Current vegetated filter strip research, design, and implementation

Challenges and shortcomings

Federal Agency for Water Management
Section Watershed Hydrology and Erosion

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#EUsoil

ONLINE WORKSHOP ON
SOIL EROSION FOR THE EU 20 – 22 JUNE 2022 | JRC Ispra

European Commission

What are VFS?

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What is the problem?

Effectivity of nutrient retention highly variable:

HOFFMANN et al. 2009

Pollutant	Min %	Max %
TP	32	93
DRP	-71	95

STUTTER et al. 2021

Pollutant	Min %	Max %
TP	-55	98
DP	-375	100
Sediment	-36	100
Nitrate	-1650	100

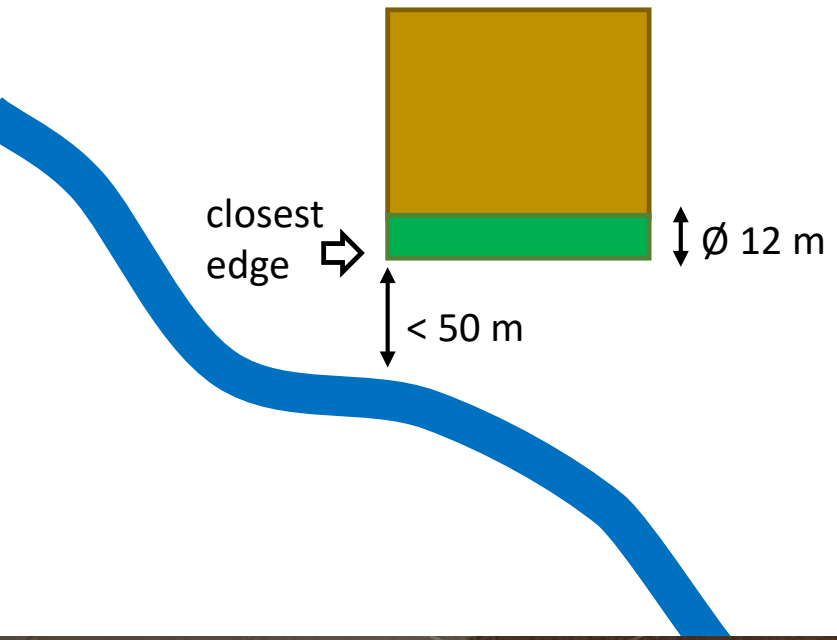
What is causing the problem?

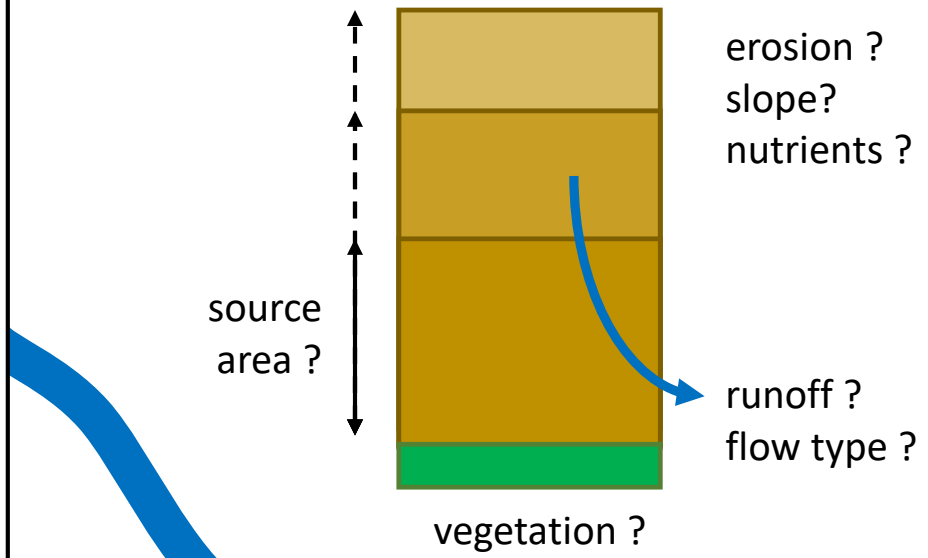
VFS research / monitoring with (over-) simplified approaches

