REGISTRATION REPORT

Part B

Section 8

Environmental Fate

Detailed summary of the risk assessment

Product code: **Nordox 75 WG**

Chemical active substance(s):

Copper (I) oxide (Cu_2O), 750 g/kg

NATIONAL ASSESSMENT

Poland

(Authorization in accordance to Art. 43)

Applicant: Nordox AS

Submission date: 31/01/2022

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Version history

When	What
31/01/2022	Original version from the applicant Nordox AS for Art. 43 submission. All new data and information are marked in yellow.
12/2022	zRMS version for comments

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Submission and Evaluation of Copper compounds under Art.43 of 1107/2009

General observation: Deviation from standard Guidance Documents and EFSA conclusion is necessary and unavoidable for Copper.

The RMS and EFSA are held to assess plant protection products according to the existing methodology described in a series of guidance documents (GDs). Those have been developed for synthetic, organic molecules, and are in most cases not applicable to minerals and Copper. This has led to an EFSA conclusion that indicated a number of critical concerns, or assessments that could not be finalized, which do not reflect any realistic risk, but rather illustrate the inappropriateness of the current GDs for the assessment of Copper. This can easily be seen in a number of endpoints that suggest a high risk exists at concentrations below natural background of this essential micronutrient. **This has been recognized by EFSA, the RMS and several MS (see comments from DE and IT in the Peer review Report), and the EU Commission has mandated EFSA with the development with a Copper specific guidance (Mandate No. 2019-0036).**
Art.43 submissions and their evaluation by MS are unfortunately due before this GD will be available. The current EFSA conclusion and list of endpoints could at best be considered as a first tier, and applicants as well as MS are required to deviate from the standard procedures described in the GD for the following reasons:

- The current GD do not consider bio-availability; for an essential, ubiquitous micronutrient that is a metal it is indispensable to provide assessment methodologies that consider the bioavailability and the potentially toxic fraction in each real-world exposure scenario. Total concentrations do not result in any meaningful outcome.
- Data normalisation to enable comparison of toxicological lab and field data as well as data obtained with different bioavailable fractions is a pre-requisite to allow a realistic assessment of potential risk. Simplistic worst-case scenarios will always indicate a high risk already at naturally occurring concentrations.
- For a homeostatically tight controlled essential element the application of assessment factors is meaningless. The question whether an excess exposure or deficiency leads to an adverse disruption of the homeostatic control cannot be approached in this way. Further, the exceptional data richness of the Copper dossier and more than 100 years of experience with the use as fungicide make safety factors unnecessary.

These unique features of Copper are already considered in the assessment of Copper under separate legislation (REACH, BPD). While COM directed EFSA in their mandate to take advantage of those methodologies, TF members have to anticipate their use and in their proposed assessments of the critical areas of concern identified in the EFSA conclusion. This should be reviewed once the new GD is available and no use should be cancelled until then.

Submission and Evaluation of Copper compounds under Art.43 of 1107/2009

General observation: Copper compounds should not be considered as Candidate for Substitution (CfS).

The implementing Regulation (EU) 2018/1981 is renewing the approval of the active substance Copper compounds as candidate for substitution (CfS), in accordance with Regulation (EC) 1107/2009. Whereas (12) considers that Copper compounds are persistent and toxic in accordance with points 3.7.2.1 and 3.7.2.3 of Annex II to Regulation (EC) 1107/2009 (PBT assessment), and fulfil the condition set in the second indent of point 4 of Annex II to Regulation (EC) 1107/2009.

The EUCuTF disagrees with the approval as CfS. The conditions in Annex to Regulation (EC) 1107/2009 lack the exemption of inorganic compounds like Copper minerals from the PBT assessment as it has been established under other chemical legislations like REACh and BPD. As laid down in those legislations, the term persistence is meaningless for an element or mineral, due to its natural occurrence. Persistence per se is therefore not a relevant parameter and consequently a PBT assessment is not carried out for inorganic compounds under REACh and BPD. The recent mandate from COM to EFSA directs the development of a guidance towards methods and procedures available under those legislations better adapted for the assessment of inorganic compounds, where the relevant parameter is their bioavailability. This should include an exempt statement regarding the PBT assessment to harmonize the assessment of the same compounds under different legislations.

It should be noted that persistence of minerals is considered not relevant for being categorized as low-risk active substance according to Regulation (EU) 2017/1432. This is clearly not compatible with the same parameter leading to a classification as CfS under the same Regulation (EC) 1107/2009.

The EUCuTF is of the opinion that Copper compounds should not be considered CfS, and have lodged an action for annulment against Regulation (EU) 2018/1981 and renewing the approval of the active substance Copper compounds as candidate for substitution (case number T-153/19 European Union Task Force v. European Commission).

8 Fate and behaviour in the environment (KCP 9)

8.1 Critical GAP and overall conclusions

Table 8.1-1: Critical use pattern of the formulated products

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Use-No. *	Member state(s)	Crop and/or situation (crop destination / purpose of crop)	F, Fn, Fpn G, Gn, Gpn or I **	Pests or Group of pests controlled (additionally: developmental stages of the pest or pest group)	**Application**				**Application rate**			PHI (days)	Remarks: e.g. g safener/ synergist per ha	**Conclusion**
					Method / Kind	Timing / Growth stage of crop & season	Max. number a) per use b) per crop/ season	Min. interval between applications (days)	kg product/ha a) max. rate per appl. b) max. total rate per crop/season	kg as/ha a) max. rate per appl. b) max. total rate per crop/season	Water L/ha min/max			Groundwater
Zonal uses (field or outdoor uses, certain types of protected crops)														
1, 2	PL	Pome fruit (apple, pear, quince)	F	*Venturia pyrina* *Venturia inaequalis* Bacteriosis: *Pseudomonas syringae* *Ervinia amylovora* *Nectria galligena*	Foliar spray	BBCH 03-BBCH 53 AND from the beginning of dormancy period (autumn - BBCH 99) and before BBCH 54 (spring)	a) 2 b) 2	14	a) 1.67 b) 3.34	a) 1.25 b) 2.50	500-1000	144		
3	PL	Vine	F	*Plasmopara viticola*	Foliar spray	BBCH 15 - BBCH 81 & BBCH 91	a) 2 b) 2	7	a) 1.60 b) 3.20	a) 1.20 b) 2.40	200-400	21		
4	PL	Strawberry	F	*Marssonina fragariae*, *Zythia fragariae* *Mycosphaerella*, *bacterial disease*, *Colletotrichum sp.*	Foliar spray	BBCH 13 - BBCH 85	a) 3 b) 3	7	a) 1.33 b) 3.99	a) 1.0 b) 3.0	200 - 800	3		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Use-No. *	Member state(s)	Crop and/or situation (crop destination / purpose of crop)	F, Fn, Fpn G, Gn, Gpn or I **	Pests or Group of pests controlled (additionally: developmental stages of the pest or pest group)	**Application**				**Application rate**			PHI (days)	Remarks: e.g. g safener/ synergist per ha	**Conclusion**
					Method / Kind	Timing / Growth stage of crop & season	Max. number a) per use b) per crop/ season	Min. interval between applications (days)	kg product/ha a) max. rate per appl. b) max. total rate per crop/season	kg as/ha a) max. rate per appl. b) max. total rate per crop/season	Water L/ha min/max			Groundwater
5, 8, 9	PL	Fruiting vegetables (tomato, eggplant, pepper, cucumber, pumpkin, courgettes, melon)	F	*Phytophtora spp., Alternaria, Colletotrichum, Bacterial disease (Pseudomonas spp., Xanthomonas spp.).*	Foliar spray	BBCH 15 - BBCH 89	a) 3 b) 3	7	a) 1.33 b) 3.99	a) 1.0 b) 3.0	200-1000	10		
6	PL	Bulb vegetables (shallots, onion, garlic)	F	*Alternaria, Antracnosis, Bacterial disease, Peronospora destructor, Stemphyllum*	Foliar spray	BBCH 14 - BBCH 47	a) 3 b) 3	7	a) 1.33 b) 3.99	a) 1.0 b) 3.0	200-1000	3		
7	PL	Lettuce, scarole	F	*Alternaria, Bremia lactucae Bacterial disease: Erwinia spp., Pseudomonas spp. Xanthomonas spp.*	Foliar spray	BBCH12 - BBCH49	a) 3 b) 3	7	a) 1.33 b) 3.99	a) 1.0 b) 3.0	300-1000	3		
10	PL	Ornamental plants	F	*Alternaria, Antracnosis, Phytophtora spp.,*	Foliar spray	Spring - until the beginning of flowering	a) 3 b) 3	7	a) 1.33 b) 3.99	a) 1.0 b) 3.0	200-1000	-		

* Use number(s) in accordance with the list of all intended GAPs in Part B, Section 0 should be given in column 1

** F: professional field use, Fn: non-professional field use, Fpn: professional and non-professional field use, G: professional greenhouse use, Gn: non-professional greenhouse use, Gpn: professional and non-professional greenhouse use, I: indoor application

Explanation for column 15 “Conclusion”

A	Safe use
R	Further refinement and/or risk mitigation measures required
C	To be confirmed by cMS
N	No safe use

Table 8.1-2: Assessed (critical) uses during approval of Copper compounds concerning the Section Environmental Fate

Crop and/or situation (a)	Member State	Product Name	F G I (b)	Pests or group of pests controlled (c)	Formulation		Application				Application rate per treatment			PHI (days) (l)	Remarks (m)
					Type (d-f)	Conc of a.s. g/kg (i)	Method kind (f-h)	Growth stage and season (j)	Number min max (k) a) per use b) per crop/ season	Interval between applications (min)	Kg a.s./hl min max (g/hl)	Water l/ha min max	kg a.s./ha a) max. rate per appl. b) max. total rate per crop/season		
Grape	C/S	Nordox 75 WG	F	*Bacterial necrosis Elsinoë ampelina*	WG	750	Airblast sprayer	BBCH 91 - 11	a) 3 b) 3	21 days	n.a.	400-1000	a) 1.25 b) 3.75	90	
Grape	C/S	Nordox 75 WG	F	*Plasmopara viticola, Elsinoë ampelina*	WG	750	Airblast sprayer Knapsack Sprayer	BBCH 12 - 89	a) 8 b) 8	7 days	n.a.	100-1200	a) 1.25 b) 6.0	21	Annual application must not exceed 5 kg/ha during the bird breeding season
Tomato	C/S	Nordox 75 WG	F	*Phytophthora spp Alternaria, Colletotrichum, Pseudomonas, Xanthomonas*	WG	750	Foliar spray	BBCH 12 - 89	a) 8 b) 8	7 days	n.a.	200-1000	a) 0.85 b) 6.0	3	Annual application must not exceed 5 kg/ha during the bird breeding season RMS remarks: No Northern trials were available.
Tomato	C/S	Nordox 75 WG	G	*Phytophthora spp Alternaria, Colletotrichum, Pseudomonas, Xanthomonas*	WG	750	Foliar spray	BBCH 12 - 89	a) 8 b) 8	7 days	n.a.	200–1000	a) 1.25 b) 6.0	3	Annual application must not exceed 5 kg/ha during the bird breeding season
Cucurbits	C/S	Nordox 75 WG	F	*Peronospora cubensis; Alternaria spp Colletotrichum spp Bacterial diseases*	WG	750	Foliar spray	BBCH 10 - 89	a) 8 b) 8	7 days	n.a.	200–1500	a) 0.85 b) 6.0	See Column Remarks	Annual application must not exceed 5 kg/ha during the bird breeding season PHI: 3 d (Cucumber, zucchini), 7 d (Melon, watermelon
Cucurbits	C/S	Nordox 75 WG	G	*Peronospora cubensis; Alternaria spp Colletotrichum spp Bacterial diseases*	WG	750	Foliar spray	BBCH 10 - 89	a) 8 b) 8	7 days	n.a.	200–1500	a) 1.25 b) 6.0	See Column Remarks	Annual application must not exceed 5 kg/ha during the bird breeding season PHI: 3 d (Cucumber, zucchini), 7 d (Melon, watermelon

Crop and/or situation (a)	Member State	Product Name	F G I (b)	Pests or group of pests controlled (c)	Formulation		Application				Application rate per treatment			PHI (days) (l)	Remarks (m)
					Type (d-f)	Conc of a.s. g/kg (i)	Method kind (f-h)	Growth stage and season (j)	Number min max (k) a) per use b) per crop/ season	Interval between applications (min)	Kg a.s./hl min max (g/hl)	Water l/ha min max	kg a.s./ha a) max. rate per appl. b) max. total rate per crop/season		
Grape	C/S	Nordox 75 WG	F	*Plasmopara viticola, Elsinoë ampelina*	WG	750	Airblast sprayer	BBCH 12 - 89	a) 8 b) 8	7 days	n.a.	100–1200	a) 1.25 b) See Column Remarks	21	Flexible dosing regimen Total applied must not exceed 30 kg/ha in any rolling 5 year period and 8 kg/ha/yr in any single

* Use number(s) in accordance with the list of all intended GAPs in Part B, Section 0 should be given in column 1

** F: professional field use, Fn: non-professional field use, Fpn: professional and non-professional field use, G: professional greenhouse use, Gn: non-professional greenhouse use, Gpn: professional and non-professional greenhouse use, I: indoor application

8.2 Metabolites considered in the assessment

As Copper is an elementary atomic particle there are no relevant metabolites for Copper.

8.3 Rate of degradation in soil (KCP 9.1.1)

Studies on degradation in soil with the formulation were not performed, since it is possible to extrapolate from data obtained with the active substance.

8.3.1 Aerobic degradation in soil (KCP 9.1.1.1)

Copper is an elementary atomic particle and therefore cannot be degraded. In the absence of a route and consequently a rate of degradation, the distribution of the different forms of Copper in soil is the important factor influencing the environmental fate of Copper and bio-availability to plants and soil organisms.

The mobile, active and toxicologically significant substance is the free Copper^{2+} ion present in the soil solution. It is a highly reactive species and consequently most of the Copper in the soil is strongly bound to a wide range of soil substances, therefore limiting the amount of free Copper^{2+} ions in the soil solution. The strongest interactions are formed with organic matter and oxides of manganese and iron, whilst clay minerals although adsorbing less strongly also contribute significantly because they are present throughout the soil profile. These strong interactions with soil particles result in the majority of soil Copper (typically > 99% of the total) being present as a bound residue. A small proportion of soil Copper is located in the soil solution as hydrated Copper ($[Cu(H_2O)_6]^{2+}$) and as soluble inorganic or organic complexes. The levels of Copper in the soil solution are small, usually representing < 1% of the total soil Copper, whilst the levels of the free Copper^{2+} ion in the soil solution are very small (usually < 0.1 % of the total soil Copper) due to rapid complexation.

The amount of free Copper^{2+} ion in the soil solution is controlled primarily by pH and the amount of dissolved organic carbon in the soil. In acid soils (pH < 6) the concentration of Copper^{2+} ions in the soil solute`1ion will be greater than at neutral or alkaline pH. This is because the $[Cu(H_2O)_6]^{2+}$ ion can exist at low pH, but as alkalinity increases reactions with inorganic anions result in the formation of sparingly solubility salts and these remove Copper^{2+} ions from solution by precipitation. The stability of Copper-organic matter complexes also increases as pH is raised. These complexes are formed by the interaction of Copper with organic functional groups such as carboxylic acids which are protonated at low pH and consequently have less affinity for Copper^{2+} ions.

Under anaerobic conditions the level of Copper^{2+} ions in solution is controlled by the formation and precipitation of sparingly soluble sulphides and changes in redox potential do not significantly affect the level of Copper^{2+} ions in solution.

Maintaining an alkaline soil pH and abundant supply of organic matter in the soil are therefore important means of regulating the level of bio-available Copper. The addition of lime and low Copper compost materials are methods to achieve these aims and can be conducted routinely as part of normal farming practice.

Soil Copper concentrations are given in terms of total soil Copper, however as previously described the vast majority of Copper in soil is bound to solid components and consequently not available to plant and soil organisms. The concentration of free Copper^{2+} ions (the toxicologically significant form) in the soil

solution, or of poorly adsorbed Copper forms which can easily be released as free $Copper^{2+}$ in the soil solution, is more relevant. Simple measurements of total Copper in the soil should not be used as a means of assessing exposure risk without taking these important facts into account.
In laboratory studies, Copper added to soil became bound primarily to inorganic and organic matter and to oxide fractions within the soil. Measurement of the concentration of Copper in bio-available fractions (exchangeable and soil solution) showed that levels did not change substantially, even in soils containing already elevated levels of Copper. These studies were performed using exaggerated application rates up to 500 mg Copper/kg and 24.3 kg Copper/ha and over a very short time which may not have allowed true equilibrium to be established. Ageing processes are important for Copper because over time residues become increasingly bound and consequently less available. Indeed, care should be taken when considering the results obtained from spiking experiments because the solubility and therefore the bioavailability of added Copper may be overestimated under these artificial conditions. Where field (aged) soil samples are compared to freshly spiked soil samples, it was found that bioavailability was increased for the spiked soils and this was related to a much greater soluble Copper concentration at any given level of total soil Copper. A generic lab-to-field (L/F) factor of 4 is proposed in order to correct for higher toxicity observed in standard tests with laboratory-spiked soils compared to tests in soils affected by long-term use of Cu-based plant protection products. This factor is based on a comprehensive comparison of Cu toxicity in 11 vineyard soils with high Cu concentrations because of the application of Cu fungicides and corresponding reference soils spiked with $CuCl_2$. This correction factor should be performed when comparing toxicity data from freshly spiked soils with total exposure concentrations measured in field-contaminated soils.

The degradation of Copper in soil under aerobic conditions was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152.

8.3.2 Anaerobic degradation in soil (KCP 9.1.1.1)

The degradation of Copper in soil under anaerobic conditions was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152.

8.4 Field studies (KCP 9.1.1.2)

The dissipation rate of Copper in soil under field conditions was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152.

In 2003, the European Copper Task Force (EUCuTF) initiated a 10-year earthworm field monitoring study. After 10 years of treatment with Copper the NOEC of the study was the dose rate T2 (8 kg Copper/ha/year). Soil total Copper concentrations at this treatment rate in the top soil layer (0-5 cm) at Niefern increased from an initial value of around 28 mg/kg up to a maximum value of 130.8 mg/kg dry weight at sampling 32 (Mar 2013). At Heiligenzimmern, concentrations in the top soil layer at the 8 kg Copper/ha/year treatment rate increased from an initial value of around 32 mg/kg dry weight up to a maximum value of 132.9 mg/kg dry weight at sampling 29 (Nov 2011, after 25th application). In the deeper soil layer (5-30 cm) at both sites the total Copper content did not increase significantly.
'Bioavailable' Copper content (as defined by $CaCl_2$ extraction) were very low throughout the ten years of the study at all treatment levels and soil depths. Levels were ≤ 2.6 mg/kg dry weight, with the exception of

the highest Copper treatment rate (40 kg Copper/ha/year) in 2009 where a maximum value of 4.8 mg Copper/kg dry weight at sampling 24 (after 18^{th} application) was detected.

In addition, a review of the existing monitoring programs and published literature on Copper levels in European agricultural soils has been conducted, with the aim of identifying a concentration suitable for use in soil exposure assessments for various crops. No convincing evidence for accumulation of Copper in arable fields was found, but elevated Copper levels were observed in a proportion of vineyard soils and to a much lesser extent in some orchard soils.

It can be seen in the following table (Appendix A EFSA Journal 2018; 16(1):5152,119 pp doi:10.2903/j.efsa.2018.5152) that following an extensive review of European monitoring programs a median soil concentration of 11 mg Cu/kg has been found for top soil across Europe and is considerably lower than the very conservative value of 32 considered by EFSA in 2013.

Soil	**Soil concentration (mg Cu/kg soil DM)**	
Background level	**11.5**	
Vineyards[a]	28 ~~66.4~~ 72 160 ~~73~~ 67 29.5	Overall median 10^{th} percentile value Overall median value Overall median 90^{th} percentile value Overall mean value
Vineyards	26.09 128.0 49.26	Overall median 10^{th} percentile value LUCAS data[c] Overall median value LUCAS data Overall median 90^{th} percentile value LUCAS data[d] Overall mean value LUCAS data
Arable fields[b]	7 13.2 26 15	Overall median 10^{th} percentile value Overall median value Overall median 90^{th} percentile value Overall mean value
Orchards[b]	- ~~39.8~~ 48.3 58 23	Overall median 10^{th} percentile value Overall median value Overall median 90^{th} percentile value Overall mean value
Olive groves	24.7 74.5 33.5	Overall median value LUCAS data Overall median 90^{th} percentile value LUCAS data Overall mean value LUCAS data

[a] Recently published data from the EU LUCAS program [Copper distribution in European Topsoils: An assessment based on LUCUS soil survey, Ballabio et al., Science of the Total Environment 636 (2018) 282-298] confirms the assumption that the data for vineyards in the LOEP values are biased towards the higher end as they are mainly based on published literature, which focusses mainly on contaminated sites.
[b] Includes new data from the EU LUCAS program.
[c] Calculated from the standard deviation of the set of data in the paper described in [a].
[d] Calculated from the standard deviation of the set of data in the paper described in [a].

8.4.1.1 Soil dissipation testing on a range of representative soils (KCP 9.1.1.2.1)

The dissipation rate of Copper in soil under field conditions was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152.

8.4.2 Soil accumulation testing (KCP 9.1.1.2.2)

The accumulation potential of Copper in soil under field conditions was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152.
A review of European monitoring programs was used to identify levels of Copper present in soil from natural or anthropogenic sources other than the regulated use for the soil exposure assessments. The values suitable for use in soil exposure assessments are summarised below.

Soil	**Soil concentration (mg Cu/kg soil DM)**	
Background level	**11.5**	
Vineyards[a]	28	Overall median 10th percentile value
	~~66.4~~ 72	Overall median value
	160	Overall median 90th percentile value
	~~73~~ 67	Overall mean value
	29.5	
Vineyards		Overall median 10th percentile value
	26.09	LUCAS data[c]
	128.0	Overall median value LUCAS data
		Overall median 90th percentile value LUCAS
	49.26	data[d]
		Overall mean value LUCAS data
Arable fields[b]	7	Overall median 10th percentile value
	13.2	Overall median value
	26	Overall median 90th percentile value
	15	Overall mean value
Orchards[b]	-	Overall median 10th percentile value
	~~39.8~~ 48.3	Overall median value
	58	Overall median 90th percentile value
	23	Overall mean value
Olive groves	24.7	Overall median value LUCAS data
	74.5	Overall median 90th percentile value LUCAS data
	33.5	Overall mean value LUCAS data

[a] Recently published data from the EU LUCAS program [Copper distribution in European Topsoils: An assessment based on LUCUS soil survey, Ballabio et al., Science of the Total Environment 636 (2018) 282-298] confirms the assumption that the data for vineyards in the LOEP values are biased towards the higher end as they are mainly based on published literature, which focusses mainly on contaminated sites.
[b] Includes new data from the EU LUCAS program.
[c] Calculated from the standard deviation of the set of data in the paper described in [a].
[d] Calculated from the standard deviation of the set of data in the paper described in [a].

Remaining values taken from Appendix A EFSA Journal 2018; 16(1):5152,119 pp doi:10.2903/j.efsa.2018.5152.

It can be seen following an extensive review of European monitoring programs a median soil concentration of 13.4 mg Cu/kg has been found for arable soil across Europe and is considerably lower than the very conservative value of 32 considered by EFSA in 2013.

A review of monitoring programs for copper in soil was carried out in 2018 and was used to identify ‘background levels’ of copper present in soil from natural or anthropogenic sources other than the regulated use for use in soil exposure assessments. The results taken from the LoEP (Appendix A EFSA Journal 2018; 16(1):5152,119 pp doi:10.2903/j.efsa.2018.5152) are summarised in the table above. The EUCuTF stated in their monitoring report that these values are most likely biased towards the higher end as they are mainly based on published literature, which focusses mainly on contaminated sites.

Recently published data from the EU LUCAS program [Coper distribution in European Topsoils: An assessment based on LUCUS soil survey, Ballabio et al., Science of the Total Environment 636 (2018) 282-298] confirms the assumption for this bias and provides lower average values for vineyards, and also shows there is no measurable accumulation for field crops. The EUCuTF have used the LUCAS data set to the extend the data set and to refine the values presented in the LoEP for their PEC soil calculations.

8.5 Mobility in soil (KCP 9.1.2)

Studies on mobility in soil with the formulation were not performed, since it is possible to extrapolate from data obtained with the active substance.

The adsorption/desorption of Copper was evaluated during Annex I renewal as published in EFSA Journal 2018; 16(1):5152. A survey of adsorption K_d in European arable and grazing land soils was selected as the key study for assessing Copper distribution between the aqueous phase and soil. The soils were representative for the variability in physico-chemical properties of soils in Europe and K_d values were measured at relevant doses and realistic conditions. It was concluded that Copper exhibited medium mobility to immobility in soil and that the adsorption of Copper was pH dependent. The geometric K_{doc} value for soil at pH 4-5 of 19509.9 L/kg was selected as a generic K_{doc} value for soil for a first tier exposure assessment.

