How can risk management practices be considered in regulatory risk assessments: reducing pesticide transport via surface run-off and soil erosion?

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Introduction and Objective

On sloped agricultural fields, water and sediment can be transported downhill as run-off and erosion. These processes cause loss of valuable soil, nutrients and plant protection products (PPP) into adjacent surface water bodies. Risk mitigation measures such as micro-dams are effective means to reduce these losses significantly by keeping run-off water on the field and allow more time for infiltration. The effect of micro-dams can be accounted for in regulatory risk assessment. In Europe and the US, runoff of PPP is calculated with the simulation model PRZM, which uses the USDA runoff curve number (CN) concept to quantitate the amount of run-off water. A high CN indicates a relatively large run-off susceptibility of a field compared to a lower CN. Results from field trials can be used to estimate the effect of micro-dams between the ridges of potato or in maize fields and to determine the mitigation effect by deriving the CN reduction. These modified CN values can in turn be used in the simulation model to quantitatively consider the effect of mitigation on the surface water exposure (EU: PECsw / US: EEC/EDWC). The MAgPIE workshop[1] proposes a lowering of the CN by 3 points for micro-dams and other in-field bunds. The objective of the present work was to enlarge the underlying small database for the effect of micro-dams and to provide a better founded recommendation.

Materials and Methods

Field trials. Existing trials with micro-dams in potato and maize cultivation were evaluated. In Fig. 1 and 2, examples of the cultivation techniques are depicted. Measurements were available for precipitation/runoff dynamics, partly for eroded soil material and PPP loads.

Calculations. Runoff *Q* [mm] in European and American risk assessment is calculated applying the (FOCUS) PRZM[2] model based on the precipitation *P* [mm] using:

$$Q = \frac{(P - 0.2 * S)^2}{P + 0.8 * S}$$

The corresponding daily watershed parameter *S* [L] was inversely estimated, and consequently, the (dimensionless) curve number *CN*, being the quantification in risk assessment:

$$S = 25.4 * (\frac{1000}{CN} - 10)$$

Figure 3 shows the relation of precipitation and runoff quantified by different curve numbers.

Figure 1: Installation of microdams on a potato field, using the "Barbutte" equipment[8].

Figure 2: Erosion reduction with disc plough (above) or drum plough (below)[8].

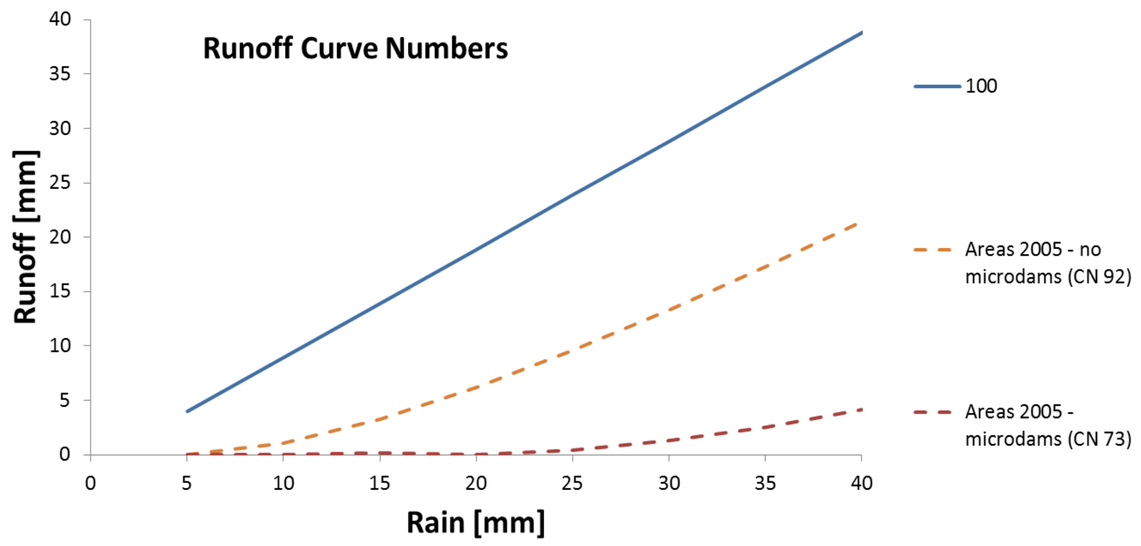

Figure 3: Relationship between rain and runoff expressed by the curve number.

Results & Discussion

Table 1 lists the various effects of the application of micro-dams in potatoes or similar techniques in maize. This measure leads to a decrease of the runoff from agricultural fields, which is reflected in lower (average) curve numbers. Consequently, the eroded sediment quantities and the amounts of transported PPP were lowered. Figure 3 exemplarily shows the results of the Areas 2005[6] trial – with and without the application of microdams in potato fields.

Table 1: Measured effects on (average) curve numbers (CN), runoff quantities and plant protection product (PPP) loads resulting from the mitigation measures

	Potatoes					Maize	
	CRA-W (2011)[3]	Goffart et al. (2013)[4] 2009	Goffart et al. (2013)[4] 2010	Aurbacher et al. (2010)[5]	Areas (2005)[6]	Areas (2007)[7]	CIPF (2013)[8]	UCL (2012)[9]
CN untreated	83	38	14	75	92	95	68	78
CN treated	73	28	11	39	73	78	66	74
CN reduction	**10 (12%)**	**10 (28%)**	**3 (21%)**	**36 (48%)**	**19 (21%)**	**17 (18%)**	**2 (3%)**	**4 (5%)**
Runoff reduction	47 – 100%	30 – 98%		98%	-	84%	24 – 89%	19 – 82%
Erosion reduction	13 – 100%	58 – 100%		97%	-		54 – 98%	70 – 77%
PPP reduction	84 – 97% (n=4)	43 – 81% (n=5)		-	-	-	38 – 87% (n=5)	36 – 56% (n=1)
CN change	**− 24% (± 12%), 10th percentile: − 15%**						**− 4% (± 2%)**	

Conclusions and Outlook

The evaluation of several field studies suggests that micro-dams justify a reduction of the average runoff curve number for surface water exposure modelling on average by 24% (16 points) in potatoes and 4% (3 points) in maize. For potatoes this goes far beyond the recommendation by the MAgPIE workshop of only 3 reduction points for bunds in row crops, which is however based on fewer studies. It is highly recommended that the curve number reductions due to micro-dams in potatoes be increased accordingly. In addition, a percentage rather than absolute reduction should be used to control for differences in fields. Further studies in maize are planned for more experimental evidence.

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