# Mitigation of runoff in the FOCUS Surface Water Scenarios

Note of the fate group of the Environmental Risk Assessment team of Alterra on the interpretation of the mitigation of runoff in the FOCUS Landscape and Mitigation report (2007)

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Alterra-rapport 1794, ISSN 1566-7197

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Interpretation of the mitigation of runoff in the FOCUS Surface Water Scenarios as described in the FOCUS L&M report

Commissioned by research theme BO-06-010 Beoordelingssystematiek toelating gewasbeschermingsmiddelen (Methodology of risk assessment for registration of plant protection products) of the Dutch Ministry of Agriculture, Nature and Food Safety.

# Interpretation of the mitigation of runoff in the FOCUS Surface Water Scenarios as described in the FOCUS L&M report

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**Alterra-rapport 1794**

**Alterra, Wageningen, 2009**

ABSTRACT

Horst, M.M.S. ter, P.I. Adriaanse, J.J.T.I. Boesten, 2009. *Interpretation of the mitigation of runoff in the FOCUS Surface Water Scenarios as described in the FOCUS L&M report.* Wageningen, Alterra, Alterra-rapport 1794. 34 blz. ; 6 figs.; 5 refs.

The FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment published her final report in 2007. In Volume 1 (Extended Summary and Recommendations) as well as in Volume 2 (Detailed Technical Reviews) the Working Group gave guidance on how to mitigate runoff and erosion entries in the FOCUS Surface Water Scenarios on runoff. The guidance was written in such a way, that different interpretations with respect to dilution of runoff fluxes with clean water in the FOCUS Runoff scenarios are possible. Our interpretation is that the reduced runoff fluxes (water and mass) of the 20 ha upstream are combined with the unchanged runoff water fluxes of the remaining 80 ha upstream catchment. This implies that the reduction factor on exposure concentrations in FOCUS streams of Step 4 FOCUS scenarios calculations compared to those of Step 3 calculations approximately equals the reduction factor applied on the runoff fluxes (water and mass of the 20 ha upstream).

Keywords: FOCUS Landscape and Mitigation, runoff reduction

Photographs frontpage: Werner Pol (Ctgb) and Jos Boesten (Alterra)

ISSN 1566-7197

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# Contents

# Preface

If calculations with the Step 3 FOCUS Surface Water Scenarios indicate that there are insufficient safe uses in the EU to place a compound on Annex 1 of EU Directive 91/414/EEC so-called Step 4 FOCUS calculations may be performed. The FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment developed guidance on possible approaches that result in more realistic and lower exposure concentrations in Step 4 FOCUS Surface Water Scenarios calculations.

Members of the Environmental Risk Assessment team of Alterra are regularly involved in performing Step 4 FOCUS Surface Water Scenarios calculations for external parties. Some were also involved in the opinion of the Scientific Panel on Plant protection products and their Residues on request from the EFSA (European Food and Safety Authority) on the final report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment (2006). These two types of activities led to a close and critical reading of the two volumes of the FOCUS Landscape and Mitigation report. We concluded that the text of the FOCUS Landscape and Mitigation report is written in such a way that several interpretations are possible. After contacts with the chairman of the FOCUS L&M Working Group (C. Brown) as well as with the release manager (G. Görlitz) of the SWAN software tool ( recommended in the FOCUS L&M report) we describe here an unambiguous interpretation  of the reduction of runoff and erosion in the FOCUS Surface Water Scenarios on the PEC values. The feed back of both the FOCUS L&M Chairman as the SWAN release manager have been incorporated in this report.

# Summary

In this report we first explain which reduction factors can be defined for the FOCUS Surface Water Scenarios to obtain reductions in runoff or erosion. Next, we demonstrate that the guidance of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment was written in such a way that different interpretations are possible with respect to dilution of runoff fluxes with clean water. The FOCUS L&M Working Group published her final report consisting of a Volume 1 (Extended Summary and Recommendations) and a Volume 2 (Detailed Technical Reviews) in 2007. The report gives guidance on how to mitigate runoff and erosion entries in the FOCUS Surface Water Scenarios on runoff. Our interpretation of the guidance of the FOCUS Working Group is that the reduced runoff fluxes (water and mass) of the treated 20 ha upstream are combined with the unchanged runoff water fluxes of the remaining 80 ha upstream catchment. This implies that the reduction factor on exposure concentrations in FOCUS streams of Step 4 FOCUS scenarios calculations compared to those of Step 3 calculations approximately equals the reduction factor applied on the runoff fluxes (water and mass of the treated 20 ha upstream).

FOCUS L&M advises to use the SWAN tool, developed by the ECPA, to calculate exposure concentrations after runoff and erosion mitigation. We compared the reduction factors used in SWAN to those defined by us and concluded they correspond. We also concluded that the SWAN software is in line with the guidance of FOCUS L&M, i.e. the runoff of the treated 20 ha upstream is reduced, while the runoff of the 80 remaining ha are not reduced.

# 1 Introduction

## 1.1 FOCUS Surface Water scenarios

The risk assessment process related to the EU Guideline 91/414/EEC requires an estimation of the PECs in surface water. A tiered approach with four levels of assessment with increasing realism (Step 1 to 4) was developed. For the purposes of a Step 3 EU-level assessment of concentration estimation, ten FOCUS surface water scenarios were developed. They are a set of ten standard combinations of weather, soil and cropping data and water bodies, which collectively represent agriculture in the EU. Step 3 calculations represent reasonable worst-case exposure. Generally Step 3 calculations are performed, but in case of a more detailed specific assessment, Step 4 estimates of PECs based on specific local situations can be used. An option for Step 4 calculation is to include a form of label mitigation, e.g. vegetated buffer zones.

