Concentrated Flow: Implications for Buffer Performance and Design

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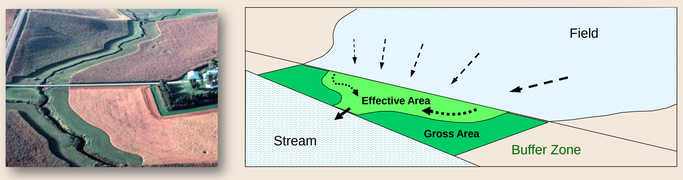
Problem

❖ Concentrated flow is reported to be a common, if not dominant, spatial pattern of overland runoff from agricultural fields.

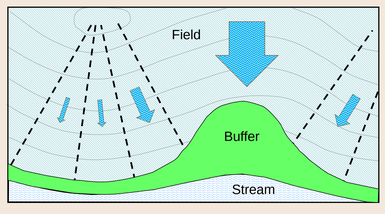
Examples of concentrated flow

❖ Concentrated flow is typically ignored in design and performance assessment of filter strips.

❖ Concentrated flow can overwhelm parts of a filter strip and bypass other parts, thereby reducing its overall effectiveness (Dosskey et al. 2002).



❖ Reconfiguring filter strip to match spatial patterns of runoff flow has been postulated to improve filter strip performance (Dosskey et al. 2005).



Objectives

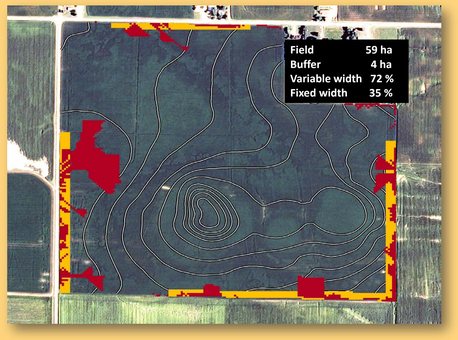
1. Quantify how performance of filter strips is affected by concentrated flow.
2. Compare performance of fixed- and variable-width configurations.

Method

❖ **Sites:** Six fields in the mid-western U.S. (KY, IL, IA, MO) were selected for modeling analysis.

❖ **Model:** *AgBufferBuilder v. 1.0*, a GIS-based model (Dosskey et al. 2015) used with a 5-m DEM grid to:

- Identify detailed spatial patterns of overland flow,
- Estimate sediment trapping by fixed-width filter strips,
- Design variable-width filter strips that match overland flow patterns.



References

Dosskey et al. 2002. Assessment of concentrated flow through riparian buffers. J. Soil Water Conserv. 57:336-343.

Dosskey et al. 2005. Establishing conservation buffers using precision information. J. Soil Water Conserv. 60:349-354.

Dosskey et al. 2015. AgBufferBuilder: A GIS tool for precision design and performance assessment of filter strips. J. Soil Water Conserv. 70:209-217.

Results

❖ Fixed-width filter strips under DEM-indicated runoff patterns had, on average, <u>one half</u> the effectiveness of that predicted under sheet flow.

				% of Sediment Trapped by 15 m-wide Buffer	
Field	Field size (ha)	Soil texture	Tillage type	Under assumed sheet flow	Under DEM-indicated flow
1	59.3	SiCL	Plow	76	35
2	25.1	SiCL	No-till	71	40
3	14.9	SiCL	No-till	73	62
4	30.1	CL-SiCL	No-till	77	24
5	4.05	CL-SiCL	No-till	72	16
6	15.2	SiCL	No-till	77	33
Mean				74	35

❖ Filter strip designed to match DEM-identified runoff patterns (i.e., variable-width) required only <u>one third</u> of the area required by a fixed-width filter strip to achieve the <u>same</u> performance level.

		Filter Strip Size		
Field	% of Sediment Trapped	Fixed 15 m-wide design (ha)	Variable-width design (ha)	Variable-width size as % of fixed-width size
1	35	4.05	1.19	29
2	40	3.44	1.36	40
3	62	0.93	0.67	72
4	24	0.76	0.15	20
5	16	0.09	0.012	13
6	33	0.80	0.27	34
Mean				35

Conclusions

❖ Concentrated flow reduces effectiveness of fixed-width designs;

❖ Variable-width designs require less area than fixed-width designs to achieve same performance level;

❖ Disregarding precise overland flow patterns risks <u>over</u>estimating effectiveness of fixed-width designs.

Model and references available at:
http://nac.unl.edu/tools/AgBufferBuilder.htm