Parent							
Soil Type	**OC %**	**Soil pH[a)]**	**K_d [mL/g]**	**K_{doc} [mL/g]**	**K_F [mL/g]**	**K_{Foc} [mL/g]**	**1/n**
494 topsoil samples from arable land and grass land across Europe	0.5-48.0	3.28-4.00	-	2300.0-35202.4	-	-	-
	0.6-49.0	4.01-4.99	-	908.7-337000	-	-	-
	0.7-36.0	5.08-5.48	-	1727.8-505444.4	-	-	-
	0.5-42.0	5.53-6.50		350.0-430400.0	-	-	-
	0.5-22.0	6.51-7.98	-	5163.3-1062833.3	-	-	-

Median value (if not pH dependent)	-		-	-	
Geometric mean (if not pH dependent)	-	pH 4-5: 19509.9 pH 5.5-6.5: 33918.3	-	-	
Arithmetic mean (if not pH dependent)	-	-			-
pH dependence, *Yes or No*	Yes				

[a] Measured in $CaCl_2$

8.5.1 Column leaching (KCP 9.1.2.1)

Discussion of the soil mobility of Copper (soil adsorption/desorption and aged soil column leaching) can be found in the EFSA Journal 2018; 16(1):5152. A summary of the information provided is included below:
Mobility of Copper in soil is influenced significantly by all components of the soil and by different physical, chemical and biological parameters whose relative importance are not well known. For these reasons, standard laboratory sorption tests have not been performed. If these tests had been conducted the resulting K_{oc} values obtained would considerably underestimate adsorption and overestimate the movement of Copper because K_{oc} is a function of the soil organic carbon content only.
Tests performed to determine the extent of Copper adsorption showed that humic acids, manganese and iron oxides and clay particles all contribute significantly to adsorption, with humic acids and manganese oxides showing the highest propensity for binding. Adsorption to these materials is in agreement with the Langmuir adsorption equation and is pH dependent, with increased adsorption observed as soil pH is increased. Although adsorption to iron oxides and clays was less strong compared to organic matter and manganese oxides their abundance throughout the soil profile will mean that their overall adsorption will be at least as great as organic matter and manganese oxides and will not be restricted to surface layers as is the case for organic matter interactions.
Investigations into Copper mobility were performed using column leaching experiments conducted under laboratory conditions with standard Speyer soils (2.1, 2.2 and 2.3) at application rates up to 18 kg/ha (2.25 times the maximum annual rate according to the EU GAP). After leaching with 370 to 393 mL of water over a period of 48 hours, the levels of Copper detected in the leachate did not differ from those observed in control leachate. Movement through the leaching column was minimal, with applied Copper located almost exclusively in the upper most soil segment (0-6 cm).
In these studies, column leaching was performed without ageing, which could have led to an overestimation of the leaching potential as the degree of Copper binding increases with time. Despite these worst-case conditions, the results of the test showed that Copper applied to the column did not leach.

8.5.2 Lysimeter studies (KCP 9.1.2.2)

A review of the existing monitoring programs and published literature on Copper levels in groundwater has been conducted which confirms the limit of 2 mg/L for Copper will not be exceeded following the regulated use of Copper as a fungicide as published in EFSA Journal 2018; 16(1):5152.
Generally natural levels of Copper in groundwater were low, with background concentrations ranging from <0.63 to 25 µg/L, with the exception of volcanic aquifers. In the upper soil layers, typical Copper

concentrations in soil water and leachate from field leaching and lysimeter studies ranged from 1 to 90 µg/L, with a peak concentration of 164.2 µg/L detected at a depth of 25 cm. A review of Copper levels in groundwater aquifers with possible anthropogenic inputs detected a range of concentrations from <LOD to 39 µg/L, with a peak concentration of 90 µg/L. Typical concentrations in ranged from < 0.1 to 18 µg/L which is within the range of natural background levels Copper concentrations never approach the legal limit of 2 mg/L set by the European Drinking Water Directive (98/83/EC7) for groundwater.

8.5.3 Field leaching studies (KCP 9.1.2.3)

Not used in exposure/risk assessment.

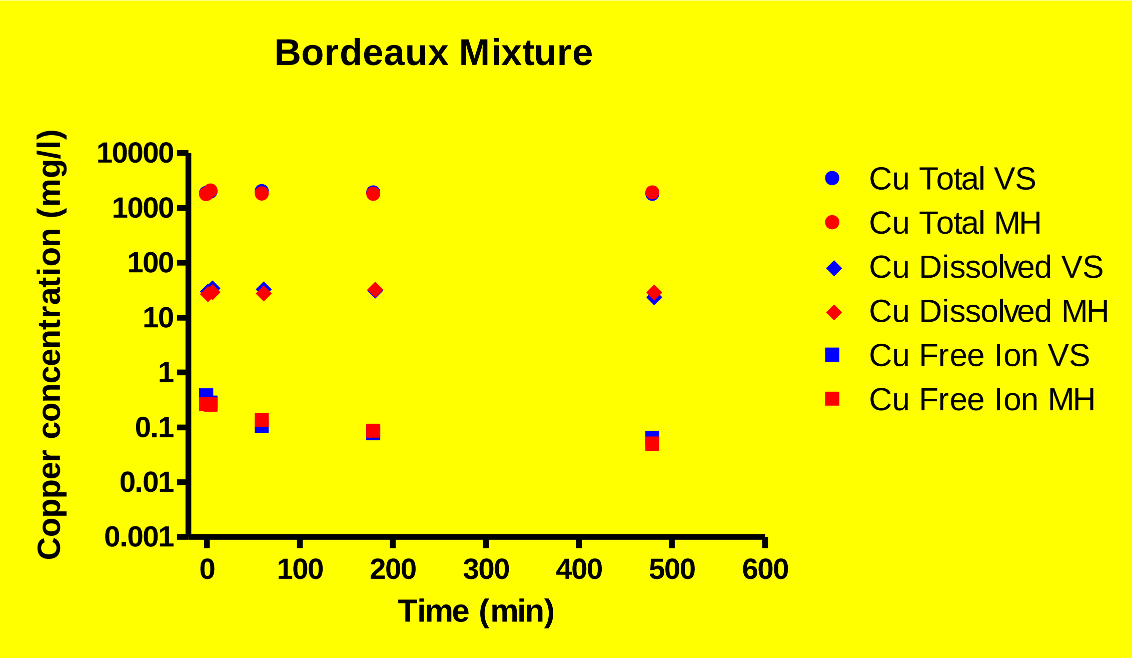
8.6 Degradation in the water/sediment systems (KCP 9.2, KCP 9.2.1, KCP 9.2.2, KCP 9.2.3)

Studies on degradation in water/sediment systems with the formulation were not performed, since it is possible to extrapolate from data obtained with the active substance.

Data on the behaviour of Copper in water sediment systems was evaluated during Annex I renewal inclusion as published in EFSA Journal 2018; 16(1):5152.

No regulatory study was conducted to assess the behaviour of the formulated product or Copper compounds in water/sediment system. However, a laboratory microcosm study was conducted and the results used for determination of the relevant parameters to be used for risk assessment purposes. Dissipation times based on total Copper concentrations in the microcosm study varied between 4 and 30.5 days (mean 9 days, n =18). Also, representative literature studies are provided as complementary data to illustrate the dissipation of Copper from surface water under field and laboratory conditions.

Under the spray drift scenario, the particulate, barely water-soluble Copper compound that hits the surface water will start dissolving while complexation to DOC and sedimentation remove copper from the dissolved fraction. The results from the Blust and Joosen 2016 study (CP-9.2.3/01) have demonstrated that in a realistic water/sediment scenario the total Copper declines very rapidly in the water phase while dissolved Copper was at least a factor of 10 lower.



This study describes best the speciation and kinetic behaviour of Copper in an aquatic environment following a spray drift event. Despite this, the EUCuTF has proposed a more conservative total/dissolved value of 3 for use in the risk assessment, based on the measurements in the mesocosm study.

Based on a very large body of literature, the order of toxic potential is Me^{2+} > inorganic complexes > organic complexes. Copper toxicity to aquatic biota is primarily due to dissolved cupric ion (Cu^{2+}). Assessment of the dissipation time based on the toxic Copper species, i.e. free cupric ion Cu^{2+}, revealed much lower dissipation times. At the highest concentrations in the microcosm study (120 and 240 µg Cu/L) DT_{50} values were ±1 day while at lower concentrations (24, 12 and 2.5 µg Cu/L) no changes in free cupric ion concentrations are observed, therefore indicating DT_{50} << 1 day.

As described above, the spray drift scenario starts with a non-equilibrium phase during which total Copper dissipates with a DT_{50} of < 1 day (Blust and Joosen 2016). Any free Copper ions also dissipate with < 1 day (Ma 2008). The system will reach an equilibrium stage within ca. 24 hours, and the resulting dissolved Copper concentration will be a function of the water chemistry (pH, DOC, hardness, etc.).

Therefore, a DT_{50} of < 1 day is appropriate and the single application scenario shall be presented as the worst-case scenario.

8.7 Predicted Environmental Concentrations in soil (PEC_{soil}) (KCP 9.1.3)

zRMS Comments:	The PECs assessment was accepted. The risk envelope approach was accepted. The worst case scenario of 0% interception and all relevant crops were used in PECs assessment (active substance and formulation). The natural copper background in vineyards, arable crops, orchards and olive groves, (median and 90[th] percentile values) assessed by EU LUCAS program was taken into consideration. As the used soil concentration of Cu proposed by the Applicant is based on

	copper distribution in the soils of 25 European Union Member States (over 21 k soil samples), the approach could be accepted at the Member State level. In LoEP for copper (EFSA Journal 2018; 16(1):5152) the different background values were agreed for vines: <table><tr><td>Soil</td><td>Soil concentration (mg Cu/kg soil DM)</td></tr><tr><td>Overall median 10th percentile value</td><td>28</td></tr><tr><td>Overall median value</td><td>72</td></tr><tr><td>Overall median 90th percentile value</td><td>160</td></tr></table>and for orchards – the overall median value of 48.3 were agreed and these background values were taken into consideration. The PECs accum of active substance and formulation with agreed background level was recalculated by evaluator and corrected values are presented in the Table 8.7-4. The relevant PECs values will be used in further risk assessment.

8.7.1 Justification for new endpoints

Endpoints were taken from EFSA Journal 2018;16(1):5152 and EFSA Supporting publication 2018:EN-1486 (confirmatory data).

8.7.2 Active substance(s) and relevant metabolite(s)

Calculations were based on a simple first tier approach (Excel sheet) assuming even distribution of the compound in upper 0-5 cm soil layer following a single season's application. The long-term potential accumulation for Copper was estimated following repeated annual applications for a 20 cm depth of soil.
A standard soil density of 1.5 g/cm^3 was assumed for all calculations.
In addition to the levels of Copper arising from the regulated use, a need to include natural background levels of Copper originating from geogenic Copper and previous anthropogenic Copper inputs from a variety of sources in the soil exposure assessment. This requirement to include sources other than the regulated use is specific to Copper and so a standard soil exposure assessment is not possible. European monitoring programs provided a comprehensive overview of Copper levels in agricultural soils. No convincing evidence for accumulation of Copper in arable fields was found, but elevated Copper levels were observed in a proportion of vineyard soils. Concentrations suitable for use in soil exposure assessments, including sources other than the regulated use, were identified.
Crop interception data, which correspond to the intended growth stages, are taken from the FOCUS groundwater guidance paper (FOCUS 2002). Crop interception will reduce the amount of a compound reaching the soil and therefore this would normally be taken into account depending on the growth stage at application. For Copper, the estimation of PEC_{soil} has assumed that there is no crop interception. Although foliar application to crops will involve, at later growth stages, high levels of interception, the assumption has been made that since Copper is a contact fungicide with no systemic activity, all the Copper applied

will eventually be deposited to the soil either by mechanical action (as a consequence of prevailing wind) or be washed off by rain.

Table 8.7-1: Input parameters related to application for PEC_{soil} calculations

Individual Crop	**Single Total Amount Reaching the Soil per Season [g a.s./ha]**
Arable fields	
Bulb vegetables (onion, garlic, shallots)	3000
Fruiting vegetables	3000
Lettuce & similar	3000
Strawberry	3000
Vineyards	
Vine	2400
Orchards	
Pome fruit	2500
Ornamentals	3000

Risk envelope used for the PEC_{soil} calculations

Table 8.7-2: Input parameters related to application for PEC_{soil} calculations

Use No.	4, 5, 6, 7, 8, 9	3	1, 2, 10
Crop	Arable field	Vineyard	Orchards
Application rate [g a.s/ha]	3000*	2400*	3000*
Number of applications/interval	1	1	1
Crop interception [%]	0	0	0
Depth of soil layer (relevant for plateau concentration) [cm]	5 cm (no tillage)	5 cm (no tillage)	5 cm (no tillage)

*Single total amount reaching the soil per season

An accumulated PEC_{soil} value was calculated for repeated annual applications. For Copper, which is not degraded, this value comprised the predicted accumulated concentration in the soil after repeated applications for nine years in 20 cm depth of soil, plus the concentration arising from the final years' application in 5 cm depth of soil, plus the concentration arising from Copper already present in the soil.
A comprehensive review of European monitoring programs was used to identify levels of Copper present in soil from natural or anthropogenic sources other than the regulated use for the soil exposure assessments. The values suitable for use in soil exposure assessments are summarised below and are taken from Appendix A EFSA Journal 2018; 16(1):5152,119 pp doi:10.2903/j.efsa.2018.5152 of the revised list of endpoints of the updated RAR August 2018.

Soil	**Soil concentration (mg Cu/kg soil DM)**	
Background level	**11.5**	
Vineyards	26.09 128.0 49.26	Overall median 10th percentile value LUCAS data[c] Overall median value LUCAS data Overall median 90th percentile value LUCAS data[d] Overall mean value LUCAS data
Arable fields[b]	7 13.2 26 15	Overall median 10th percentile value Overall median value Overall median 90th percentile value Overall mean value
Orchards[b]	- ~~39.8~~ 48.3 58 23	Overall median 10th percentile value Overall median value Overall median 90th percentile value Overall mean value
Olive groves	24.7 74.5 33.5	Overall median value LUCAS data Overall median 90th percentile value LUCAS data Overall mean value LUCAS data

[a] Recently published data from the EU LUCAS program [Copper distribution in European Topsoils: An assessment based on LUCUS soil survey, Ballabio et al., Science of the Total Environment 636 (2018) 282-298] confirms the assumption that the data for vineyards in the LOEP values are biased towards the higher end as they are mainly based on published literature, which focusses mainly on contaminated sites.
[b] Includes new data from the EU LUCAS program.
[c] Calculated from the standard deviation of the set of data in the paper described in [a].
[d] Calculated from the standard deviation of the set of data in the paper described in [a].

A review of monitoring programs for Copper in soil was carried out in 2018 and was used to identify 'background levels' of Copper present in soil from natural or anthropogenic sources other than the regulated use for use in soil exposure assessments. The results taken from the LoEP (Appendix A EFSA Journal 2018; 16(1):5152,119 pp doi:10.2903/j.efsa.2018.5152) are summarised in the table above. The EUCuTF stated in their monitoring report that these values are most likely biased towards the higher end as they are mainly based on published literature, which focusses mainly on contaminated sites.
Recently published data from the EU LUCAS program confirms the assumption for this bias and provides lower average values for vineyards, and also shows there is no measurable accumulation for field crops. **The EUCuTF have used the LUCAS data set to extend the data set and to refine the values presented in the LoEP for their PEC soil calculations.**

Findings: The $PEC_{soil\ initial}$ values for total Copper in soil following a single season's application are summarised below in

Table 8.7-3. As Copper does not degrade PEC_{soil} values with time are not relevant.

Table 8.7-3: PEC$_{soil\ initial}$ for total Copper

Individual Crop	Rate per Season [g a.s./ha]	Soil depth [cm]	PEC$_{soil,\ initial}$ [mg/kg]
Arable fields	1 x 3000	5	4.00
Vineyards	1 x 2400	5	3.20
Orchards	1 x 3000	5	4.00

PEC$_{soil}$ accumulation values which consider different values of the soil background level (e.g. 90th percentile value, median value, 10th percentile value) are provided below. The calculations are based on a worst-case assumption that the maximum dose is applied for each year of the period authorization is requested for (7 years) and PEC$_{soil}$ values for Copper do not consider any dissipation routes, with no degradation or other losses considered for this time period.

Table 8.7-4: PEC$_{soil\ accumulation}$ for total Copper over seven-year registration

Individual Crop	Rate per Season [g a.s. /ha]	DT$_{50}$ [A]	PEC$_{soil\ accumulation}$ calculation			Background Monitoring Value [B] [mg/kg]	Overall PEC$_{soil,\ accumulation}$ [C] [mg/kg]
			Soil depth [cm]	No. of years	C$_{low}$ [mg/kg]		
Arable fields	1 x 3000	Not relevant	20	6	8	7	19.0
						13.2	25.2
						26	38.0
Vineyards	1 x 2400	Not relevant	5	6	32	~~29.5~~ 28	~~64.7~~ 63.2
						~~26.09~~ 72	~~61.3~~ 107.7
						~~128~~ 160	~~163.2~~ 195.2
Orchards	1 x 3000	Not relevant	5	6	32	-	-
						~~39.8~~ 8.3	~~75.8~~ 84.3
						58	94.0

[A] Copper is an element so DT$_{50}$ value is not relevant
[B] 10th percentile value, median value and 90th percentile value in European arable and vineyard soils
[C] Overall PEC$_{soil,\ accumulation}$ = Background monitoring value + C$_{low}$ + PEC$_{soil,\ initial}$ over 7 years

8.8 Predicted Environmental Concentrations in groundwater (PEC$_{gw}$) (KCP 9.2.4)

ZRMS Comments:	The submitted justification and PECgw calculation were accepted. It should be noted, that the FOCUS models are not designed /validated to predict the concentration of minerals and metals in groundwater. ZRMS recommends to Member States to consider the monitoring data, if available, at the national level. Based on statement and agreed PECgw assessment in EFSA Journal 2018;16(1):5152 for much higher application rate of copper (6000 g Cu/ha) – the PECgw values for all

	scenarios for every crop included in proposed uses, are below the trigger value of 0.1 µg Cu/L. The assessed PECgw value is below trigger value of 0.1 µg/L and also below 2.0 mg/L (legal limit set by the European Drinking Water Directive (98/83/EC) for groundwater). In accordance with groundwater monitoring results (2021, available in Polish language) the average concentration of copper in groundwater in Poland was 1.228 µg Cu/L. In accordance with national law – Regulation of Minister of Health, 20th April, 2010 amending the regulation on the quality of water intended for human consumption (Journal of Laws 2010 No. 72, item. 466) – the highest acceptable copper concentration in drinking water is 2.0 mg/l.

In FOCUS groundwater models substance sorption to soil is described solely by interaction with organic material. The adsorption properties of the Cu^{2+} ion are not limited to organic carbon binding and other significant processes occur, many of which are effectively irreversible. Many of the Copper species formed are only sparingly soluble and are therefore less likely to be affected by any downward movement of water in the soil. Furthermore, important binding processes for the Cu^{2+} ion, such as adsorption to clay and mineral oxides can occur at all depths in the soil column and not just at the surface layer as is the case for organic matter interactions.

It should be noted that the FOCUS models are not designed or validated to predict the behaviour of metals in the environment. Nevertheless, an assessment of the potential for Copper to reach groundwater according to standard FOCUS modelling has been conducted.

A review of the existing monitoring programs and published literature on Copper levels in groundwater has been conducted (EFSA Journal 2018; 16(1):5152.). Generally natural levels of Copper in groundwater were low, with background concentrations ranging from < 0.63 to 25 µg/L, with the exception of volcanic aquifers. In the upper soil layers, typical Copper concentrations in soil water and leachate from field leaching and lysimeter studies ranged from 1 to 90 µg/L, with a peak concentration of 164.2 µg/L detected at a depth of 25 cm.

A review of Copper levels in groundwater aquifers with possible anthropogenic inputs detected a range of concentrations from <LOD to 39 µg/L, with a peak concentration of 90 µg/L. Typical concentrations in ranged from < 0.1 to 18 µg/L which is within the range of natural background levels. Copper concentrations never approach the legal limit of 2 mg/L set by the European Drinking Water Directive (98/83/EC7) for groundwater. Furthermore the Copper concentrations are generally below the threshold values established for Copper in European Member States as reported by the commission in the following report Brussels, 5.3.2010 C(2010) 1096 final; and sec (2010) 166 final except for Finland and partly the UK see table below. It should be noted that in this context 29 out of the 33 groundwater bodies considered by member states to be at risk with regard to Copper have no (Finland) or only very limited (UK, grapes only) uses of Copper as a plant protection product. Overall concentrations of Copper in groundwater are not of concern and are the result of natural background or sources other than Copper fungicides.

Member state	**Threshold value**	**Unit**	**GWB at risk**	**GWB at poor status**
Austria	2	mg/L	no	no
Belgium	100	µg/L	1	no
Bulgaria	2	mg/L	1	no
Cyprus	No threshold value			
Czech Republic	No threshold value			

Member state	**Threshold value**	**Unit**	**GWB at risk**	**GWB at poor status**
Denmark	No threshold value			
Estonia	No threshold value			
Finland	20	µg/L	3	2
France	No threshold value			
Germany	No threshold value			
Greece	No threshold value			
Hungary	No threshold value			
Ireland	1500	µg/L	no	no
Italy	No threshold value			
Latvia	No threshold value			
Lithuania	No threshold value			
Luxembourg	No threshold value			
Malta	1	mg/L	no	no
The Netherlands	No threshold value			
Poland	~~0.2~~ 2	mg Cu/L	1	no
Portugal	No threshold value			
Romania	No threshold value			
Slovak Republic	500.2 - 504.5	µg/L	no	no
Slovenia	No threshold value			
Spain	2	mg/L	1	-
Sweden	No threshold value			
United Kingdom	10.1 - 1500	µg/L	26	14

GWB = ground water bodies

An additional study has looked at the levels of Copper in bottled drinking water across Europe as being representative of ground water across Europe and has been summarised below.

Reference:	**CP 9.2.4/01, Demetriades, A. et al., 2012**
Title:	European Ground Water Geochemistry Using Bottled Water as a Sampling Medium
Report No.:	Clean Soil and Safe Water
Guidelines:	Not Applicable
Deviations:	No
GLP:	No
Published:	Literature
Comment:	-

In a further study a total of 1785 bottled waters were purchased from supermarkets in 40 European countries that represented 1247 wells/drill holes/springs at 884 locations and were representative of groundwater across Europe. Each of the bottled waters were analysed for 72 parameters which included the concentration of copper at the laboratories of the Federal Institute for Geosciences and Natural Resources (BGR) in Germany.

	Minimum	Median	Maximum
Copper at µg/L	< 0.1	0.27	100

The levels of Copper in the bottled water purchased from across Europe and deemed to be representative of the ground water from where they had been sampled was found to be between < 0.1 and 100 µg/L.

zRMS Comments	The submitted publication has been evaluated in 2020. The submitted publication considers “groundwater” samples as a bottled mineral water bought from supermarkets throughout Europe. The analytical data for copper content in bottled water can be used as an additional data giving only general information of copper content differentiation in consumed mineral/table water. The submitted information/data will be used at the national level.

8.8.1 Justification for new endpoints

Endpoints were taken from EFSA Journal 2018;16(1):5152.

Parameter	**Unit**	**Total Copper**	**Comment**
Molar mass	[g/mol]	63.54	-
Water solubility	[mg/L]	500	at 20°C, pH 5.6 LoEP EFSA Journal 2018; 16(1):5152
Vapour Pressure	[Pa]	0	Not applicable inorganic solid with negligible volatility.
K_d	[mL/g]	19509.9	Geometric mean calculated from soils pH range 4-5 LoEP EFSA Journal 2018; 16(1):5152
Freundlich Exponent	[-]	1	Default value
DT_{50}	[days]	1,000,000	Appropriate value to simulate no degradation LoEP EFSA Journal 2018; 16(1):5152
Plant uptake factor	[-]	0	Default value

8.8.2 Active substance(s) and relevant metabolite(s) (KCP 9.2.4.1)

The PEC_{gw} calculations are performed for three FOCUS crop scenarios pome fruit, vines and fruiting vegetables..Application rates are summarised in Table 8.8-1. Since the FOCUS modelling is not designed or validated to predict the behaviour of metals in the environment, and thus is not suitable for Copper predictions and was only carried out for completeness, the choice of the suitable FOCUS crop scenario is not relevant. Therefore, the presented calculations for the presented scenarios cover all other intended uses presented in the GAP table.