- flow convergence not considered
- subsurface soil not considered
- (long term) temporal aspects not considered
  → nutrient saturation

- State-of-the-art research not effectively communicated

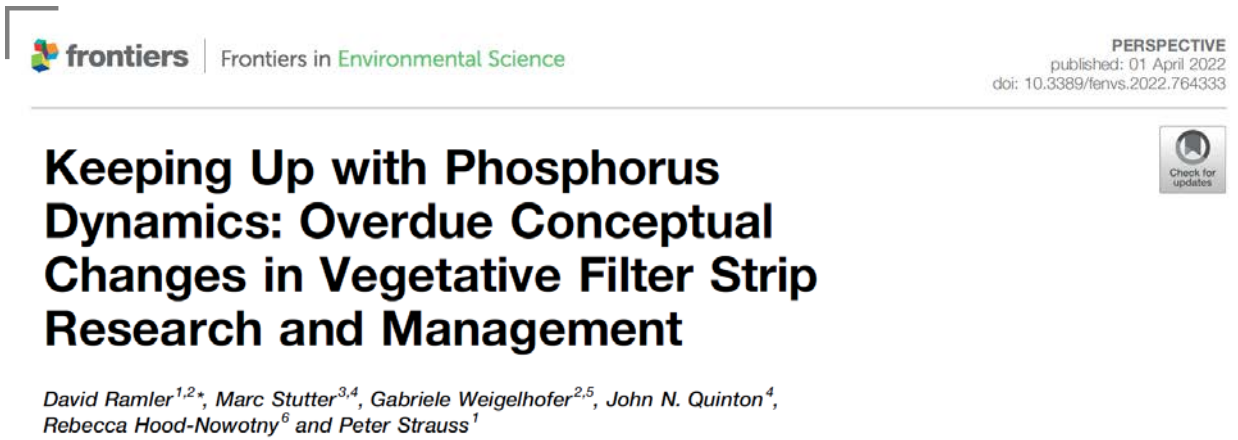
Buffer strips in ÖPUL





This presentation

- **illustrate** problem
- present **solutions** / points for **discussion**
- focus on **P**



