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Pesticide concentrations and transport in water from a small agricultural catchment in southern Sweden

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Avdelningen för vattenvårdslära

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Division of Water Quality Management

Contents

SUMMARY

A pesticide monitoring study was initialized in spring 1990 to examine the loss of pesticides in stream water from an agricultural catchment in southern Sweden under normal management practices. Information on pesticide usage was collected annually through interviews with the 35 farmers operating in the area. In the present report results are presented on pesticide usage in the catchment during 1996/97 growing season and the occurrence and transport of pesticides in water leaving the area during May-November 1997.

The weather during the investigation period was predominantly warm and dry, with annual precipitation below normal and annual temperature above normal . The annual flow volume was considerably less than normal. Total flow volume during the sampling period May-November was the smallest volume recorded since the start of the investigation in 1990.

The total amount of pesticides applied in the catchment during the 1996/97 crop rotation was *ca.* 1500 kg active ingredient (AI), with 24% applied in the autumn and 76% during spring/early summer. During the previous four crop rotations the total amount used have been lower, *ca.* 1200 kg AI. A large area was grown with sugar beet during 1997 and since pesticide use in sugar beet is intensive this resulted in larger quantities of herbicides being used than previously. A total of 28 different pesticides were applied in the catchment.

During the investigation period 25 pesticides were detected in water samples, including 20 herbicides, 2 fungicides, 1 insecticides and 2 metabolites. The most frequently detected pesticides in water were: bentazone, isoproturon, mecoprop, terbuthylazine, propyzamide, atrazine and ethofumesate. Detectable concentrations of pesticides in culvert discharge were observed throughout the sampling period, with an average total pesticide concentration of *ca.* 5 µg/l. This was lower than detected during previous years in samples from the same site. Pesticides applied in the autumn prevailed in water collected during the following spring and summer.

Total load of pesticides transported in water leaving the area during May-November was 0.45 kg. Losses of single pesticides used in the field were generally less than 0.1% of the applied amount and the average loss for all pesticides was 0.02% during May-September and 0.06% during May-November. These losses were comparable with those registered previously.

INTRODUCTION

A pesticide monitoring study was initialized in spring 1990 to examine the loss of pesticides from an agricultural catchment in southern Sweden under normal management practices. The results from the first seven years, 1990-1996, were presented in two earlier technical reports (Kreuger, 1996; Kreuger, 1997) and in one article (Kreuger, 1998). In the present report results of pesticide occurrence and transport in water during 1997 are presented. The catchment is part of the Swedish environmental monitoring program 'Typområden för jordbruksmark' with the aim to investigate agricultural impact on water quality in small agricultural catchments throughout Sweden. Results of nutrient losses from the catchment are reported elsewhere (Mårtensson & Kyllmar, 1998).

MATERIAL AND METHODS

A complete description of the catchment, data collection procedures, techniques and calculations, analytical procedures and quality assurance is given in Kreuger (1996). A brief description will be given below.

Catchment description

The Vemmenhög catchment is located in the far south of Sweden on the south-western plain of Skåne (Scania province). It forms the upper reach of the Vemmenhög Stream drainage basin which empties into the Baltic Sea. The catchment has undulating topography with glacial till-derived soils rich in chalk. It has an area of 9 km^2 consisting of 95% arable land, with sandy loam soils dominating. Extensive tile-drainage systems have been installed within the area. pH-value in tile drainage water is in the range 7.5-8.0. Throughout the upper part of the catchment, drainage water is channeled through a large culvert, apart from a small open ditch with a length of 100 m. The culvert collects primarily tile drainage, but can also, as customary in tile-drained areas, carry runoff water due to surface runoff inlets along the tile drains in the field. Surface runoff inlets can also be found on some courtyards and along roads.

Data collection

Information on crops, fertilization and pesticide usage on the field scale (i.e. type of pesticides, dosage, time of spraying and field site location and size) was collected annually through interviews with the 33 farmers operating in the catchment area (902 ha). Previously there was one farm (with 2.5% of the arable land) that did not participate in the investigation. This farm (except for one field of 4.5 ha) is from 1997 cultivated jointly with a neighbouring farm and information from these fields are thus incorporated into the investigation.

During 1997, water samples for pesticide analysis were collected from site UT10, situated at the outlet of the culvert (**Figure 1**). The drainage area at this site is 828 ha. Sampling period was May-November, with interruption during low-flow periods.

Water flow rates at the culvert outlet (UT10) were measured using a 90-degree V-notch weir and an ultrasonic sensor (ISCO model 3210 flow meter with plotter).

Rainfall was measured on a daily basis, both within the catchment (one gauge situated close to site NA1 and the other by the village close to site SH5) as well as at an official meteorological station located 6 km to the north-east of the catchment. During certain time periods, rainfall was registered on an hourly basis by data loggers using tipping bucket rain gauges, one situated at LU12 (Campbell datalogger) and one by the village close to SH5 (ISCO 674L datalogger) (**Figure 1**).

Water samples were collected using a programmable automatic sampler with refrigerator (ISCO model 3700FR). The sampler collected time-paced samples at weekly intervals, each sample being a composite of sub-samples taken at hourly intervals. Samples were collected in glass bottles, prewashed with ethanol, and stored during the collection procedure at +4°C in the sampler refrigerator. To inhibit microbial degradation of the pesticides during the collection period, dichloromethane was added as a preservative to one of two parallel sampling bottles in advance, plus distilled water to prevent evaporation losses of the dichloromethane. Water from the bottle without dichloromethane was used for analysis of phenoxy acids with solid phase extraction (see below). After the completion of the sampling program, the bottles, capped with Teflon-lined screw caps, were delivered to the laboratory within 48 hours and extracted within 24 hours of delivery.

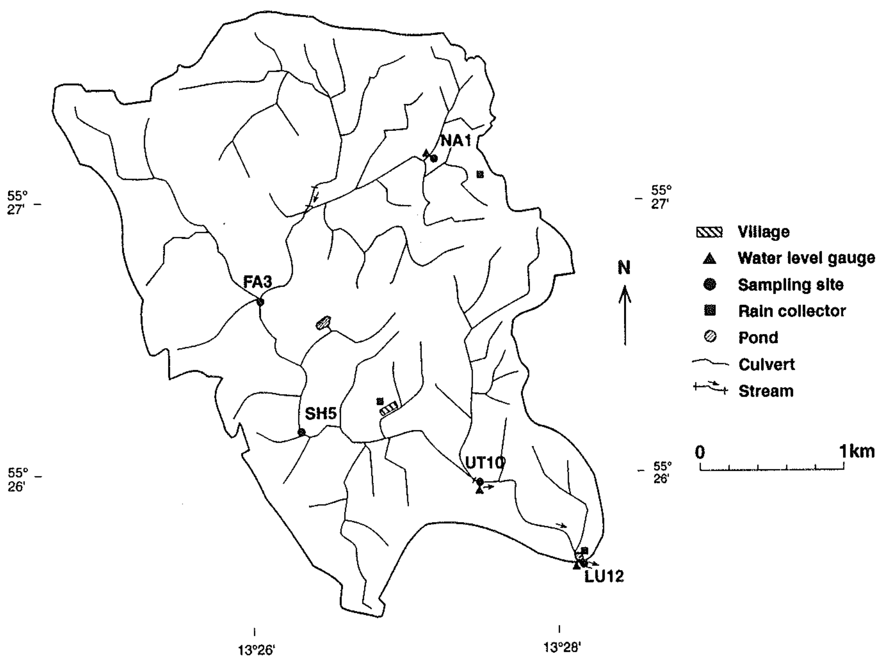


Figure 1. Location of sampling sites and measurement devices in the catchment area.