Table 8.8-1: Input parameters related to application for PEC_{gw} calculations

Use No.	1,2	3,4	5, 8, 9*
Crop	**Pome fruit**	**Vine, Ornamentals**	**Fruiting vegetables**
Application rate [g as/ha]	2500	3000	3000
Number of applications/interval [d]	1	1	1
Relative application date	Please refer to the table below	Please refer to the table below	Please refer to the table below

Crop interception [%]	0	0	0
Frequency of application	Annual	Annual	Annual
Models used for calculation	FOCUS PEARL v5.5.5, FOCUS PELMO v6.6.4, FOCUS MACRO v5.5.3	FOCUS PEARL v5.5.5, FOCUS PELMO v6.6.4, FOCUS MACRO v5.5.3	FOCUS PEARL v5.5.5, FOCUS PELMO v6.6.4, FOCUS MACRO v5.5.3

*Covers use 4, 6 and 7

Table 8.8-2: Application dates used for groundwater risk assessment

	Scenario	Application dates (absolute)*		
Crop		Pome fruit	Vine	Tomato
	Châteaudun	10th October (Julian Day: 283#)	2nd November (Julian Day: 306#)	23rd August (Julian Day: 234#)
	Hamburg	8th November	31st October	--
	Jokioinen	24th October	--	--
	Kremsmünster	8th November	31st October	--
	Okehampton	24th September	--	--
	Piacenza	10th November	2nd November	23rd August
	Porto	9th November	1st October	28th August
	Sevilla	24th October	1st December	30th June
	Thiva	29th October	21st October	7th September

*Based on AppDate version 3.06
relevant for FOCUS Macro

Table 8.8-3: Input parameters related to active substance total Copper for PEC_{gw} calculations

Compound	Total Copper	Value in accordance with EU endpoint y/n/ Reference*
Molecular weight [g/mol]	63.54	-
Water solubility [g/mol]:	500	at 20°C, pH 5.6 LoEP EFSA Journal 2018; 16(1):5152
Saturated vapour pressure [Pa]:	0	Not applicable inorganic solid with negligible volatility.
DT_{50} in soil [d]	1,000,000	Appropriate value to simulate no degradation according to LoEP EFSA Journal 2018; 16(1):5152
Transformation rate	-	-

Compound	**Total Copper**	**Value in accordance with EU endpoint y/n/ Reference***
K_{foc} [mL/g]/K_{fom}	19509.9	Geometric mean calculated from soils pH range 4-5 LoEP EFSA Journal 2018; 16(1):5152
1/n	1	Conservative default value
Plant uptake factor	0	Assumed non systemic
Formation fraction	-	-

Table 8.8-4: PEC$_{gw}$ for total Copper on pome fruits

Crop	**Scenario**	**80th Percentile PEC$_{gw}$ at 1 m Soil Depth [µg/L]**		
		FOCUS PEARL	**FOCUS PELMO**	**FOCUS MACRO**
Pome fruit	Châteaudun	0.000000	0.000	<0.00001
	Hamburg	0.000000	0.000	-
	Jokioinen	0.000000	0.000	-
	Kremsmünster	0.000000	0.000	-
	Okehampton	0.000000	0.000	-
	Piacenza	0.000000	0.000	-
	Porto	0.000000	0.000	-
	Sevilla	0.000000	0.000	-
	Thiva	0.000000	0.000	-

Table 8.8-5: PEC$_{gw}$ for total Copper on vine

Crop	**Scenario**	**80th Percentile PEC$_{gw}$ at 1 m Soil Depth [µg/L]**		
		FOCUS PEARL	**FOCUS PELMO**	**FOCUS MACRO**
Vine	Châteaudun	0.000000	0.000	<0.00001
	Hamburg	0.000000	0.000	-
	Kremsmünster	0.000000	0.000	-
	Piacenza	0.000000	0.000	-
	Porto	0.000000	0.000	-
	Sevilla	0.000000	0.000	-

	Thiva	0.000000	0.000	-

Table 8.8-6: PEC$_{gw}$ for total Copper on tomato

Crop	Scenario	80th Percentile PEC$_{gw}$ at 1 m Soil Depth [µg/L]		
		FOCUS PEARL	FOCUS PELMO	FOCUS MACRO
Tomato	Châteaudun	0.000000	0.000	<0.00001
	Piacenza	0.000000	0.000	-
	Porto	0.000000	0.000	-
	Sevilla	0.000000	0.000	-
	Thiva	0.000000	0.000	-

- The scenario is not parameterised

8.9 Predicted Environmental Concentrations in surface water (PEC$_{sw}$) (KCP 9.2.5)

zRMS Comments	The submitted PECsw and PECsed calculations with Step 1 & 2 were accepted. In Step 1 & 2 all relevant exposure routes were taken into consideration. The presented drift, drainage and runoff assessment for copper in Step 1 & 2 was accepted. The proposed risk envelope was accepted. The worst case of no interception and application timing of Oct – Feb were taken into consideration. The further refinement for formulation was also accepted. The endpoints used for surface water exposure assessment are consistent with list of endpoints. The relevant mitigation measures for PECsed reduction were taken into account: • Dissolved copper with 80% mitigation, equivalent to a 10m VFS; • Dissolved copper with 90% mitigation, equivalent to a 20m VFS. Additionally, the vegetative buffer strips were proposed with 85% and 90% mitigation equivalent to 10 m VBS and 20 VBS, respectively. The 10 m and 20 m vegetative buffer strip with 10 m and 20 m NSS, respectively, as a mitigation measure was agreed at the EU level. The submitted PECsed accumulation assessment for 7 years was accepted. The correction factor for dissolved copper of 3 was not accepted. In accordance with Copper RAR, 2017 and LoEP, 2018 the total Cu/dissolved Cu ratio of 1 was used for further assessment. The mitigations (drift reduction nozzles) were added. The relevant PECsw are presented in the table below: **Intended use** Arable fruits

Active substance	Copper									
Application rate (g/ha)	1000									
No-spray buffer (m)	5	10	20	30	40	50	60	70	80	90
Vegetated filter strip (m)	-	-	-	-						
Nozzle reduction	PECsw µg/L									
None	1.7415	0.9236	0.4799	0.3254	0.2466	0.1987	0.1665	0.1434	0.1259	0.1123
50 %	0.8708	0.4618	0.2400	0.1627	0.1233	0.0994	0.0833	0.0717	0.0630	0.0562
75 %	0.4354	0.2309	0.1200	0.0814	0.0617	0.0497	0.0416	0.0359	0.0315	0.0281
90 %	0.1742	0.0924	0.0480	0.0325	0.0247	0.0199	0.0167	0.0143	0.0126	0.0112

Intended use	Vineyards, late application									
Active substance	Copper									
Application rate (g/ha)	1200									
No-spray buffer (m)	5	10	20	30	40	50	60	70	80	90
Vegetated filter strip (m)	-	-	-	-						
Nozzle reduction	PECsw µg/L									
None	12.51	4.5316	1.5894	0.8535	0.5477	0.3878	0.2923	0.2301	0.187	0.1557
50 %	6.25	2.2658	0.7947	0.4268	0.2739	0.1939	0.1462	0.1151	0.0935	0.0779
75 %	3.128	1.1329	0.3974	0.2134	0.1369	0.0970	0.0731	0.0575	0.0468	0.0389
90 %	1.251	0.4532	0.1589	0.0854	0.0548	0.0388	0.0292	0.0230	0.0187	0.0156

Intended use	Vineyards, early application									
Active substance	Copper									
Application rate (g/ha)	1200									
No-spray buffer (m)	5	10	20	30	40	50	60	70	80	90
Vegetated filter strip (m)	-	-	-	-						

Nozzle reduction	PECsw µg/L									
None	4.0976	1.4425	0.4919	0.2593	0.1644	0.1153	0.0862	0.0674		
50 %	2.0489	0.7213	0.2460	0.1297	0.0822	0.0577	0.0431	0.0337		
75 %	1.0244	0.3606	0.1230	0.0648	0.0411	0.0288	0.0216	0.0169		
90 %	0.4098	0.1443	0.0492	0.0259	0.0164	0.0115	0.0086	0.0067		

Intended use	Pome fruits, late application									
Active substance	Copper									
Application rate (g/ha)	1250									
No-spray buffer (m)	5	10	20	30	40	50	60	70	80	90
Vegetated filter strip (m)	-	-	-	-						
Nozzle reduction	PECsw µg/L									
None	31.302	13.99	4.3163	2.1445	1.3018	0.8828	0.6423	0.4907	0.3886	0.3162
50 %	15.651	6.9950	2.1582	1.0723	0.6509	0.4414	0.3212	0.2454	0.1943	0.1581
75 %	7.8254	3.4975	1.0791	0.5361	0.3255	0.2207	0.1606	0.1227	0.0972	0.0791
90 %	3.1302	1.3990	0.4316	0.2145	0.1302	0.0883	0.0642	0.0491	0.0389	0.0316

Intended use	Pome fruits, early application									
Active substance	Copper									
Application rate (g/ha)	1250									
No-spray buffer (m)	5	10	20	30	40	50	60	70	80	90
Vegetated filter strip (m)	-	-	-	-						
Nozzle reduction	PECsw µg/L									
None	77.26	47.45	10.85	4.149	2.0895	1.2253	0.7916	0.5468	0.3967	0.2989
50 %	38.63	23.7250	5.4250	2.0745	1.0448	0.6127	0.3958	0.2734	0.1984	0.1495
75 %	19.32	11.8625	2.7125	1.0373	0.5224	0.3063	0.1979	0.1367	0.0992	0.0747
90 %	7.7262	4.7450	1.0850	0.4149	0.2090	0.1225	0.0792	0.0547	0.0397	0.0299

	The submitted report considering the IDMM modelling results as not accepted at zonal level. Model IDMM-ag v. 1.0 was not accepted as a harmonised tool. The calculation results can be considered at the Member State level. The submitted report was not accepted at National PL level. National assessment for Poland is covered by zonal one. The relevant mitigation measures will be chosen in Section 9.

A review of the existing monitoring programs and published literature on Copper levels in surface water has been conducted (EFSA Journal 2018; 16(1):5152. & 10.2903/sp.efsa.2018.EN-1486. Generally natural levels of dissolved Copper in surface water ranged over two orders of magnitude, from <0.08 to 14.6 µg/L, with a median value of 0.88 µg/L (807 samples). An additional review of monitoring data conducted during 2014 to 2016 by JRC showed that dissolved Copper concentrations in inland surface waters ranged from 0.01 to 10,000 µg/L, with a median value of 1.97 µg/L, (n = 104254 samples). Dissolve Copper concentrations in vineyard catchments ranged from 0 to 117 µg/L (n = 326 samples) and from agricultural catchments ranged from <LOQ to 9.77 µg/L (n = 139 samples).

Predicted concentration in surface water have been calculated for Copper as follows:

The applicant would firstly like to reiterate that FOCUS modelling is not designed or validated to predict the behaviour of metals in the environment, and thus is not suitable for Copper predictions and was only carried out for completeness. The applicant would like to request that more suitable assessment protocols are used for minerals such as Copper.

Standard FOCUS Step 1 and 2 PEC_{SW} values as described below were calculated for fruiting vegetables, vineyards, ornamentals and pome fruits as they are representative of the risk envelope for Copper:

A) *Via* spray drift / runoff / drainage – without mitigation

FOCUS Step 1 and 2 PEC_{sw} values (FOCUS Steps 1 and 2, version 3.2) were calculated considering all entry routes to water bodies with an interception of 0 % (no cover crop) selected as a worst-case scenario.

B) *Via* runoff / drainage only – with runoff mitigation

FOCUS Step 1 and 2 values were firstly calculated with the no spray drift option to derive the PEC from runoff and drainage only. As these results showed that mitigation measures were required the FOCUS landscape mitigation document (FOCUS 2007) states that the maximum possible reductions in exposure via runoff should not exceed 90 % (e.g. 20 m vegetated buffer) a percentage of 90 % run-off mitigation was therefore carried out.

C) *Via* spray drift only – with spray drift mitigation

FOCUS Step 1 and 2 values were then calculated using the no drainage and runoff option with spray drift values for a single application. These values were then factored down based on different spray drift mitigation values taken for different distances from the FOCUS spray drift calculator (version 1.1) in the SWASH shell, not going beyond 95 % mitigation [PEC Step 2 / (% drift for Step 2 / % drift for the buffer)]. These values were then added to the values estimated from the runoff and drainage calculation. These results were based on the highest acceptable mitigation for all entry routes to water bodies (95% limit on spray drift mitigation and 90 % limit on runoff mitigation). These values were then added to the values estimated from the runoff and drainage calculation in FOCUS Step 2.

The applicants would like to point out that on page 15 of the EFSA conclusion that they are pleased to see that EFSA recognises that due to the very rapid dissipation of Copper (Cu^{2+} ions) from surface waters to sediment, ***it was considered that the single application scenario represents the worst-case for the exposure assessment.*** As a result of this statement the notifier would like the PEC surface water modelling results for multiple applications from Appendix A (LoEP) to be considered as irrelevant, as they ignore any dissipation from the water phase.

As described above, the spray drift scenario starts with a non-equilibrium phase during which total Copper dissipates with a DT_{50} of < 1 day (Blust and Joosen 2016). Any free Copper ions also dissipate with < 1 day (Ma 2008). The system will reach an equilibrium stage within ca. 24 hours, and the resulting dissolved copper concentration will be a function of the water chemistry (pH, DOC, hardness, etc.).

Therefore, a DT_{50} of < 1 day is appropriate and the single application scenario shall be presented as the worst-case scenario in Art.43 evaluations.

Under the spray drift scenario, the particulate, barely water-soluble Copper compound that hits the surface water will start dissolving while complexation to DOC and sedimentation remove copper from the dissolved fraction. The results from the Blust and Joosen 2016 study (CP-9.2.3/01) have demonstrated that in a realistic water/sediment scenario the total Copper declines very rapidly in the water phase while dissolved Copper was at least a factor of 10 lower. This study describes best the speciation and kinetic behaviour of Copper in an aquatic environment following a spray drift event. Despite, the EUCuTF has proposed a more conservative total/dissolved value of 3 for use in the risk assessment, based on the measurements in the mesocosm study.

The EFSA evaluation used a total/dissolved ratio of 1, which suggests that all Copper is dissolved. This is against all observations in the monitoring studies and studies from the dossier cited above. The Art.43 evaluation should apply a total to dissolved copper ratio of at least 3.

The notifier would like to reiterate that all interested parties had previously agreed that the FOCUS models are not appropriate for predicting the behaviour of metals such as copper. In the FOCUS models substance sorption to soil or sediment is described solely by interaction with organic material and thus are not suitable to predict the behaviour of Copper reaching surface water bodies from run-off and drainage. The adsorption properties of the Cu^{2+} ion is not limited to organic carbon binding and other significant processes occur, many of which are effectively irreversible. Many of the Copper species formed are only sparingly soluble. Furthermore, important binding processes for the Cu^{2+} ion, such as adsorption to clay and mineral oxides can occur in soil and sediment. The IDMM model has been considered by EFSA in the authorisation process for use of manure containing Copper. If MS continue to refuse evaluating this model and reject it an appropriate model should be recommended to the applicants for their Art.43 submissions.

8.9.1 Justification for new endpoints

Endpoints were taken from EFSA Journal 2018;16(1):5152.

End-Point	EU agreed endpoints	Value used for modelling

Molar mass	63.54	63.54
Aqueous solubility [mg/L]	500	500
DT_{50} soil [days]	1000	1000
K_{oc} [mL/g]	33918.3[A]	33918.3[A]
DT_{50} total system [days]	1000	1000
DT_{50} water [days]	1000	1000
DT_{50} sediment [days]	1000	1000

[A] Geomean K_{doc} value derived from pH range 5.5-6.5 LoEP EFSA Journal 2018; 16(1):5152 used for PECsw

8.9.2 Active substance(s), relevant metabolite(s) and the formulation (KCP 9.2.5)

Table 8.9-1: Input parameters related to application for $PEC_{sw/sed}$ calculations

Individual Crop	**Single Total Amount [kg a.s./ha]**
Arable fields	
Bulb vegetables (onion, garlic, shallots)	1.0
Fruiting vegetable (tomato, eggplant, pepper, cucumber, pumpkin, courgettes, melon)	1.0
Lettuce & similar	1.0
Strawberry	1.0
Vineyards	
Grape	1.2
Orchards	
Pome fruit	1.25
Others	
Ornamentals	1.0

Risk envelope used for the $PEC_{sw/sed}$ calculations

The risk envelope use patterns are summarized in the table below.

Input parameters related to application for $PEC_{sw/sed}$ calculations

Crop	**Arable fields**	**Vineyards**	**Pome fruit**	**Ornamentals**
Application rate [kg as/ha]	1.0	1.2	1.25	1.0
Number of applications/interval [d]	1	1	1	1
Application window for FOCUS Step 1&2	Northern Europe Oct.-Feb. Mar.-May June-Sep.			
Application method	-	-	-	
CAM (Chemical application method)	-	-	-	
Soil depth [cm]	-	-	-	
Models used for calculation	FOCUS Step 1 & 2, version 3.2			

Table 8.9-2: Input parameters related to active substance Copper for $PEC_{sw/sed}$ calculations STEP 1/2

Compound	Copper	Value in accordance to EU endpoint y/n/ Reference
Molecular weight [g/mol]	63.54	-
Saturated vapour pressure [Pa]	0	Not applicable inorganic solid with negligible volatility.
Water solubility [mg/L]	500	at 20°C, pH 5.6 LoEP EFSA Journal 2018; 16(1):5152
Diffusion coefficient in water [m²/d]	not required for Step 1+2/ 4.3×10^{-5}	Default
Diffusion coefficient in air [m²/d]	not required for Step 1+2/0.43	Default
K_{foc} [mL/g]	33918.3 10 000 for PEC_{sed}	Geometric mean calculated from soils pH range 5.5-6.5 LoEP EFSA Journal 2018; 16(1):5152
Freundlich Exponent 1/n	-	-
Plant Uptake	not required for Step 1+2	-
Wash-Off factor from Crop [1/mm]	not required for Step 1+2/ 0.05 (MACRO) 0.50 (PRZM)	-
$DT_{50,soil}$ [d]	1000	Maximum value accepted by model
$DT_{50,water}$ [d]	1000	Maximum value accepted by model
$DT_{50,sed}$ [d]	1000	Maximum value accepted by model
$DT_{50,whole\ system}$ [d]	1000	Maximum value accepted by model
Maximum occurrence observed (% molar basis with respect to the parent)	-	-
Formation fraction in soil	-	-
Background Copper level in sedimnet	17 mg/kg	LoEP EFSA Journal 2018; 16(1):5152

For a FOCUS Step 1 & 2 input and output example please refer to Appendix 3.

PEC_{sw} results

A) *Via* spray drift / runoff / drainage – without mitigation

FOCUS Step 1 and 2 PEC_{sw} values (FOCUS Steps 1 & 2, version 3.2) were calculated considering all entry routes to water bodies with an interception of 0 % (no cover crop) selected as a worst-case scenario.

Table 8.9-3: Standard FOCUS Step 1, 2 maximum PEC_{sw} and PEC_{sed} for active substance Copper following a single application (all entry routes to water bodies considered)

Uses **"FOCUS crop type"**	**Application pattern [g a.s/ha]**	**Season of application**	**Region**	**Step 1**		**Step 2**	
				PECsw [µg/L]	PECsed [µg/kg]	PECsw [µg/L]	PECsed [µg/kg]
Arable fields "Fruiting vegetables"	1 x 1000	Oct.-Feb.	N	16.41	2.51E03	9.20	1.29E03
		Mar.-May	N				554.74
		June-Sep.	N				554.74
Vineyards "Vines, late applications" (worst case for drift values)	1 x 1200	Oct.-Feb.	N	40.77	3.17E03	32.11	1.7E03
		Mar.-May	N				819.80
		June-Sep.	N				819.80
Pome fruit "Pome/stone fruit, early applications"	1 x 1250	Oct.-Feb.	N	130.67	3.95E03	121.65	2.41E03
		Mar.-May	N				1.5E03
		June-Sep.	N				1.5E03
Pome fruit "Pome/stone fruit, late applications"	1 x 1250	Oct.-Feb.	N	74.53	3.54E03	65.52	2.0E03
		Mar.-May	N				1.09E03
		June-Sep.	N				1.09E03
Ornamentals "Vines, early applications"	1 x 1000	Oct.-Feb.	N	16.21	2.51E03	9.0	1.28E03
		Mar.-May	N				553.28
		June-Sep.	N				553.28

It is shown that the season "Oct.-Feb." results in the highest PEC values, therefore in the following calculations only this season was calculated.

***B) Via* runoff / drainage only – with runoff mitigation**

FOCUS Step 1 and 2 values were firstly calculated with the no spray drift option to derive the PEC from runoff and drainage only. As these results showed that mitigation measures were required the FOCUS landscape mitigation document (FOCUS 2007) states that the maximum possible reductions in exposure via runoff should not exceed 90 % (e.g. 20 m vegetated buffer) a percentage of 90 % run-off mitigation was therefore carried out.

Table 8.9-4: FOCUS Step 1, 2 maximum PECsw and PECsed for active substance Copper following a single application (only entry routes by runoff/drainage to water bodies considered)

Uses "FOCUS crop type"	Application pattern [g a.s/ha]	Season of application*	Region	Step 1		Step 2	
				PECsw [µg/L]	PECsed [µg/kg]	PECsw [µg/L]	PECsed [µg/kg]
Arable fields **Ornamentals** "No drift"	1 x 1000	Oct.-Feb.	N	7.21	2.45E03	3.60	1.22E03
Vineyards "No drift"	1 x 1200	Oct.-Feb.	N	8.65	2.94E03	4.31	1.46E03
Pome fruit "No drift"	1 x 1250	Oct.-Feb.	N	9.01	3.06E03	4.49	1.52E03

* It is shown that the season "Oct.-Feb." results in the highest PEC values, therefore in the following calculations only this season was calculated.

Mitigation – 90 % runoff reduction

Table 8.9-5: FOCUS Step 1, 2 maximum PECsw for active substance Copper following a single application (only entry routes by runoff/drainage to water bodies considered) including 90 % mitigation

Uses "FOCUS crop type"	Application pattern [g a.s/ha]	Season of application*	Region	Step 2	
				PECsw [µg/L]	PECsw [µg/L] with **90% runoff reduction**
Arable fields **Ornamentals** "No drift"	1 x 1000	Oct.-Feb.	N	3.60	0.360
Vineyards "No drift"	1 x 1200	Oct.-Feb.	N	4.31	0.431
Pome fruit "No drift"	1 x 1250	Oct.-Feb.	N	4.49	0.449

* It is shown that the season "Oct.-Feb." results in the highest PEC values, therefore in the following calculations only this season was calculated.

C) *Via* spray drift only – with spray drift mitigation

FOCUS Step 1 and 2 values were then calculated using the no drainage and runoff option with spray drift values for a single application. These values were then factored down based on different spray drift mitigation values taken for different distances from the FOCUS spray drift calculator (version 1.1) in the SWASH shell, not going beyond 95 % mitigation [PEC Step 2 / (% drift for Step 2 / % drift for the buffer)]. These values were then added to the values estimated from the runoff and drainage calculation. These results were based on the highest acceptable mitigation for all entry routes to water bodies (95 % limit on spray drift mitigation and 90 % limit on runoff mitigation).

Table 8.9-6: FOCUS Step 1, 2 maximum PECsw and PECsed for active substance Copper following a single application (only entry routes by spray drift to water bodies considered)

Uses **"FOCUS crop type"**	**Application pattern [g a.s./ha]**	**Season of application / Region**	**Step 1**		**Step 2**	
			PECsw [µg/L]	PECsed [µg/kg]	PECsw [µg/L]	PECsed [µg/kg]
Arable fields "Fruiting vegetables"	1 x 1000	No Runoff/drainage	16.41	2.51E03	9.20	66.41
Vineyards "Vines, late applications" (worst case for drift values)	1 x 1200	No Runoff/drainage	40.77	3.17E03	32.11	231.89
Pome fruit "Pome/stone fruit, early applications"	1 x 1250	No Runoff/drainage	130.67	3.95E03	121.65	878.50
Pome fruit "Pome/stone fruit, late applications"	1 x 1250	No Runoff/drainage	74.53	3.54E03	65.52	473.14
Ornamentals "Vines, early applications"	1 x 1000	No Runoff/drainage	16.21	2.51E03	9.00	64.97

Drift mitigation – spray drift reduction

Table 8.9-7: FOCUS Step 2 maximum PECsw for active substance Copper following a single application (drift mitigation considered)

Uses **"FOCUS crop type"**	**Application pattern [g a.s./ha]**	**Season of application / Region**	**Buffer (m)**	**Drift rate [%]***	**PECsw [µg/L]****
Arable fields "Fruiting vegetables"	1 x 1000	No Runoff/ drainage	Step 2	1.927	9.20
			5	0.522	2.49
			10	0.277	1.32
			20	0.144	0.69
Vineyards "Vines, late applications" (worst case for drift values)	1 x 1200	No Runoff/ drainage	Step 2	5.173	32.11
			5	3.127	19.41
			10	1.132	7.03
			20	0.397	2.46

Pome fruit "Pome/stone fruit, early applications"	1 x 1250	No Runoff/ drainage	Step 2 5 10 20	23.598 18.542 11.387 2.603	121.65 95.59 58.70 13.42
Pome fruit "Pome/stone fruit, late applications"	1 x 1250	No Runoff/ drainage	Step 2 5 10 20	11.134 7.512 3.356 1.035	65.52 44.21 19.75 6.09
Ornamentals "Vines, early applications"	1 x 1000	No Runoff/ drainage	Step 2 5 10 20	1.718 1.024 0.360 0.122	9.00 5.36 1.89 0.64

* FOCUS drift values
** PEC Step 2 / (% drift for Step 2 / % drift for the buffer)

PEC_{sw} from calculations reported in points B) and C) were summed in order to derive the **final PEC results from all entry routes to water bodies that introduced the maximum mitigation agreed i**n FOCUS Landscape and mitigation (FOCUS, 2007) guidance.

Table 8.9-8: FOCUS Step 2 maximum PECsw for active substance Copper following a single application (runoff/drainage with 90% mitigation plus spray 20 m spray drift mitigation)

Uses **"FOCUS crop type"**	**Application pattern [g a.s./ha]**	**Season of application / Region**	**PECsw [µg/L] Step 2 – runoff/drainage – including 90% reduction**	**PECsw [µg/L] Step 2 – spray drift – including 20 m reduction**	**PECsw [µg/L] total – 90 % runoff reduction + 20 m spray drift reduction**
Arable fields "Fruiting vegetables"	1 x 1000	Oct.-Feb. EU-N	0.360	0.69	1.05
Vineyards "Vines, late applications" (worst case for drift values)	1 x 1200	Oct.-Feb. EU-N	0.431	2.46	2.89
Pome fruit "Pome/stone fruit, early applications"	1 x 1250	Oct.-Feb. EU-N	0.449	13.42	13.87
Pome fruit "Pome/stone fruit, late applications"	1 x 1250	Oct.-Feb. EU-N	0.449	6.09	6.54
Ornamentals "Vines, early applications"	1 x 1000	Oct.-Feb. EU-N	0.360	0.64	1.00

Under the spray drift scenario, the particulate, barely water soluble Copper compound that hits the surface water will start dissolving while complexation to DOC and sedimentation remove Copper from the dissolved fraction. The results from the Blust and Joosen 2016 study (CP-9.2.3/01) have demonstrated that in a realistic water/sediment scenario the total Copper declines very rapidly in the water phase while

dissolved Copper was at least a factor of 10 lower. This study describes best the speciation and kinetic behaviour of Copper in an aquatic environment following a spray drift event. Despite, the EUCuTF has proposed a more conservative total/dissolved value of 3 for use in the risk assessment, based on the measurements in the mesocosm study.
The EFSA evaluation used a total/dissolved ratio of 1, which suggests that all Copper is dissolved. This is against all observations in the monitoring studies and studies from the dossier cited above. The Art.43 evaluation should apply a total to dissolved Copper ratio of at least 3.