frontiers | Frontiers in Environmental Science

PERSPECTIVE
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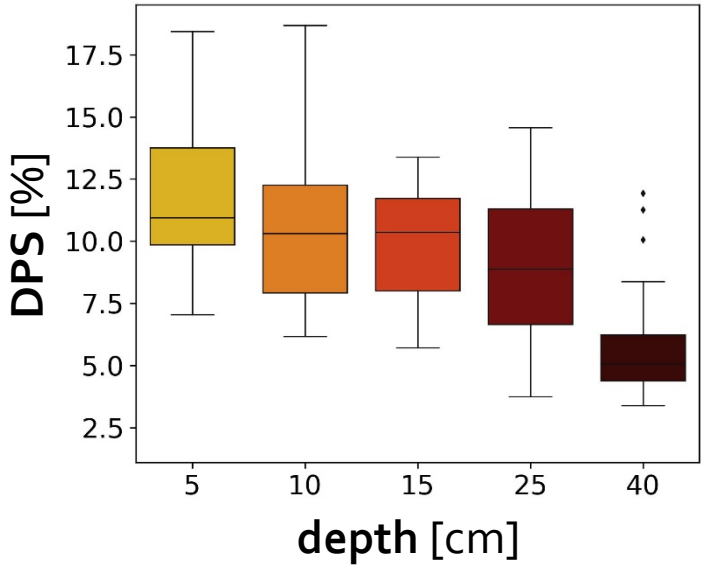
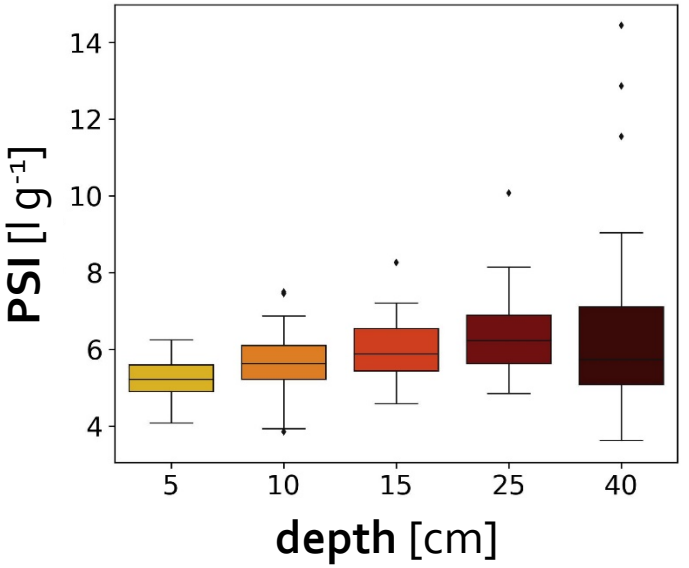
Keeping Up with Phosphorus Dynamics: Overdue Conceptual Changes in Vegetative Filter Strip Research and Management

David Ramler[1,2]*, Marc Stutter[3,4], Gabriele Weigelhofer[2,5], John N. Quinton[4], Rebecca Hood-Nowotny[6] and Peter Strauss[1]

