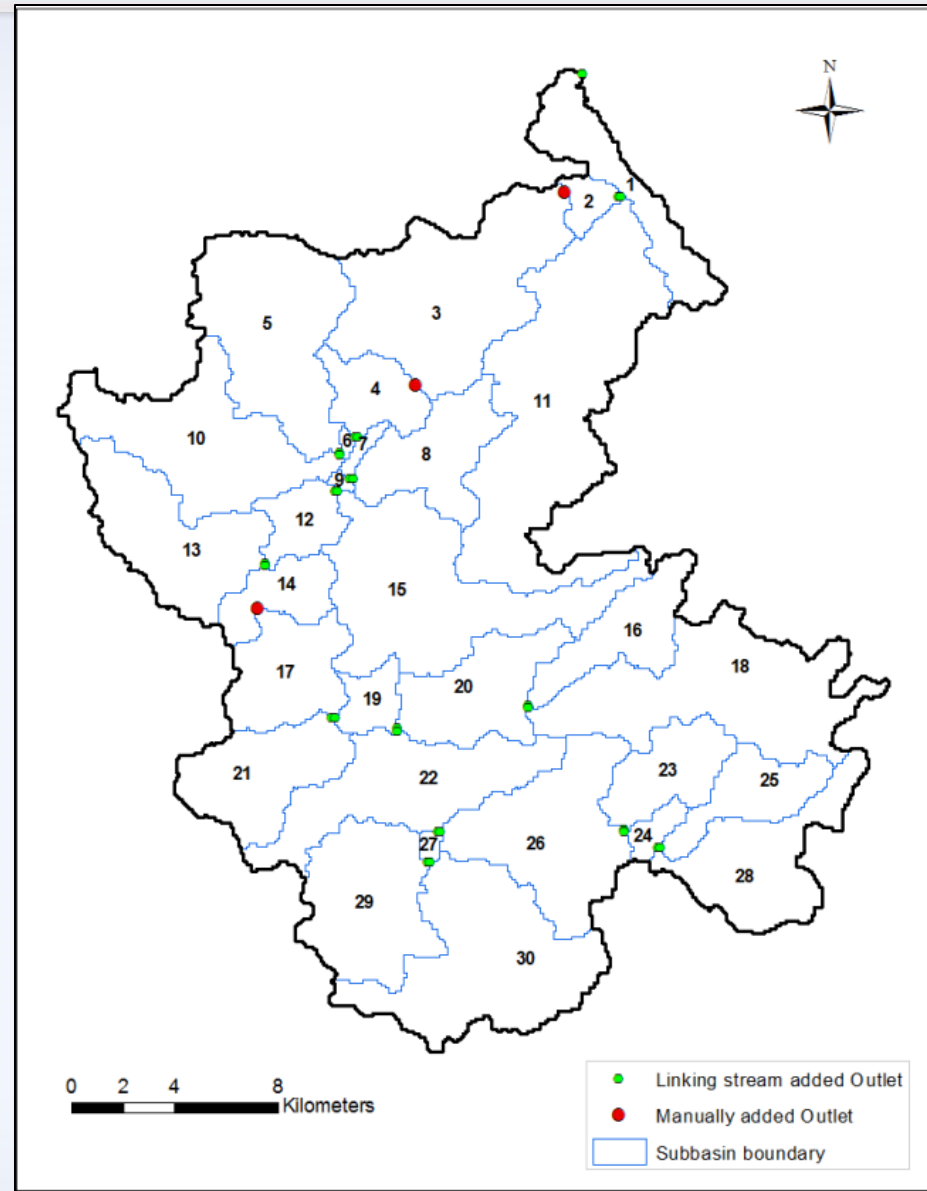
$Q_{tile,ly}$: equals to 'fqtile (ly, j)', amount of tile flow loss in given soil layer in for HRU 'j', in mm H₂O.