Analytical procedures

Pesticide residue analyses were conducted by the Organic Environmental Chemistry Unit, Department of Environmental Assessment at the Swedish University of Agricultural Sciences, Uppsala. Unfiltered water samples were primarily analyzed by two different procedures, the phenoxy acid method and the multiresidue method (Åkerblom et al., 1990). Thereby about 80 different pesticides can be detected. The phenoxy acid method was slightly modified during the year, with liquid-liquid extraction replaced by solid phase extraction (SPE). The first 65% of the samples were run using both extraction methods to preclude any systematic differences between the two methods. Samples were spiked with surrogate analytes (2,4,5-TP in the phenoxy acid method and ethion in the multiresidue method) to monitor the accuracy and precision of the analytical procedures and concentrations were corrected according to extraction efficiency of these analytes. The analyses were performed using gas chromatography and mass spectrometry (GC/MS), with a recovery efficiency of most substances in the range 75-100%.

Analysis of the sulfonylurea herbicide tribenuron-methyl, during May-October, was performed using liquid-liquid extraction after pH-adjustment, followed by LC/MS with TSP+. Findings were confirmed using a different ionization technique (LC/MS with API-ES+) including two massnumbers.

A limit of determination was calculated for every pesticide in each sample. For several of the pesticides the limit of determination was lower than during previous years. The results reported were not corrected for recovery efficiency. The limit of determination for each pesticide is given in **Table 5**.

RESULTS

Weather

Table 1 and **Figures 2 and 3** summarize the climatic data during the study period. The mean annual temperature in the area was 8.6°C in 1997, which is considerably above the long-term (1961-1990) average value of 7.2°C. Especially February-March, August and December were much warmer than normal (**Figure 2**).

The annual precipitation in the area was 585 mm during 1997, which is lower than the long-term (1961-1990) average value of 662 mm. Monthly amounts of precipitation were mostly below normal throughout the year, with only February, May and October receiving more than normal precipitation (**Figure 3**). Also in 1995 and in 1996 there were long periods with precipitation amounts below normal.

Table 1. Monthly precipitation totals, monthly average temperature and departure from normal, along with monthly flow totals, during the 1997 sampling period

Month	Prec.* mm	Dep.° mm	Temp.# °C	Dep.° °C	Flow^ mm
May	79	+39	9.6	-1.0	6.9
Jun	29	-25	14.7	+0.3	2.1
Jul	42	-22	17.2	+1.2	0.6
Aug	51	-8	18.9	+3.2	0.2
Sep	34	-34	13.5	+1.2	0.2
Oct	105	+39	7.4	-1.2	0.7
Nov	39	-37	5.3	+1.3	1.8

* Precipitation measured at an official meteorological station in Skurup, 6 km NE of the catchment.
° Departure from 'normal'. 'Normal' is the 30-year average precipitation measured at Skurup and temperature measured at Sturup (12 km NW of the catchment).
Temperature measured by a datalogger at site LU12.
^ Flow measured at sampling site UT10.

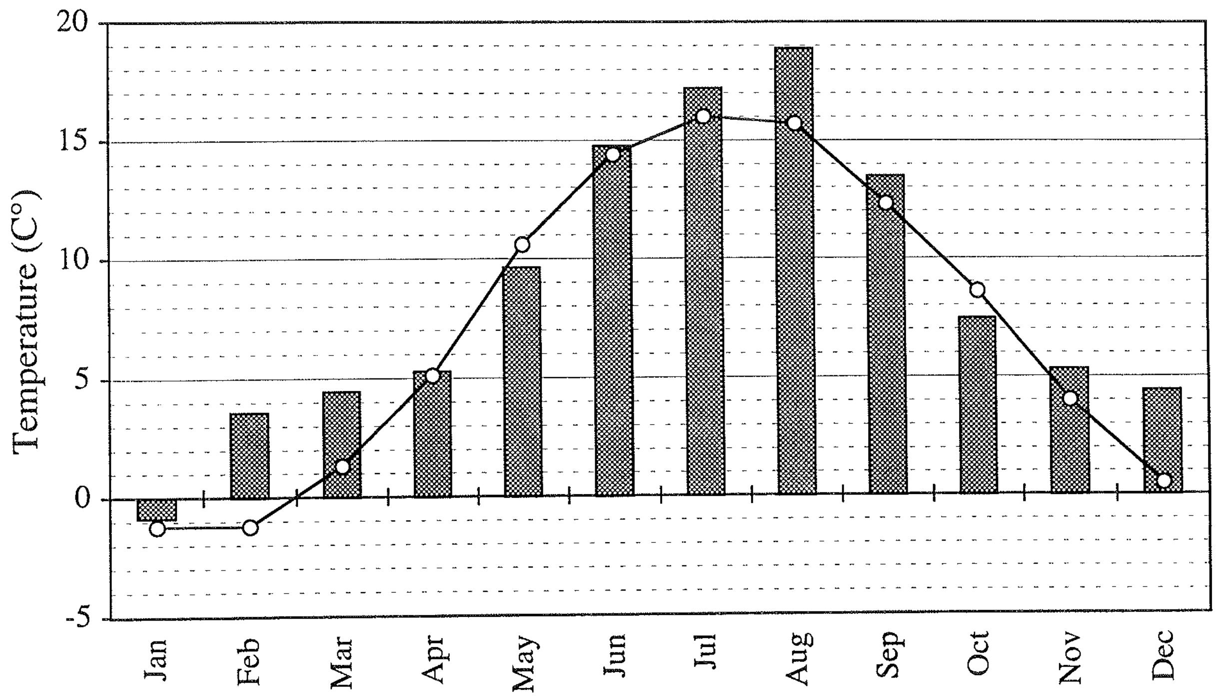


Figure 2. Monthly average temperature during 1997, with the 30-year average monthly temperature indicated as a curve.