~~**Table 8.9-9: FOCUS Step 2 maximum PECsw for active substance DISSOLVED Copper following a single application (runoff/drainage with 90 % mitigation plus 20 m spray drift mitigation) – using a dissolved Copper ratio of 3**~~

~~**Uses "FOCUS crop type"**~~	~~**Application pattern [g a.s./ha]**~~	~~**Season of application / Region**~~	~~**PECsw [µg/L] Step 2 – runoff/drainage – including 90% reduction**~~	~~**PECsw [µg/L] Step 2 – spray drift – including 20 m reduction**~~	~~**PECsw [µg/L] total – 90 % runoff reduction + 20 m spray drift reduction**~~
~~**Arable fields** "Fruiting vegetables"~~	~~1 x 1000~~	~~Oct.-Feb. EU-N~~	~~0.12~~	~~0.23~~	~~0.35~~
~~**Vineyards** "Vines, late applications" (worst case for drift values)~~	~~1 x 1200~~	~~Oct.-Feb. EU-N~~	~~0.14~~	~~0.82~~	~~0.96~~
~~**Pome fruit** "Early applications"~~	~~1 x 1250~~	~~Oct.-Feb. EU-N~~	~~0.15~~	~~4.47~~	~~4.62~~
~~**Pome fruit** "Late applications"~~	~~1 x 1250~~	~~Oct.-Feb. EU-N~~	~~0.15~~	~~2.03~~	~~2.18~~
~~**Ornamentals** "Vines, early applications"~~	~~1 x 1000~~	~~Oct.-Feb. EU-N~~	~~0.12~~	~~0.21~~	~~0.33~~

PEC_{sed} results

To calculate the PEC sediment accumulation over seven years, the FOCUS step 2 sediment via spray drift and run-off / drainage with a Koc worst case default value of 10,000 mL/g values are added to a median background level of Copper in European sediments of 17 mg/kg.
Mitigation measures: 80-90 % reduction on runoff

Table 8.9-10: FOCUS Step 2 maximum PECsed for active substance Copper following a single application (only entry routes by runoff/drainage to water bodies considered)

Uses “FOCUS crop type”	Application pattern [g a.s./ha]	Season of application / Region*	Step 2 via run-off / drainage			
			PECsed, [mg/kg]	PECsed, Total Copper + background [mg/kg]	PECsed, Total Copper + background [mg/kg] Mitigation applied: 80%	PECsed, Total Copper + background [mg/kg] Mitigation applied: 90%
Arable fields “Fruiting vegetables”	1 x 1000	Oct.-Feb. EU-N	1.22	18.22	17.24	17.12
Vineyards “Vines, late applications” (worst case for drift values)	1 x 1200	Oct.-Feb. EU-N	1.61	18.61	17.32	17.16
Pome fruit “Early applications”	1 x 1250	Oct.-Feb. EU-N	2.29	19.29	17.46	17.23
Pome fruit “Late applications”	1 x 1250	Oct.-Feb. EU-N	1.90	18.9	17.38	17.19
Ornamentals “Vines, early applications”	1 x 1000	Oct.-Feb. EU-N	1.22	18.22	17.24	17.12

* It is shown that the season “Oct.-Feb.” results in the highest PEC values, therefore in the following calculations only this season was calculated.

The quantity of Copper in sediments has also been investigated experimentally in stream sediments taken from a stream in southern Germany next to an on-going field trial treated with Copper to show that the level of Copper in stream sediments is low. The study is summarized below.

Reference:	**CP 9.2.5/01, Axmann S, 2015**
Title:	A field study to determine Copper residues in stream sediments
Report No.:	S17-04438
Guidelines:	Regulations (EU) 283/2013 and 284/2013 implementing Regulation (EC) 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC EU Guidance Document SANCO/3029/99 rev. 4 for generating and reporting methods of analysis in support of pre-registration data requirements
Deviations:	No
GLP:	Yes
Published:	No
Comment:	-

Executive Summary

The objective of the study was to determine the Copper contents in stream sediments close to a field trial that had previously been treated with Copper. Sediment samples were taken from four sectors in the stream. Two sectors (1a and 1b) which were located upstream from the field site and represented controls without any possible copper input from the field site and two further sectors 2 and 3 which were located close to the field site and represented areas potentially exposed to Copper from treatments on the adjacent field trial.

Two samples were taken per sector – one sample from the surface (actual) sediment layer and one from the deeper (older) sediment layer(s). The layers were identified visually (i.e. colour, structure). Samples were taken with a spade to avoid disturbance of sediments before sampling, sampling direction was always downstream to upstream.

The trial site is part of an ongoing study S13-02262 “A Field Study to Evaluate the Effects of Copper on Earthworm Fauna in Central Europe” (Olaf Klein), Eurofins Agroscience Services Ecotox GmbH, Eutinger Str.24, 75233 Niefern-Öschelbronn, Germany). The study started in the autumn of 2003 and had been treated with (Copper hydroxide) at three different treatment rates, 4 kg/ha/year (T1), 8 kg/ha/year (T2) and 40 kg/ha/year (T3). The last treatment was at 40 kg/ha/year (T3) in March 2009. Annual Copper treatments from 2003 until November 2017 resulted in total amounts of 56 kg/ha (T1), 112 kg/ha (T2) and 240 kg/ha (T3).

From 2003 to 2017 there were no flood events recorded or data on flood events available. Intense rain events were recorded twice in 2013. Several rain events were indicated as possible intense rain events. The inclination of the trial site is low (0.6°) and directed north-northwest towards the stream Stunzach. The available data on area surface, the fluvial system of the stream Stunzach and precipitation data do not indicate intense runoff of Copper from the trial site into the waterbody of the trial S17-04438-01 by surface water (TOPPS, 2015).

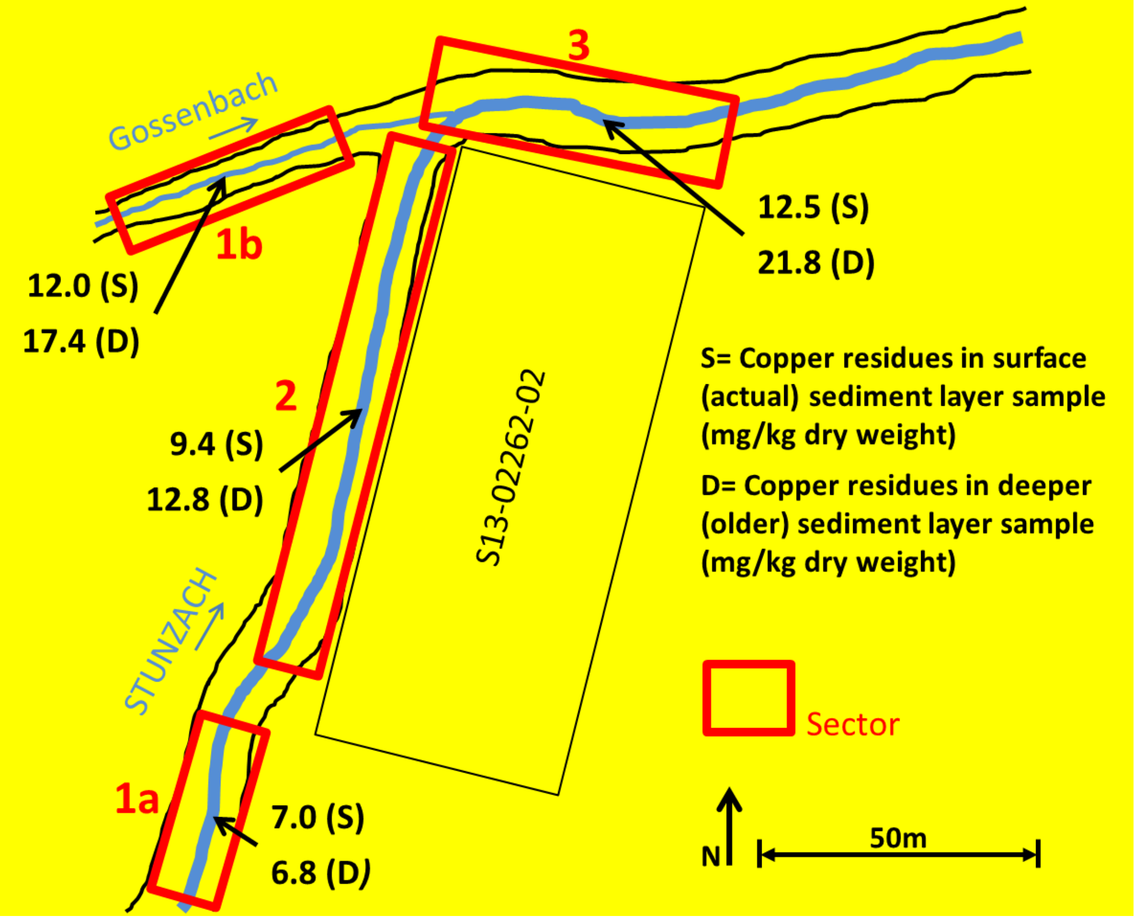
The dried and homogenised sediment was extracted using a mixture of strong acids in a suitable heat extraction system. Final analysis of total Copper was done with ICP-OES (inductively coupled plasma with optical emission spectrometry).

Procedural recoveries run concurrently with test specimen at levels of 4 mg/kg, 10 mg/kg, 20 mg/kg and 100 mg/kg gave an overall mean recovery of 85.6 ± 6.7 %.

Copper concentrations below 10 mg/kg dry sediment, were found in the samples from sector 1a, 12 (surface) and 17.4 (deeper) mg/kg dry sediment in sector 1b which both represent a control without any possible copper input from the field site. This was in the range of geogenic copper background in sediments of 17 mg/kg (RAR 2018). Copper concentrations in the samples of the potentially exposed sectors 2 and 3 were below 13 mg/kg except for the deeper, older sediment layer of sector 3 with a copper residue concentration of (21.8 mg/kg dry sediment)

In sectors 1b, 2 and 3 the concentration of Copper in deeper (older) sediment was up to 74 % higher than in the surface sediment layer. In sector 1a the Copper concentration in both sediment layers was at the same level.

Despite of 15 years of Copper application on the adjacent field no increase of the Copper concentration in the upper 5 cm sediment layer was observed.



Sample code	Sector	Sediment layer	Mean Copper Residue (mg/kg dry sediment)
S17-04438-01-1a-1	1a	Surface (actual)	7.0
S17-04438-01-1a-2	1a	Deeper (older)	6.8
S17-04438-01-1b-1	1b	Surface (actual)	12.0
S17-04438-01-1b-2	1b	Deeper (older)	17.4
S17-04438-01-2-1	2	Surface (actual)	9.4
S17-04438-01-2-2	2	Deeper (older)	12.8
S17-04438-01-3-1	3	Surface (actual)	12.5
S17-04438-01-3-2	3	Deeper (older)	21.8

I. MATERIALS AND METHODS

The field phase was carried out in Southern Germany at the field site of the study S13-02262 (trial -02). Sediment samples were taken from four sectors. Two sectors (1a, 1b) were located upstream from the field site and represented the control without any possible copper input from the field site. Sectors 2 and 3 were located close to the field site and represented possible copper (passive-) treated areas. Two samples per sector were taken – one sample from the surface (actual) sediment layer and one sample from deeper (older) sediment layer(s).

The field trial S13-02262-02 is part of the ongoing study S13-02262 “A Field Study to Evaluate the Effects of Copper on Earthworm Fauna in Central Europe” (Olaf Klein, Eurofins Agroscience Services Ecotox GmbH, Eutinger Str.24, 75233 Niefern-Öschelbronn, Germany). The study started on 01 Oct 2013. Before the initiation of the study S13-02262 the field site was the trial G03N047N of the study 20031343/G1-NFEw (Klein, O. (2015): A Field Study to Evaluate the Effects of Copper on Earthworm Fauna in Central Europe), which had been running 10 years from autumn 2003 until autumn 2013. Both studies were conducted on grassland.

The study started on 01 Oct 2013 and had been treated with (Copper hydroxide) at three different treatment rates, 4 kg/ha/year (T1), 8 kg/ha/year (T2) and 40 kg/ha/year (T3). The last treatment was at 40 kg/ha/year (T3) in March 2009. Annual copper treatments from 2003 until November 2017 resulted in total amounts of 56 kg/ha (T1), 112 kg/ha (T2) and 240 kg/ha (T3).

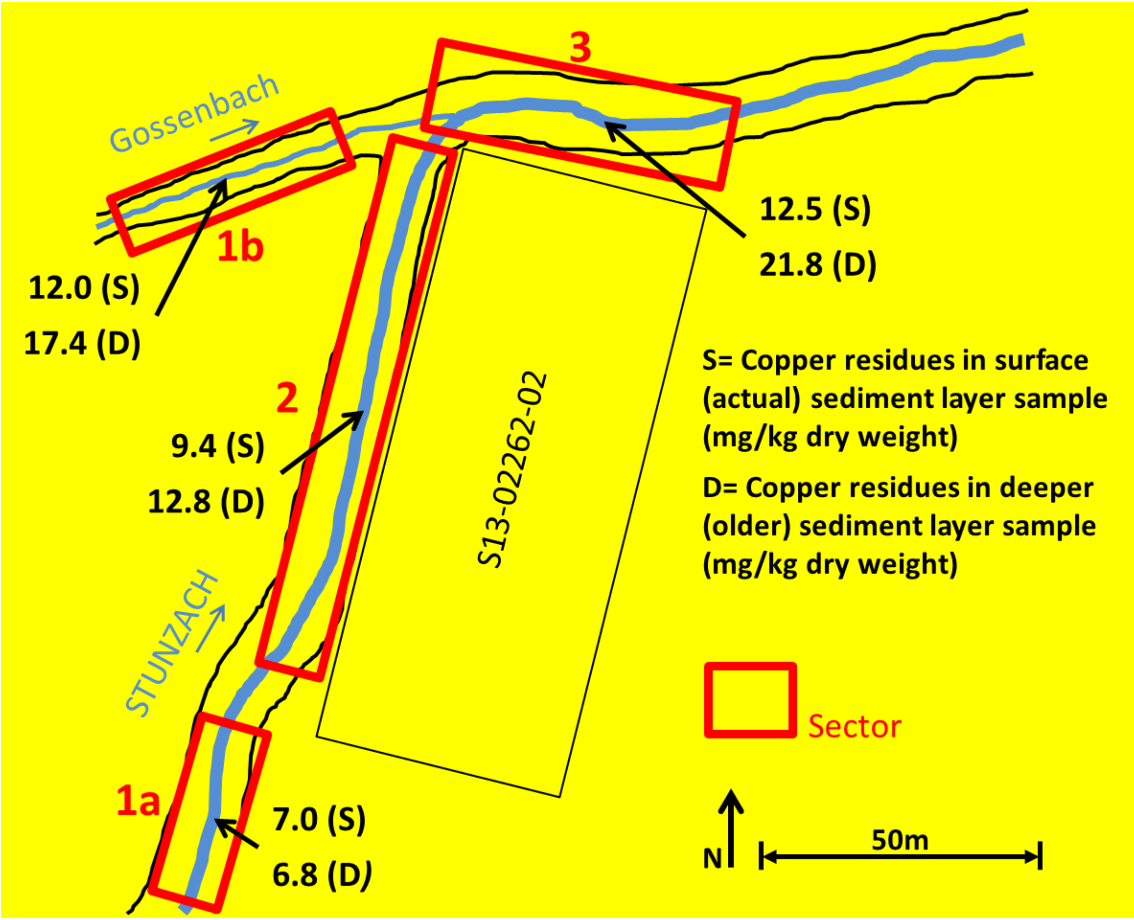
Table 8.9-11: Summary of test item copper hydroxide applied (target) in studies 20031343/G1-NFEw and S13-02262

Study/trial	**Period**	**Total amount of test item applied***
20031343/G1-NFEw / G03N047N	Autumn 2003 – autumn 2013 **(T3 from autumn 2003 – spring 2009)	40 kg/ha (T1) 80 kg/ha (T2) 240 kg/ha (T3)**
S13-02262 / S13-02262-02	01 Oct 2013 – 15 Nov 2017	16 kg/ha (T1) 32 kg/ha (T2)
Total	Autumn 2013 – 15 Nov2018	56 kg/ha (T1) 112 kg/ha (T2) 240 kg/ha(T3)**

*According to target application mode in studies 20031343/G1-NFEw and S13-02262

Sediment sampling took place on 15 Nov 2017. Sediment samples were taken from four sectors. Two samples per sector were taken – one sample from the surface (actual) sediment layer and one sample from deeper (older) sediment layer(s). Samples were taken with a spade to avoid disturbing the sediments. The sampling direction order was from downstream to upstream (sector 3 → sector 2 → sector 1a / sector 1b). In each sector the surface sediment layer sample was taken before the deeper sediment layer sample.

Sampling was done in four stream sectors near to trial site -02 of the study S13-02262. The sectors 1a and 1b represent stream areas without any possible Copper input from the trial site, sectors 2 and 3 were areas with possible passive Copper input from the trial site.



The dried and homogenised sediment was extracted using a mixture of strong acids in a suitable heat extraction system. Final analysis of total Copper was done with ICP-OES (inductively coupled plasma with optical emission spectrometry). Appropriate dilutions were prepared to meet the respective working range of the ICP-OES.

Procedural recoveries run concurrently with test specimen at levels of 4 mg/kg, 10 mg/kg, 20 mg/kg and 100 mg/kg gave an overall mean recovery of 85.6 ± 6.7 %.

II. RESULTS AND DISCUSSION

The Copper residues in the samples from sector 1a were low when compared to possible natural Copper content in soil 40-60 mg/kg (Scheffer & Schachtschabel, 2002). Slightly higher, but still low copper residues were found in the samples from sector 1b and sector 3. The maximum Copper residue (21.8 mg/kg dry sediment) was found in the deeper sediment layer sample from sector 3).

In sectors 1b, 2 and 3 the concentration of Copper in deeper (older) sediment was up to 74 % higher than in the surface sediment layer. In sector 1a the Copper concentration in both sediment layers was at the same level.

Table 8.9-12: Summary of Copper Residues in Sediment

Sample code	Sector	Sediment layer	Mean Copper Residue (mg/kg dry sediment)
S17-04438-01-1a-1	1a	Surface (actual)	7.0
S17-04438-01-1a-2	1a	Deeper (older)	6.8
S17-04438-01-1b-1	1b	Surface (actual)	12.0
S17-04438-01-1b-2	1b	Deeper (older)	17.4
S17-04438-01-2-1	2	Surface (actual)	9.4
S17-04438-01-2-2	2	Deeper (older)	12.8
S17-04438-01-3-1	3	Surface (actual)	12.5
S17-04438-01-3-2	3	Deeper (older)	21.8

III. CONCLUSIONS

Despite 15 years of Copper application on the adjacent field no increase of the Copper concentration in the upper 5 cm sediment layer was observed.

Comments of zRMS:	The study was previously submitted. The study results were used at the zonal level. The study results can be considered at the Member State level.

It should be noted FOCUS models, which are not designed or validated to predict the behaviour of metals in the environment, are not suitable for Copper predictions. For this reason, the environmental risk assessment has also been done with the IDMM model, designed specifically to model the long-term behaviour of metals.

Comparison of both the FOCUS and IDMM models show that resulting values are in the same region and the IDMM model is suitable for computing long term concentrations of metals in soils.

Focus modeling	**Intermediate Dynamic Model for Metals (agricultural version IDMM-ag**	
1 x 1250 g a.s./ha Buffer (20 m)	**1 x 6000 g a.s./ha 10 m VFS 10 years application**	**1 x 6000 g a.s./ha 20 m VFS 10 years application**
2.01 – 4.44 µg/L	0.30 – 4.42 µg/L	0.30 – 2.7 µg/L

Determination of PEC_{sw} and PEC_{sed} from drainage and run-off with Intermediate Dynamic Model for Metals (agricultural version IDMM-ag)

The IDMM–ag is a model for computing long term (years/decades) concentrations and pools of metals in soils, transfers to surface waters and concentrations in surface waters and sediments, for small agricultural catchments.

While the model is initialised, the catchment is assumed to receive only natural external metal inputs (due to natural atmospheric deposition). After initialisation the model is run in dynamic mode, predicting annual soil metal concentrations (labile and total metal for each layer), surface water concentrations (time-averaged dissolved metal for each year) and sediment concentrations (labile, aged and sulphide-bound).

The IDMM-ag model has been applied to the ten drainage and runoff scenarios developed in the FOCUS surface water model. Annual PEC_{sw} and PEC_{sed} values, following 315 years of non-fungicide inputs of Copper with 10 years of fungicide applications at a rate of 6 kg Cu/ha/annum, are used in the aquatic risk assessment.

The model estimates the total dissolved copper in the surface water. This will comprise

- free Copper ion content,
- Copper complexed to DOC and
- Copper complexed to inorganic ligands.

As discussed earlier, it is considered that the toxic fraction comprises the free Copper ions and the inorganic complexes. The copper-DOC complexes are considered to be not bioavailable.

PEC_{sw} and PEC_{sed} from drainage and run-off with the IDMM-ag model

Reference:	**CP 9.2.5/02 Lofts, S., 2015**
Title:	Prediction of soil, surface water and sediment concentrations of Copper resulting from use of fungicide Copper in agricultural catchments
Report No.:	NEC05505/1
Guidelines:	Not applicable
Deviations:	No
GLP:	No
Published:	No
Comment:	-

Executive Summary

The predicted environmental concentrations of Copper in surface water and sediment as a result of run-off and drainage were estimated for use of Copper as a fungicide on agricultural crops with the IDMM-ag v1.0 model.
Annual PECsw and PECsed values, following 315 years of non-fungicide inputs of Copper with 10 years of fungicide applications at a rate of 6 kg Cu/ha/annum, are summarised below.

Scenario	**$PEC_{sw\ dissolved}$ [µg/L]**	**$PEC_{sed\ total}$ [mg/kg]**
D6 Thiva ditch	0.44	30.9
R1 Weiherbach pond	7.04	11.4
R1 Weiherbach stream	0.49	21.4
R2 Porto stream	0.55	21.5
R3 Bologna stream	0.49	36.4
R4 Roujan stream	0.24	25.8

Comparison of the concentrations with ecotoxicological endpoints indicated that mitigation measures were required only for the R1 Weiherbach pond for some aquatic organisms. Risk mitigation measures of 10 m vegetative filter strips (equivalent to 60 % runoff and 85 % eroded soil mitigation) were considered sufficient.

PEC_{sw} = 4.42 µg/L dissolved Cu with 10 m VFS

Materials and Methods:

The Intermediate Dynamic Model for Metals (IDMM-ag v1.0) is an intermediate complexity model for the simulation of metal accumulation in soils and leaching to surface waters. The model computes metal pools in soils, and leaching fluxes to surface waters, on an annual time-step, in response to metal inputs to the soil surface. Within each soil layer, three metal pools are simulated: dissolved, labile particulate and aged particulate. Particulate metal may be associated either with the soil solids or with solids suspended in the soil porewater (i.e. eroded soil). Processes simulated comprise equilibrium solid-solution partitioning of labile metal, exchange of soil-bound metal between labile and aged pools, equilibrium speciation of metal in the soil porewater, removal of metal following uptake into the harvestable parts of crop plants, and weathering of metal from 'inert' mineral forms into the labile pool. Multiple soil layers of user-defined depth can be simulated. Water entering the uppermost layer by precipitation or irrigation can leach either laterally to surface water or vertically to the lower layers. From the lowest layer water may percolate vertically to groundwater or leach to surface water via field drainage. A portion of the metal associated with water percolating to groundwater is 'lost' from the system, the remainder emerges to surface water in baseflow. Metal movement within the soil and to surface waters may occur in one of three forms: dissolved metal, labile metal adsorbed to suspended matter in the porewater, and aged metal in suspended matter. The IDMM-ag v1.0 further simulates both 'weakly aged' metal and 'strongly aged' metal in soils. Concentrations of suspended matter in the porewater moving within and out of the soil are specified as driving variables. On each annual time-step, labile adsorbed and aged metal pools in each soil layer are calculated.
Surface water dissolved Copper, and Copper concentrations in freshwater sediments, are calculated by assuming that water leaching from the soil layers (soilflow) enters a waterbody of defined volume, along with a constant baseflow assumed to represent upstream flow and seepage from deep soil and groundwater to surface water. The amount of soilflow varies daily and is input as a driving variable, while the concentration of Copper in soilflow is assumed constant over each year. Within each annual timestep, surface water concentrations of metal and suspended particulate matter are computed daily by mixing baseflow and soilflow with the water present in the waterbody. The baseflow is assumed to have Copper and suspended sediment concentrations equal to those in the water draining from the base of the soil profile. Redistribution of Copper among dissolved, labile particulate and aged particulate forms in the suspended

sediment is first calculated using WHAM/Model VI. This step assumes that the organic carbon content of the suspended sediment is 5%, in accordance with EU Risk Assessment guidelines. The loss of suspended sediment particles and associated Copper from the water column by settling is then simulated using the fractional settling of suspended sediment on each daily timestep. The fractional settling is calculated daily, from the calculated velocity of water through the waterbody and assuming a particle settling velocity of 1 meter per day; thus, the daily settling rate varies with the discharge of water from the soil; higher discharge will give a lower settling rate. In stream and ditch scenarios (but not ponds) sediment may resuspend above a threshold water flow rate, and sediment may also be removed from the waterbody by bedload movement. The sediment is assumed to comprise two layers (an oxic and an anoxic layer) containing a mixture of fine material (derived from soil erosion) and coarse material (which is assume to be physically and chemically inert, i.e. it does not move and does not bind metals). The anoxic layer of sediment may contain acid-volatile sulphide, which can bind labile metal as a solid sulphide and render it non-labile.