## 1.2 FOCUS Runoff stream scenarios

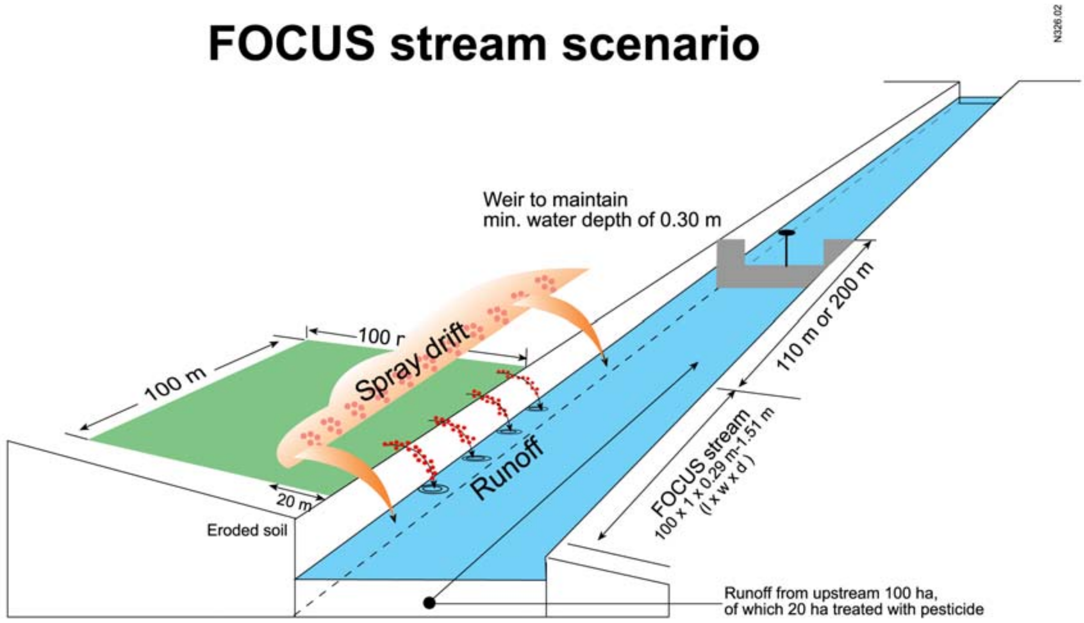


*Figure 1 Geometry of a FOCUS runoff stream scenario*

A FOCUS runoff stream is fed by a constant, small base flow plus part of the variable infiltration flux (this is part of the infiltration flux at 1 m depth in the soil profile defined by PRZM), calculated by the PRZM model for the 100 ha upstream catchment and the neighbouring 1 ha field (Fig. 1). Both flows do not contain pesticides. Next to the base flow and the infiltration flux, runoff water containing pesticides enters the stream. Often the runoff water fluxes largely exceed the base flow plus infiltration flow. In every FOCUS stream scenario 20 ha of the 100 ha upstream catchment is treated and the 1 ha neighbouring field is treated (Fig. 2).

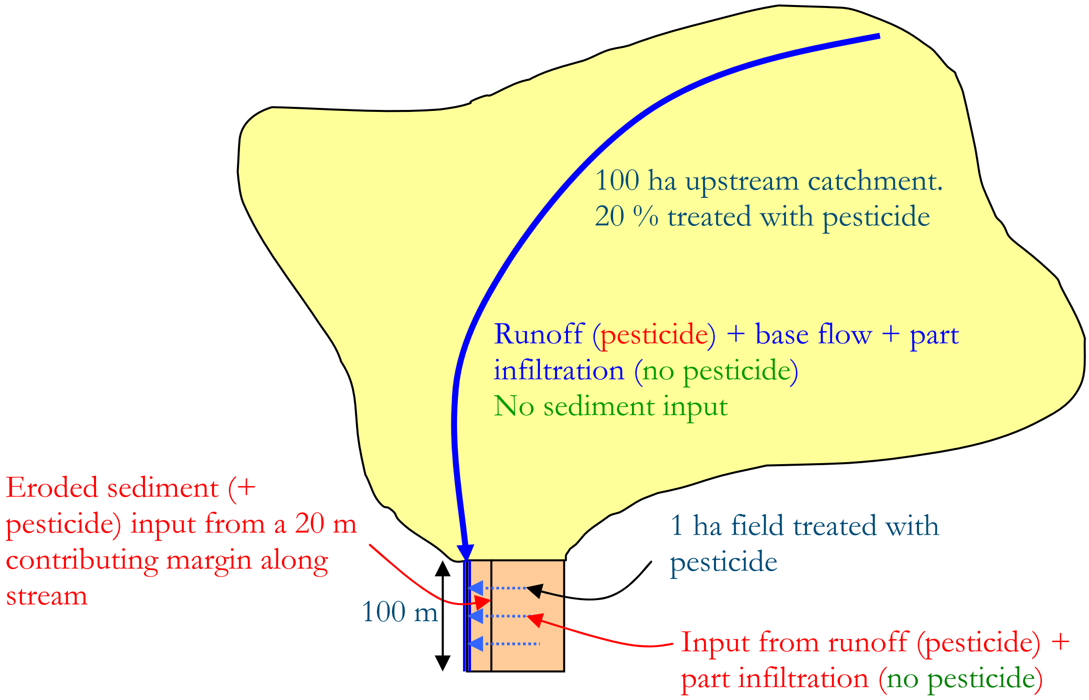


*Figure 2 Conceptual outline of the FOCUS runoff stream scenario (from FOCUS, 2001)*

In those cases where the runoff water fluxes largely exceed the base flow plus infiltration flow the PEC can be approximated by:

$$PEC_{step3} = \frac{21M}{101V} \qquad \text{(Eq. 1)}$$

where:

| | | |
|---|---|---|
| $PEC_{step3}$: | Predicted Environmental (peak) Concentration as calculated for the Step3 EU-level assessment of concentration estimation | $\mu g\ L^{-1}$ |
| M: | mass of the pesticide in runoff water entering the FOCUS stream | $\mu g\ ha^{-1}$ |
| V: | volume of runoff water entering the FOCUS stream | $L\ ha^{-1}$ |

Equation 1 represents a worst case calculation of the PEC (that neglects the continuous base flow of the stream and the variable infiltration flux).