Methodology: case study

The Odense River Basin

- Island of Funen, Denmark
- Area: 612 km²
- Agriculture dominated
- **Heavily tile-drained**
- Calibrated SWAT hydrological model
 - 30 subbasins
 - 808 HRUs





Methodology : Model setup

Selected pesticides: **Bentazone, MCPA, Pendimethalin**

<i>Parameters</i>	<i>unit</i>	Mobile Non-persistent		Immobile Persistent
		Bent.	MCPA	Pend.
<i>IPNUM</i>	-	31	234	167
<i>SKOC</i>	(mg/kg)/(mg/L)	34	35	5000
<i>WOF</i>	-	0.6	0.6	0.4
<i>HLIFE_F</i>	days	2	8	30
<i>HLIFE_S</i>	days	20	25	90
<i>AP_EF</i>	-	0.75	0.75	0.75
<i>WSOL</i>	mg/L	2300000	825	0.275
<i>Ann. Aver. App. rate</i>	kg/ha	0.106	0.511	0.067



Methodology : Model setup

Simulation duration:

8 years (1994-2001)

Warming-up: 1994

Inc. of tile pst. transport	Simulation code
No	RunOri.L
Yes	RunTile.L



Results: Mass balance

Mass mismatch in % of the effective application ('+': loss; '-': creation)

<i>Pesticide</i>	Bentazone	MCPA	Endimethalin
<i>RunOri.L</i>	-0.002%	0.000%	-0.388%
<i>RunTile.L</i>	-0.002%	0.000%	-0.388%

Sequential computation?

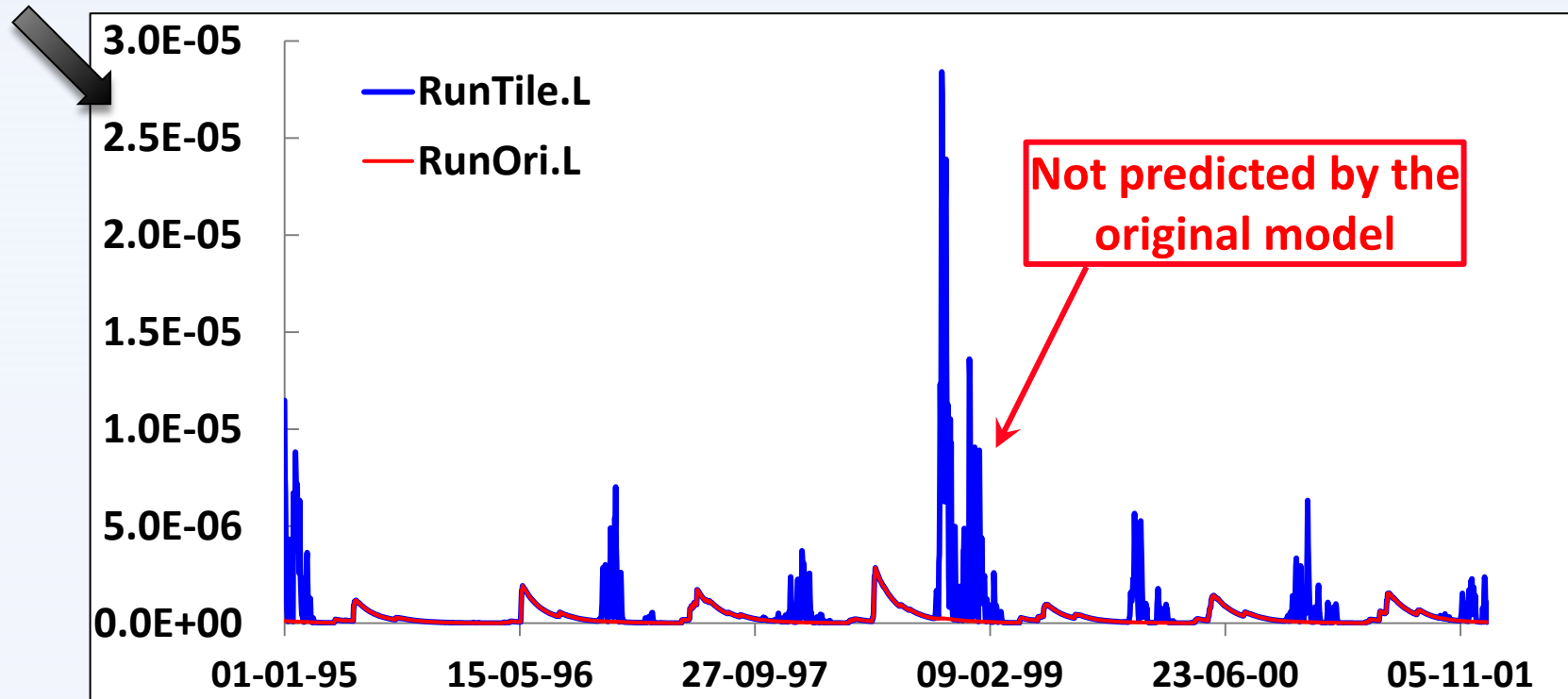
**Total load to
streams: < 0.25%!!**

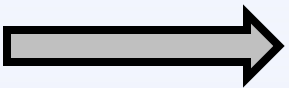
- Ⓢ Not for use, but acceptable in general;
- Ⓢ Better for Bent./MCPA;
- Ⓢ **Influence on pesticide load prediction.**