The sediment PEC is taken as the mean concentration of Copper (mg/kg dry weight) in the top 5 cm of the settled sediment. Fluxes of dissolved and suspended particulate Copper in the waterbody outflow are computed assuming the daily outflow to equal the daily inflow.

The IDMM is applied by initially calculating the metal present in the soil (dissolved, labile particulate and aged particulate) under 'pristine' steady state conditions (i.e. where the annual input and output fluxes in each soil layer balance. The model then simulates metal dynamics forward in time from this 'pristine' state, in response to changes in metal inputs (e.g. from atmospheric deposition and application of fertilisers/fungicides), soil pH, and the mass of harvestable plant removed annually.

For this work, the model has been applied to the ten soil-water scenarios used by the FOCUS group. The characteristics of the soils and surface waters in each scenario were set up within the model. Basic soil characteristics (e.g. site density, pH, organic matter and clay content) are based on measurements at the sites as provided in the FOCUS report. Surface water characteristics are not based on site measurements, but are interpolated from spatial measurements of surface water quality in the FOREGS geochemical baselines database. Temporal patterns of inputs due to atmospheric deposition and fertilizer were used.

Scenarios were run for the years 1745 (pristine conditions) to 2060. Non-fungicide inputs of Copper to the catchment soils were natural deposition (applied throughout the period), anthropogenic atmospheric deposition (starting in 1800) and fertilizers (starting in 1930). Addition of Copper as a fungicide was begun either in 1900 or 2010. Three application rates of Copper as a fungicide were simulated: 4, 6, and 8 kg per hectare per annum. In running the scenarios, it was assumed that all input Copper (regardless of source) was fully labile and entered the topsoil, i.e. interception of applied Copper by plant surfaces and subsequent removal by harvesting was negligible. In terms of Copper entering the soil system, the simulated input rates therefore represent 'worst case' scenarios for the actual field application rates.

In order to simulate the influence of topsoil runoff attenuation through the use of vegetation strips, the fluxes of water and eroded particles to surface water may be empirically decreased by fixed proportions. In this study, we used three options for attenuation in the runoff scenarios:

- No attenuation;
- Presence of 10 wide vegetation filter strips, reducing water fluxes by 60 % and eroded particle fluxes by 85 %.
- Presence of 20 m wide vegetation filter strips, reducing water fluxes by 80 % and eroded particle fluxes by 95 %.

Annual average concentrations of Copper in surface water and sediment were calculated after 10, 20 and 50 years of applications at 4, 6 and 8 kg Cu/ha each year for each of the FOCUS scenarios 'drainage' scenarios D1 to D6, and 'runoff' scenarios R1 to R4. PEC values considered relevant for the aquatic risk assessment for the application rate of 6 kg Cu/ha and the scenarios relevant for fruiting vegetables and vines are summarized below. Additional scenarios and application rates are provided in the report.

Input parameters:

The key substance parameters used in the IDMM calculations are summarised below in Table 8.9-13.

Table 8.9-13: Key Copper parameters used in the IDMM calculations

Parameter	Value	Description
M_r	63.55	Atomic weight of Copper, g/mol
Parameters in the expression relating free metal ion and adsorbed labile metal in soil [a]		
α_0	-6.37	Constant term
α_1	0.64	Coefficient of pH_{pw}
α_2	0.87	Coefficient of log(SOM)
α_3	0	Coefficient of log(*clay*)
n	0.57	Power coefficient of $[M]_{free}$
Parameters for metal aging		
γ_0	-8.37	Constant term
γ_1	0	Coefficient of pH_{pw}
γ_2	0	Coefficient of log(SOM)
γ_3	0	Coefficient of log(clay)
γ_4	0	Coefficient of log ($[M]_{free}$)
Parameters in the expression computing harvestable crop metal content from soil metal concentration and soil chemistry [b]		
$A_{f,a}$, $B_{f,a}$, $C_{f,a}$, $D_{f,a}$	-2.5,0,0.8,7.4	terms in expression for log $k_{f,a}$ [c]
$A_{b,a}$, $B_{b,a}$, $C_{b,a}$, $D_{b,a}$	-2.1,0,0.5,7.5	terms in expression for log $k_{b,a}$ [d]
$A_{f,m}$, $B_{f,m}$, $C_{f,m}$, $D_{f,m}$	-5,0,0,0	terms in expression for log $k_{f,m}$ [e]
$A_{b.m}$, $B_{b,m}$, $C_{b,m}$, $D_{b,m}$	-6,0,0,0	terms in expression for log $k_{b,m}$ [f]
Parameters for Copper binding to dissolved organic matter in soil solution		
$K_{MA,FA}$	102.16	Binding constant for binding of Copper to fulvic acid [g]
$\Delta LK_{2, Cu}$	2.34	Binding constant for strong binding of Copper to fulvic acid
Parameters for Copper binding to inorganic ligands in soil solution and surface water		
K_{CuOH}, ΔH_{CuOH}	6.48, 0	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuOH^+$ species in soil porewater and surface water
$K_{Cu(OH)2}$, $\Delta H_{Cu(OH)2}$	11.78, 0	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuOH_2^0$ species in soil porewater and surface water
K_{CuHCO3}, ΔH_{CuHCO3}	14.62, 0	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuHCO_3^+$ species in soil porewater and surface water
K_{CuCO3}, ΔH_{CuCO3}	6.75, 0	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuCO_3^0$ species in soil porewater and surface water
$K_{Cu(CO3)2}$, $\Delta H_{Cu(CO3)2}$	9.92, 0	Binding constant and reaction enthalpy (kcal/mol) for formation of the $Cu(CO_3)_2^{2-}$ species in soil porewater and surface water
K_{CuCl}, , ΔH_{CuCl}	0.4, 1.6	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuCl^+$ species in soil porewater and surface water
K_{CuSO4}, ΔH_{CuSO4}	2.36, 2.1	Binding constant and reaction enthalpy (kcal/mol) for formation of the $CuSO_4^0$ species in soil porewater and surface water

Findings:

The results of the IDMM calculations relevant for the proposed use on tomatoes, cucumbers and vines are summarised in Table 8.9-14 to Table 8.9-16.

The scenarios were run from the year 1745 (pristine conditions) to 2060 (315 years in total). Soils were assumed to receive each the following inputs of Copper:

1) Natural deposition of Copper throughout this period
2) Atmospheric deposition starting in 1800 and
3) Fertilizer applications starting in 1930
4) Addition of Copper as a fungicide was simulated to begin either in 1900 or 2010.

Concentrations are presented for 10 years applications of 6 kg/ha per annum in Table 8.9-14. It should be noted the maximum application rate in any single year in the proposed use pattern for vines is 8 kg/ha but the total applied in any 5 year period must not exceed 30 kg/ha. The flexible dosing regimen proposed for vines was considered equivalent to the main use on vines at a maximum of 6 kg/ha each year. The maximum application rate in any single year in the proposed use pattern for tomatoes and cucumbers is 6 kg/ha.

PECsw values are provided for dissolved Copper, while PECsed values are provided for total and labile Copper. Values for labile Copper have been calculated assuming three levels of acid volatile sulphides (AVS) in sediment (0, 0.004 and 0.63 µmol AVS/g). AVS can form insoluble precipitates with metals and thus reduce the amount of labile Copper available in sediment. No AVS in sediment is considered an absolute worst case, while 0.004 and 0.63 µmol /g represent the 95th and 50th percentiles of the range of AVS measured in a survey of 84 small streams across 10 countries and nine ecoregions of Europe (Burton et al., 2007).

Table 8.9-14: Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 10 years

Scenario	**1 x 6000 g a.s./ha 10 years application**				
	$PEC_{sw\ dissolved}$	**$PEC_{sed\ total}$**	**$PEC_{sed\ labile}$ AVS = 0 µmol/g**	**$PEC_{sed\ labile}$ AVS = 0.004 µmol/g**	**$PEC_{sed\ labile}$ AVS = 0.63 µmol/g**
	[µg/L]	**[mg/kg]**	**[mg/kg]**	**[mg/kg]**	**[mg/kg]**
D6 Thiva ditch	0.44	30.9	3.14	2.99	1.26
R1 Weiherbach pond	7.04	11.4	2.90	2.74	1.16
R1 Weiherbach stream	0.49	21.4	5.93	5.78	2.37
R2 Porto stream	0.55	21.5	8.33	8.17	3.33
R3 Bologna stream	0.49	36.4	9.05	8.89	3.62
R4 Roujan stream	0.24	25.8	2.28	2.12	0.91

Comparison of the concentrations with ecotoxicological endpoints indicated that mitigation measures were required only for the R1 Weiherbach pond for some aquatic organisms. PEC values for 10 years applications of 6 kg/ha per annum considering risk mitigation measures of 10 m and 20 m vegetative filter strips (equivalent to 60 % and 80 % runoff mitigation) are presented in Table 8.9-15 and Table 8.9-16.

Table 8.9-15 Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 10 years including a 10 m vegetative filter strip

Scenario	1 x 6000 g a.s./ha 10 m VFS 10 years application				
	$PEC_{sw\ dissolved}$	$PEC_{sed\ total}$	$PEC_{sed\ labile}$ AVS = 0 µmol/g	$PEC_{sed\ labile}$ AVS = 0.004 µmol/g	$PEC_{sed\ labile}$ AVS = 0.63 µmol/g
	[µg/L]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
D6 Thiva ditch	-	-	-	-	-
R1 Weiherbach pond	4.42	11.3	1.52	1.37	0.61
R1 Weiherbach stream	0.56	17.4	3.42	3.27	1.37
R2 Porto stream	0.61	16.1	4.94	4.79	1.98
R3 Bologna stream	0.59	28.7	4.93	4.78	1.97
R4 Roujan stream	0.30	23.2	1.37	1.22	0.55

Table 8.9-16: Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 10 years including a 20 m vegetative filter strip

Scenario	1 x 6000 g a.s./ha 20 m VFS 10 years application				
	$PEC_{sw\ dissolved}$	$PEC_{sed\ total}$	$PEC_{sed\ labile}$ AVS = 0 µmol/g	$PEC_{sed\ labile}$ AVS = 0.004 µmol/g	$PEC_{sed\ labile}$ AVS = 0.63 µmol/g
	[µg/L]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
D6 Thiva ditch	-	-	-	-	-
R1 Weiherbach pond	2.73	12.4	1.08	0.93	0.43
R1 Weiherbach stream	0.53	16.3	2.60	2.45	1.04
R2 Porto stream	0.54	13.6	3.38	3.23	1.35
R3 Bologna stream	0.57	26.0	3.44	3.28	1.37
R4 Roujan stream	0.30	22.4	1.09	0.94	0.44

In addition Copper concentrations are presented for IDMM calculations after 110 years applications of 6 kg/ha per annum are presented in Table 8.9-17 to Table 8.9-19.

Table 8.9-17 Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 110 years

Scenario	1 x 6000 g a.s./ha 110 years application				
	$PEC_{sw\ dissolved}$	$PEC_{sed\ total}$	$PEC_{sed\ labile}$ AVS = 0 µmol/g	$PEC_{sed\ labile}$ AVS = 0.004 µmol/g	$PEC_{sed\ labile}$ AVS = 0.63 µmol/g
	[µg/L]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
D6 Thiva ditch	2.87	86.9	36.0	35.8	14.4
R1 Weiherbach pond	59.7	31.2	15.2	15.0	6.08
R1 Weiherbach stream	1.51	60.9	25.2	25.1	10.1
R2 Porto stream	4.70	76.8	46.2	46.1	22.1
R3 Bologna stream	1.24	75.7	30.7	30.5	12.3
R4 Roujan stream	1.12	49.0	14.3	14.2	5.73

Table 8.9-18: Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 110 years including a 10 m vegetative filter strip

Scenario	1 x 6000 g a.s./ha 110 years application				
	$PEC_{sw\ dissolved}$	$PEC_{sed\ total}$	$PEC_{sed\ labile}$ AVS = 0 µmol/g	$PEC_{sed\ labile}$ AVS = 0.004 µmol/g	$PEC_{sed\ labile}$ AVS = 0.63 µmol/g
	[µg/L]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
D6 Thiva ditch	-	-	-	-	-
R1 Weiherbach pond	37.9	13.7	2.79	2.64	1.12
R1 Weiherbach stream	1.80	37.9	14.1	14.0	5.65
R2 Porto stream	4.96	51.2	29.3	29.1	11.7
R3 Bologna stream	1.49	47.9	15.9	15.8	6.37
R4 Roujan stream	1.43	34.0	7.43	7.28	2.97

Table 8.9-19: Predicted concentrations of Copper in surface water (PEC_{sw}) and sediment (PEC_{sed}) after annual applications of 6 kg/ha per annum for 110 years including a 20 m vegetative filter strip

Scenario	1 x 6000 g a.s./ha 110 years application				
	$PEC_{sw\ dissolved}$	$PEC_{sed\ total}$	$PEC_{sed\ labile}$ AVS = 0 µmol/g	$PEC_{sed\ labile}$ AVS = 0.004 µmol/g	$PEC_{sed\ labile}$ AVS = 0.63 µmol/g
	[µg/L]	[mg/kg]	[mg/kg]	[mg/kg]	[mg/kg]
D6 Thiva ditch	-	-	-	-	-
R1 Weiherbach pond	23.4	12.9	1.24	1.08	0.49
R1 Weiherbach stream	1.66	29.2	9.70	9.55	3.88
R2 Porto stream	4.31	38.0	20.5	20.4	8.20
R3 Bologna stream	1.42	38.4	10.6	10.5	4.25
R4 Roujan stream	1.44	29.6	5.27	5.12	2.11

Conclusions:

Calculations of predicted concentrations of dissolved Copper in surface water and total Copper in sediment following exposure of water bodies from runoff and drainage have been conducted with the IDMM-ag v.1.0 model developed to predict the long-term behaviour of metals in the environment.

The annual PECsw and PECsed values, following 315 years of non-fungicide inputs of Copper with 10 years of fungicide applications at a rate of 6 kg Cu/ha/annum, are summarised below.

PEC_{sw} = 7.04 µg/L dissolved Cu in R1 Weiherbach pond

$PEC_{sed\ total}$ = 36.4 mg/kg total Cu in R3 Bologna stream

Comparison of the concentrations with ecotoxicological endpoints indicated that mitigation measures were required only for the R1 Weiherbach pond for some aquatic organisms. Risk mitigation measures of 10 m vegetative filter strips (equivalent to 60 % runoff mitigation and 85 % eroded soil mitigation) were considered sufficient.

PEC_{sw} = 4.42 µg/L dissolved Cu with 10 m VFS

PECsw/sed of formulation

Not necessary for a formulation containing one active substance. Covered from the risk assessment based on the active substance Copper.

8.10 Fate and behaviour in air (KCP 9.3, KCP 9.3.1)

zRMS Comments	The submitted justification was accepted.

Copper is not volatile at environmentally relevant temperatures and will therefore not be present in air. Furthermore, Copper cannot be transformed into related metabolites or degradation products and degradation processes likely to occur in air will have no action on Copper.

Appendix 1 Lists of data considered in support of the evaluation

Tables considered not relevant can be deleted as appropriate.

MS to blacken authors of vertebrate studies in the version made available to third parties/public.

List of data submitted by the applicant and relied on

Data point	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Vertebrate study Y/N	Owner
KCP 9.2.4/01	Demetriades, A. et al	2012	European Ground Water Geochemistry Using Bottled Water as a Sampling Medium Company Report No: -- Source Clean Soil and Safe Water Non GLP Published	N	Literature Paper
KCP 9.2.5/01	Axmann, S	2015	A field study to determine copper residues in stream sediments Company Report No: S17-04438 Source N/A GLP Unpublished	N	EuCu Task Force
KCP 9.2.5/02	Lofts, S	2015	Prediction of soil, surface water and sediment concentrations of copper resulting from use of fungicide copper in agricultural catchments Company Report No: NEC05505/1 Source N/A GLP Unpublished	N	EuCu Task Force

List of data submitted or referred to by the applicant and relied on, but already evaluated at EU peer review

Data point	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Vertebrate study Y/N	Owner
KCP 9.2.5/02	Lofts, S	2015	Prediction of soil, surface water and sediment concentrations of copper resulting from use of fungicide copper in agricultural catchments Company Report No: NEC05505/1 Source N/A GLP Unpublished	N	EuCu Task Force

The following tables are to be completed by MS

List of data submitted by the applicant and not relied on

Data point	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Vertebrate study Y/N	Owner
KCP XX	Author	YYYY	Title Company Report N Source GLP/non GLP/GEP/non GEP Published/Unpublished	Y/N	Owner

List of data relied on not submitted by the applicant but necessary for evaluation

Data point	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Vertebrate study Y/N	Owner
KCP XX	Author	YYYY	Title Company Report N Source GLP/non GLP/GEP/non GEP Published/Unpublished	Y/N	Owner

Appendix 2 Detailed evaluation of the new Annex II studies

Not relevant.

Appendix 3 PEC$_{gw}$ raw data

PEC$_{gw}$ calculations were conducted with FOCUS PEARL v5.5.5, FOCUS PELMO v6.6.4, FOCUS MACRO v5.5.3. Raw data can be submitted in electronic form. In the following example files for each program are included.

A 3.1 FOCUS PEARL v5.5.5

Crop	File name
Apple	61-69
Vine	70-76
Tomato	77-81

Example file: 61

Input

```
*-----------------------------------------------------------------------------
* INPUT FILE for PEARL
* Generated by user interface version FOCUSPEARL 5.5.5 (build : 5.5.5) (October 2020) on 17/12/2021 10:08:22
*-----------------------------------------------------------------------------
* This file is intended to be used by expert users.
*
* Contact addresses:
* -----------------
* Aaldrik Tiktak                    Erik van den Berg
* Environmental Assessment Agency (PBL) Wageningen Environmental Research (WENR)
* PO BOX 30314                      PO BOX 47
* 2500 GH The Hague                 6700 AA Wageningen
* The Netherlands                   The Netherlands
* e-mail: aaldrik.tiktak@pbl.nl     erik.vandenberg@wur.nl
*
* (c) 2020 RIVM, PBL, WENR

*-----------------------------------------------------------------------------
* Section 1: Control section
*-----------------------------------------------------------------------------

FOCUSPEARL      CallingProgram
5.5.5           CallingProgramVersion
Groundwater     ExposureType
6               InitYears (y)
0               NumRep (-)
01-Jan-1901     TimStart
31-Dec-1926     TimEnd
0.001           ThetaTol (m3.m-3)
Month           OptDelTimPrn
30              DelTimPrn  (d)
OnLine          OptHyd
1E-5            DelTimSwaMin (d)
0.2             DelTimSwaMax (d)
Yes             PrintCumulatives
1.0             GWLTol (m)
30              MaxItSwa
```

```
No          OptHysteresis
0.2         PreHeaWetDryMin (cm)
All         OptSys
Yes         OptScreen
No          OptPaddy
No          OptMacropore
None        OptAux

*-----------------------------------------------------------------------------
* Section 2: Soil section
*-----------------------------------------------------------------------------

CHAT-S_Soil SoilTypeID
CHATEAUDUN Location
table SoilProfile
ThiHor NumLay
(m)
0.01    5
0.24    24
0.05    5
0.2     16
0.1     4
0.4     16
0.2     4
0.3     6
0.4     4
2.6     26
end_table
table  horizon SoilProperties
Nr    FraSand    FraSilt    FraClay    CntOm       pH
      (kg.kg-1)  (kg.kg-1)  (kg.kg-1)  (kg.kg-1)   (-)
1     0.03       0.67       0.3        0.024       8
2     0.03       0.67       0.3        0.024       8
3     0.02       0.67       0.31       0.016       8.1
4     0.02       0.67       0.31       0.016       8.1
5     0.08       0.67       0.25       0.012       8.2
6     0.3        0.44       0.26       0.005       8.5
7     0.3        0.44       0.26       0.005       8.5
8     0.38       0.38       0.24       0.0046      8.5
9     0.38       0.38       0.24       0.0046      8.5
10    0.08       0.61       0.31       0.0036      8.3
end_table
table  horizon VanGenuchtenPar
Nr    ThetaSat   ThetaRes   AlphaDry   AlphaWet   n       KSat     l
      (m3.m-3)   (m3.m-3)   (cm-1)     (cm-1)     (-)     (m.d-1)  (-)
1     0.43       0          0.05       0.1        1.08    1.728    0.5
2     0.43       0          0.05       0.1        1.08    1.728    0.5
3     0.44       0          0.05       0.1        1.095   2.592    0.5
4     0.44       0          0.05       0.1        1.095   2.592    0.5
5     0.44       0          0.05       0.1        1.095   4.32     2.5
6     0.44       0          0.015      0.03       1.16    1.0368   -2
7     0.44       0          0.015      0.03       1.16    1.0368   -2
8     0.49       0          0.0107     0.0214     1.28    0.7828   -1.5
9     0.49       0          0.0107     0.0214     1.28    0.7828   -1.5
10    0.42       0          0.0191     0.0382     1.152   1.2796   -1.18
end_table
Input          OptRho
table horizon     Rho         (kg.m-3)
1   1300.0
2   1300.0
3   1410.0
4   1410.0
5   1410.0
6   1370.0
7   1370.0
```

```
8    1410.0
9    1410.0
10   1490.0
end_table

0.002           ZPndMax         (m)

* Soil evaporation parameters
Boesten          OptSolEvp
1               FacEvpSol       (-)
0.79             CofRedEvp       (cm1/2)
0.01             PrcMinEvp       (m.d-1)

Table horizon LenDisLiq (m)
1  0.05
2  0.05
3  0.05
4  0.05
5  0.05
6  0.05
7  0.05
8  0.05
9  0.05
10 0.05
end_table
MillingtonQuirk   OptCofDifRel
2               ExpDifLiqMilNom (-)
0.6667            ExpDifLiqMilDen (-)
2               ExpDifGasMilNom (-)
0.6667            ExpDifGasMilDen (-)
Constant          OptPnd

*-------------------------------------------------------------------------------
* Section 3: Weather and irrigation section
*-------------------------------------------------------------------------------

chat-m            MeteoStation
Input            OptEvp
2.35             TemLboSta        (C)
Surface_Weekly    OptIrr
SURFACE_WEEKLY    IrrigationScheme
1.0              FacPrc (-)
1.0              FacEvp (-)
0.0              DifTem (C)
Laminar           OptTraRes
Daily            OptMetInp
No               OptRainfallEvents
No               OptSnow

*-------------------------------------------------------------------------------
* Section 4a: Lower boundary flux
*-------------------------------------------------------------------------------

-1200            ZGrwLevSta (cm)

FreeDrain         OptLbo
*-------------------------------------------------------------------------------
* Section 4b: Drainage/infiltration section
*-------------------------------------------------------------------------------

No               OptDra
No               OptSurDra
0               NumDraLev

*-------------------------------------------------------------------------------
```

```
* Section 5: Compound section
*-----------------------------------------------------------------------------

Cu SubstanceName
table compounds
Cu
end_table
EqlDom_Input       OptDT50_Cu
63.54              MolMas_Cu (g.mol-1)
table FraPrtDau (mol.mol-1)
end_table
OptimumConditions   OptCntLiqTraRef_Cu
1000000.           DT50Ref_Cu (d)
20.                TemRefTra_Cu (C)
0.7                ExpLiqTra_Cu (-)
65.4               MolEntTra_Cu (kJ.mol-1)
table horizon FacZTra (-)
hor Cu
1 1
2 1
3 0.5
4 0.5
5 0.5
6 0.3
7 0
8 0
9 0
10 0
end_table
table horizon FacZSor (-)
hor Cu
1 -99
2 -99
3 -99
4 -99
5 -99
6 -99
7 -99
8 -99
9 -99
10 -99
end_table
0.                 MolEntSor_Cu (kJ.mol-1)
20.                TemRefSor_Cu (C)
pH-independent     OptCofFre_Cu
11315.7            KomEql_Cu (L.kg-1)
1131570.           KomEqlMax_Cu (L.kg-1)
1.                 ConLiqRef_Cu (mg.L-1)
1.                 ExpFre_Cu (-)
0.                 PreVapRef_Cu (Pa)
20.                TemRefVap_Cu (C)
500.               SlbWatRef_Cu (mg.L-1)
20.                TemRefSlb_Cu (C)
27.                MolEntSlb_Cu (kJ.mol-1)
95.                MolEntVap_Cu (kJ.mol-1)
0.                 CofDesRat_Cu (d-1)
0.                 FacSorNeqEql_Cu (-)
0.                 FacUpt_Cu (-)
0.01               ThiAirBouLay (m)
Lumped             OptDspCrp_Cu
10.                DT50DspCrp_Cu (d)
0.0001             FacWasCrp_Cu (m-1)
20.                TemRefDif_Cu (C)
4.3E-5             CofDifWatRef_Cu (m2.d-1)
0.43               CofDifAirRef_Cu (m2.d-1)
```

```
*-----------------------------------------------------------------------------
* Section 6: Management section
*-----------------------------------------------------------------------------

Cu_pome_Chat ApplicationScheme
1.0             ZTgt (m)
0.0             ZEADTop (m)
0.2             ZEADBot (m)
1               DelTimEvt (a)
table Applications
10-Oct-2000  AppSolSur 2.5
end_table
table TillageDates
end_table
table interpolate CntSysEql (mg.kg-1)
0.0      0.0
50.0     0.0
end_table
table interpolate CntSysNeq (mg.kg-1)
0.0      0.0
50.0     0.0
end_table
No DepositionScheme
table    FlmDep   (kg.ha-1.d-1)
end_table
*-----------------------------------------------------------------------------
* Section 7: Crop section
*-----------------------------------------------------------------------------

CHAT-APPLES CropCalendar
Yes             RepeatCrops
Fixed           OptLenCrp
LAI    OptCov

table  Crops
01-Jan          31-Dec        apples1
end_table
table  IrrigationPeriods
01-Apr          01-Oct        apples1
end_table
table  CrpPar_apples1
0.0    0.0    1.0    1.0    0.0
0.245  0.0    1.0    1.0    0.0
0.247  0.0    1.05   1.0    0.0
0.409  4.0    1.05   1.0    0.0
0.412  4.0    1.1    1.0    0.0
0.665  4.0    1.1    1.0    0.0
0.668  4.0    0.98   1.0    0.0
0.747  4.0    0.98   1.0    0.0
0.75   0.0    1.0    1.0    0.0
1.0    0.0    1.0    1.0    0.0
end_table
table  RootDensity_apples1
0.0    1.0
1.0    1.0
end_table
-10.0           HLim1_apples1 (cm)
-25.0           HLim2_apples1 (cm)
-500.0          HLim3U_apples1 (cm)
-800.0          HLim3L_apples1 (cm)
-16000.0        HLim4_apples1 (cm)
70.0            RstEvpCrp_apples1 (s.m-1)
0.39            CofExtDif_apples1 (-)
1.0             CofExtDir_apples1 (-)
0.0001          CofIntCrp_apples1 (cm)
```

```
0.0          TemSumSta_apples1 (C)
0.0          TemSumEmgAnt_apples1 (C)
0.0          TemSumAntMat_apples1 (C)
0.2          ZTensiometer_apples1 (m)
0.5          FraCovStm_apples1 (-)
-200.0         PreHeaIrrSta_apples1 (cm)
15.0         IrgThreshold_apples1 (mm)
*-----------------------------------------------------------------------------
* Section 8: Output control
*-----------------------------------------------------------------------------

DaysFromSta      DateFormat
Yes          OptDelOutFiles
Yes          PrintCumulatives
Yes          LeachingReport
80.0         TargetPercentile (%)
No           DrainageReport
No           AirReport
No           SoilReport
0.2          ThiLayPer (m)
table VerticalProfiles
end_table
G12.4          RealFormat
table OutputDepths (m)
0.05
0.1
0.2
0.3
0.4
0.5
0.75
1.0
2.0
end_table
No           print_AmaAppCrp
Yes          print_AmaAppSol
No           print_AmaCrp
No           print_AmaDra_1
No           print_AmaDra_2
No           print_AmaDra_3
No           print_AmaDra_4
No           print_AmaDra_5
Yes          print_AmaEqlTgt
Yes          print_AmaEqlPro
No           print_AmaEqlTil
Yes          print_AmaErrMic
Yes          print_AmaForPro
No           print_AmaHarCrp
Yes          print_AmaNeqTgt
Yes          print_AmaNeqPro
No           print_AmaNeqTil
Yes          print_AmaSysTgt
Yes          print_AmaSysPro
No           print_AmaSysTil
Yes          print_AmaTraPro
Yes          print_AmaUptPro
No           print_AmaDspCrp
No           print_AmaWasCrp
No           print_ConGas
Yes          print_ConLiq
Yes          print_ConLiqLbo
Yes          print_ConLiqSatAvg
Yes          print_ConSys
No           print_ConSysEql
No           print_ConSysNeq
```