For runoff scenarios it is assumed that the stream only receives eroded soil and associated pesticide from a 20 m 'corridor' in the field adjacent to it (FOCUS, 2001).

### 1.3 Reduction of runoff and erosion

Reduction of runoff can be applied to the volume of runoff water entering the FOCUS stream and to the mass of pesticide in runoff water entering the FOCUS stream. We define the reduction factors for runoff as:

| | | |
|---|---|---|
| $f_{ro,w}$: | reduction factor applied to the volume of runoff water (in mm $h^{-1}$) that is entering the FOCUS stream. (So, if the initial volume is $V_{ini}$, then the remaining volume after reduction is (1- $f_{ro,w}$) $V_{ini.}$) | - |
| $f_{ro,su}$: | reduction factor applied to mass flux of the pesticide (in mg $m^{-2}$ $h^{-1}$) in runoff water that is entering the FOCUS stream | - |

Reduction of erosion can be applied to the mass of eroded sediment entering the FOCUS stream and to the mass of pesticide sorbed to eroded sediment entering the FOCUS stream. We define the reduction factors for erosion as:

| | | |
|---|---|---|
| $f_{er,so}$: | reduction factor applied to mass of eroded sediment (in kg $h^{-1}$) that is entering the FOCUS stream | - |
| $f_{er,su}$: | reduction factor applied to mass flux of the pesticide (in mg $m^{-2}$ $h^{-1}$) sorbed to eroded sediment that is entering the FOCUS stream | - |

# 2 Interpretation of mitigation of runoff in the FOCUS Landscape en Mitigation report

Mitigation of runoff is possible by introducing a reduction factor for runoff. Appendix 1 gives an overview of statements made in the final report of the FOCUS Landscape and Mitigation report (2007). The texts cited in Appendix 1 demonstrate that several interpretations are possible on the exact way of reducing runoff in the FOCUS scenarios.

Before asking the chairman of the WG, Alterra thought that buffer zones were installed in the entire catchment and therefore the runoff water fluxes of all 100 ha were reduced. Alterra had the idea that this was in agreement with the Opinion of the EFSA PPR Panel on the L&M report (EFSA, 2006). Also Alterra interpreted the statement of the final version of FOCUS L&M shown below wrongly because the implicit thought of the L&M Working Group, that 20% of the area of the upstream catchment is cropped by the target crop and 80% of the area is supposed to have some other landuse was not known to Alterra.

"FOCUS surface water scenarios are abstracted representations of reality, it may be difficult to justify an assumption that vegetated buffers are only applied to part of the upstream catchment; buffers are a long-term investment by a farmer and thus will likely be applied across all fields likely to be cropped with a particular system that requires the buffer." (FOCUS, 2007)

Alterra interpreted the text above as follows: the pesticide mass fluxes of the 1 ha neighbouring field and the 20 ha of the upstream catchment are reduced and that the runoff water fluxes from the 1 ha neighbouring field and the entire upstream catchment of 100 ha are also reduced. This approach means that exposure concentrations in the FOCUS stream will not change unless the runoff water fluxes are so much reduced (generally >90, 95%) that the constant low base flow (+ part of the PRZM infiltration flux, both without pesticides) starts to be important for diluting the concentration in the runoff water. This dilution happens when the size of the clean baseflow (+part of PRZM infiltration flux) approaches the size of the runoff water flow into the stream. This approach also implies that the size of the runoff event determines the reduction percentage, i.e. this method is not very robust. If e.g. the baseflow (+part of the PRZM infiltration flux) is 200 $m^3/d$ and the runoff results in an additional 8000 $m^3/d$ in the stream less reduction of the runoff water and mass fluxes are needed than if the runoff event results in 20 000 $m^3/d$ discharge to obtain a wished PEC value.

- So, for the authorization procedure this option means that very high reduction percentages are needed in order to lower the exposure concentrations in the FOCUS stream. Reduction of predicted environmental concentrations is only achieved when very high reductions (>90%) are applied.

- Later on this idea could not be underpinned by text in the Opinion, or by the Alterra member of this Panel and so, the interpretation Alterra made can not be underpinned. Also confirmation of the interpretation of Alterra could not be found in the FOCUS L&M as the text is not clear enough (see Appendix 1).

In the final version of the FOCUS Landscape and Mitigation report (FOCUS, 2007) the FOCUS WG assumes that the buffer zones are installed at the 21 ha with treated crops only, and not on the remaining 80 ha of the upstream catchment. They implicitly assume that the remaining 80 ha of the upstream catchment is cropped with something else. At these 80 ha there are no buffer zones and runoff water fluxes are not reduced.

- For the authorization procedure this means that exposure concentrations in the step 4 FOCUS Runoff scenarios (including mitigation) are reduced compared to those of Step 3 calculations because the runoff water fluxes of the 80 ha remain unchanged. So, the reduced pesticide mass fluxes are diluted by unchanged runoff water fluxes from 80 ha and 20 ha reduced runoff water fluxes coming out the 100 ha upstream catchment.
- The final version of the L&M report (FOCUS, 2007)) is vague about the exact way the reduction factors ($f_{ro,w}$, $f_{ro,su}$, $f_{er,so}$, $f_{er,su}$) need to be applied, therefore the chairman of the WG was asked for clarifications via email, which resulted in the description given above (see Appendix 2 for email exchange).
- Appendix 1 gives an overview of the relevant paragraphs in the latest version of the L&M report. L&M advocates the use of the software SWAN in which it is assumed that 21 ha of the total 101 ha (1 ha neighbouring field plus 100 ha upstream catchment) has buffer zones (see Chapter 3).

# 3 Calculation of runoff reduction

## 3.1 SWAN theory

In the SWAN software (version 1.1.4, ECPA and Tessalla Support Services, 2008) runoff reduction factors are applied to 21M and 21V (1 ha neighbouring field and 20% of 100 ha treated; see Fig. 2).

