A Screening Tool to Assess the Intrinsic Vulnerability of Catchments to Lose Corn Herbicides to Surface Water

Christian Leu

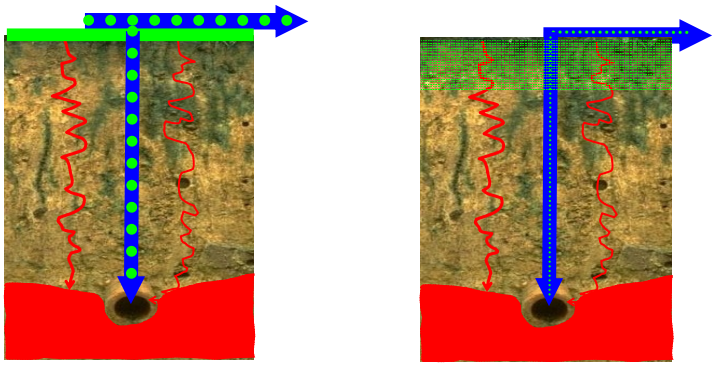
Overview

- Conceptual background → Importance of fast flow
- Model approach
- Model calibration
- One example
- Summary

Fast Flow: Key Driver

Spring Flush: **May, June, July**

After spring flush period



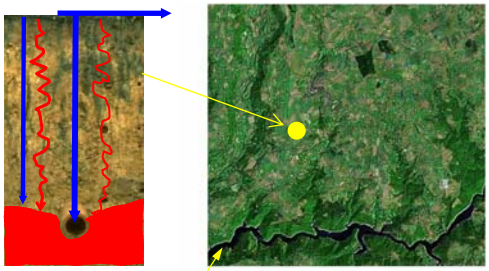
Fast Flow: Surface runoff and preferential flow into subsurface drains

Slow Flow: Slow percolation through soil micropores

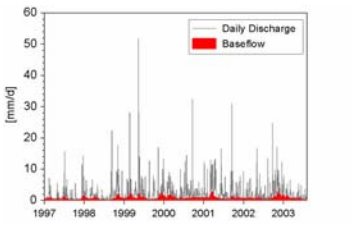
Herbicides (Surface applied, relatively mobile corn herbicide)

syngenta

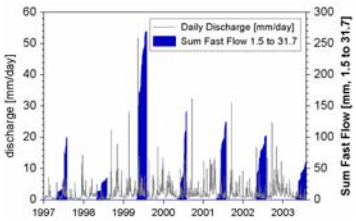
Integrative Catchment Response: Hydrograph



But ?



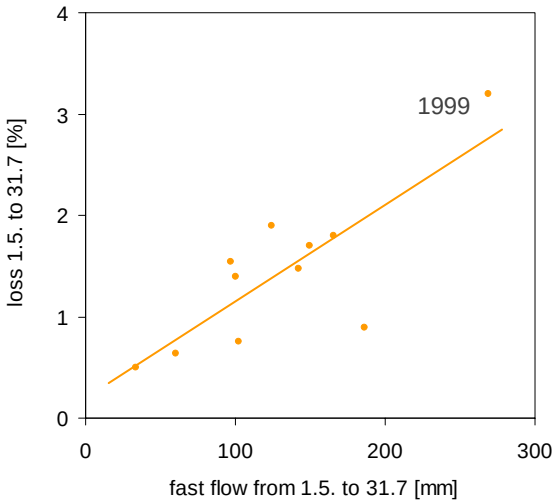
BFI: Percentage of baseflow from total discharge



syngenta

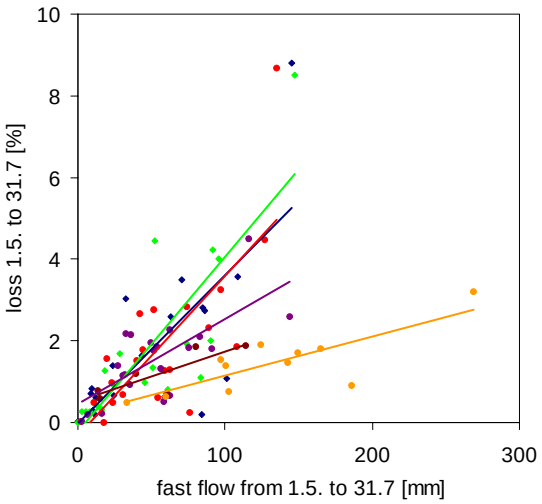
syngenta

Atrazine Losses From Greifensee Catchment (11 Years)