No	print_DelTimPrl
Yes	print_Eps
Yes	print_FacCrpEvp
No	print_FlmDepCrp
No	print_FlmGas
Yes	print_FlmGasVol
No	print_FlmLiq
Yes	print_FlmLiqInfSys
Yes	print_FlmLiqLbo
No	print_FlmSys
No	print_FlvLiq
No	print_FlvLiqDra_3
No	print_FlvLiqDra_4
No	print_FlvLiqDra_5
Yes	print_FlvLiqEvpIntIrr
Yes	print_FlvLiqEvpIntPrc
Yes	print_FlvLiqEvpSol
Yes	print_FlvLiqEvpSolPot
Yes	print_FlvLiqIrr
Yes	print_FlvLiqLbo
No	print_FlvLiqGrw
Yes	print_FlvLiqTrp
Yes	print_FlvLiqTrpPot
No	print_FraCovCrp
Yes	print_GrwLev
No	print_LAI
No	print_PreHea
Yes	print_Theta
No	print_StoCap
No	print_FlvLiqGrwSur
No	print_VvrLiqDra
No	print_VvrLiqUpt
No	print_ZRoot
No	print_FlvLiqDra_1
No	print_FlvLiqDra_2
Yes	print_FlvLiqPrc
Yes	print_Tem
No	print_ConLiqDra_1
No	print_ConLiqDra_2
No	print_ConLiqDra_3
No	print_ConLiqDra_4
No	print_ConLiqDra_5
No	print_ConLiqDra
No	print_ZPnd
No	print_AvoLiqSol
No	print_ConGas_VPrf
No	print_ConLiq_VPrf
No	print_ConSys_VPrf
No	print_ConSysEql_VPrf
No	print_ConSysNeq_VPrf
No	print_PreHea_VPrf
No	print_Tem_VPrf
No	print_Theta_VPrf
No	print_AvoLiqErr
No	print_FlvLiqInf
No	print_RstAirLam
No	print_AmaRunOff
No	print_AmaSolSur
No	print_VelWnd
No	print_TemAir
No	print_FlvLiqCanDrp
No	print_ConLiqPer
No	print_CntSysPer
No	print_ConLiqTWA2D
No	print_ConLiqTWA3D

```
No          print_ConLiqTWA4D
No          print_CntSysTWA2D
No          print_CntSysTWA3D
No          print_CntSysTWA4D
No          print_ConLiqTWA1D
No          print_CntSysTWA1D
Yes         print_ConLiqPer
Yes         print_CntSysPer
*-----------------------------------------------------------------------------
* End of FOCUSPEARL 5.5.5 input file
*-----------------------------------------------------------------------------
```

Summary Output File

```
* -----------------------------------------------------------------------------
* PEARL REPORT: Header
* Results from the PEARL model  (c) WENR, PBL and RIVM
* PEARL kernel version       : 3.2.20
* SWAP kernel version        : swap3237
* PEARL created on           : 14-Sep-2020
*
* PEARL was called from      : FOCUSPEARL,version 5.5.5
* Working directory          : C:\Pearl\PesticideModels\FOCUSPEARL_5.5.5\FOCUSPEARL\61
* Run ID                     : 61
* Input file generated on    : 16-12-2021
* -----------------------------------------------------------------------------
*
* ExposureType               : Groundwater
* Scenario data subset       : FOCUS Groundwater version 5
* Location                   : CHATEAUDUN
* Meteo station              : chat-m
* Soil type                  : CHAT-S_Soil
* Crop calendar              : CHAT-APPLES
* Substance                  : Cu
* Application scheme         : Cu_pome_Chat
* Deposition scheme          : No
* Irrigation scheme          : SURFACE_WEEKLY
*
* End of PEARL REPORT: Header
* -----------------------------------------------------------------------------

* Key to the annual water balances in the soil system
* -----------------------------------------------------------------------------
* DelLiq     Net storage change of water in profile       (m.a-1)
* Prc        Precipitation                                (m.a-1)
* Irr        Irrigation                                   (m.a-1)
* LeaLbo     Seepage at the lower boundary                (m.a-1)
* LeaGrw     Groundwater recharge                         (m.a-1)
* LeaTgt     Flux at lower boundary of the target layer   (m.a-1)
* EvpInt     Evaporation of intercepted water             (m.a-1)
* SolAct     Actual soil evaporation                      (m.a-1)
* TrpAct     Actual transpiration                         (m.a-1)
* Dra        Total discharge to drains and channels       (m.a-1)
* Dra_1      Lateral discharge to primary system          (m.a-1)
* Dra_2      Lateral discharge to secondary system        (m.a-1)
* Dra_3      Lateral discharge to tertiary system         (m.a-1)
* Dra_4      Lateral discharge to tile drains             (m.a-1)
* Dra_5      Lateral discharge to surface drainage system (m.a-1)
* RunOff     Run-off                                      (m.a-1)
* EvpPnd     Evaporation of ponded water                  (m.a-1)
* CanDrp     Canopy drip                                  (m.a-1)
* SolPot     Potential soil evaporation                   (m.a-1)
* TrpPot     Potential transpiration                      (m.a-1)

* Key to the annual mass balance of substance at the crop
* -----------------------------------------------------------------------------
```

* AmaAppCrp Areic mass applied to the crop canopy (kg.ha-1.a-1)
* DelAmaCrp Change of areic mass at the crop canopy (kg.ha-1.a-1)
* AmaVol Areic mass volatilised from the crop canopy (kg.ha-1.a-1)
* AmaPen Areic mass penetrated into the plant tissue (kg.ha-1.a-1)
* AmaTra Areic mass transformed at the crop canopy (kg.ha-1.a-1)
* AmaDep Areic mass deposited at the crop canopy (kg.ha-1.a-1)
* AmaDsp Areic mass dissipated at the crop canopy (kg.ha-1.a-1)
* AmaWas Areic mass washed from the cropy canopy (kg.ha-1.a-1)
* AmaHar Areic mass removed by harvesting (kg.ha-1.a-1)

* Key to the annual mass balance of substance in the soil system
* ---
* AmaAppSol Areic mass applied to the soil system (kg.ha-1.a-1)
* DelAma Change of mass in the soil system (kg.ha-1.a-1)
* DelAmaEql Change of mass in the equilibrium domain (kg.ha-1.a-1)
* DelAmaNeq Change of mass in the non-equilibrium domain (kg.ha-1.a-1)
* AmaTra Areic mass transformed in the soil system (kg.ha-1.a-1)
* AmaFor Areic mass formed in the soil system (kg.ha-1.a-1)
* AmaUpt Areic mass taken-up from the soil system (kg.ha-1.a-1)
* AmaDra Areic mass drained from the soil system (kg.ha-1.a-1)
* AmaDra_1 Areic mass drained to the primary system (kg.ha-1.a-1)
* AmaDra_2 Areic mass drained to the secunary system (kg.ha-1.a-1)
* AmaDra_3 Areic mass drained to the tertiary system (kg.ha-1.a-1)
* AmaDra_4 Areic mass drained to tube drains (kg.ha-1.a-1)
* AmaDra_5 Areic mass drained to surface drain system (kg.ha-1.a-1)
* AmaDep Areic mass deposited at the soil surface (kg.ha-1.a-1)
* AmaVol Areic mass volatized from the soil surface (kg.ha-1.a-1)
* AmaLea Areic mass leached from the soil system (kg.ha-1.a-1)
* AmaLeaAqf Areic mass leached to the deep acquifer (kg.ha-1.a-1)

* Key to the output per summary period
* ---
* AmaLeaTgt Areic mass leached from the target layer (kg.ha-1)
* FlvLeaTgt Volume of water leached from the target layer (m3.m-2)
* ConLeaTgt Concentration in water leached from the target layer (ug.L-1)
* ---

* Annual water balance of the target layer
* --
----
* yr Identifier DelLiq Prc Irr LeaLbo LeaTgt EvpInt SolAct TrpAct Dra Dra_1 Dra_2 Dra_3 Dra_4
Dra_5 Run EvpPnd CanDrp SolPot TrpPot
1901 BalWatTgt 0.0543 0.5227 0.5409 0.0300 0.1726 0.0000 0.3124 0.5243 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1531 0.3829 0.5443
1902 BalWatTgt 0.0106 0.4133 0.5169 0.0971 0.1227 0.0000 0.2970 0.5000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1238 0.3858 0.5156
1903 BalWatTgt -0.0244 0.5070 0.3529 0.1530 0.1594 0.0000 0.2770 0.4478 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2021 0.3180 0.4592
1904 BalWatTgt 0.0087 0.5926 0.3671 0.1309 0.2057 0.0000 0.2833 0.4618 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2283 0.3319 0.4781
1905 BalWatTgt 0.0199 0.5541 0.3541 0.2183 0.1706 0.0000 0.2702 0.4475 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2121 0.3321 0.4607
1906 BalWatTgt -0.0086 0.6045 0.3532 0.1950 0.1732 0.0000 0.3101 0.4832 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2134 0.3531 0.4972
1907 BalWatTgt -0.0078 0.7325 0.2863 0.2038 0.2866 0.0000 0.2811 0.4588 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.3051 0.3147 0.4730
1908 BalWatTgt 0.0112 0.4733 0.5871 0.1940 0.1379 0.0000 0.3221 0.5889 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1406 0.3751 0.6108
1909 BalWatTgt 0.0001 0.7586 0.2416 0.2648 0.2879 0.0000 0.3126 0.3995 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2557 0.3381 0.4102
1910 BalWatTgt 0.0254 0.7063 0.2760 0.3014 0.2550 0.0000 0.2881 0.4139 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1949 0.3305 0.4232
1911 BalWatTgt -0.0204 0.7866 0.2916 0.2853 0.3669 0.0000 0.2948 0.4370 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1999 0.3179 0.4482

1912 BalWatTgt -0.0002 0.6903 0.2605 0.2804 0.2274 0.0000 0.2949 0.4289 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2237 0.3261 0.4382
1913 BalWatTgt 0.0227 0.8047 0.2437 0.2661 0.2901 0.0000 0.3177 0.4180 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2447 0.3423 0.4275
1914 BalWatTgt -0.0276 0.7277 0.4001 0.2613 0.3318 0.0000 0.3402 0.4835 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2276 0.3718 0.4985
1915 BalWatTgt -0.0205 0.6683 0.2348 0.3151 0.1533 0.0000 0.2989 0.4713 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2694 0.3515 0.4859
1916 BalWatTgt 0.0201 0.8461 0.3110 0.2360 0.3798 0.0000 0.2991 0.4580 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.3029 0.3578 0.4738
1917 BalWatTgt -0.0057 0.5936 0.3147 0.2855 0.1442 0.0000 0.3050 0.4650 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2374 0.3644 0.4777
1918 BalWatTgt 0.0105 0.6340 0.3662 0.1495 0.2016 0.0000 0.3179 0.4703 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1835 0.3384 0.4834
1919 BalWatTgt -0.0051 0.6577 0.3184 0.1950 0.2656 0.0000 0.2966 0.4190 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2203 0.3200 0.4300
1920 BalWatTgt -0.0159 0.6951 0.2807 0.3594 0.2755 0.0000 0.2909 0.4253 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2410 0.3146 0.4362
1921 BalWatTgt 0.0083 0.5227 0.4616 0.1479 0.1358 0.0000 0.3131 0.5272 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1531 0.3829 0.5443
1922 BalWatTgt 0.0093 0.4133 0.5102 0.1208 0.1171 0.0000 0.2971 0.5002 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1238 0.3858 0.5156
1923 BalWatTgt -0.0245 0.5070 0.3526 0.1549 0.1593 0.0000 0.2770 0.4478 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2021 0.3180 0.4592
1924 BalWatTgt 0.0087 0.5926 0.3671 0.1309 0.2057 0.0000 0.2833 0.4618 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2283 0.3319 0.4781
1925 BalWatTgt 0.0199 0.5541 0.3541 0.2183 0.1706 0.0000 0.2702 0.4475 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2121 0.3321 0.4607
1926 BalWatTgt -0.0086 0.6045 0.3532 0.1950 0.1732 0.0000 0.3101 0.4832 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2134 0.3531 0.4972

* Annual water balance of the soil profile
* --
* yr Identifier DelLiq Prc Irr LeaLbo LeaGrw EvpInt SolAct TrpAct Dra Dra_1 Dra_2 Dra_3 Dra_4 Dra_5 Run EvpPnd CanDrp SolPot TrpPot
1901 BalWatSol 0.1969 0.5227 0.5409 0.0300 0.0300 0.0000 0.3124 0.5243 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1531 0.3829 0.5443
1902 BalWatSol 0.0362 0.4133 0.5169 0.0971 0.0971 0.0000 0.2970 0.5000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1238 0.3858 0.5156
1903 BalWatSol -0.0180 0.5070 0.3529 0.1530 0.1530 0.0000 0.2770 0.4478 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2021 0.3180 0.4592
1904 BalWatSol 0.0836 0.5926 0.3671 0.1309 0.1309 0.0000 0.2833 0.4618 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2283 0.3319 0.4781
1905 BalWatSol -0.0279 0.5541 0.3541 0.2183 0.2183 0.0000 0.2702 0.4475 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2121 0.3321 0.4607
1906 BalWatSol -0.0304 0.6045 0.3532 0.1950 0.1950 0.0000 0.3101 0.4832 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2134 0.3531 0.4972
1907 BalWatSol 0.0751 0.7325 0.2863 0.2038 0.2038 0.0000 0.2811 0.4588 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.3051 0.3147 0.4730
1908 BalWatSol -0.0448 0.4733 0.5871 0.1940 0.1940 0.0000 0.3221 0.5889 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1406 0.3751 0.6108
1909 BalWatSol 0.0232 0.7586 0.2416 0.2648 0.2648 0.0000 0.3126 0.3995 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2557 0.3381 0.4102
1910 BalWatSol -0.0210 0.7063 0.2760 0.3014 0.3014 0.0000 0.2881 0.4139 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1949 0.3305 0.4232
1911 BalWatSol 0.0612 0.7866 0.2916 0.2853 0.2853 0.0000 0.2948 0.4370 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.1999 0.3179 0.4482
1912 BalWatSol -0.0532 0.6903 0.2605 0.2804 0.2804 0.0000 0.2949 0.4289 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2237 0.3261 0.4382
1913 BalWatSol 0.0468 0.8047 0.2437 0.2661 0.2661 0.0000 0.3177 0.4180 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2447 0.3423 0.4275
1914 BalWatSol 0.0429 0.7277 0.4001 0.2613 0.2613 0.0000 0.3402 0.4835 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.2276 0.3718 0.4985

1915 BalWatSol -0.1824 0.6683 0.2348 0.3151 0.3151 0.0000 0.2989 0.4713 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2694 0.3515 0.4859
1916 BalWatSol 0.1639 0.8461 0.3110 0.2360 0.2360 0.0000 0.2991 0.4580 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.3029 0.3578 0.4738
1917 BalWatSol -0.1469 0.5936 0.3147 0.2855 0.2855 0.0000 0.3050 0.4650 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2374 0.3644 0.4777
1918 BalWatSol 0.0626 0.6340 0.3662 0.1495 0.1495 0.0000 0.3179 0.4703 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1835 0.3384 0.4834
1919 BalWatSol 0.0655 0.6577 0.3184 0.1950 0.1950 0.0000 0.2966 0.4190 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2203 0.3200 0.4300
1920 BalWatSol -0.0998 0.6951 0.2807 0.3594 0.3594 0.0000 0.2909 0.4253 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2410 0.3146 0.4362
1921 BalWatSol -0.0038 0.5227 0.4616 0.1479 0.1479 0.0000 0.3131 0.5272 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1531 0.3829 0.5443
1922 BalWatSol 0.0055 0.4133 0.5102 0.1208 0.1208 0.0000 0.2971 0.5002 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.1238 0.3858 0.5156
1923 BalWatSol -0.0201 0.5070 0.3526 0.1549 0.1549 0.0000 0.2770 0.4478 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2021 0.3180 0.4592
1924 BalWatSol 0.0835 0.5926 0.3671 0.1309 0.1309 0.0000 0.2833 0.4618 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2283 0.3319 0.4781
1925 BalWatSol -0.0279 0.5541 0.3541 0.2183 0.2183 0.0000 0.2702 0.4475 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2121 0.3321 0.4607
1926 BalWatSol -0.0304 0.6045 0.3532 0.1950 0.1950 0.0000 0.3101 0.4832 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.2134 0.3531 0.4972

* Annual mass balance of substance at the crop canopy
* --
* yr Identifier AmaApp DelAmaCrp AmaDep AmaDsp AmaWas AmaHar
1901 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1902 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1903 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1904 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1905 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1906 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1907 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1908 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1909 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1910 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1911 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1912 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1913 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1914 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1915 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1916 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1917 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1918 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1919 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1920 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1921 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1922 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1923 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1924 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1925 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
1926 BalCrp_Cu 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

* Annual mass balance (kg.ha-1) of compound Cu in the target layer
* --
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* yr Identifier AmaAppSol DelAma DelAmaEql DelAmaNeq AmaTra AmaFor AmaUpt AmaDra AmaDra_1
AmaDra_2 AmaDra_3 AmaDra_4 AmaDra_5 AmaDep AmaVol AmaLea ConLeaTgt
1901 BalTgt_Cu 2.500 2.500 2.500 0.000 0.4973E-04 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1902 BalTgt_Cu 2.500 2.500 2.500 0.000 0.3964E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000

1903 BalTgt_Cu 2.500 2.499 2.499 0.000 0.6799E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1904 BalTgt_Cu 2.500 2.499 2.499 0.000 0.9858E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1905 BalTgt_Cu 2.500 2.499 2.499 0.000 0.1212E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1906 BalTgt_Cu 2.500 2.498 2.498 0.000 0.1838E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1907 BalTgt_Cu 2.500 2.498 2.498 0.000 0.1912E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1908 BalTgt_Cu 2.500 2.498 2.498 0.000 0.2450E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1909 BalTgt_Cu 2.500 2.498 2.498 0.000 0.2471E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1910 BalTgt_Cu 2.500 2.497 2.497 0.000 0.2633E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1911 BalTgt_Cu 2.500 2.497 2.497 0.000 0.3054E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1912 BalTgt_Cu 2.500 2.497 2.497 0.000 0.3276E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1913 BalTgt_Cu 2.500 2.496 2.496 0.000 0.3897E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1914 BalTgt_Cu 2.500 2.496 2.496 0.000 0.4452E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1915 BalTgt_Cu 2.500 2.495 2.495 0.000 0.4727E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1916 BalTgt_Cu 2.500 2.495 2.495 0.000 0.4642E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1917 BalTgt_Cu 2.500 2.495 2.495 0.000 0.4785E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1918 BalTgt_Cu 2.500 2.495 2.495 0.000 0.5169E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1919 BalTgt_Cu 2.500 2.494 2.494 0.000 0.5544E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1920 BalTgt_Cu 2.500 2.494 2.494 0.000 0.6129E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1921 BalTgt_Cu 2.500 2.493 2.493 0.000 0.7045E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1922 BalTgt_Cu 2.500 2.493 2.493 0.000 0.7377E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1923 BalTgt_Cu 2.500 2.493 2.493 0.000 0.7055E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1924 BalTgt_Cu 2.500 2.493 2.493 0.000 0.7268E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1925 BalTgt_Cu 2.500 2.493 2.493 0.000 0.7080E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1926 BalTgt_Cu 2.500 2.491 2.491 0.000 0.8942E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000

* Annual mass balance (kg.ha-1) of compound Cu in the soil profile
* ---
* yr Identifier AmaAppSol DelAma DelAmaEql DelAmaNeq AmaTra AmaFor AmaUpt AmaDra AmaDra_1
AmaDra_2 AmaDra_3 AmaDra_4 AmaDra_5 AmaDep AmaVol AmaLea AmaLeaAqf
1901 BalSol_Cu 2.500 2.500 2.500 0.000 0.4973E-04 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1902 BalSol_Cu 2.500 2.500 2.500 0.000 0.3964E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1903 BalSol_Cu 2.500 2.499 2.499 0.000 0.6799E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1904 BalSol_Cu 2.500 2.499 2.499 0.000 0.9858E-03 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1905 BalSol_Cu 2.500 2.499 2.499 0.000 0.1212E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000

1906 BalSol_Cu 2.500 2.498 2.498 0.000 0.1838E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1907 BalSol_Cu 2.500 2.498 2.498 0.000 0.1912E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1908 BalSol_Cu 2.500 2.498 2.498 0.000 0.2450E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1909 BalSol_Cu 2.500 2.498 2.498 0.000 0.2471E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1910 BalSol_Cu 2.500 2.497 2.497 0.000 0.2633E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1911 BalSol_Cu 2.500 2.497 2.497 0.000 0.3054E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1912 BalSol_Cu 2.500 2.497 2.497 0.000 0.3276E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1913 BalSol_Cu 2.500 2.496 2.496 0.000 0.3897E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1914 BalSol_Cu 2.500 2.496 2.496 0.000 0.4452E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1915 BalSol_Cu 2.500 2.495 2.495 0.000 0.4727E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1916 BalSol_Cu 2.500 2.495 2.495 0.000 0.4642E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1917 BalSol_Cu 2.500 2.495 2.495 0.000 0.4785E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1918 BalSol_Cu 2.500 2.495 2.495 0.000 0.5169E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1919 BalSol_Cu 2.500 2.494 2.494 0.000 0.5544E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1920 BalSol_Cu 2.500 2.494 2.494 0.000 0.6129E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1921 BalSol_Cu 2.500 2.493 2.493 0.000 0.7045E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1922 BalSol_Cu 2.500 2.493 2.493 0.000 0.7377E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1923 BalSol_Cu 2.500 2.493 2.493 0.000 0.7055E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1924 BalSol_Cu 2.500 2.493 2.493 0.000 0.7268E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1925 BalSol_Cu 2.500 2.493 2.493 0.000 0.7080E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000
1926 BalSol_Cu 2.500 2.491 2.491 0.000 0.8942E-02 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000 0.000