The formula's shown in Figure 3 are given in the Help function of SWAN.

```
Run-off volume      (column 2 in *.p2t file)

RVStep_4 = RVStep_3 * [Af * (1-frv) + Ac * (1 - F * frv)] / [Af + Ac]

          Af         = area of treated field (1 ha)
          Ac         = area of upgradient fields
                         4.5 ha for pond
                         100 ha for stream
          F          =  fraction of catchment that is treated
                         1.0 for pond
                         0.2 for stream
          frv        = fractional reduction in run-off volume due to buffer strip
          RVStep_3   = run-off volume read from Step 3 .p2t file
          RVStep_4   = run-off volume written to Step 4 .p2t file


Run-off flux        (column 3 in *.p2t file)

RFStep_4 = RFStep_3  * (1 - frf)

          frf        = fractional reduction in run-off flux due to buffer strip
          RFStep_3   = run-off flux read from Step 3 .p2t file
          RFStep_4   = run-off flux written to Step 4 .p2t file
```

*Figure 3 Formulas regarding reduction of runoff from the help file of SWAN* [*]

The terminology in SWAN might be confusing. However, reduction in runoff volume (frv) corresponds to the reduction in the volume of runoff water (in mm $h^{-1}$). The remaining volume (so after being reduced) enters the FOCUS stream. Reduction in runoff flux (frf) corresponds to the reduction of mass flux of the pesticide (in mg $m^{-2}$ $h^{-1}$) in runoff water. And the remaining mass flux (so after being reduced) enters the FOCUS stream. So, the reduction factors frv and frf in Figure 3[*] correspond to respectively the reduction factors $f_{ro,w}$, $f_{ro,su}$ defined in Chapter 1.

[*] *Please note that according to FOCUS 2001 (page 102) the area of upgradient fields for the pond is not 4.5 ha but 0.45 ha (4500 $m^2$). We did not test whether SWAN uses the correct value of 0.45 ha in its calculations.*

Please note that it is possible in SWAN to specify different values of the reduction factor for reduction of the volume of runoff water and the mass of the pesticide in runoff water (Figure 4).

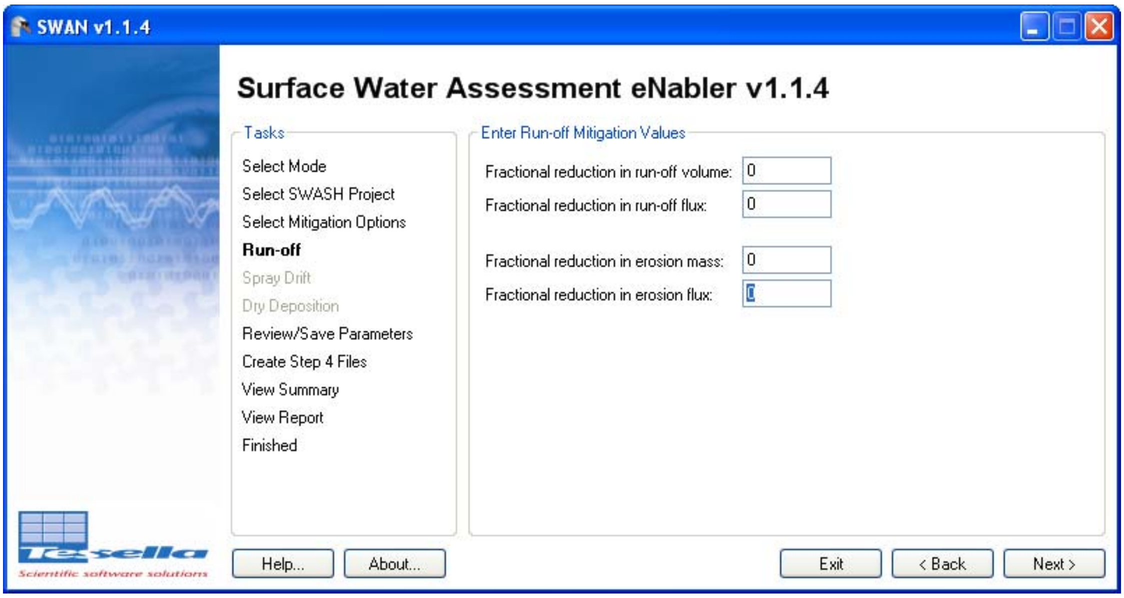


*Figure 4 Input screen of SWAN showing different boxes for reduction of runoff and erosion.*

We tested whether the way the SWAN software handles reduction in runoff is in line with the assumption of the FOCUS WG on landscape and mitigation i.e. assuming that the buffer zones are installed at the 21 ha with treated crops only, and not on the remaining 80 ha of the upstream catchment

It is difficult to establish directly from the equations in Fig. 3 if reduction if applied to 21 ha (1 ha neighbouring field and 20% of 100 ha treated; see Fig. 2) as assumed by the FOCUS WG on landscape and mitigation. It is therefore necessary to fill and write out the equations in Fig. 3.

Filling in the values below in the equation for calculating the reduced volume of runoff water entering the FOCUS stream (Fig. 3) gives equation 2.

- RVstep_3 = 101V
- Af = 1 ha
- Ac =100 ha
- F = 0.2
- frv = $f_{ro,w}$

$$RVStep\_4 = \frac{101V\left[1\left(1-f_{ro,w}\right)+100\left(1-0.2f_{ro,w}\right)\right]}{1+100} = \frac{101V\left[1-f_{ro,w}+100-20f_{ro,w}\right]}{101}$$

Eliminating the number 101 in the numerator and the denominator gives:

$$RVStep\_4 = V\lfloor 101 - 21f_{ro,w} \rfloor = 101V - 21Vf_{ro,w} \qquad \text{(Eq. 2)}$$

Eq. 2 shows that the reduction factor applied the volume of runoff water entering the FOCUS stream is applied to 21V, so to 21 ha (1 ha neighbouring field and 20% of 100 ha treated; see Fig. 2).

Filling in the values below in the equation for calculating the reduced mass of the pesticide in runoff water gives equation 3.