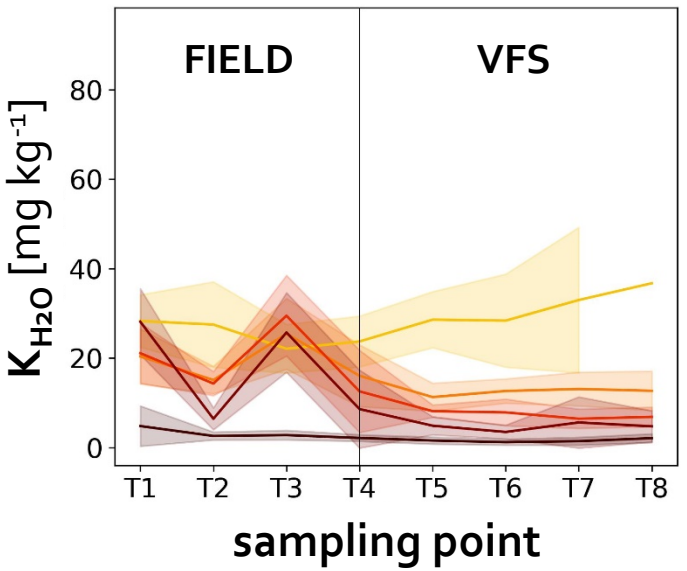
A) Effective volume

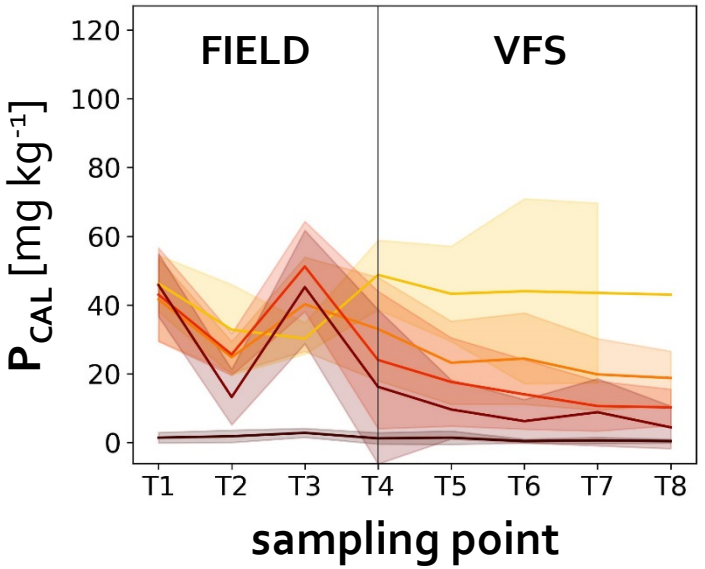




RAMLER et al. *in prep*

A) Effective volume





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A) Effective volume

- undisturbed soil monoliths
- artificial runoff experiments

  - surface runoff
  - subsurface interflow
  - percolating water
  - bypass water

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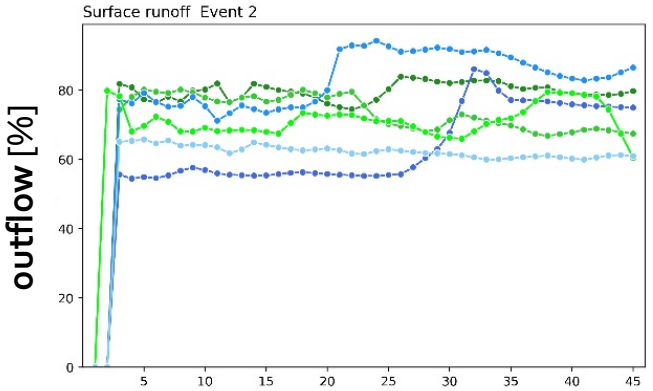
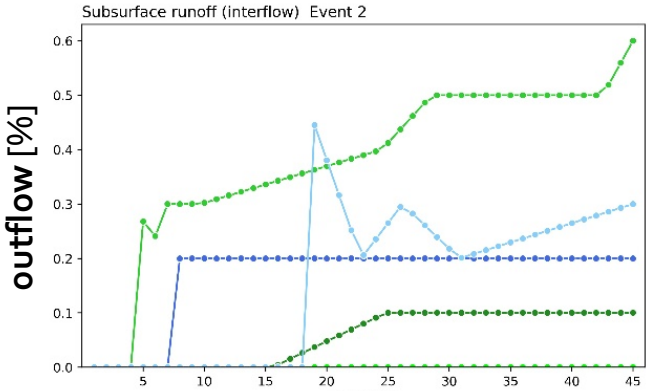
A) Effective volume

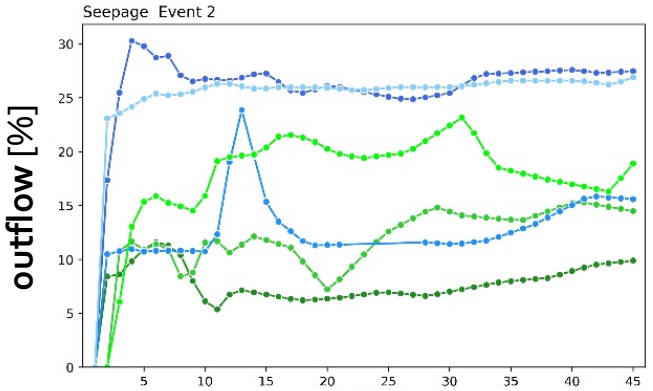
surface runoff [55-95 %]



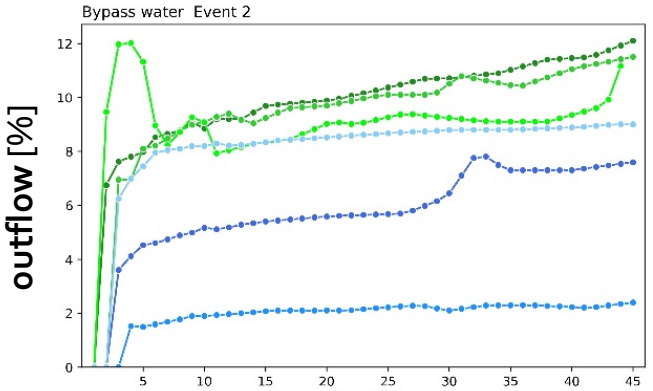
subsurface interflow [< 1 %]



percolating water [5-30 %]



bypass water [2-12 %]