Results: Model improvement

Total MCPA load into streams, kg/ha

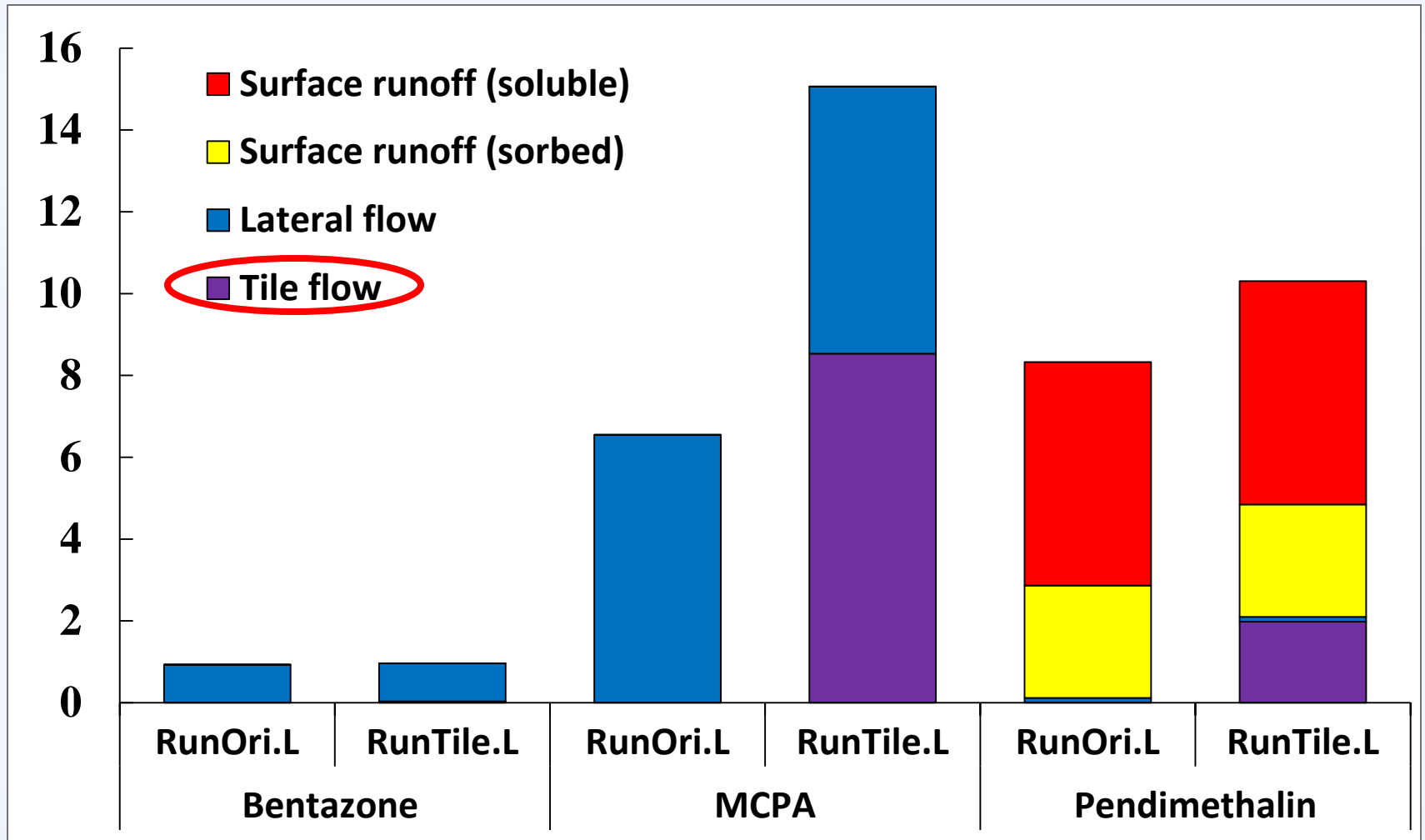


Modified SWAT2005 enables flux prediction during the wet season (winter).  **More realistic**