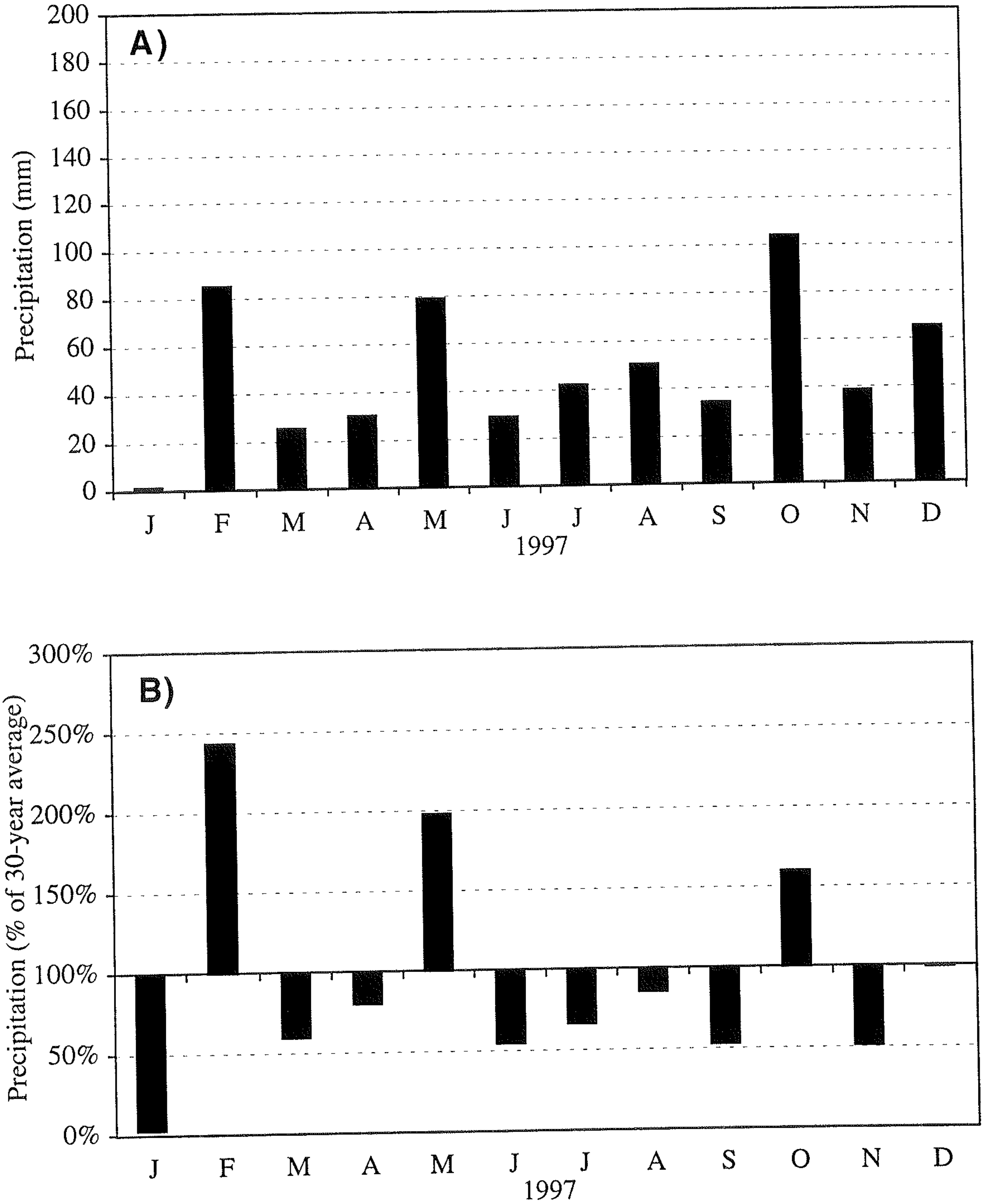


Figure 3. A) Monthly precipitation totals. B) Precipitation as departure from normal (30-year average measured 1961-1990).

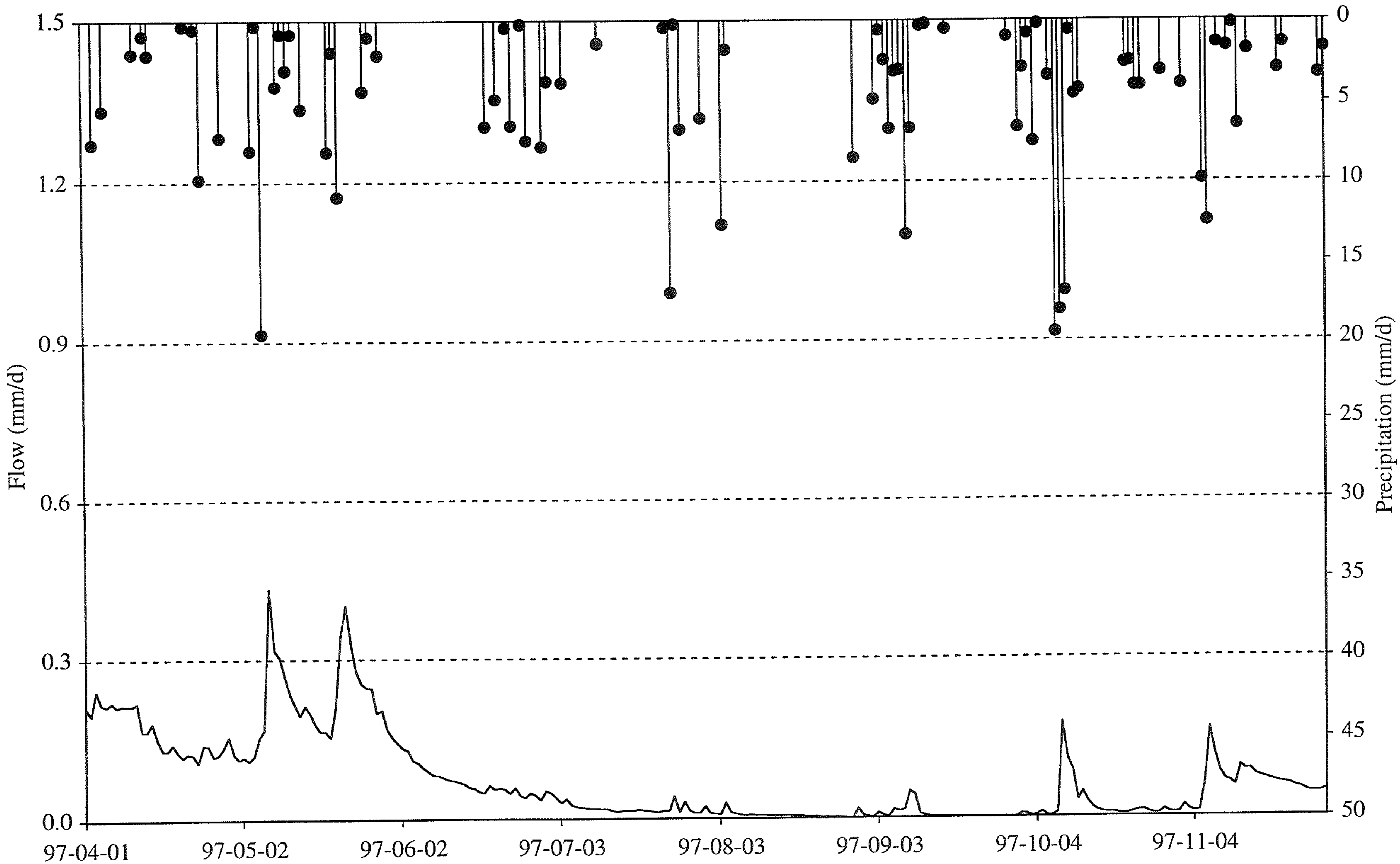


Figure 4. Waterflow measured at sampling site UT10 and precipitation measured in the area during April-November 1997.

Table 2. Crop distribution in the catchment area during 1997

Crop	1997	Average 1990-1996
Fallow	2%	1%
Grass ley	2%	2%
Meadow	1%	1%
Oats	3%	2%
Peas	1%	2%
Rye wheat	3%	1%
Set aside land	0%	1%
Spring barley	21%	25%
Spring rape	-	0%
Spring wheat	-	7%
Sugar beet	34%	18%
Winter barley	2%	2%
Winter rape	2%	16%
Winter rye	-	1%
Winter wheat	30%	21%

Waterflow

Table 1 and **Figure 4** summarize flow data measured at the culvert outlet (site UT10) during the study period. The annual flow volume was 76 mm in 1997. The average annual flow volume is 262 mm based on 20 years of flow measurement data from a field site within the catchment (NA1). Flow volume in 1997 was obviously considerably less than the average, i.e. 29% of normal. The total flow volume during the sampling period May-November was 12.5 mm in 1997, which was the smallest volume recorded during this time period since the start of the investigation in 1990.