RAMLER et al. *in prep*

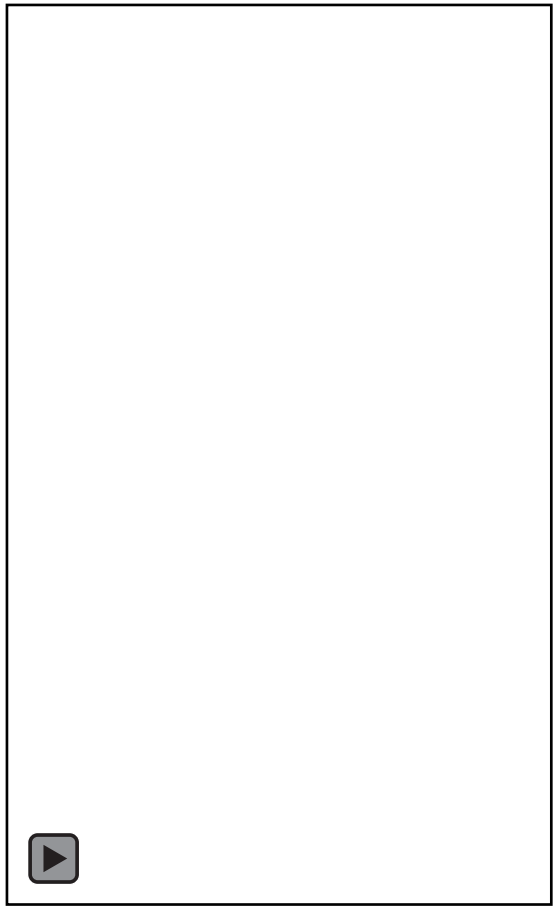
A) Effective volume

fast onset of percolating and bypass water

- high share of macropores
- preferential flow

→ earthworm channels

Is this good or bad?



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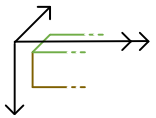
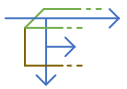
A) Effective volume - synopsis

- soils are **three-dimensional** entities
- **subsoils** with high potential for nutrient uptake
- infiltration vs. **preferential flow**

Simplified approach with only few factors considered	Holistic consideration of contributing factors
 • only width considered • width fixed	 • whole **soil volume** considered, **3D** view • **width adjusted** to local conditions
 • only surface runoff considered	 • **surface**, **subsurface**, and **preferential flow** pathways considered