* Intermediate target output for compound Cu
* --
* yr Identifier AmaLea FlvLea ConLea
* (kg/ha) (m) (ug/L)
1907 Target_Cu 0.0000 0.28659 0.0000
1908 Target_Cu 0.0000 0.13794 0.0000
1909 Target_Cu 0.0000 0.28790 0.0000
1910 Target_Cu 0.0000 0.25498 0.0000
1911 Target_Cu 0.0000 0.36695 0.0000
1912 Target_Cu 0.0000 0.22739 0.0000
1913 Target_Cu 0.0000 0.29011 0.0000
1914 Target_Cu 0.0000 0.33180 0.0000
1915 Target_Cu 0.0000 0.15326 0.0000
1916 Target_Cu 0.0000 0.37982 0.0000
1917 Target_Cu 0.0000 0.14423 0.0000
1918 Target_Cu 0.0000 0.20158 0.0000
1919 Target_Cu 0.0000 0.26562 0.0000
1920 Target_Cu 0.0000 0.27548 0.0000
1921 Target_Cu 0.0000 0.13583 0.0000
1922 Target_Cu 0.0000 0.11705 0.0000
1923 Target_Cu 0.0000 0.15927 0.0000
1924 Target_Cu 0.0000 0.20571 0.0000

1925 Target_Cu	0.0000	0.17058	0.0000
1926 Target_Cu	0.0000	0.17321	0.0000

* Leaching summary per summary period:
* ---

* Rank	Identifier	Percent	DateSta	DateEnd	ConLeaTgt	Year
* (-)		(%)			(ug/L)	(a)
1	ConLea_Cu	2.50	01-Jan-1907	31-Dec-1907	0.00	1907
2	ConLea_Cu	7.50	01-Jan-1908	31-Dec-1908	0.00	1908
3	ConLea_Cu	12.50	01-Jan-1909	31-Dec-1909	0.00	1909
4	ConLea_Cu	17.50	01-Jan-1910	31-Dec-1910	0.00	1910
5	ConLea_Cu	22.50	01-Jan-1911	31-Dec-1911	0.00	1911
6	ConLea_Cu	27.50	01-Jan-1912	31-Dec-1912	0.00	1912
7	ConLea_Cu	32.50	01-Jan-1913	31-Dec-1913	0.00	1913
8	ConLea_Cu	37.50	01-Jan-1914	31-Dec-1914	0.00	1914
9	ConLea_Cu	42.50	01-Jan-1915	31-Dec-1915	0.00	1915
10	ConLea_Cu	47.50	01-Jan-1916	31-Dec-1916	0.00	1916
11	ConLea_Cu	52.50	01-Jan-1917	31-Dec-1917	0.00	1917
12	ConLea_Cu	57.50	01-Jan-1918	31-Dec-1918	0.00	1918
13	ConLea_Cu	62.50	01-Jan-1919	31-Dec-1919	0.00	1919
14	ConLea_Cu	67.50	01-Jan-1920	31-Dec-1920	0.00	1920
15	ConLea_Cu	72.50	01-Jan-1921	31-Dec-1921	0.00	1921
16	ConLea_Cu	77.50	01-Jan-1922	31-Dec-1922	0.00	1922
17	ConLea_Cu	82.50	01-Jan-1923	31-Dec-1923	0.00	1923
18	ConLea_Cu	87.50	01-Jan-1924	31-Dec-1924	0.00	1924
19	ConLea_Cu	92.50	01-Jan-1925	31-Dec-1925	0.00	1925
20	ConLea_Cu	97.50	01-Jan-1926	31-Dec-1926	0.00	1926

* ---
* PEARL REPORT: Leaching
* Start date : 01-Jan-1901
* End date : 31-Dec-1926
* Target depth : 1.00 m
* Annual application to the soil surface at 10-Oct; dosage = 2.5000 kg.ha-1

* Leaching summary for compound Cu
* Molar mass (g.mol-1) : 63.5
* Saturated vapour pressure (Pa) : 0.00 ; measured at (C) 20.0
* Solubility in water (mg.L-1) : 500. ; measured at (C) 20.0
* Half-life (d) in soil : ********; measured at (C) 20.0
* Kom (coef. for sorption on soil organic matter) (L.kg-1) : 11315.7
* KF (overall sorption coefficient of the soil target layer) (L.kg-1) : 149.
* Freundlich exponent (-) : 1.00
* Plant uptake factor (-) : 0.00
* ---

* Period number	From	To	Water percolated below target depth (mm)	Substance leached below target depth (kg/ha)	Average substance concentration in water at target depth (ug/L)
1	01-Jan-1907	31-Dec-1907	286.588	0.0000000	0.000
2	01-Jan-1908	31-Dec-1908	137.939	0.0000000	0.000
3	01-Jan-1909	31-Dec-1909	287.900	0.0000000	0.000
4	01-Jan-1910	31-Dec-1910	254.983	0.0000000	0.000
5	01-Jan-1911	31-Dec-1911	366.947	0.0000000	0.000
6	01-Jan-1912	31-Dec-1912	227.391	0.0000000	0.000
7	01-Jan-1913	31-Dec-1913	290.113	0.0000000	0.000
8	01-Jan-1914	31-Dec-1914	331.804	0.0000000	0.000
9	01-Jan-1915	31-Dec-1915	153.263	0.0000000	0.000
10	01-Jan-1916	31-Dec-1916	379.816	0.0000000	0.000
11	01-Jan-1917	31-Dec-1917	144.231	0.0000000	0.000
12	01-Jan-1918	31-Dec-1918	201.575	0.0000000	0.000
13	01-Jan-1919	31-Dec-1919	265.621	0.0000000	0.000
14	01-Jan-1920	31-Dec-1920	275.476	0.0000000	0.000
15	01-Jan-1921	31-Dec-1921	135.831	0.0000000	0.000

16	01-Jan-1922 31-Dec-1922	117.054	0.0000000	0.000
17	01-Jan-1923 31-Dec-1923	159.272	0.0000000	0.000
18	01-Jan-1924 31-Dec-1924	205.710	0.0000000	0.000
19	01-Jan-1925 31-Dec-1925	170.576	0.0000000	0.000
20	01-Jan-1926 31-Dec-1926	173.213	0.0000000	0.000

* The average concentration of Cu closest to the 80th percentile is 0.000000 ug/L

* End of PEARL REPORT: Leaching
* --

* --
* PEARL REPORT: Project_Summary
* Report_type Leaching
* Result_text Concentration closest to the 80th percentile (ug/L)
* Run_Id 61
* ExposureType Groundwater
* Scenario data subset FOCUS Groundwater version 5
* Location CHATEAUDUN
* Meteo_station chat-m
* Soil_type CHAT-S_Soil
* Crop_calendar CHAT-APPLES
* Substance Cu
* Application_scheme Cu_pome_Chat
* Irrigation_scheme SURFACE_WEEKLY
* Deposition_scheme No
* Result_Cu 0.000000

* End of PEARL REPORT: Project_Summary
* --

*
* The run time was 1 minutes and 44 seconds

A 3.2 FOCUS PELMO v6.6.4

Crop	**File name**
Apple	Copper_Pome
Vine	Copper_Vine
Tomato	Copper_Tom

Example file: Copper_Pome (Châteaudun)

Echo of Input data

```
1
 ***********************************
 *                                 *
 *  PESTICIDE LEACHING MODEL       *
 *  PELMO 5.0, DEC 2020            *
 *  FOCUSPELMO 6.6.4               *
 *                                 *
 *                                 *
 ***********************************


 DEVELOPED BY:
      U.S. ENVIRONMENTAL PROTECTION AGENCY
      OFFICE OF REASEARCH AND DEVELOPMENT
      ATHENS ENVIRONMENTAL RESEARCH LABORATORY
      ATHENS, GA.  30613
```

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D-67435 NEUSTADT/WSTR.
Tel ++ 49-6321-671-422

PELMO 5.0, DEC 2020

**************HYDROLOGY DATAS**************

FOCUS GW Simulation: 6 warming-up years

YEAR 1: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:01
YEAR 2: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:02
YEAR 3: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:03
YEAR 4: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:04
YEAR 5: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:05
YEAR 6: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:06
YEAR 7: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:07
YEAR 8: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:08
YEAR 9: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:09
YEAR 10: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:10
YEAR 11: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:11
YEAR 12: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:12
YEAR 13: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:13
YEAR 14: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:14
YEAR 15: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:15
YEAR 16: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:16
YEAR 17: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:17
YEAR 18: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:18
YEAR 19: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:19
YEAR 20: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:20
YEAR 21: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:21
YEAR 22: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:22
YEAR 23: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:23
YEAR 24: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:24
YEAR 25: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:25
YEAR 26: Ver 4 Châteaudun scenario (48.05 N, 1.38 E)) Year:26

HYDROLOGY AND SEDIMENT RELATED PARAMETERS

Variable time step

Pan Evaporation data are used.

LATTITUDE OF THE LOCATION: 48.00

CROPNAME GENERAL Apples

PAN COEFFICIENT FOR EVAPORATION (NO CROP) 1.000 1.000
PAN COEFFICIENT FOR EVAPORATION (MID SEASON) 1.000 1.100
PAN COEFFICIENT FOR EVAPORATION (LATE SEASON) 1.000 0.8600
FLAG FOR ET (0=EVAP,1=TEMP,2=EVAP/TEMP) 0
DEPTH TO WHICH ET IS COMPUTED YEAR-ROUND [CM] 20.00
SNOW MELT COEFFICIENT [CM/DEG-C-DAY] 0.4600
INITIAL CROP NUMBER 1
INITIAL CROP CONDITION 1

NO CALCULATION OF RUNOFF EVENTS
CROP INFORMATION

MAXIMUM IRRIGATION PERENNIAL SURFACE
INTERCEPT.MAXIMUM MINIMUM MAXIMUM FLG(0=NO) CROP CONDITION
USLE COVER MANAGEMENT
CROP POTENTIAL ROOT DEPTH LAI LAI WEIGHT (1=CANOPY) (0=NO) AFTER AMC
RUNOFF CURVE NUMBERS "C" FACTOR
NUMBER [CM] [CM] [-] [-] [KG/M**2] 2=DRIP) (1=YES) HARVEST FALLOW CROP
RESIDUE FALLOW CROP RESIDUE EXT. COEFF. SPRING POINT

I 54 54 54
24 0.0000 100.0 0.0000 4.000 0.0000 2 1 3 II 73 73 73 1.0000 1.0000
1.0000 0.39000
III 86 86 86

CROP ROTATION INFORMATION

CROP NUMBER	EMERGENCE DATE	MATURATION DATE	SENESCENCE DATE	HARVEST DATE
Apples	1 APR., 1	31 MAY , 1	1 SEP., 1	1 OCT., 1
Apples	1 APR., 2	31 MAY , 2	1 SEP., 2	1 OCT., 2
Apples	1 APR., 3	31 MAY , 3	1 SEP., 3	1 OCT., 3
Apples	1 APR., 4	31 MAY , 4	1 SEP., 4	1 OCT., 4
Apples	1 APR., 5	31 MAY , 5	1 SEP., 5	1 OCT., 5
Apples	1 APR., 6	31 MAY , 6	1 SEP., 6	1 OCT., 6
Apples	1 APR., 7	31 MAY , 7	1 SEP., 7	1 OCT., 7
Apples	1 APR., 8	31 MAY , 8	1 SEP., 8	1 OCT., 8
Apples	1 APR., 9	31 MAY , 9	1 SEP., 9	1 OCT., 9
Apples	1 APR., 10	31 MAY , 10	1 SEP., 10	1 OCT., 10
Apples	1 APR., 11	31 MAY , 11	1 SEP., 11	1 OCT., 11
Apples	1 APR., 12	31 MAY , 12	1 SEP., 12	1 OCT., 12
Apples	1 APR., 13	31 MAY , 13	1 SEP., 13	1 OCT., 13
Apples	1 APR., 14	31 MAY , 14	1 SEP., 14	1 OCT., 14
Apples	1 APR., 15	31 MAY , 15	1 SEP., 15	1 OCT., 15
Apples	1 APR., 16	31 MAY , 16	1 SEP., 16	1 OCT., 16
Apples	1 APR., 17	31 MAY , 17	1 SEP., 17	1 OCT., 17
Apples	1 APR., 18	31 MAY , 18	1 SEP., 18	1 OCT., 18
Apples	1 APR., 19	31 MAY , 19	1 SEP., 19	1 OCT., 19
Apples	1 APR., 20	31 MAY , 20	1 SEP., 20	1 OCT., 20
Apples	1 APR., 21	31 MAY , 21	1 SEP., 21	1 OCT., 21
Apples	1 APR., 22	31 MAY , 22	1 SEP., 22	1 OCT., 22
Apples	1 APR., 23	31 MAY , 23	1 SEP., 23	1 OCT., 23
Apples	1 APR., 24	31 MAY , 24	1 SEP., 24	1 OCT., 24
Apples	1 APR., 25	31 MAY , 25	1 SEP., 25	1 OCT., 25
Apples	1 APR., 26	31 MAY , 26	1 SEP., 26	1 OCT., 26

Apples	1 APR., 27	31 MAY , 27	1 SEP., 27	1 OCT., 27
Apples	1 APR., 28	31 MAY , 28	1 SEP., 28	1 OCT., 28
Apples	1 APR., 29	31 MAY , 29	1 SEP., 29	1 OCT., 29
Apples	1 APR., 30	31 MAY , 30	1 SEP., 30	1 OCT., 30
Apples	1 APR., 31	31 MAY , 31	1 SEP., 31	1 OCT., 31
Apples	1 APR., 32	31 MAY , 32	1 SEP., 32	1 OCT., 32
Apples	1 APR., 33	31 MAY , 33	1 SEP., 33	1 OCT., 33
Apples	1 APR., 34	31 MAY , 34	1 SEP., 34	1 OCT., 34
Apples	1 APR., 35	31 MAY , 35	1 SEP., 35	1 OCT., 35
Apples	1 APR., 36	31 MAY , 36	1 SEP., 36	1 OCT., 36
Apples	1 APR., 37	31 MAY , 37	1 SEP., 37	1 OCT., 37
Apples	1 APR., 38	31 MAY , 38	1 SEP., 38	1 OCT., 38
Apples	1 APR., 39	31 MAY , 39	1 SEP., 39	1 OCT., 39
Apples	1 APR., 40	31 MAY , 40	1 SEP., 40	1 OCT., 40
Apples	1 APR., 41	31 MAY , 41	1 SEP., 41	1 OCT., 41
Apples	1 APR., 42	31 MAY , 42	1 SEP., 42	1 OCT., 42
Apples	1 APR., 43	31 MAY , 43	1 SEP., 43	1 OCT., 43
Apples	1 APR., 44	31 MAY , 44	1 SEP., 44	1 OCT., 44
Apples	1 APR., 45	31 MAY , 45	1 SEP., 45	1 OCT., 45
Apples	1 APR., 46	31 MAY , 46	1 SEP., 46	1 OCT., 46
Apples	1 APR., 47	31 MAY , 47	1 SEP., 47	1 OCT., 47
Apples	1 APR., 48	31 MAY , 48	1 SEP., 48	1 OCT., 48
Apples	1 APR., 49	31 MAY , 49	1 SEP., 49	1 OCT., 49
Apples	1 APR., 50	31 MAY , 50	1 SEP., 50	1 OCT., 50
Apples	1 APR., 51	31 MAY , 51	1 SEP., 51	1 OCT., 51
Apples	1 APR., 52	31 MAY , 52	1 SEP., 52	1 OCT., 52
Apples	1 APR., 53	31 MAY , 53	1 SEP., 53	1 OCT., 53
Apples	1 APR., 54	31 MAY , 54	1 SEP., 54	1 OCT., 54
Apples	1 APR., 55	31 MAY , 55	1 SEP., 55	1 OCT., 55
Apples	1 APR., 56	31 MAY , 56	1 SEP., 56	1 OCT., 56
Apples	1 APR., 57	31 MAY , 57	1 SEP., 57	1 OCT., 57
Apples	1 APR., 58	31 MAY , 58	1 SEP., 58	1 OCT., 58
Apples	1 APR., 59	31 MAY , 59	1 SEP., 59	1 OCT., 59
Apples	1 APR., 60	31 MAY , 60	1 SEP., 60	1 OCT., 60
Apples	1 APR., 61	31 MAY , 61	1 SEP., 61	1 OCT., 61
Apples	1 APR., 62	31 MAY , 62	1 SEP., 62	1 OCT., 62
Apples	1 APR., 63	31 MAY , 63	1 SEP., 63	1 OCT., 63
Apples	1 APR., 64	31 MAY , 64	1 SEP., 64	1 OCT., 64
Apples	1 APR., 65	31 MAY , 65	1 SEP., 65	1 OCT., 65
Apples	1 APR., 66	31 MAY , 66	1 SEP., 66	1 OCT., 66
Apples	1 APR., 67	31 MAY , 67	1 SEP., 67	1 OCT., 67
Apples	1 APR., 68	31 MAY , 68	1 SEP., 68	1 OCT., 68
Apples	1 APR., 69	31 MAY , 69	1 SEP., 69	1 OCT., 69
Apples	1 APR., 70	31 MAY , 70	1 SEP., 70	1 OCT., 70
Apples	1 APR., 71	31 MAY , 71	1 SEP., 71	1 OCT., 71
Apples	1 APR., 72	31 MAY , 72	1 SEP., 72	1 OCT., 72
Apples	1 APR., 73	31 MAY , 73	1 SEP., 73	1 OCT., 73
Apples	1 APR., 74	31 MAY , 74	1 SEP., 74	1 OCT., 74
Apples	1 APR., 75	31 MAY , 75	1 SEP., 75	1 OCT., 75
Apples	1 APR., 76	31 MAY , 76	1 SEP., 76	1 OCT., 76
Apples	1 APR., 77	31 MAY , 77	1 SEP., 77	1 OCT., 77
Apples	1 APR., 78	31 MAY , 78	1 SEP., 78	1 OCT., 78
Apples	1 APR., 79	31 MAY , 79	1 SEP., 79	1 OCT., 79
Apples	1 APR., 80	31 MAY , 80	1 SEP., 80	1 OCT., 80
Apples	1 APR., 81	31 MAY , 81	1 SEP., 81	1 OCT., 81
Apples	1 APR., 82	31 MAY , 82	1 SEP., 82	1 OCT., 82
Apples	1 APR., 83	31 MAY , 83	1 SEP., 83	1 OCT., 83
Apples	1 APR., 84	31 MAY , 84	1 SEP., 84	1 OCT., 84
Apples	1 APR., 85	31 MAY , 85	1 SEP., 85	1 OCT., 85
Apples	1 APR., 86	31 MAY , 86	1 SEP., 86	1 OCT., 86
Apples	1 APR., 87	31 MAY , 87	1 SEP., 87	1 OCT., 87
Apples	1 APR., 88	31 MAY , 88	1 SEP., 88	1 OCT., 88
Apples	1 APR., 89	31 MAY , 89	1 SEP., 89	1 OCT., 89
Apples	1 APR., 90	31 MAY , 90	1 SEP., 90	1 OCT., 90
Apples	1 APR., 91	31 MAY , 91	1 SEP., 91	1 OCT., 91

Apples	1 APR., 92	31 MAY , 92	1 SEP., 92	1 OCT., 92
Apples	1 APR., 93	31 MAY , 93	1 SEP., 93	1 OCT., 93
Apples	1 APR., 94	31 MAY , 94	1 SEP., 94	1 OCT., 94
Apples	1 APR., 95	31 MAY , 95	1 SEP., 95	1 OCT., 95
Apples	1 APR., 96	31 MAY , 96	1 SEP., 96	1 OCT., 96
Apples	1 APR., 97	31 MAY , 97	1 SEP., 97	1 OCT., 97
Apples	1 APR., 98	31 MAY , 98	1 SEP., 98	1 OCT., 98
Apples	1 APR., 99	31 MAY , 99	1 SEP., 99	1 OCT., 99
Apples	1 APR., 100	31 MAY , 100	1 SEP., 100	1 OCT., 100
Apples	1 APR., 101	31 MAY , 101	1 SEP., 101	1 OCT., 101
Apples	1 APR., 102	31 MAY , 102	1 SEP., 102	1 OCT., 102
Apples	1 APR., 103	31 MAY , 103	1 SEP., 103	1 OCT., 103
Apples	1 APR., 104	31 MAY , 104	1 SEP., 104	1 OCT., 104
Apples	1 APR., 105	31 MAY , 105	1 SEP., 105	1 OCT., 105
Apples	1 APR., 106	31 MAY , 106	1 SEP., 106	1 OCT., 106
Apples	1 APR., 107	31 MAY , 107	1 SEP., 107	1 OCT., 107
Apples	1 APR., 108	31 MAY , 108	1 SEP., 108	1 OCT., 108
Apples	1 APR., 109	31 MAY , 109	1 SEP., 109	1 OCT., 109
Apples	1 APR., 110	31 MAY , 110	1 SEP., 110	1 OCT., 110
Apples	1 APR., 111	31 MAY , 111	1 SEP., 111	1 OCT., 111
Apples	1 APR., 112	31 MAY , 112	1 SEP., 112	1 OCT., 112
Apples	1 APR., 113	31 MAY , 113	1 SEP., 113	1 OCT., 113
Apples	1 APR., 114	31 MAY , 114	1 SEP., 114	1 OCT., 114
Apples	1 APR., 115	31 MAY , 115	1 SEP., 115	1 OCT., 115
Apples	1 APR., 116	31 MAY , 116	1 SEP., 116	1 OCT., 116
Apples	1 APR., 117	31 MAY , 117	1 SEP., 117	1 OCT., 117
Apples	1 APR., 118	31 MAY , 118	1 SEP., 118	1 OCT., 118
Apples	1 APR., 119	31 MAY , 119	1 SEP., 119	1 OCT., 119
Apples	1 APR., 120	31 MAY , 120	1 SEP., 120	1 OCT., 120

MECHANICAL TREATMENTS

NO	DATE	DEPTH[CM]

*** PARAMETERS OF ACTIVE SUBSTANCE (Copper)***
****

APPLICATION DATE	PESTICIDE APPLIED [KG/HA]	UPPER INCORP. DEPTH [CM]	LOWER INCORP. DEPTH [CM]	FFIELD [-]
10 OCT., 1	2.500	0.0000	0.0000	0.0000
10 OCT., 2	2.500	0.0000	0.0000	0.0000
10 OCT., 3	2.500	0.0000	0.0000	0.0000
10 OCT., 4	2.500	0.0000	0.0000	0.0000
10 OCT., 5	2.500	0.0000	0.0000	0.0000
10 OCT., 6	2.500	0.0000	0.0000	0.0000
10 OCT., 7	2.500	0.0000	0.0000	0.0000
10 OCT., 8	2.500	0.0000	0.0000	0.0000
10 OCT., 9	2.500	0.0000	0.0000	0.0000
10 OCT., 10	2.500	0.0000	0.0000	0.0000
10 OCT., 11	2.500	0.0000	0.0000	0.0000
10 OCT., 12	2.500	0.0000	0.0000	0.0000
10 OCT., 13	2.500	0.0000	0.0000	0.0000
10 OCT., 14	2.500	0.0000	0.0000	0.0000
10 OCT., 15	2.500	0.0000	0.0000	0.0000
10 OCT., 16	2.500	0.0000	0.0000	0.0000
10 OCT., 17	2.500	0.0000	0.0000	0.0000
10 OCT., 18	2.500	0.0000	0.0000	0.0000

10 OCT., 19	2.500	0.0000	0.0000	0.0000
10 OCT., 20	2.500	0.0000	0.0000	0.0000
10 OCT., 21	2.500	0.0000	0.0000	0.0000
10 OCT., 22	2.500	0.0000	0.0000	0.0000
10 OCT., 23	2.500	0.0000	0.0000	0.0000
10 OCT., 24	2.500	0.0000	0.0000	0.0000
10 OCT., 25	2.500	0.0000	0.0000	0.0000
10 OCT., 26	2.500	0.0000	0.0000	0.0000

PLANT PESTICIDE PARAMETERS

CROP INTERCEPTION: 1
(1=SOIL(NO), 2=LINEAR, 3=EXPONENTIAL, 4=MANUAL)

VOLATILIZATION PARAMETERS ACTIVE SUBSTANCE

TEMPERATURE [deg C] 20.00
HENRY-CONSTANT [Pa*m3/mole] or [J/mole] 0.0000
CALCULATED USING
VAPOUR PRESSURE [Pa] 0.0000
MOLECULAR MASS [g/mole] 63.54
WATER SOLUBILITY [mg/l] 500.0

TEMPERATURE [deg C] 30.00
HENRY-CONSTANT [Pa*m3/mole] or [J/mole] 0.1412E-03
CALCULATED USING
VAPOUR PRESSURE [Pa] 0.4000E-03
MOLECULAR MASS [g/mole] 63.54
WATER SOLUBILITY [mg/l] 180.0

Q10-Factor for Henry's constant: 1.000

DIFFUSION COEFF.AIR [cm2/d] 4303.
DEPTH OF SURFACE LAYER FOR VOLATILIZATION [CM] 0.1000
HENRY CONSTANT AT 20.0 deg C [-] 0.0000
HENRY CONSTANT AT 30.0 deg C [-] 0.5602E-07

PLANT UPTAKE OF ACTIVE SUBSTANCE

PLANT UPTAKE FACTOR (-) 0.0000

TRANSFORMATION PARAMETERS

DegT50 of the compound (d) at 20 °C at pF 2: 990210.26

TRANSFORM. TRANSFORM. TEMP. Q10 MOISTURE-DURING-STUDY MOISTURE REL.
TRANSFORM FORMATION
TO in EQ.Domaine OF STUDY VALUE ABSOLUTE RELATIVE EXPONENT IN NEQ DOMAIN
FACTOR
[/DAY] [C] [-] [%] [%] [-] [-] [-]
BR/CO2 0.7000E-06 20.00 2.200 0.0000 100.0 0.7000 0.0000 1.000