Results: Pathways

Average annual total channel load by pathway, kg/yr





Results: Instream concentration

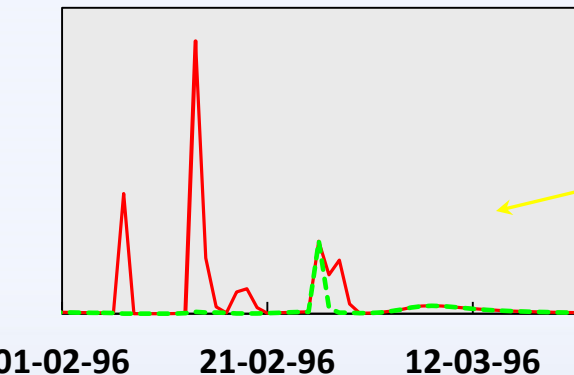
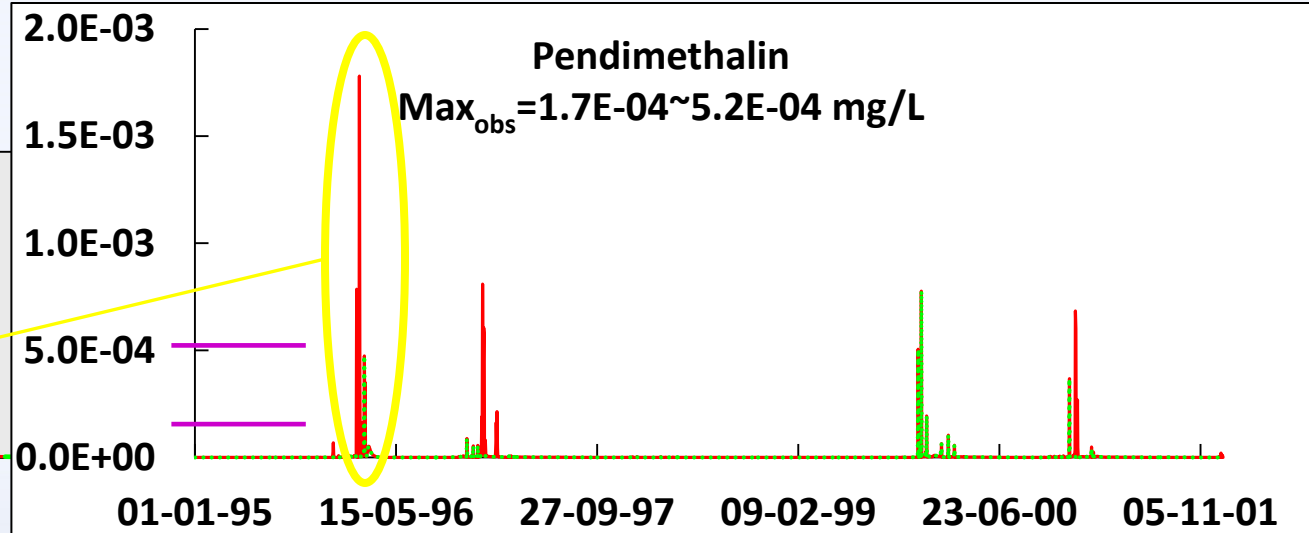
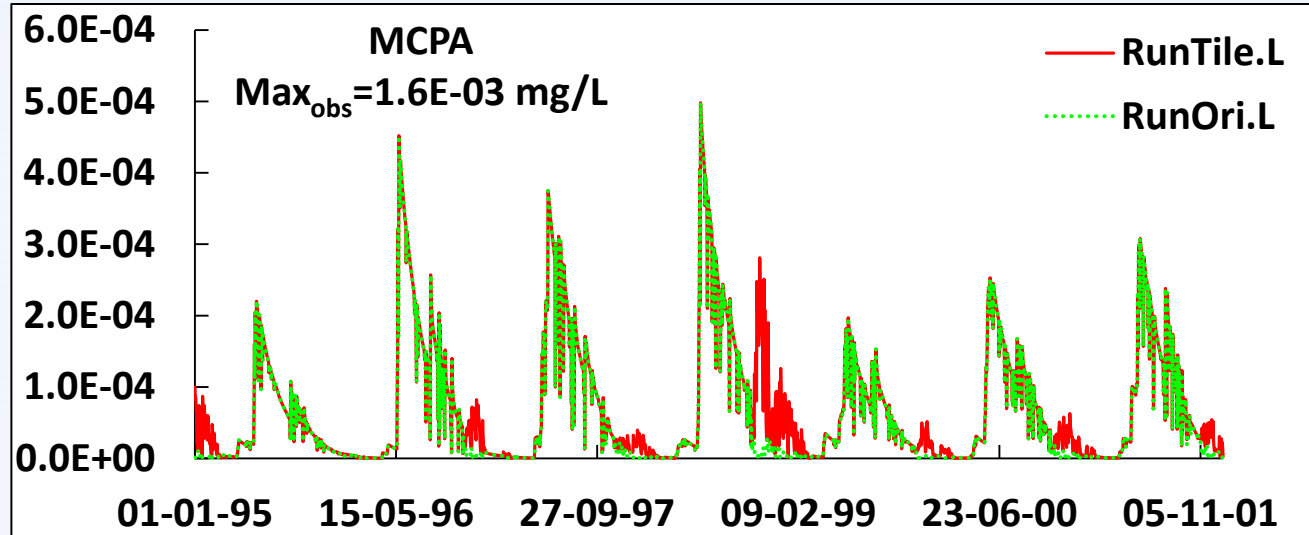
Pesticide conc. at the watershed outlet, mg/L