- RFstep_3 = 21M
- frf = $f_{ro,su}$

$$RFStep\_4 = 21M(1 - f_{ro,su}) = 21M - 21Mf_{ro,su} \qquad \text{(Eq. 3)}$$

Eq. 3 shows that the reduction factor applied the mass of the pesticide in runoff water entering the FOCUS stream is applied to 21M, so to 21 ha (1 ha neighbouring field and 20% of 100 ha treated; see Fig. 2).

We concluded that the way the SWAN software handles reduction in runoff is in line with the assumption of the FOCUS WG on landscape and mitigation that the buffer zones are installed at the 21 ha with treated crops only, and not on the remaining 80 ha of the upstream catchment.

However, the SWAN software is not in line with the advise of the FOCUS Landscape and Mitigation report (FOCUS, 2007; Volume 1 page 33 and Volume 2 pages 144-145 BOX 9) to apply **the same** reduction factor to both the volume of runoff water as the loading of dissolved phase pesticide in that runoff (i.e. the mass of the pesticide in runoff water).

If we assume that $f_{ro,w} = f_{ro,su} = f_{ro,w/su}$ (where $f_{ro,w/su}$ is the fraction of reduction applied both to the volume of runoff water as the mass of the pesticide in runoff water) and that the concentration is calculated as the quotient of mass (M) and volume (V), the predicted environmental concentration can be approximated by:

$$PEC_{step4} = \frac{RFStep\_4}{RVStep\_4} = \frac{21M(1 - f_{ro,w/su})}{101V - 21Vf_{ro,w/su}} = \frac{21(1 - f_{ro,w/su})M}{80V + 21(1 - f_{ro,w/su})V} \qquad \text{(Eq. 4)}$$

Note that Eq.4 represents a worst case calculation of the PEC (that neglects the continuous base flow of the stream and part of the variable infiltration flux).

## 3.2 Unjustified claim in the Landscape and Mitigation report (FOCUS, 2007)

This implies that it is justified to link the runoff reduction method of SWAN and the FOCUS WG to a particular statement in the FOCUS L&M report i.e.: "a 60% reduction in dissolved pesticide load will result in a significantly smaller reduction in the predicted environmental concentration because the volume of runoff water (and thus part of the dilution capacity) is also reduced by 60%" (FOCUS, 2007).

This means that FOCUS L&M suggests that the reduction in PEC of a FOCUS scenario will be significantly lower than the reduction applied to 21M and 21V, incase identical reduction factors are applied to both the mass of the pesticide in runoff water (M) and volume of runoff water (V). However, we question this assumption because for 80% of the area of the upstream catchment the volume of runoff water is not reduced, hence giving a rather large dilution (note that in most cases the volume of runoff water of the 80% of area of the upstream catchment will largely exceed the base flow). To check our idea we used equations 1 and 4 to calculate the reduction in $PEC_{step3}$ for several values of the reduction factor in runoff:

$$f_{ro,PEC} = 100\% \left[ \frac{PEC_{step3} - PEC_{step4}}{PEC_{step3}} \right]$$

$$f_{ro,PEC} = 100\% \left[ \frac{21M/101V - 21(1 - f_{ro,w/su})M / 80V + 21(1 - f_{ro,w/su})V}{21M/101V} \right]$$

$$f_{ro,PEC} = 100\% \left[ 1 - \frac{101V\left[21M - 21Mf_{ro,w/su}\right]}{21M\left[80V + 21(1 - f_{ro,w/su})V\right]} \right]$$

Eliminating the term 21M in both the numerator and the denominator gives:

$$f_{ro,PEC} = 100\% \left[ 1 - \frac{101V(1 - f_{ro,w/su})}{80V + 21(1 - f_{ro,w/su})V} \right] = 100\% \left[ 1 - \frac{101V(1 - f_{ro,w/su})}{101V - 21V(f_{ro,w/su})} \right]$$

$$f_{ro,PEC} = 100\% \left[ \frac{101V - 21V(f_{ro,w/su})}{101V - 21V(f_{ro,w/su})} - \frac{101V(1 - f_{ro,w/su})}{101V - 21V(f_{ro,w/su})} \right]$$

$$f_{ro,PEC} = 100\% \left[ \frac{101V - 101V - 21V(f_{ro,w/su}) + 101V(f_{ro,w/su})}{101V - 21V(f_{ro,w/su})} \right]$$

Eliminating the term V in both the numerator and the denominator gives:

$$f_{ro,PEC} = 100\% \left[ \frac{80\left(f_{ro,w/su}\right)}{101 - 21\left(f_{ro,w/su}\right)} \right] \quad \text{(Eq. 5)}$$

where $f_{ro,PEC}$ is the reduction in the $PEC_{step3}$ resulting from applying the runoff reduction calculation method advised by FOCUS L&M.

Figure 5 shows the reduction in the $PEC_{step3}$ resulting from applying the runoff reduction calculation method advised by FOCUS L&M as function of the applied reduction to pesticide mass in runoff water and volume of runoff water. From Figure 5 it can be seen that the relation between the reduction in $PEC_{step3}$ and the applied (identical) reduction to pesticide mass in runoff water and volume of runoff water is almost linear. The suggestion of FOCUS L&M that reduction in PEC of a FOCUS scenario will be significantly lower than the identical reduction applied to pesticide mass in runoff water and volume of runoff water seems a bit overstated if the runoff reduction calculation method advised by FOCUS L&M is used.