Agronomic practices and pesticide use

Crops

Table 2 summarize the crop data during 1997. The three crops dominating within the catchment were spring barley, sugar beet and winter wheat, their total percentage of the cultivated area being 85%. Very little winter rape was sown in the autumn 1996, of which a large part (57%) out-wintered, resulting in winter rape being grown on only 2% of the area, which was much less than the long term average. Cereals were grown on 59% of the cultivated area. Sugar beet was grown on 34% of the area, which was considerably more than during any of the previous seven years.

Pesticide usage

Courtyard application

Several of the farmers living within the catchment applied the herbicide glyphosate (in 'Roundup' and 'Avans') for weed control outside the field, mostly on courtyards, but also along roads and around field edges, poles and surface water inlet wells. No other herbicides were recorded being used on courtyards during 1997.

Field application

The total amount of pesticides applied within the catchment during the 1996/97 crop rotation was 1470 kg active ingredient (AI), with 24% applied in the autumn and 76% during spring/early summer (**Figure 5**). During the previous four crop rotations the total amount used have been lower, *ca.* 1200 kg AI. Pesticide use in sugar beet is intensive and the large area grown with sugar beet during 1997 resulted in large quantities of herbicides being used.

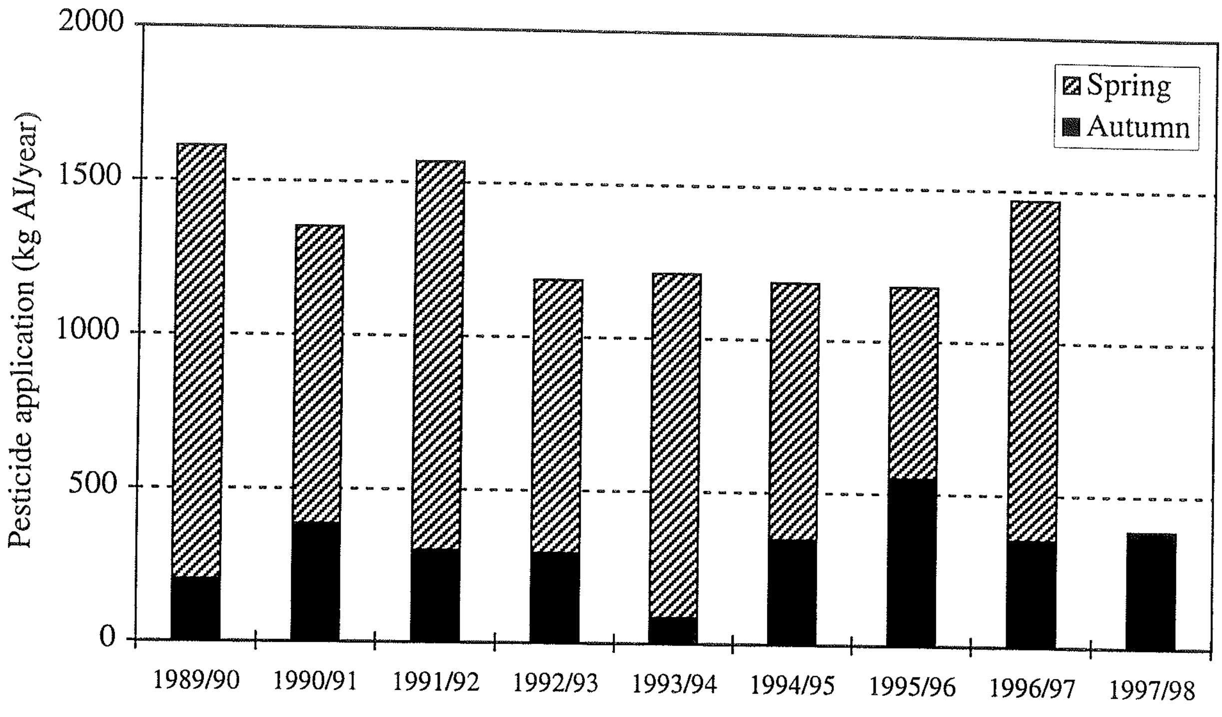


Figure 5. Total pesticide use in the catchment area during the growing seasons 1989/90-1996/97.

Table 3. Annually treated area (draining to UT10) and applied average rate

	Treated area (ha)			Dose (kg/ha)		
	1995	1996	1997	1995	1996	1997
Spring						
Herbicides	447	552	542	1.5	0.7	1.8
Fungicides	234	465	309	0.3	0.4	0.4
Insecticides	231	427	323	0.02	0.03	0.01
Growth regulators	4	3	-	1.4	0.8	-
Total	615	684	712	1.2	0.9	1.5
Autumn						
Herbicides	324	281	138	1.6	1.1	1.1
Fungicides	-	-	47	-	-	4.8
Insecticides	51	-	10	0.002	-	0.03
Growth regulators	-	-	-	-	-	-
Total	324	281	195	1.6	1.1	1.9

Of the total area draining to sampling site UT10, 86% (712 ha) was treated with pesticides during spring and early summer in 1997 and 34% (281 ha) during the autumn 1996 (**Table 3**). The average applied herbicide rate during spring/early summer in 1997 (1.5 kg/ha) was higher than during the two previous years. This was largely attributed to the high percentage of the area grown with sugar beet in 1997. Herbicide doses are generally considerably lager per hectare in sugar beets than in cereals. The area treated with fungicides and insecticides varies greatly between years as a result of different weather situations. In 1997, *ca.* 38% (*ca.* 315 ha) of the area was treated with fungicides and insecticides, compared to *ca.* 55% (*ca.* 450 ha) in 1996 (**Table 3**). The high dose of fungicides during autumn 1997 was due to autumn application of sulfur as a treatment of mildew in some fields with sugar beet.

During the 1996/97 cropping season 28 different AI's were applied on fields within the catchment (**Table 4**). Ten of these AI's accounting for 92% of total weight applied. The pesticide usage during spring/early summer 1997 was dominated by herbicide applications (89%), with the remainder made up of fungicides (11%) and insecticides (<0.5%) (**Table 4**). Autumn application 1996 was completely dominated by herbicides (100%), whereas in autumn 1997 herbicides constituted only 42% (due to the fungicide treatment with sulfur, as mentioned above).

Six of the 28 pesticides used in the catchment were not included in the analyses (**Table 4**) and represented *ca.* 6% of the total amount applied 1996/97.

Table 4. Seasonal amounts of field applied pesticides in the catchment (LU12) and in the subcatchment draining to site UT10

		LU12			UT10		
	Type	autumn 1996	spring 1997	autumn 1997	autumn 1996	spring 1997	autumn 1997
Substance	*	kg	kg	kg	kg	kg	kg
aclonifen°	H		4.3			4.3	
azoxystrobin#	FU		10.8			10.0	
bentazone	H		2.0			2.0	
chloridazon	H		60.6			60.6	
clopyralid	H		0.2			0.2	
cycloxidim#	H		7.4	3.7		7.4	3.7
cyfluthrin	IN		0.1	0.3		0.1	0.3
deltamethrin	IN		0.4			0.3	
dichlorprop-P	H		32.3			32.3	
diflufenican	H	20.7		6.4	17.7		5.2
esfenvalerate	IN		2.5			2.1	
ethofumesate	H		51.0			49.1	
fenpropimorph	FU		84.5			75.6	
fluroxypyr	H		5.4			4.0	
glyphosate#	H	69.7	3.7	60.2	65.9	2.7	54.5
isoproturon	H	236.2	9.4	59.2	211.0	9.4	52.1
lambda-cyhalothrin	IN		0.8			0.8	
MCPA	H		42.6			42.1	
mecoprop-P	H		66.7			65.6	
metamitron	H		562.1			542.6	
metazachlor	H	25.2		33.1	13.1		33.1
methabenzthiazuron	H		11.2			11.2	
phenmedipham¤	H		128.2			124.2	
propiconazole	FU		28.2			25.2	
quinmerac#	H		1.4			1.4	
sulfur#	FU			222.0			222.0
thifensulfuron-methyl#	H		0.4			0.4	
tribenuron-methyl^	H		1.2			1.2	
Total amount		351.8	1117.3	384.9	307.7	1074.7	370.9
Herbicides		351.8	990.0	162.6	307.7	960.6	148.6
Fungicides			123.5	222.0		110.8	222.0
Insecticides			3.8	0.3		3.2	0.3
Herbicides		100%	89%	42%	100%	89%	40%
Fungicides			11%	58%		10%	60%
Insecticides			0%	0%		0%	0%