The pattern for bentazone is similar to MCPA

Max_{obs}: Observed maximum conc. in

headwaters

(Kronvang et al. 2003; Styczen et al. 2004)





To conclude...

- Modified SWAT2005: more realistic for Odense, maybe used for modeling tile-drained basins with additional validation;
- Bentazone/MCPA more reliably simulated than pendimethalin (mass balance, load, instream concentration);
- Preferred pathways → not identical among pesticides.

Thanks!





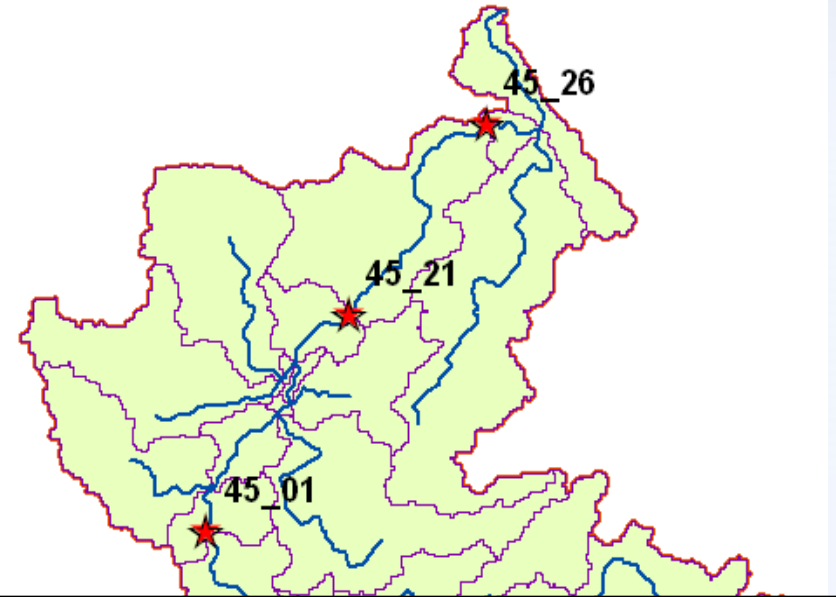
References

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- Ⓢ Neitsch, S. L., J. Arnold, J. R. Kiniry and J. R. Williams (2005), Soil and Water Assessment Tool Theoretical Documentation, Version 2005 USDA Agricultural Research Service & Blackland Research Centre, Texas A&M University, USA.
- Ⓢ Kronvang, B., H. L. Iversen, K. Vejrup, B. B. Mogensen, A. M. Hansen and L. B. Hansen (2003), Pesticides in streams and subsurface drainage water within two arable catchments in Denmark: Pesticide application, concentration, transport and fate. Ministry of Environment, Danish Environmental Protection Agency.
- Ⓢ Styczen, M., S. Petersen, M. Jessen, O. Z. Rasmussen, D. Andersen, M. Buck and P. B. Sørensen (2004), Calibration of Models Describing Pesticide Fate and Transport in Lillebæk and Odder Bæk Catchment Pesticides Research, pp. 218.