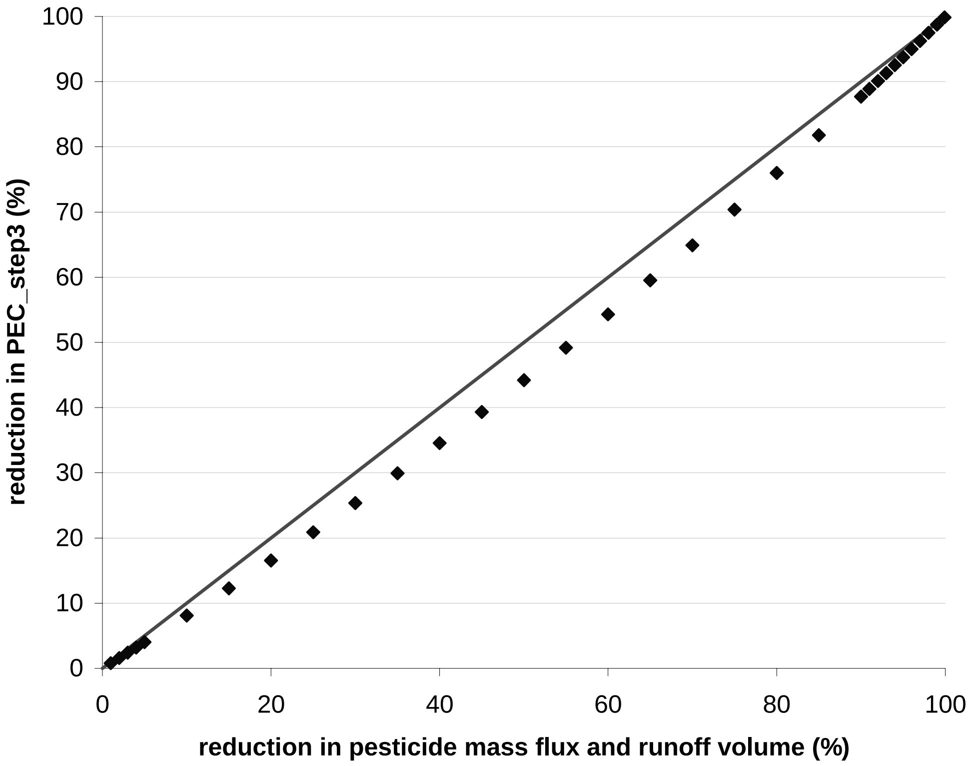


*Figure 5 The reduction in the $PEC_{step3}$ ($f_{ro,PEC}$; Eq. 5) resulting from applying the runoff reduction calculation method advised by FOCUS L&M as function of the applied reduction to pesticide mass in runoff water and volume of runoff water (identical reduction applied to 21M and 21V) . The reduction in the $PEC_{step3}$ corresponds to $f_{ro,PEC}$ in Eq. 5 and is thus calculated using Eq. 5.*

# 4 Calculation of erosion reduction

## 4.1 SWAN theory

In the SWAN software (version 1.1.4, ECPA and Tessalla Support Services, 2008) a erosion reduction factors are applied to the eroded sediment input from a 20 m contributing margin along the 100 m long FOCUS stream (Fig. 2).

The formula's shown in Figure 6 are given in the Help function of SWAN.

**Erosion mass (column 4 in *.p2t file)**

*EMStep_4 = EMStep_3 * (1 - fem)*

| | |
|---|---|
| *fem* | = fractional reduction in erosion mass due to buffer strip |
| *EMStep_3* | = erosion mass read from Step 3 .p2t file |
| *EMStep_4* | = erosion mass written to Step 4 .p2t file |

**Erosion flux (column 5 in *.p2t file)**

*EFStep_4 = EFStep_3 * (1 - fef)*

| | |
|---|---|
| *fef* | = fractional reduction in erosion flux due to buffer strip |
| *EFStep_3* | = erosion flux read from Step 3 .p2t file |
| *EFStep_4* | = erosion flux written to Step 4 .p2t file |

*Figure 6 Formulas regarding reduction of erosion from the help file of SWAN*

The terminology in SWAN is rather confusing. However, reduction in erosion mass due to buffer strip (fem) corresponds to reduction of the mass of eroded sediment (in kg $h^{-1}$). The remaining mass of eroded sediment (so after being reduced) enters the FOCUS stream. Reduction in erosion flux (fem) corresponds to the reduction of mass of the pesticide (in mg $m^{-2}$ $h^{-1}$) sorbed to eroded sediment. The remaining mass of the pesticide sorbed to eroded sediment (so after being reduced) enters the FOCUS stream. So the reduction factors fem and fef in Figure 6 correspond to respectively the reduction factors $f_{er,so}$, $f_{er,su}$ defined in Chapter 1.

Please note that it is possible in SWAN to specify different values of the reduction factor for reduction of the mass of eroded sediment and mass of the pesticide (in mg $m^{-2}$ $h^{-1}$) sorbed to eroded sediment (Figure 4).

## Acknowledgements

We thank Colin Brown (CSL) and Gerhard Görlitz (Bayer CropScience) for useful critical comments to a draft of this report.

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# Appendix 1 Relevant sections of the Landscape and Mitigation report (FOCUS 2007) and possible interpretations by Alterra

## Interpretation of the texts of FOCUS L&M regarding step 4 calculations for FOCUS SW scenarios

### Volume 1 page 31:

*3.5.2 Mitigation Options for Annex I Registrations*

Three mitigation options that are suited to regulatory assessments are:

1. A reduction in the application rate, giving a similar reduction in losses to surface waters via surface runoff or erosion;
2. A restriction in the application window, normally to avoid application during or immediately before periods when the risk of runoff is greatest.
3. The application of a vegetated buffer zone (or filter strip) to intercept runoff water and eroded sediment prior to entry into surface water.

For the first two options, the principles are similar to approaches applied in many Member States to mitigate the risk of leaching to groundwater. Both options should thus be broadly acceptable. The FOCUS surface water scenarios provide a harmonised approach to investigate the impact of the mitigation on pesticide exposure in surface waters. The SWAN software is now freely available to support Step 4 calculations (contact: gerhard.goerlitz@bayercropscience.com). The user can manually enter values for reduction in runoff water, pesticide fluxes and eroded sediment and the system will document the inputs and calculate refined outputs from the FOCUS surface water scenarios. [Comment Alterra: Recommendation of FOCUS L&M: Use the SWAN software to calculate effects of mitigation on the PEC calculated by the FOCUS SW scenario's]

For the third option, there are already good examples of such approaches being successfully applied at Member State level, where label restrictions are applied to limit runoff input at the point of entry (i.e., next to the water body). For example, in Germany, 5 m and 10 m buffer strips are respectively considered to provide 50% and 90% reduction in runoff inputs (i.e. both water and pesticide load). These measures have been tested in several field studies over recent years and have been found to be effective.