SORPTION PARAMETERS

--PARAMETERS TO CALCULATE KD-VALUES WITH KOC--
KOC [CM**3/G] 0.1951E+05
FREUNDLICH-SORPTION EXPONENT 1/n 1.000
[PEARL] FACTOR DESCRIBING NON-EQ-SITES EQ-SITES (-): 0.0000

[PEARL] DESORPTION RATE [1/D]: 0.0000

MIN. CONC FOR FREUNDLICH-SORPTION [æG/L] 0.1000E-19

DEPTH DEPENDEND SORPTION AND TRANSFORMATION PARAMETERS

HORIZON	KOC [CM**3/G]	KD [CM**3/G]	FR-EXP [-]	TRANSFORMATION RATE TO BR/CO2 [/DAY]
1	0.1951E+05	271.2	1.000	0.7000E-06
2	0.1951E+05	181.4	1.000	0.3500E-06
3	0.1951E+05	136.6	1.000	0.3500E-06
4	0.1951E+05	58.53	1.000	0.2100E-06
5	0.1951E+05	58.53	1.000	0.0000
6	0.1951E+05	52.68	1.000	0.0000
7	0.1951E+05	40.97	1.000	0.0000

(C
Ver 4 Châteaudun

Ver 4 Châteaudun, apples

GENERAL SOIL INFORMATION

CORE DEPTH [CM] 260.0
TOTAL HORIZONS IN CORE 7
TOTAL COMPARTMENTS IN CORE 52
DPFLAG FLAG (0=DISP.COEFF.1=DISP.LENGTH) 1
THETA FLAG (0=INPUT,1=PRZM 2=PELMO) 0
PARTITION COEFFICIENT FLAG (0=INPUT,1=CALCULATED) 1
BULK DENSITY FLAG (0=INPUT,1=CALCULATED) 0
SOIL HYDRAULICS MODULE free drainage
COMPARTMENT DEPTH FLAG (0=const,1=depth dep.) 0

SOIL HORIZON INFORMATION

HORIZON	THICKNESS [CM]	BULK DENSITY [G/CM**3]	INITIAL SOIL WATER CONTENT [CM/CM]	DRAINAGE PARAMETER [/DAY]	FIELD CAPACITY WATER CONTENT [CM/CM]	WILTING POINT WATER CONTENT [CM/CM]	DISPERSION LENGTH [CM]	ORGANIC CARBON [%]	BIODEG. FACTOR [-]	PH [-]
1	25.0000	1.3000	0.3740	0.1970	0.3740	0.2530	5.0000	1.3900	1.0000	8.0000
2	25.0000	1.4100	0.3720	0.1950	0.3720	0.2350	5.0000	0.9300	0.5000	8.1000
3	10.0000	1.4100	0.3720	0.2130	0.3720	0.2350	5.0000	0.7000	0.5000	8.2000
4	40.0000	1.3700	0.3860	0.2650	0.3860	0.1850	5.0000	0.3000	0.3000	8.5000
5	20.0000	1.3700	0.3860	0.2650	0.3860	0.1850	5.0000	0.3000	0.0000	8.5000
6	70.0000	1.4100	0.4170	0.2960	0.4170	0.1160	5.0000	0.2700	0.0000	8.5000
7	70.0000	1.4900	0.3620	0.2050	0.3620	0.1760	5.0000	0.2100	0.0000	8.3000

OUTPUT FILE PARAMETERS

OUTPUT	TIME STEP	LAYER FREQ
WATR	YEAR	1

PEST YEAR 1
CONC YEAR 1

Total number of layers in the top meter: 21

PLOT FILE INFORMATION

NUMBER OF PLOTTING VARIABLES 15

TIMSER NAME	MODE	DEPTH(CM)	ARGUMENT	CONSTANT	SUBSTANCE
PRSN	TSER	0.	1	1.000	PESTIC
TETD	TSER	0.	1	1.000	PESTIC
INFL	TSER	100.	22	1.000	PESTIC
RUNF	TSER	0.	1	1.000	PESTIC
THET	TSER	0.	1	1.000	PESTIC
THET	TSER	30.	7	1.000	PESTIC
TEMP	TSER	0.	1	1.000	PESTIC
TEMP	TSER	30.	7	1.000	PESTIC
TPAP	TSER	0.	1	0.1000E+06	PESTIC
TDKF	TSER	0.	1	0.1000E+06	PESTIC
TUPF	TSER	0.	1	0.1000E+06	PESTIC
TPST	TSER	5.	2	0.1000E+07	PESTIC
PFLX	TSER	100.	21	0.1000E+06	PESTIC
RFLX	TSER	0.	1	0.1000E+06	PESTIC
LEAC	TSER	100.	21	0.1000E+10	PESTIC

Average concentration in Leachate
*** FOCUS PELMO 6. 6. 4 *** (PELMO 5.0)
Compound: (C) Copper
Soil: Ver 4 Châteaudun
Crop: Ver 4 Châteaudun, apples

Results for ACTIVE SUBSTANCE (Copper) in the percolate at 1 m soil depth

Period	Pesticide Flux (g/ha)	Percolate (L/m²)	Pesticide Conc. (µg/L)
1	0.00E+00	290.400	0.000
2	0.00E+00	174.200	0.000
3	0.00E+00	247.100	0.000
4	1.62E-19	269.800	0.000
5	3.51E-18	342.600	0.000
6	1.94E-17	251.200	0.000
7	1.60E-16	320.400	0.000
8	6.64E-16	257.300	0.000
9	1.50E-15	185.400	0.000
10	1.81E-14	428.100	0.000
11	2.14E-14	155.700	0.000
12	4.05E-14	153.300	0.000
13	1.63E-13	254.600	0.000
14	6.20E-13	312.800	0.000
15	4.12E-13	101.500	0.000
16	2.90E-13	53.9900	0.000
17	9.06E-13	120.200	0.000
18	2.92E-12	205.100	0.000
19	5.15E-12	180.600	0.000
20	1.02E-11	186.300	0.000

Total	2.07E-11	4490.59	0.000
80 Perc.(17/16)	1.20E-12	174.190	0.000

Results for ACTIVE SUBSTANCE (Copper) in the percolate at the bottom of the simulated soil core

Period	Pesticide (g/ha)	Flux Percolate (L/m²)	Pesticide Conc. (µg/L)
1	0.00E+00	290.400	0.000
2	0.00E+00	174.200	0.000
3	0.00E+00	247.100	0.000
4	0.00E+00	269.800	0.000
5	0.00E+00	342.600	0.000
6	0.00E+00	251.200	0.000
7	0.00E+00	320.400	0.000
8	0.00E+00	257.300	0.000
9	0.00E+00	185.400	0.000
10	0.00E+00	428.100	0.000
11	0.00E+00	155.700	0.000
12	0.00E+00	153.300	0.000
13	0.00E+00	254.600	0.000
14	0.00E+00	312.800	0.000
15	0.00E+00	101.500	0.000
16	0.00E+00	53.9900	0.000
17	0.00E+00	120.200	0.000
18	0.00E+00	205.100	0.000
19	0.00E+00	180.600	0.000
20	0.00E+00	186.300	0.000
Total	0.00E+00	4490.59	0.000
80 Perc.(4/5)	0.00E+00	612.400	0.000

A 3.3 FOCUS MACRO v5.5.3

Crop	**File name**
Apple	125
Vine	126
Tomato	124

Example file: Apple (125)

MACRO in FOCUS Version 5.5.4
Output File = C:\SWASH\MACRO\macro125.bin
Type of compound = parent
Compound : Cu
Scenario : Chateaudun
Groundwater

Simulation from 19010101 to 19270101, application every year
(6 year warm-up)

Crop : Pome/stone fruit, irrigated

Number of applications : 1

Application 1 : 2500 g/ha of Cu on day 283

Massp

Period	Applied	Degraded	Leached	Runoff	Uptake	Changeofstorage
1	0.004585824	0	0	0	249.9965	
2	0.03757461	0	0	0	249.9752	
3	0.06400527	0	0	0	249.9502	
4	0.09317128	0	0	0	249.9512	
5	0.1131474	0	0	0	249.9354	
6	0.1740286	0	0	0	249.8817	
7	0.1806649	0	0	0	249.8851	
8	0.2325784	0	0	0	249.8187	
9	0.232791	0	0	0	249.8447	
10	0.2430072	0	0	0	249.8596	
11	0.2864934	0	0	0	249.8106	
12	0.3019583	0	0	0	249.7918	
13	0.3607676	0	0	0	249.7668	
14	0.4212255	0	0	0	249.7463	
15	0.4334362	0	0	0	249.795	
16	0.4395418	0	0	0	249.867	
17	0.4393508	0	0	0	249.7843	
18	0.4798436	0	0	0	249.8124	
19	0.5157089	0	0	0	249.8389	
20	0.5739079	0	0	0	249.7405	
21	0.6512723	0	0	0	249.7369	
22	0.6883759	0	0	0	249.6957	
23	0.6570816	0	0	0	249.6212	
24	0.6789255	0	0	0	249.6766	
25	0.654089	0	0	0	249.6433	
26	0.8359947	0	0	0	249.4395	

Massw

Period	Precipitation	Evapotranspiration	Percolation	Runoff	Changeofstorage
1	1074.784	1005.378	26.88712	0	42.51894
2	941.1853	931.7608	9.391674	0	0.02181298
3	869.2025	855.4144	42.80658	0	-29.02956
4	966.2571	899.6899	58.61964	0	7.931946
5	915.7759	861.947	26.32016	0	27.49588
6	970.6694	931.5562	49.90129	0	-10.79892
7	1037.342	891.0698	161.9948	0	-16.21338
8	1069.567	1062.705	-16.27652	0	23.12564
9	1004.961	836.9917	169.7247	0	-1.770902
10	986.8076	826.6475	122.7862	0	37.35612
11	1098.758	855.9463	270.9889	0	-28.19968
12	957.375	843.5908	110.1785	0	3.5909
13	1052.096	861.6152	170.0957	0	20.36669
14	1135.026	967.7842	196.1271	0	-28.90717
15	911.7568	897.9199	40.63879	0	-26.81354
16	1161.45	914.5137	227.1262	0	19.42993
17	913.8271	889.4375	27.53564	0	-3.157043
18	1006.127	909.2705	81.49695	0	15.34536
19	980.4727	853.9453	136.828	0	-10.31765
20	979.1133	837.0195	159.6147	0	-17.53802
21	993.9531	979.1445	-3.290527	0	18.08636

22	935.002	929.7168	5.259766	0	0.01540429
23	868.7461	855.1973	42.56543	0	-29.02804
24	966.248	899.6895	58.6106	0	7.931946
25	915.793	861.9648	26.31982	0	27.49607
26	970.6777	931.5605	49.9043	0	-10.79886

Conc

Period	Av_FluxConc_at_reporting_depth
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	9.801522E-41
19	2.195877E-39
20	6.003753E-38
21	2.631367E-35
22	1.023851E-33
23	3.557284E-34
24	1.936943E-33
25	3.095186E-32
26	1.985597E-31

Appendix 4 FOCUS Step 1&2 raw data

As an example file, the application in vineyards, N-EU in Oct.-Feb. is presented below.

PECsw - Via spray drift / runoff / drainage

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Predictions Step 1

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:48:56

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Application/crop type:	vines, late applns
Number of applications per season:	1.00
Water solubility (mg/L):	500.00
KOC compound(L/kg):	33918.30
DT50 water/sediment (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	3.00
Spraydrift (% of application):	8.0280
Runoff + drainage(% of application):	10.00
Ratio of field to water body:	10.00

Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Equilvalent app. rate for drift (g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha) of parent:	0.00E+00
Loading to water body via drift (mg/m²):	9.6336
Loading to water body via runoff/drainage(mg/m²):	120.0000
fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment phase:	0.9784

Table: Calculated Concentrations in the water body

	PECsw (µg/L)		PECsed(µg/kg dry sediment)	
Time (d)	Actual	TWA	Actual	TWA
0				
40.7654		2.94E+03		
1	9.3417	25.0535	3.17E+03	3.05E+03
2	9.3352	17.1960	3.17E+03	3.11E+03
4	9.3223	13.2624	3.16E+03	3.14E+03
7	9.3029	11.5696	3.16E+03	3.15E+03
14	9.2579	10.4250	3.14E+03	3.15E+03
21	9.2130	10.0285	3.12E+03	3.14E+03
28	9.1685	9.8190	3.11E+03	3.14E+03
42	9.0799	9.5874	3.08E+03	3.12E+03
50	9.0297	9.5022	3.06E+03	3.11E+03
100	8.7221	9.1886	2.96E+03	3.06E+03

Maximum PECsw values in water and sediment are calculated from single application.
Compare with ecotox endpoints. If TER values are less than regulatory triggers, then go to Step 2

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Preditions Step 2

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:48:58

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Crop Interception:	no interception (0 %)
Application/crop type:	vines, late applns
Number of applications per season:	1
Region and season of application:	North Europe, Oct. - Feb.
Water solubility (mg/L):	500.00
KOC assessed compound(L/kg):	33918.30
KOC parent compound(L/kg):	0.00E+00
DT50 water(d):	1000.00
DT50 sediment (d):	1000.00
DT50 soil (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	3.00
Spraydrift (% of application):	8.0280
Runoff + drainage(% of application):	5.00
Ratio of field to water body:	10.00

Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Number of application per season considered for this run:	1

Equilvalent application rate for drift (g/ha):	1200.00
Equilvalent application rate for runoff/drainage(g/ha):	1200.00

Loading to water body per drift event(mg/m²):	9.6336
Loading to water body via runoff/drainage (mg/m²):	59.8339
fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment:	0.9784

Total Loading to water body via drift (mg/m²):	9.6336 (13.8678%)
Total Loading to water body via water phase(mg/m²):	1.2944 (1.8633%)
Total Loading to water body via sediment phase (mg/m²):	58.5395 (84.2689%)
Maximum PECSW (µg/L):	32.1120
Maximum PECSW occuring on day:	0
Maximum PECsed (µg/kg dry sediment):	1.7E+03
Maximum PECsed occuring on day:	5

Table: Calculated Concentrations in the water body

PECsw (µg/L)	PECsed(µg/kg dry sediment)

Time after max. peak(d)	Actual	TWA	Actual	TWA
0	32.1120	---	1.7E+03	---
1	11.1594	21.6357	1.7E+03	1.7E+03
2	4.3305	14.6903	1.69E+03	1.7E+03
4	5.6934	9.1243	1.69E+03	1.69E+03
7	4.9971	7.4067	1.69E+03	1.69E+03
14	4.9729	6.1959	1.68E+03	1.69E+03
21	4.9489	5.7842	1.67E+03	1.68E+03
28	4.9249	5.5724	1.66E+03	1.68E+03
42	4.8773	5.3486	1.65E+03	1.67E+03
50	4.8504	5.2710	1.64E+03	1.67E+03
100	4.6851	5.0192	1.58E+03	1.64E+03

PECsw - Via runoff / drainage only

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Predictions Step 1

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:54:07

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper (No spray drift)

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Application/crop type:	no drift (incorp or seed trtmt)
Number of applications per season:	1.00
Water solubility (mg/L):	500.00
KOC compound(L/kg):	33918.30
DT50 water/sediment (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	1.00
Spraydrift (% of application):	0.0000
Runoff + drainage(% of application):	10.00
Ratio of field to water body:	10.00
Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Equilvalent app. rate for drift (g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha) of parent:	0.00E+00
Loading to water body via drift (mg/m²):	0.0000
Loading to water body via runoff/drainage(mg/m²):	120.0000
fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment phase:	0.9784

Table: Calculated Concentrations in the water body

	PECsw (µg/L)		PECsed(µg/kg dry sediment)	
Time (d)	Actual	TWA	Actual	TWA
0				
8.6534		2.94E+03		
1	8.6474	8.6504	2.93E+03	2.93E+03
2	8.6415	8.6474	2.93E+03	2.93E+03
4	8.6295	8.6415	2.93E+03	2.93E+03
7	8.6116	8.6325	2.92E+03	2.93E+03
14	8.5699	8.6116	2.91E+03	2.92E+03
21	8.5284	8.5908	2.89E+03	2.91E+03

28	8.4871	8.5700	2.88E+03	2.91E+03
42	8.4051	8.5287	2.85E+03	2.89E+03
50	8.3587	8.5052	2.84E+03	2.88E+03
100	8.0739	8.3603	2.74E+03	2.84E+03

Maximum PECsw values in water and sediment are calculated from single application.
Compare with ecotox endpoints. If TER values are less than regulatory triggers, then go to Step 2

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Preditions Step 2

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:54:09

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper (No spray drift)

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Crop Interception:	no interception (0 %)
Application/crop type:	no drift (incorp or seed trtmt)
Number of applications per season:	1
Region and season of application:	North Europe, Oct. - Feb.
Water solubility (mg/L):	500.00
KOC assessed compound(L/kg):	33918.30
KOC parent compound(L/kg):	0.00E+00
DT50 water(d):	1000.00
DT50 sediment (d):	1000.00
DT50 soil (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	1.00
Spraydrift (% of application):	0.0000
Runoff + drainage(% of application):	5.00
Ratio of field to water body:	10.00

Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Number of application per season considered for this run:	1

Equilvalent application rate for drift (g/ha):	1200.00
Equilvalent application rate for runoff/drainage(g/ha):	1200.00

Loading to water body per drift event(mg/m²):	0.0000
Loading to water body via runoff/drainage (mg/m²):	59.8339

fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment:	0.9784

Total Loading to water body via drift (mg/m²):	0.0000 (0.0000%)
Total Loading to water body via water phase(mg/m²):	1.2944 (2.1634%)
Total Loading to water body via sediment phase (mg/m²):	58.5395 (97.8366%)
Maximum PECSW (µg/L):	4.3147
Maximum PECSW occuring on day:	4
Maximum PECsed (µg/kg dry sediment):	1.46E+03
Maximum PECsed occuring on day:	4

Table: Calculated Concentrations in the water body

	PECsw (µg/L)		PECsed(µg/kg dry sediment)	
Time after max. peak(d)	Actual	TWA	Actual	TWA
0	4.3147	---	1.46E+03	---
1	4.3117	4.3132	1.46E+03	1.46E+03
2	4.3088	4.3118	1.46E+03	1.46E+03
4	4.3028	4.3088	1.46E+03	1.46E+03
7	4.2939	4.3043	1.46E+03	1.46E+03
14	4.2731	4.2939	1.45E+03	1.46E+03
21	4.2524	4.2835	1.44E+03	1.45E+03
28	4.2318	4.2731	1.44E+03	1.45E+03
42	4.1909	4.2525	1.42E+03	1.44E+03
50	4.1678	4.2408	1.41E+03	1.44E+03
100	4.0258	4.1686	1.37E+03	1.41E+03

PECsw - Via spray drift only

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Predictions Step 1

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:56:05

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper (No run-off/Drainage)

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Application/crop type:	vines, late applns
Number of applications per season:	1.00
Water solubility (mg/L):	500.00

KOC compound(L/kg):	33918.30
DT50 water/sediment (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	3.00
Spraydrift (% of application):	8.0280
Runoff + drainage(% of application):	10.00
Ratio of field to water body:	10.00

Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Equilvalent app. rate for drift (g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha):	1200.00
Equilvalent app. rate for runoff/drainage(g/ha) of parent:	0.00E+00
Loading to water body via drift (mg/m²):	9.6336
Loading to water body via runoff/drainage(mg/m²):	120.0000
fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment phase:	0.9784

Table: Calculated Concentrations in the water body

	PECsw (µg/L)		PECsed(µg/kg dry sediment)	
Time (d)	Actual	TWA	Actual	TWA
0				
40.7654		2.94E+03		
1	9.3417	25.0535	3.17E+03	3.05E+03
2	9.3352	17.1960	3.17E+03	3.11E+03
4	9.3223	13.2624	3.16E+03	3.14E+03
7	9.3029	11.5696	3.16E+03	3.15E+03
14	9.2579	10.4250	3.14E+03	3.15E+03
21	9.2130	10.0285	3.12E+03	3.14E+03
28	9.1685	9.8190	3.11E+03	3.14E+03
42	9.0799	9.5874	3.08E+03	3.12E+03
50	9.0297	9.5022	3.06E+03	3.11E+03
100	8.7221	9.1886	2.96E+03	3.06E+03

Maximum PECsw values in water and sediment are calculated from single application.
Compare with ecotox endpoints. If TER values are less than regulatory triggers, then go to Step 2

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Preditions Step 2

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:56:07

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper (No run-off/Drainage)

Active substance:	Copper
Application rate (g/ha) of a.i.:	1200.00
Crop Interception:	no interception (0 %)
Application/crop type:	vines, late applns
Number of applications per season:	1
Region and season of application:	No Runoff/Drainage
Water solubility (mg/L):	500.00
KOC assessed compound(L/kg):	33918.30
KOC parent compound(L/kg):	0.00E+00
DT50 water(d):	1000.00
DT50 sediment (d):	1000.00
DT50 soil (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	3.00
Spraydrift (% of application):	8.0280
Runoff + drainage(% of application):	0.00E+00
Ratio of field to water body:	10.00

Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Number of application per season considered for this run:	1

Equilvalent application rate for drift (g/ha):	1200.00
Equilvalent application rate for runoff/drainage(g/ha):	1200.00

Loading to water body per drift event(mg/m²):	9.6336
Loading to water body via runoff/drainage (mg/m²):	0.0000
fraction of substance entering water body in water phase:	0.0216
fraction of substance entering water body in sediment:	0.9784

Total Loading to water body via drift (mg/m²):	9.6336 (100.0000%)
Total Loading to water body via water phase(mg/m²):	0.0000 (0.0000%)
Total Loading to water body via sediment phase (mg/m²):	0.0000 (0.0000%)
Maximum PECSW (µg/L):	32.1120
Maximum PECSW occuring on day:	0
Maximum PECsed (µg/kg dry sediment):	231.8890
Maximum PECsed occuring on day:	7

Table: Calculated Concentrations in the water body

Time after max. peak(d)	PECsw (µg/L) Actual	PECsw (µg/L) TWA	PECsed(µg/kg dry sediment) Actual	PECsed(µg/kg dry sediment) TWA
0	32.1120	---	231.8890	---
1	11.1594	21.6357	231.7896	231.8393
2	4.3305	14.6903	231.6489	231.7793
4	1.3786	8.5850	231.3366	231.6366
7	1.0380	5.3934	230.8571	231.4053
14	1.0209	3.2092	229.7397	230.8516
21	1.0160	2.4790	228.6277	230.2955

28	1.0111	2.1126	227.5211	229.7401
42	1.0013	1.7438	225.3239	228.6337
50	0.9958	1.6246	224.0779	228.0043
100	0.9619	1.3016	216.4450	224.1219

PECsed

STEPS 1-2 in FOCUS

FOCUS Surface water Tool for Exposure Preditions Step 2

developed by Michael Klein

Program version:	Version 3.2
Date of this simulation:	09.11.2020, 13:15:17

OVERVIEW ON THE SUBSTANCE SPECIFIC INPUT DATA USED IN THE CALCULATION

Comments: Nordox 75 copper (SED calculations, professional use)

Active substance:	Coppersed
Application rate (g/ha) of a.i.:	1200.00
Crop Interception:	no interception (0 %)
Application/crop type:	vines, late applns
Number of applications per season:	1
Region and season of application:	North Europe, Oct. - Feb.
Water solubility (mg/L):	500.00
KOC assessed compound(L/kg):	10000.00
KOC parent compound(L/kg):	0.00E+00
DT50 water(d):	1000.00
DT50 sediment (d):	1000.00
DT50 soil (d):	1000.00

SCENARIO DATA USED IN THE CALCULATION

Distance to the water body (m):	3.00
Spraydrift (% of application):	8.0280
Runoff + drainage(% of application):	5.00
Ratio of field to water body:	10.00
Water depth (cm):	30.00
Sediment depth (cm):	5.00
Effective sediment depth for sorption (cm):	1.00
Sediment OC (%):	5.00
Sed. bulk density (kg/L):	0.80

RESULTS OF THE CALCULATION

Number of application per season considered for this run:	1
Equilvalent application rate for drift (g/ha):	1200.00
Equilvalent application rate for runoff/drainage(g/ha):	1200.00
Loading to water body per drift event(mg/m²):	9.6336
Loading to water body via runoff/drainage (mg/m²):	59.8339

fraction of substance entering water body in water phase:	0.0698
fraction of substance entering water body in sediment:	0.9302

Total Loading to water body via drift (mg/m²):	9.6336 (13.8678%)
Total Loading to water body via water phase(mg/m²):	4.1745 (6.0092%)
Total Loading to water body via sediment phase (mg/m²):	55.6594 (80.1230%)
Maximum PECSW (µg/L):	32.1120
Maximum PECSW occuring on day:	0
Maximum PECsed (µg/kg dry sediment):	1.61E+03
Maximum PECsed occuring on day:	5

Table: Calculated Concentrations in the water body

	PECsw (µg/L)		PECsed(µg/kg dry sediment)	
Time after max. peak(d)	Actual	TWA	Actual	TWA
0	32.1120	---	1.61E+03	---
1	12.1891	22.1506	1.61E+03	
	1.61E+03			
2	6.0142	15.6261	1.61E+03	
	1.61E+03			
4	17.4192	11.7671	1.61E+03	
	1.61E+03			
7	16.1155	13.7286	1.61E+03	
	1.61E+03			
14	16.0375	14.9025	1.6E+03	
	1.61E+03			
21	15.9598	15.2679	1.59E+03	1.6E+03
28	15.8826	15.4312	1.58E+03	1.6E+03
42	15.7292	15.5561	1.57E+03	
	1.59E+03			
50	15.6422	15.5768	1.56E+03	
	1.59E+03			
100	15.1094	15.4755	1.51E+03	
	1.56E+03			