Supplementary info.

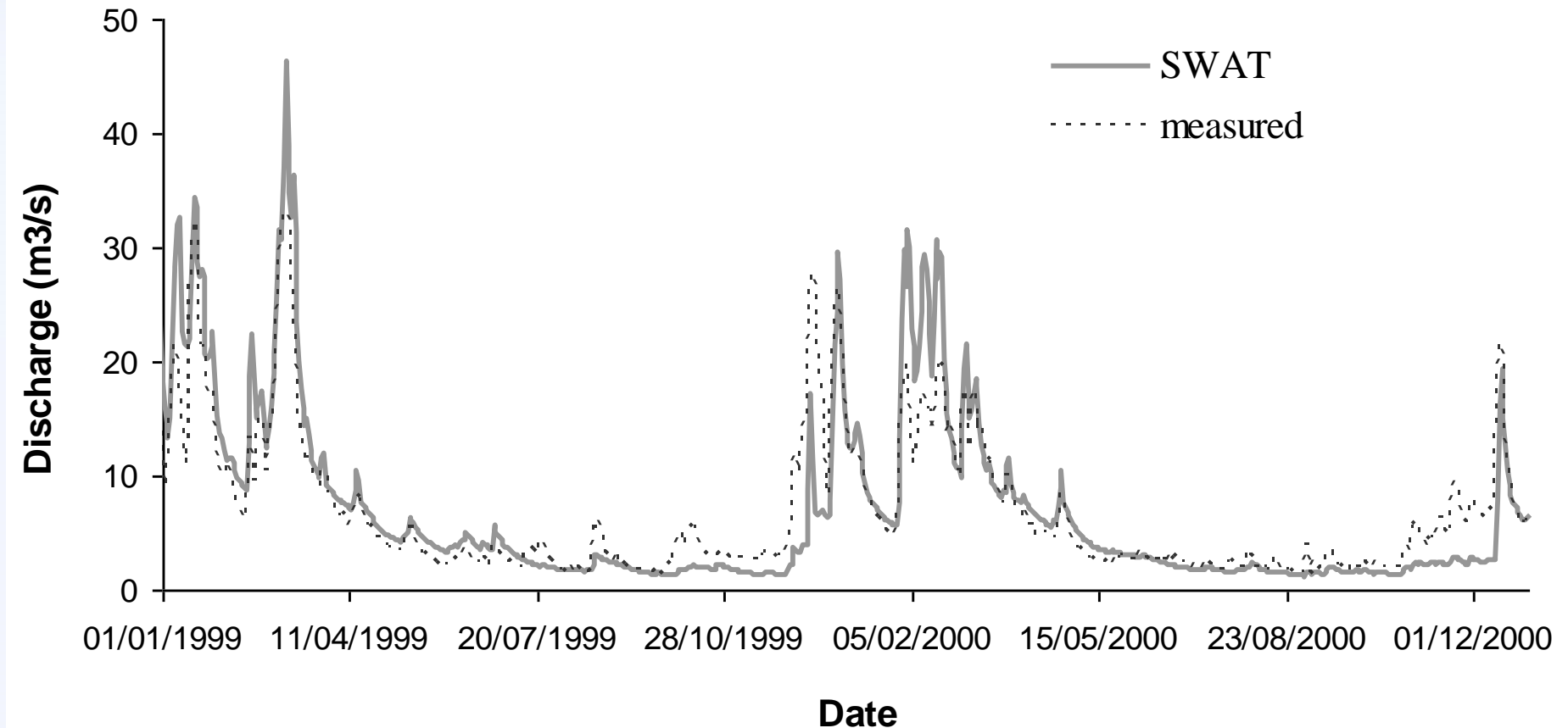
From Hoang et al, 2012



Period	Criteria/ Station	Daily			Monthly		
		45_26	45_21	45_01	45_26	45_21	45_01
Calibration	NSE_Q	0.81	0.76	0.79	0.85	0.80	0.84
	R_Q	0.92	0.91	0.90	0.96	0.95	0.95
Validation	NSE_Q	0.79	0.76	0.80	0.84	0.81	0.85
	R_Q	0.90	0.90	0.91	0.93	0.93	0.93



Supplementary info.



From Hoang et al, 2012