* H = Herbicide; FU = Fungicide; IN = Insecticide.
° = Pesticide only analysed during May-July 1997.
= Pesticide not included in the analyses.
¤ = Pesticide only analysed during June-November 1997.
^ = Pesticide only anaylsed during May-October 1997.

The main application season during autumn stretches from the end of August to mid-October and during spring from the beginning of April to early July. On average, *ca.* 60% of the total amount used each spring/early summer is applied in May. In 1997, *ca.* 70% of the pesticide amount was applied in May (**Figure 6**). Due to late insect control in sugar beet small amounts (0.1 kg) of the insecticide esfenvalerate was applied in the beginning of August (week 31, not visible in the figure). Some sugar beet fields were even sprayed in late August and early September, but these applications were compiled into the autumn application calculations in Table 4 and in Appendix 3. A compilation of amounts used, area treated, doses and application period during 1997 (including autumn 1996) for each pesticide is given in **Appendices 1-3**. Trade names of the commercial products used in the catchment and the included active ingredients are given in **Appendix 4**.

In **Figure 7** the use of herbicides, fungicides and insecticides in Sweden (Kvist, 1998), and in the catchment, since the start of the investigation in 1990 are compared. The use of fungicides within the catchment in 1997 was dominated by the high volume compound sulfur with a total of 222 kg applied, remaining fungicides amounted to a total use of 124 kg during 1997. Pesticide usage in the catchment correspond to *ca.* 0.1% of the total amount used within agriculture in Sweden.

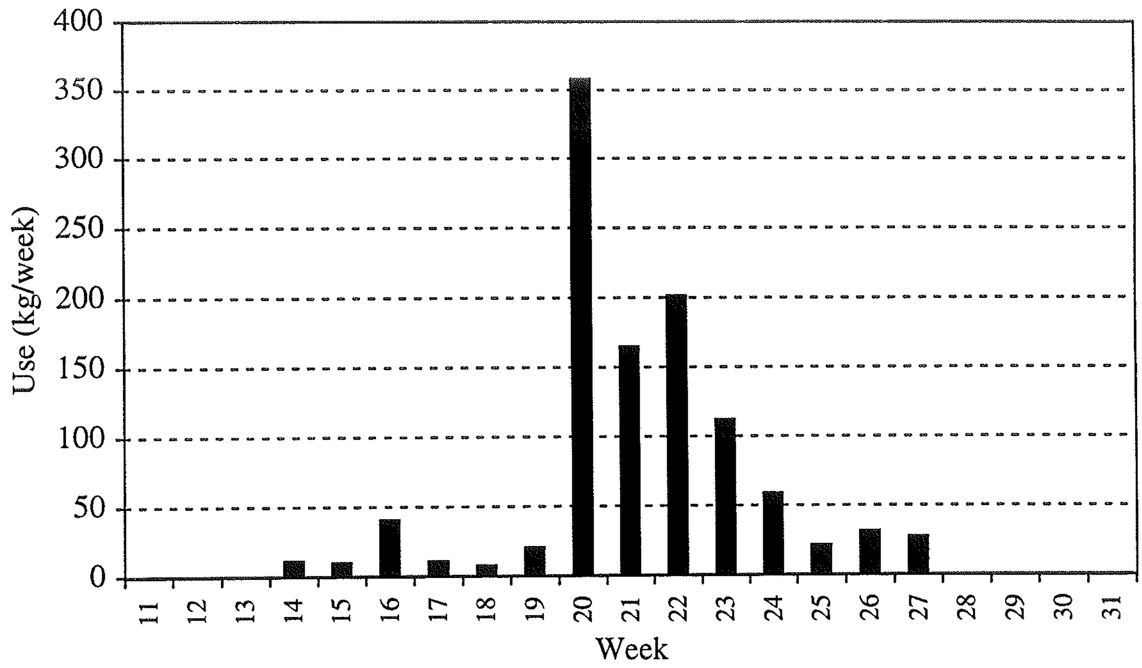
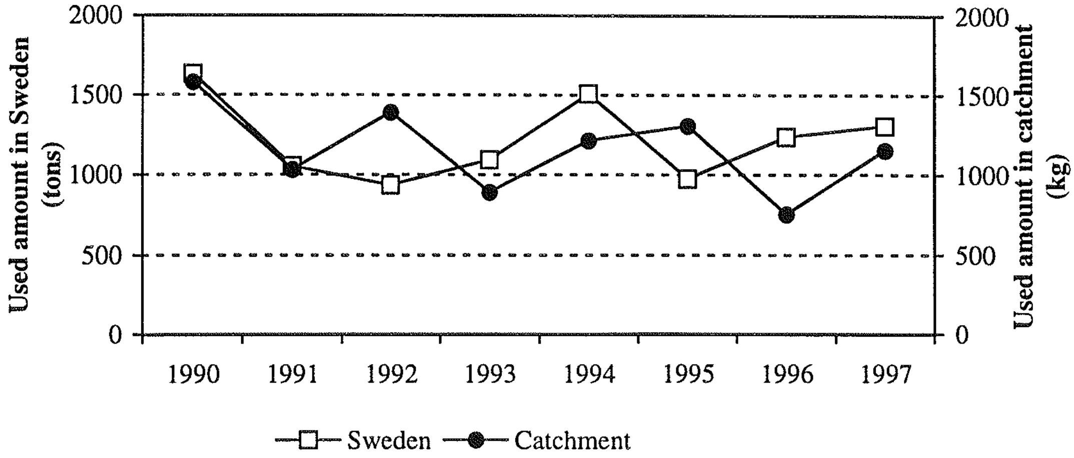
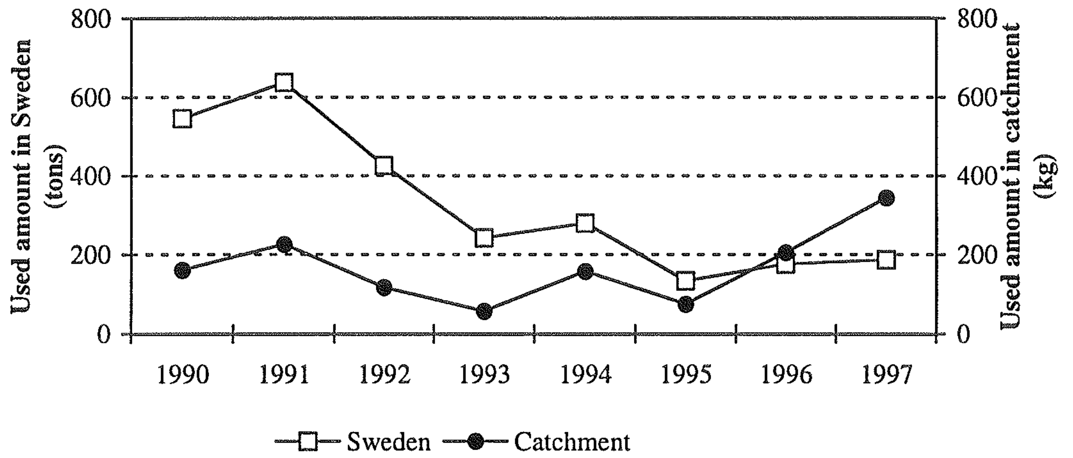


Figure 6. Temporal distribution of spring/early summer application of pesticides in the catchment.