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B) Flow convergence

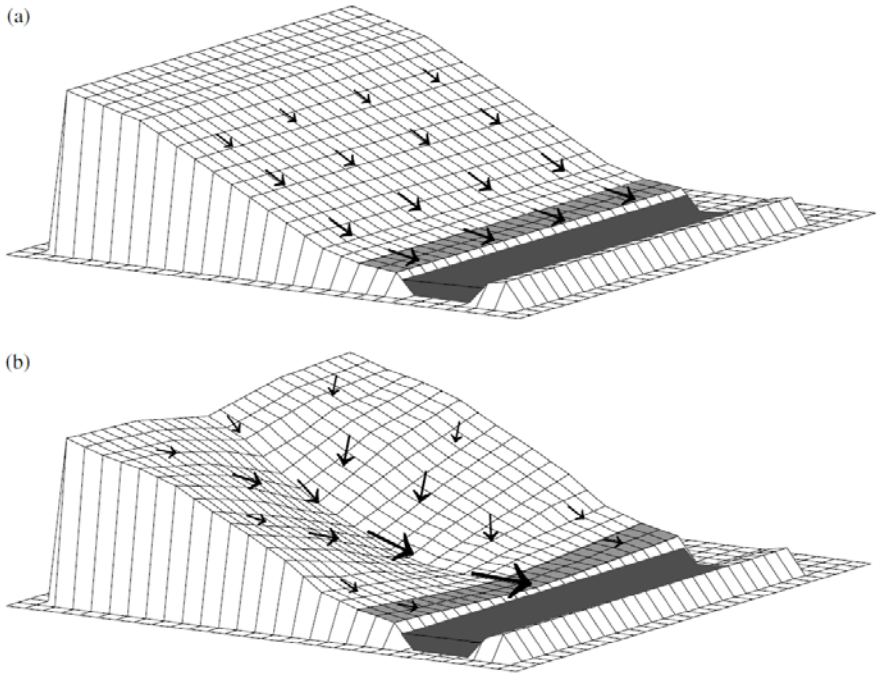
Sheet flow vs. **concentrated** flow

- Flow convergence in **field**

  thalweg | rill erosion | gullies

- Flow convergence at field **edge**

  microtopography | barriers



VERSTRAETEN et al. 2006

B) Flow convergence - sheet flow

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B) Flow convergence - thalweg

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B) Flow convergence - plough shares

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B) Flow convergence - topography

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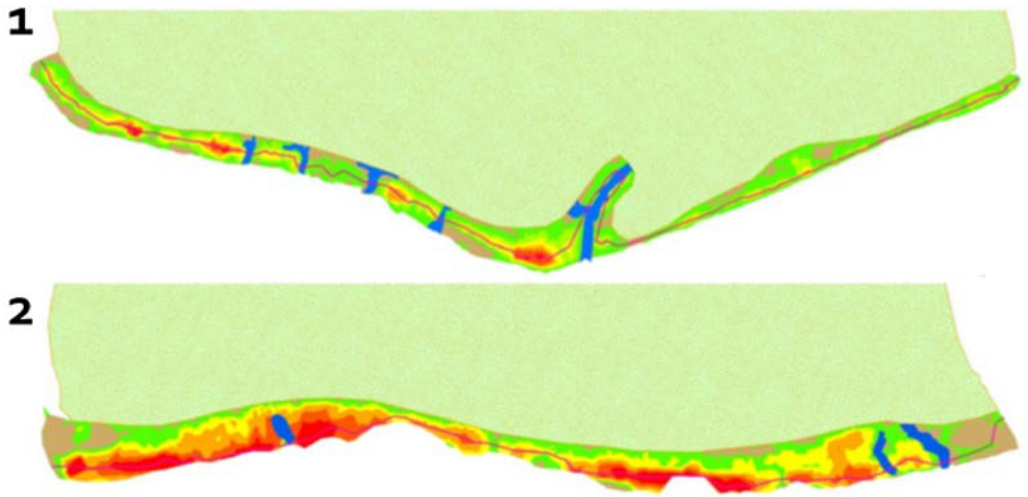
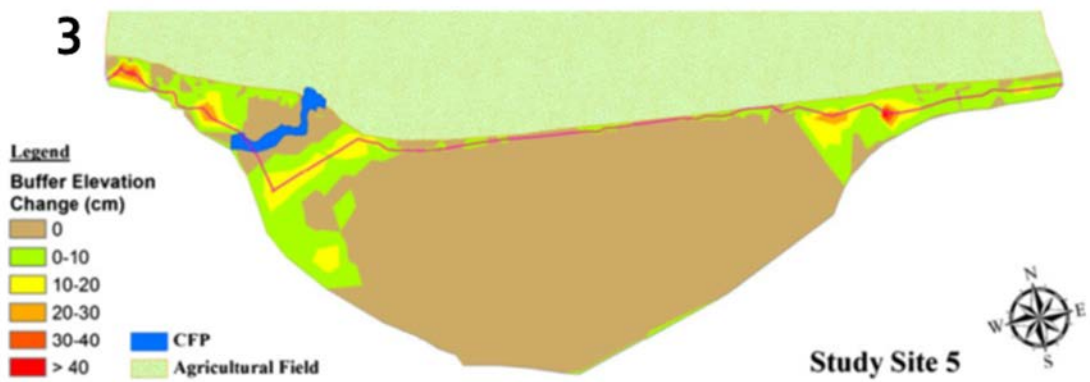
B) Flow convergence - in the buffer