## Volume 1 page 33:

**Table 7. 90th percentile worst-case values for reduction efficiencies for different widths of vegetated buffers and different phases of surface runoff**

| Buffer width (m) | 10-12 | 18-20 |
|---|---|---|
| Reduction in volume of runoff water (%) | 60 | 80 |
| Reduction in mass of pesticide transported in aqueous phase (%) | 60 | 80 |
| *n (for aqueous phase)* | *36* | *30* |
| Reduction in mass of eroded sediment (%) | 85 | 95 |
| Reduction in mass of pesticide transported in sediment phase (%) | 85 | 95 |
| *n (for sediment phase)* | *19* | *11* |

The values provided in Table 7 are recommended as reasonable worst-case assumptions for efficacy of vegetated buffer zones in good condition. **It should be noted that the reductions apply both to the volume of runoff water and the loading of dissolved-phase or sediment-bound pesticide in that runoff. Thus, for example, a 60% reduction in dissolved pesticide load will result in a significantly smaller reduction in the predicted environmental concentration because the volume of runoff water (and thus part of the dilution capacity) is also reduced by 60%.** [Interpretation Alttera: If you assume that FOCUS L&M recommends using the SWAN software to calculate new PECs after reduction is entered as input in SWAN, then this text suggests that when using the SWAN software, the reduction in PEC is significantly smaller than the reduction applied. This is not the case as illustrated in Fig. 5, chapter 3]

The values in Table 7 for reduction in water volume and sediment load are not calculated from measured data, but are set to the same values as for reduction in pesticide load for consistency and ease of use. Variability in the data is greater for narrower buffers (Reichenberger et al., 2007) and for this reason it is not recommended that a buffer of less than 10 m width be considered for Annex I listing. The proposed reduction values represent 90th percentiles from measured distributions; their use in combination with Step 3 exposure values that are themselves realistic worst-case is expected to yield conservative values for use in risk assessment.

## Volume 1 page 39:

Development of software tools to support Step 4 calculations was outside the scope of the working group. Independent work has been undertaken by ECPA to develop a modelling tool called SWAN. The software operates within the framework of the existing FOCUS surface water scenarios and supports Step 4 calculations through changes to input files for PRZM, FOCUS and TOXSWA. For example, the system allows the user to incorporate mitigation of spray drift or surface runoff or to add in exposure via air where this is known to be a significant route of environmental exposure. SWAN is freely available to users (contact: gerhard.goerlitz@bayercropscience.com). [comment Alterra: FOCUS L&M advocates to use SWAN to incorporate mitigation of a.o. runoff in the FOCUS SW calculations.]

## Volume 2 pages 144-145

*BOX 9*

*Mitigation of runoff and erosion: Practical Step 4 refinements within the FOCUS modelling framework*

*Method 1*

A relatively simple approach to perform Step 4 modelling of the effects of buffer strips on attenuating runoff and erosion is to post-process the Step 3 *.p2t files created by PRZM for subsequent use by TOXSWA as Step 4 calculations. The primary influence of buffer strips is to reduce the mass loading of chemical entering adjacent surface water bodies via runoff and/or erosion. Viewed mechanistically, buffer zones mitigate runoff by intercepting a portion of the runoff volume as well as sorbing some of the dissolved chemical. Buffer zones reduce erosion losses by intercepting and retaining a portion of the transported sediment which contains bound chemical. **Thus, reductions reported in Volume 1, Table 7 apply both to the volume of runoff water and the loading of dissolved-phase or sediment bound pesticide in that runoff. Thus, for example, a 60% reduction in dissolved pesticide load will result in a significantly smaller reduction in the predicted environmental concentration because the volume of runoff water (and thus part of the dilution capacity) is also reduced by 60%.**[Interpretation Alttera: If you assume that FOCUS L&M recommends using the SWAN software to calculate new PECs after reduction is entered as input in SWAN, then this text suggests that when using the SWAN software, the reduction in PEC is significantly smaller than the reduction applied. This is not the case as illustrated in Fig. 5, chapter 3] Before attempting to simulate the effect of buffer zones in mitigation runoff and erosion, it is important to understand that TOXSWA uses the calculated runoff volume reported in *.p2t files to determine the volume of runoff entering the water body both from the treated field and from the appropriate upstream catchment (only part of which will be treated). [interpretation Alterra: only part of the upstream catchment is treated, but the volume of runoff entering the water body used by TOXSWA is the sum of the runoff volume of the area of the neighbouring field and the runoff volume of the entire area of the upstream catchment] As the FOCUS surface water scenarios are abstracted representations of reality, it may be difficult to justify an <u>assumption</u> that vegetated buffers are only applied to part of the upstream catchment; buffers are a long-term investment by a farmer and thus will likely be applied across all fields likely to be cropped with a particular system that requires the buffer. [interpretation Alterra: vegetated buffer zones are thus not applied to part of the upstream catchment in the FOCUS SW scenarios, but the to entire upstream catchment (=100 ha for stream scenarios).

Another interpretation is that the authors want to say that vegetated buffers should be applied to that part of the upstream catchment containing all fields likely to be cropped with a particular system. If the authors of L&M assume that the 20% treated fields are the fields 'likely to be cropped with a particular system' then the SWAN calculation method is correct. However, it is not specified anywhere in the FOCUS L&M report nor the FOCUS SW report that 20% of the area of the upstream catchment of a FOCUS SW scenario is cropped with a particular system and the other 80% of the area represents some other land use (forest, urban, other crop). So, how should the reader know what is meant with "all fields likely to be cropped with a particular system"?]