Herbicides



Fungicides



Insecticides

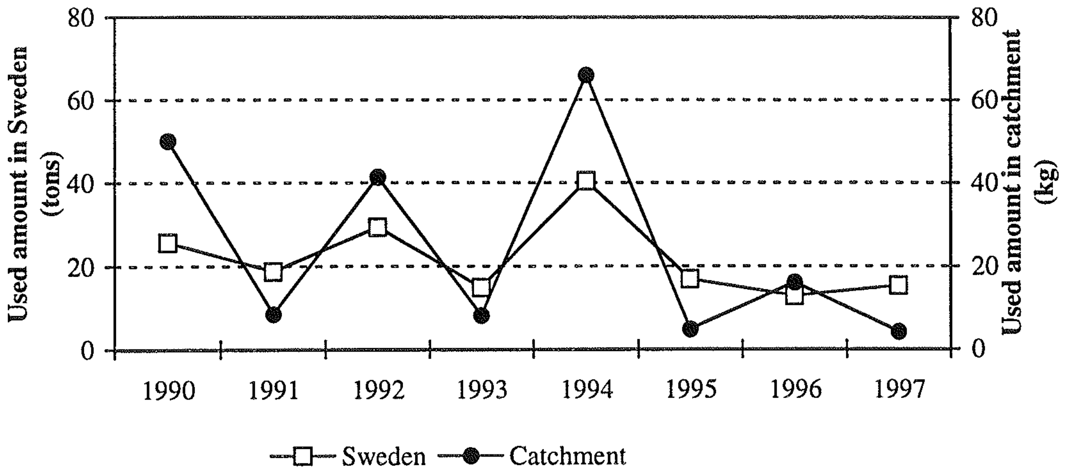


Figure 7. The use of herbicides, fungicides and insecticides in Sweden as a whole and in the catchment 1990-1997.

Pesticide findings in water

Concentrations

During 1997 a total of 20 water samples were collected at the culvert discharge (site UT10) during the sampling period 4 May-30 November. All samples, but the first sample in May, were time-paced composite samples and were collected continuously during the sampling season, except during low flow periods. Consequently, owing to the warm and dry summer, only one sample was collected between the end of July and early October. A complete record of the analytical results is given in **Appendix 5** (values within parenthesis in the appendix are above the limit of detection and have been confirmed, but are below the stipulated limit of determination and are therefore not quantified with the normal precision). As a result of the general nature of the multiresidue analysis, *ca.* 80 pesticides were analyzed with the analytical methods used. However, only pesticides used within the catchment during autumn 1996 and during 1997, or those detected in water samples (either this year or during the previous two years), were included in the appendices of this report.

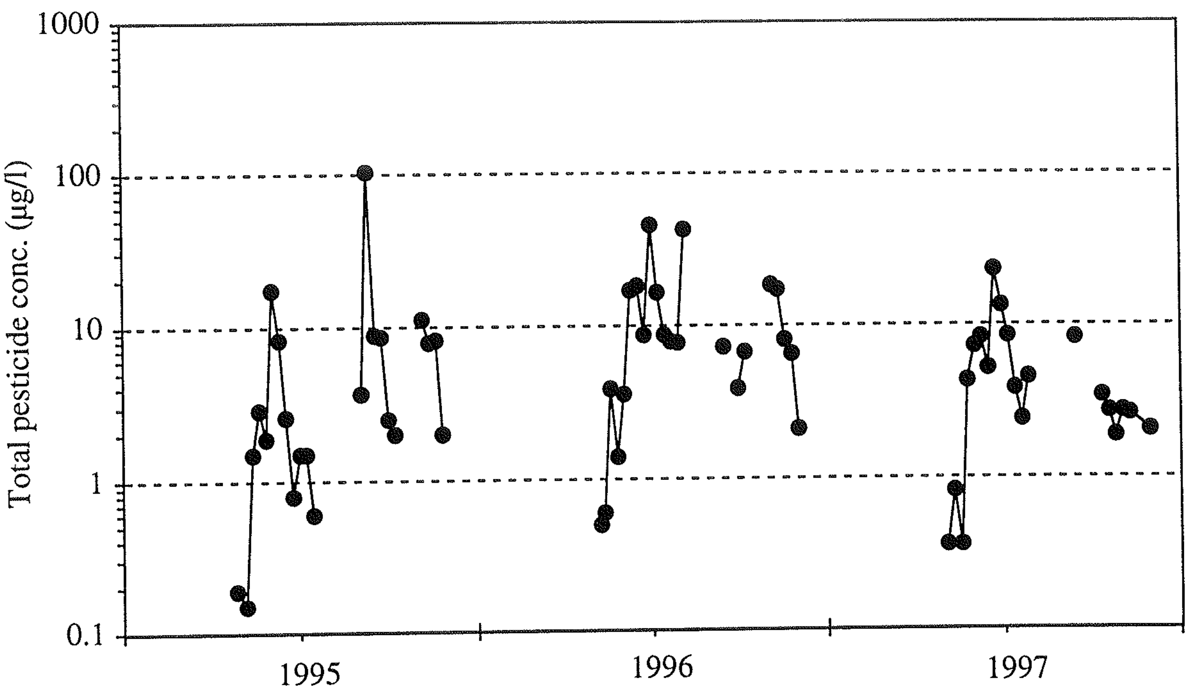


Figure 8. Total pesticide concentration in weekly composite samples collected at UT10 during May-November 1995-1997.

Table 5. Results of pesticide analysis of water samples collected at site UT10 during May-November 1997

Substance	LOD	No	Det	Freq	TWMC	Max
aclonifen	0.1	13	0	0%		
atrazine	0.03	20	18	90%	0.07	0.2
atrazine-desethyl	0.05	20	15	75%	0.05	0.1
BAM	0.05	20	10	50%	0.07	0.2
bentazone	0.02	20	20	100%	1.15	4.7
chloridazon	0.2	20	0	0%		
clopyralid	0.05	20	4	20%	0.02	0.1
cyanazine	0.1	20	13	65%	0.59	2
cyfluthrin	0.2	20	0	0%		
2,4-D	0.02	20	4	20%	0.03	0.5
deltamethrin	0.1	20	0	0%		
dichlobenil	0.05	20	0	0%		
dichlorprop	0.02	20	15	75%	0.18	1
diflufenican	0.1	20	8	40%	0.04	0.1
diuron	0.05	20	9	45%	0.06	0.4
esfenvalerate	0.1	20	0	0%		
ethofumesate	0.05	20	18	90%	0.30	2
fenpropimorph	0.05	20	12	60%	0.05	0.1
fluroxypyr	0.03	20	11	55%	0.04	0.2
isoproturon	0.1	20	20	100%	0.37	1
lambda-cyhalothrin	0.1	20	0	0%		
MCPA	0.02	20	9	45%	0.06	0.5
mecoprop	0.02	20	20	100%	0.28	2
metamitron	0.2	20	10	50%	1.04	10
metazachlor	0.1	20	11	55%	0.06	0.1
methabenzthiazuron	0.1	20	3	15%	0.03	0.1
phenmedipham	1.0	15	0	0%		
pirimicarb	0.05	20	10	50%	0.02	0.06
propiconazole	0.1	20	13	65%	0.26	0.6
propyzamide	0.05	20	19	95%	0.18	0.7
simazine	0.04	20	4	20%	0.01	0.04
terbuthylazine	0.04	20	20	100%	0.48	1
tribenuron-methyl	0.01	18	4	22%	0.01	0.05
Sum pest		20	20	100%	5.43	22.86

LOD = Median limit of determination (µg/l); No = Number of samples analysed; Det = Number of detections; Freq = Detection frequency;
TWMC = Time Weighted Mean Concentration during sampling period (µg/l);
Max = Maximum concentration detected (µg/l).