PANKAU et al. 2012

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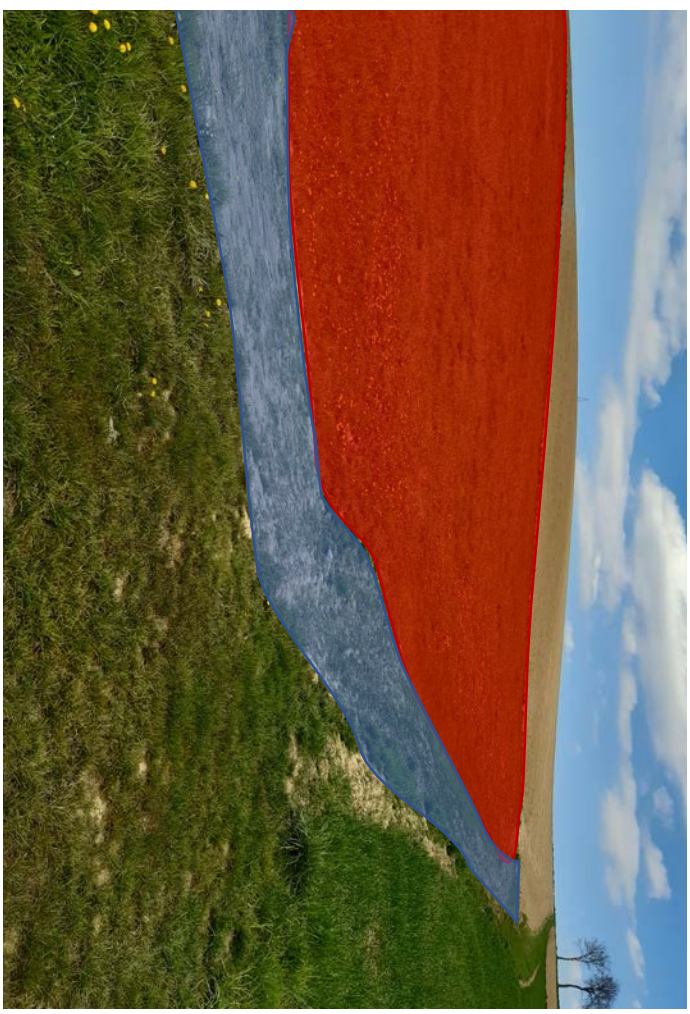