Thus, the most appropriate way to simulate the effects of buffer strips using TOXSWA is to reduce the flux of runoff and/or erosion using the appropriate mitigation factors described elsewhere in this report and to also reduce the runoff volumes calculated at Step 3. [Interpretation Alterra:. Runoff volumes of both the area of the neighbouring field and the entire area of the upstream catchment] This approach will be conservative in all cases because 1) vegetated buffers will seldom be deployed across 100% of an upstream catchment [Comment Alterra: what is meant by 100% of an upstream catchment? Interpretation 1.:100% of the area of an upstream catchment. Interpretation 2.: the authors mean 100% of all fields likely to be cropped with a particular system in the upstream catchment, by which they mean the 20% of area treated in the upstream catchment.], and 2) some of the runoff water intercepted by the buffer will be routed to surface water. The assumption could be further refined on the basis of landscape analysis and/or evidence of agronomic practice, probably involving the use of a catchment-scale model. In such cases 1) all areas assumed to be treated with the pesticide under consideration should be subjected to the reduction in runoff volumes, [interpretation Alterra: If you want to refine the assumption that vegetated buffers are only applied to part of the upstream catchment then you still should make sure that areas assumed to be treated with the pesticide under consideration (=20% of the area of the upstream catchment) should be subjected to the reduction in runoff volumes. An interpretation could be that the assumption that vegetated buffers are only applied to part of the upstream catchment should be proven by some kind of research (landscape analysis and/or evidence of agronomic practice. If it's not proven then you stick to the conservative approach of applying buffer zones to the to entire upstream catchment (=100 ha for stream scenarios)] and 2) the assessment will need to consider the extent to which runoff intercepted by the 1 buffer is purged of pesticide residues prior to any movement to surface water. Independent work has been undertaken by ECPA to develop a modelling tool called SWAN. The software operates within the framework of the existing FOCUS surface water scenarios and supports Step 4 calculations through changes to input files for PRZM, FOCUS and TOXSWA. For example, the system allows the user to incorporate mitigation of spray drift or surface runoff or to add in exposure via air where this is known to be a significant route of environmental exposure. SWAN is freely available to users (contact: gerhard.goerlitz@bayercropscience.com). [comment Alterra: FOCUS L&M advocates to use SWAN to incorporate mitigation of among others runoff in the FOCUS SW calculations.]

## Conclusions:

- The text is written in such a way that several interpretations are possible.
- L&M advocates to use SWAN
- The statement that a 60% reduction in dissolved pesticide load will result in a significantly smaller reduction in the predicted environmental concentration because the volume of runoff water (and thus part of the dilution capacity) is also reduced by 60% is not true (see the Fig. 5 in chapter 3).

# Appendix 2 Emails between Paulien Adriaanse and Colin Brown about runoff mitigation in the final version of the FOCUS Landscape and Mitigation report (relevant sections).

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From: Colin Brown [mailto:colin.brown@csl.gov.uk]
Sent: 17 July 2008 19:09
To: Adriaanse, Paulien
Subject: Re: Mitigation of runoff

Hi Paulien

I agree that it is possible to calculate a more worst-case value if we assume that we apply a 10 m buffer along all stretches of water in the catchment. My view is that we are already assuming that our stream is purely runoff driven and we are assuming that 20% of the catchment is applied concurrently.
This introduces the worst-casedness according to FOCUS SWS for the standard scenario. When we apply the buffer, we assume 10th percentile efficiency (i.e. a further 90th percentile worst-case) and it simply seems unreasonable to assume that we are going to introduce a buffer around all water bodies. If our calculations are correct, then flows would be reduced by 60% and our environment/water agency colleagues would certainly be shouting at us about the flow rate. In reality, there is a base flow component which provides the dilution and is not influenced by the introduction of a buffer. This isn't included in FOCUS SWS, hence the need to come up with some kind of pragmatic solution.

Does this address the concern?

Best wishes, Colin

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Adriaanse, Paulien wrote:
Colin,

Thanks for your rapid and clear answer, which was different from what I expected !

Just to make it crystal clear:
L&M Guidance is: Reduction factors (same value for water and loads) are applied to the 20 ha treated and no reduction to the 80 ha non-treated.

Your worst casedness remark puzzled me a bit, because not reducing the water from the 80 ha is definitely not worst case, it dilutes the reduced loads. So, is your worst casedness remark related to the fact that the reduction percentage of the water is equal to the reduction percentage of the load, while it is more likely that loads are more reduced than the associated water fluxes ?

Greetings, Paulien

-----Original Message-----
From: Colin Brown [mailto:colin.brown@csl.gov.uk]
Sent: 15 July 2008 18:36
To: Adriaanse, Paulien
Subject: Re: Mitigation of runoff

Hi Paulien

Our interpretation is that the 20 ha that are treated would require buffering, so the reduction applies. The other 80 ha are "something else" - they could be another crop or they could be forest, urban, whatever. Hence the reduction does not apply to runoff volume from these areas. As always with FOCUS, it's important to remember that the situation is not "real" and that we try to make some kind of worst-case assumption that is protective of the reality.

Hope this helps. Please come back if you need any further information.

All the best, Colin

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Adriaanse, Paulien wrote:
Clarification:

If e.g. max reduction percentages are 60%, the guidance states: apply them both to the runoff water and the runoff load (implying from the treated 20 ha). However: should the 60% reduction also apply to water volumes of the the remaining 80 ha of the upstream catchment ?

Paulien

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Van: Adriaanse, Paulien
Verzonden: di 15-7-2008 16:09
Aan: 'Colin Brown'
Onderwerp: Mitigation of runoff

Hi Colin,
I would like to ask you a question on L&M guidance (final version): Table 1.10 from Vol 2 proposes max reduction percentages for pesticide loads. At several places the report mentions that reductions apply both to the volume of runoff water and pesticide loading (e.g. Vol 1, 3.5.2 under Table 7). With respect to the FOCUS R

scenarios: Do the reductions mentioned apply to the treated 20 ha upstream catchment, or to the entire 100 ha ? See the few slides I added. Background of the question is a discussion I had with Gerhard Goerlitz, last week as well as some work we do for external parties. During my discussion with Gerhard it turned out that the interpretation of L&M guidance is not easy, so it seems best to me to go back to the source !

Thanks in advance for your answer,

Best regards, Paulien