The results of pesticide detections are statistically summarized in **Table 5**. Altogether, 25 pesticides, distributed among 20 herbicides, 2 fungicides, 1 insecticide and 2 metabolites, were identified. Most frequently detected pesticides during the 1997-period were bentazone (100% detection frequency), isoproturon (100%), mecoprop (100%), terbuthylazine (100%), propyzamide (95%), atrazine (90%) and ethofumesate (90%). The number of pesticides detected in a single water sample ranged from 6 to 22, with an average of 15 different pesticides detected in the water outflow.

Concentrations of pesticides in culvert discharge were observed throughout the sampling period (**Figure 8**). However, total pesticide concentrations were generally lower than those detected during previous years. The average total pesticide concentration in 1997 was *ca.* 5 µg/l (**Table 5**), which was lower than the average total concentration during the previous two years (10 µg/l in 1996 and 8 µg/l in 1995) and considerably lower than the average total concentration during 1992-1994 (25-30 µg/l). Time-weighted mean concentrations (TWMC) for each month is given in **Appendix 6**. Monthly total pesticide TWMC varied between 2 and 12 µg/l during 1997.

Some pesticides applied in the autumn were still detected in water samples collected the following spring prior to spring application, as has been demonstrated earlier years. For example isoproturon prevailed in water samples at 0.1-0.2 µg/l during May, before being applied on May 24. Also bentazone was detected at low concentrations prior to spring application and metazachlor was occasionally detected at 0.1 µg/l during the summer despite no spring application.

In **Figures 9-22** the response of pesticide concentration to waterflow changes, during the sampling period May-November 1997, are presented for some of the most frequently detected pesticides. Note the different scale on the concentration axes in the different figures.

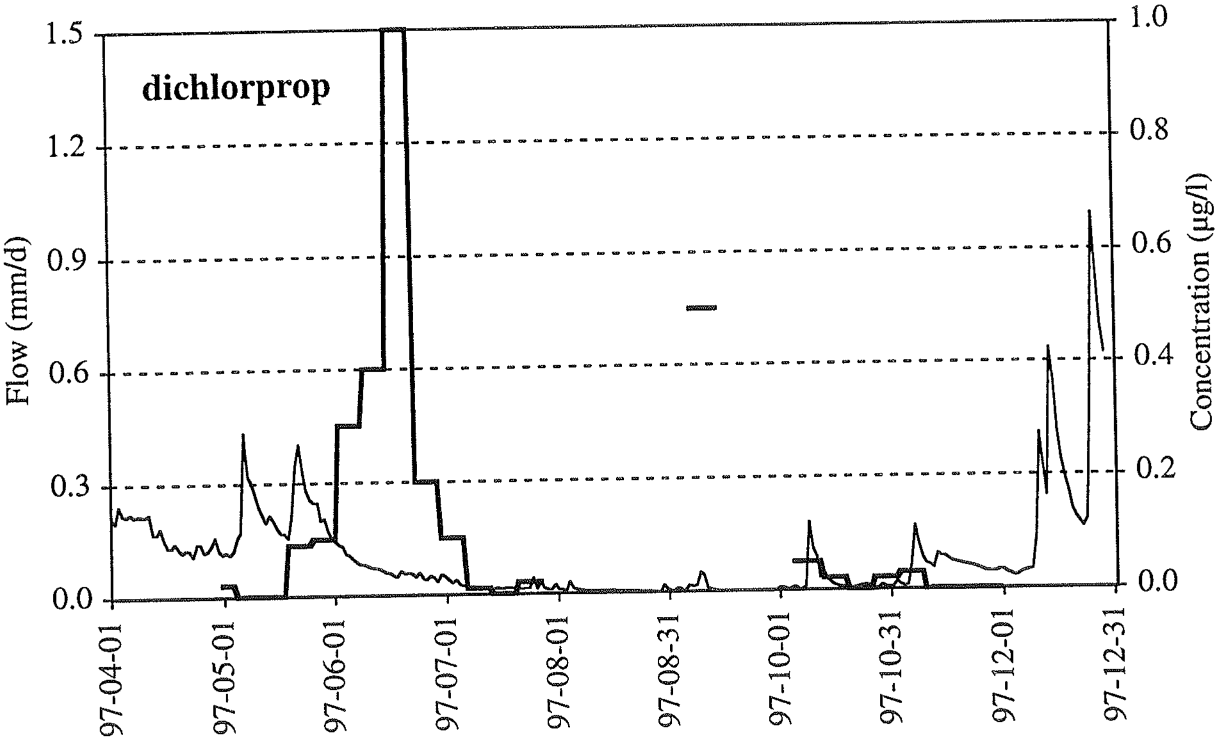


Figure 9. Waterflow and concentration of dichlorprop (bold line) at site UT10 in 1997.