Data: EAWAG, Switzerland

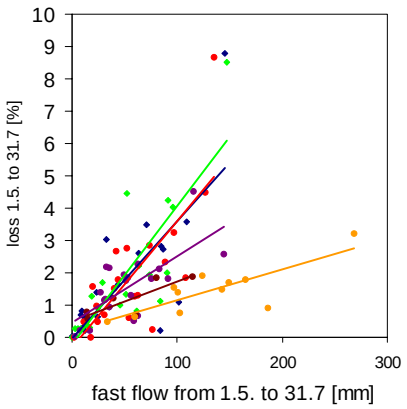
% Atrazine Losses from 6 Catchments (Together: 101 Years)

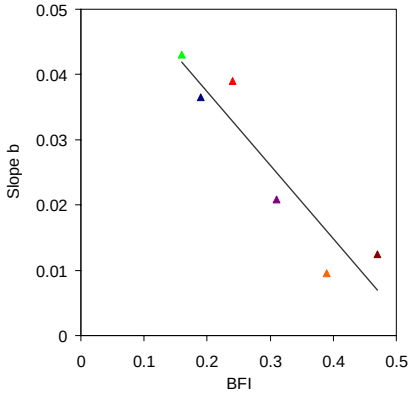


- Fast flow efficacy depends on BFI

Data: EAWAG, Switzerland and Heidelberg College, USA

Relationship between % Atrazine Loss and Fast Flow





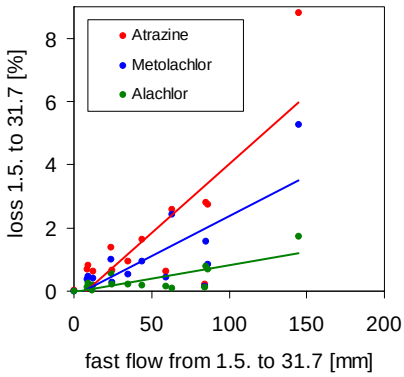
% Atrazine loss: a + **b** * fast flow [mm]

→Allows to predict atrazine losses based on hydrograph only

→ Can establish relations for other compounds

Influence of Substance Properties (Honey Creek Catchment)

One Catchment



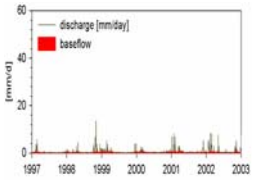
SWMI: Surface Water Mobility Index

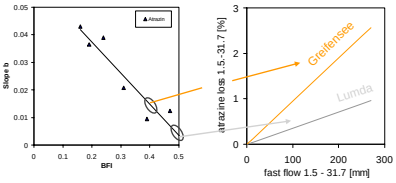
Chen, W. L et al. (2002), Environmental Toxicology and Chemistry, 21(2): 298-308

Pesticide	Type	K_{oc} (L/kg)[a]	$T_{\frac{1}{2}}$ (d)[b]	SWMI
Alachlor	Herbicide	170	15	0.5207
Metolachlor	Herbicide	200	90	0.5969
Atrazine	Herbicide	100	60	0.7184

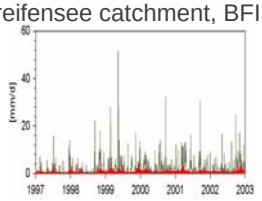
Step1: Determine BFI and Efficacy of Fast Flow