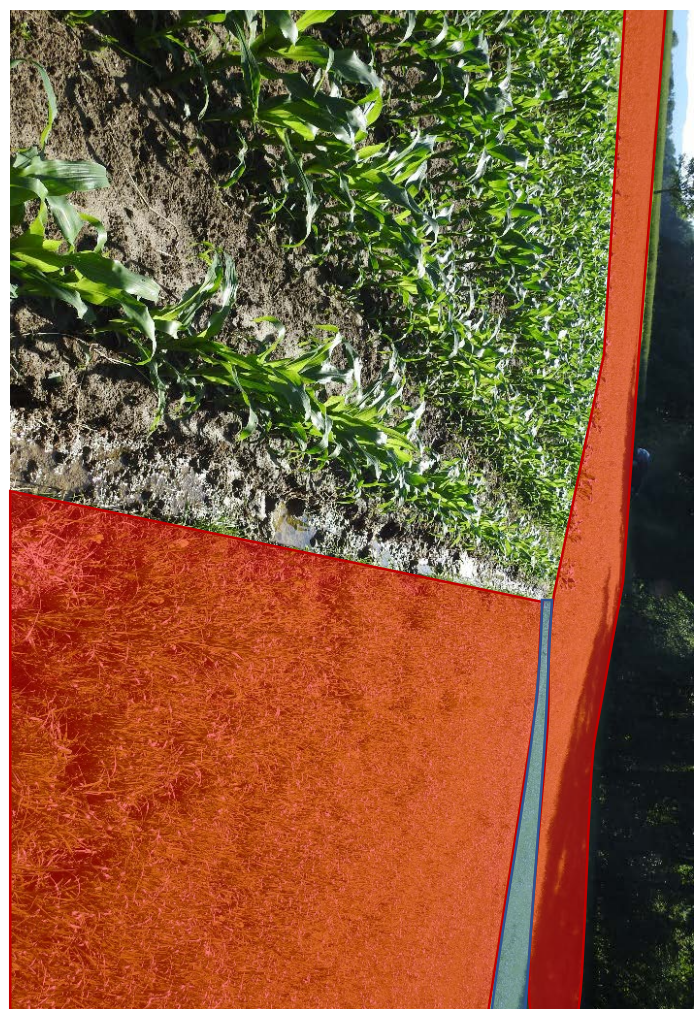

B) Flow convergence - synopsis

- **reduces** effective area / volume
- severely **limits** buffer **effectivity**
- needs more **flexible** buffer **design** & **positioning**

Simplified approach with only few factors considered	Holistic consideration of contributing factors
 • fixed VFS shape	 • VFS **shape adjusted** to runoff conditions

RAMLER et al. 2022

C) Other issues

Simplified approach with only few factors considered	Holistic consideration of contributing factors
• only duration of rainfall considered	• **duration** and **return frequency** of rainfall considered
• same conditions assumed year-round	• **seasonal effects** and **constraints** considered
• one-type-fits-all approach	• **mathematical models** used for risk assessment and corresponding VFS design
• VFS viewed in isolation	• VFS viewed in **geospatial context** • **landscape position** of VFS considered

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What is needed?

Balance of inputs and outputs

amount of incoming P

weather | tillage | cropping | fertilization | …

≤ amount of P that can be temporarily retained

effective area/volume | infiltration | soil type | …

+ amount of P that can be removed (via harvesting)

vegetation type | species | mowing frequency | …

What should be done?

Balance of inputs and outputs

Amount of incoming P

- better assessment of nutrient export potential

  source area | fertilization | slope | soil texture | …

- encourage & support in-field measures
  - reduce fertilization (nutrient pool)
  - minimize erosion risk

What should be done?

Balance of inputs and outputs

Amount of P that can be temporarily retained

- maximize contact time
- maximize contact area
- maximize contact volume
  - grass barriers → re-distributes runoff
  - selected vegetation → promotes infiltration
  - sufficient extent → adapted to nutrient export risk
  - optimal placement → adapted to local conditions

What should be done?

Balance of inputs and outputs

Amount of P that can be removed via harvesting

- optimal vegetation / species composition
- optimal mowing frequency
- management is mandatory
- other ESS

Vegetation type & species

© Ramler / BAW

Vegetation type & species

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SCIENCE

→ more sophisticated and holistic **scientific evaluation** of buffers

SCIENCE | POLICY

→ improved **understanding** of processes and contributing factors

→ improved **communication**

POLICY | FUNDING AGENCIES

→ clear, specific, and bespoke buffer **design recommendations**

PRACTITIONERS

→ long-lasting, **effective buffers**

Thank your for your attention!

Federal Agency
for Water Management
Section Watershed Hydrology and Erosion

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