Lumda catchment[1)], BFI: 0.5





Greifensee catchment, BFI: 0.39



- Catchments have similar BFI

→ Similar slope

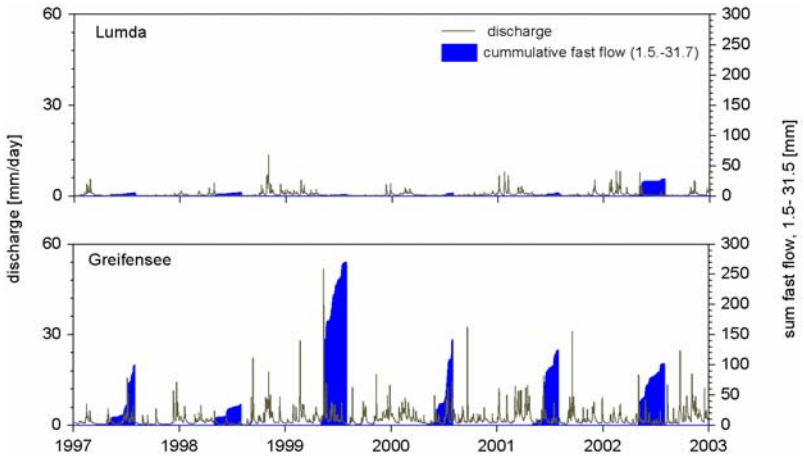
→ Similar dependence on fast flow

- Example with atrazine as surrogate for other similar mobile herbicides

1) Data from: Hessisches Landesamt fuer Umwelt und Geologie

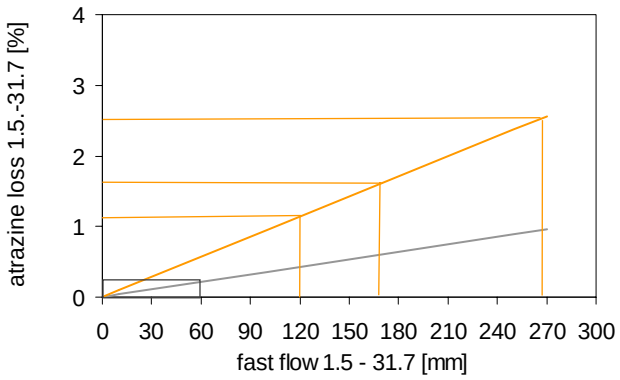
syngenta

Step 2: Determine Amount of Fast Flow (1.5 to 31.7)



syngenta

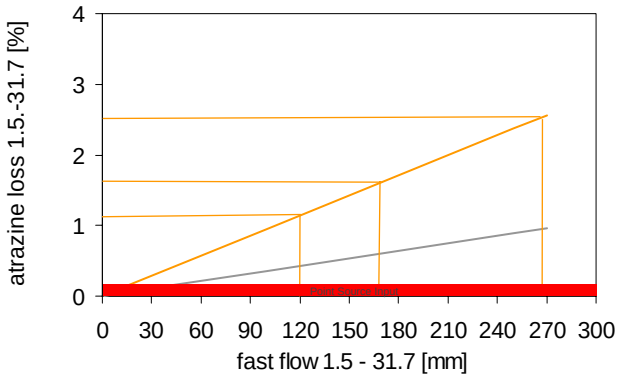
Step 3: Get % Loss and Interpretation



	Fast Flow 1.5 to 31.7 [mm] (20 years)		
	Average	80th Percentile	Maximum
Lumda	14	25	58

syngenta

Step 3: Get % Loss and Interpretation



	Fast Flow 1.5 to 31.7 [mm] (20 years)		
	Average	80th Percentile	Maximum
Lumda	14	25	58
Greifensee	120	168	269

Greifensee:

"…These measurements revealed that in the catchment of Lake Greifensee, farmers who did not perfectly comply with 'good agricultural practice' caused at least 14% of the measured agricultural herbicide load into surface waters…"

Gerecke, A. C., et al. (2002). "Sources of pesticides in surface waters in Switzerland: pesticide load through waste water treatment plants-current situation and reduction potential." Chemosphere 48(3): 307-315.

Zwester Ohm (similar like Lumda)

…."The load detected at the outlet of the catchment amounted to 9048 g a.i. The losses represent 0.22% of the pesticides applied by the farmers. The load was dominated by PSP with at least 77% of the total pollution…"

*Muller, K., M. (2002). "Point- and nonpoint-source pesticide contamination in the Zwester Ohm catchment, Germany." Journal of Environmental Quality **31**(1): 309-318.*

→No exact estimation

But looks rather promising

syngenta

syngenta

Summary

This exploratory research indicates

- Fast flow is important determinant of SW transport losses
- Each catchment is hydrologically unique and this can be defined via BFI
- Each AI has unique phys. chem. properties that will modify the response via fast flow
- Better data exists on flow characteristics than chemical monitoring and data is widely available

Uncertainties:

- Disturbed discharge (e.g. lake influences BFI but not % loss)
- Catchment in S. Europe
- Catchmets with BFI > 0.4
- Catchments with large non agricultural areas (e.g. forest and/or urban coverage)
- Very small catchments and small percentage of sprayed area
- Relationship may be clearest for single application pre-emergent herbicides as these tend to have similar phys. chemical properties to exert their biological effect
- May be different relationships for compounds applied on "as needed" basis to treat infestations rather than every year
- May be different relationships for compounds with markedly shorter half lives or higher Koc's
- May be different relationships for compounds applied multiple times per season
- May be different relationships for compounds applied to treat foliage (e.g. insecticides and fungicides)

Outlook

- Evaluate for other chemicals and catchments
- Keen to try with other catchments: More than happy if anyone provides data: Contact: christian.Leu@syngenta.ch

Acknowledgment

Thanks a lot for the excellent herbicide monitoring datasets:
Heinz Singer (EAWAG, Switzerland)
Pete Richards (Heidelberg College, USA)

Many thanks to Joshua Amos (Waterborne) for usage estimation within Erie catchments

Thanks for fruitful discussions and support:
John Hollis, Sue White, Martin Bach, Christian Stamm,
Alison Sapiets, Paul Sweeney and Paul Hendley

Thanks for HOST classification and UK SWAT:
D.B. Boorman, J. Hollis, A. Lilly, C. Brown