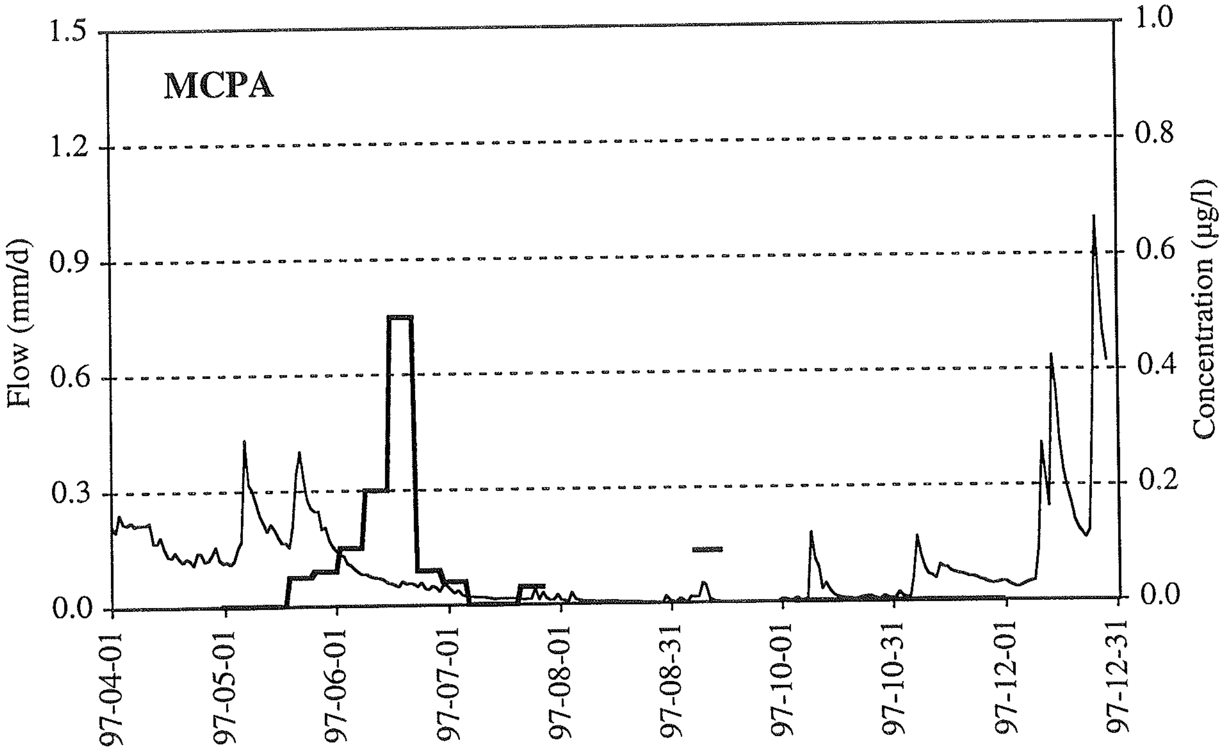


Figure 10. Waterflow and concentration of MCPA (bold line) at site UT10 in 1997.

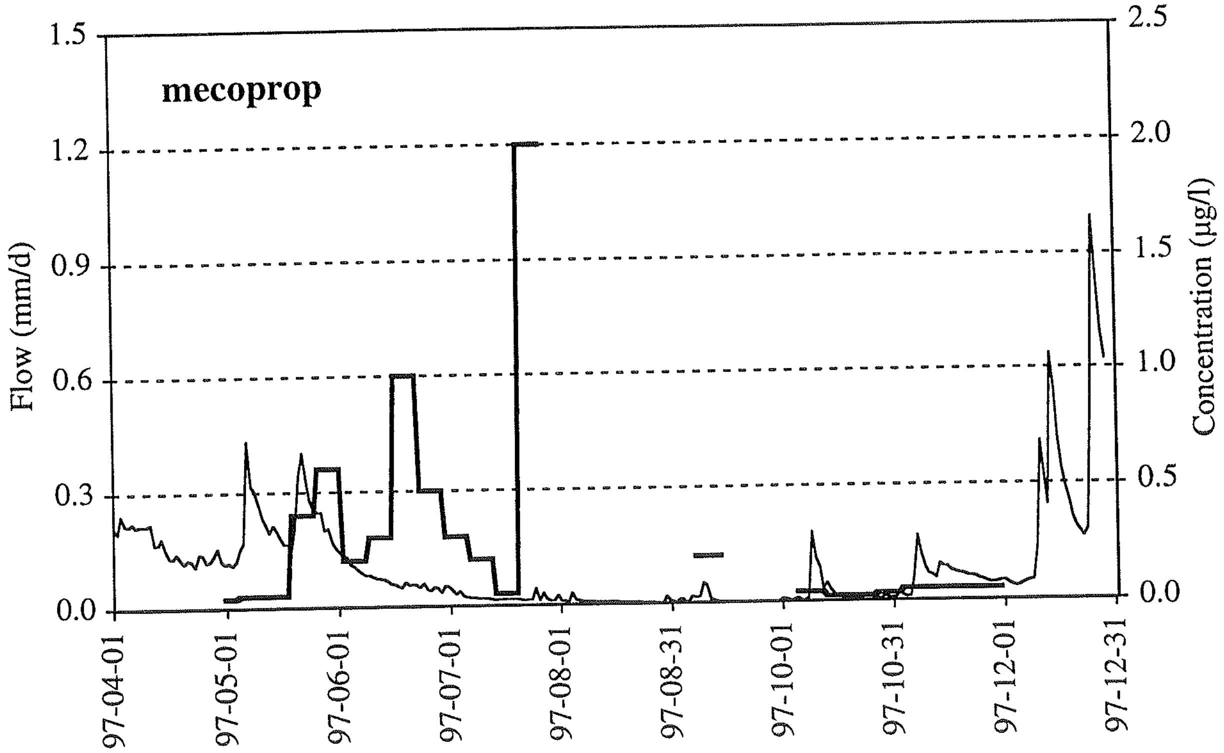


Figure 11. Waterflow and concentration of mecoprop (bold line) at site UT10 in 1997.

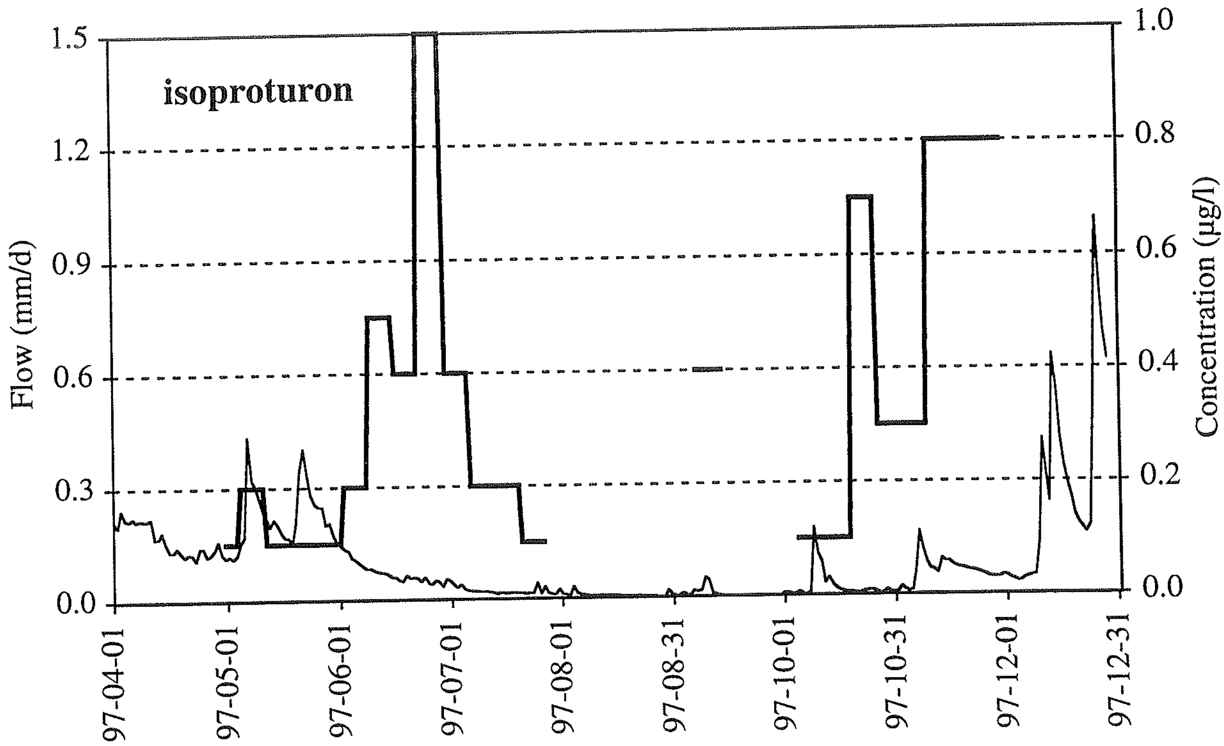


Figure 12. Waterflow and concentration of isoproturon (bold line) at site UT10 in 1997.

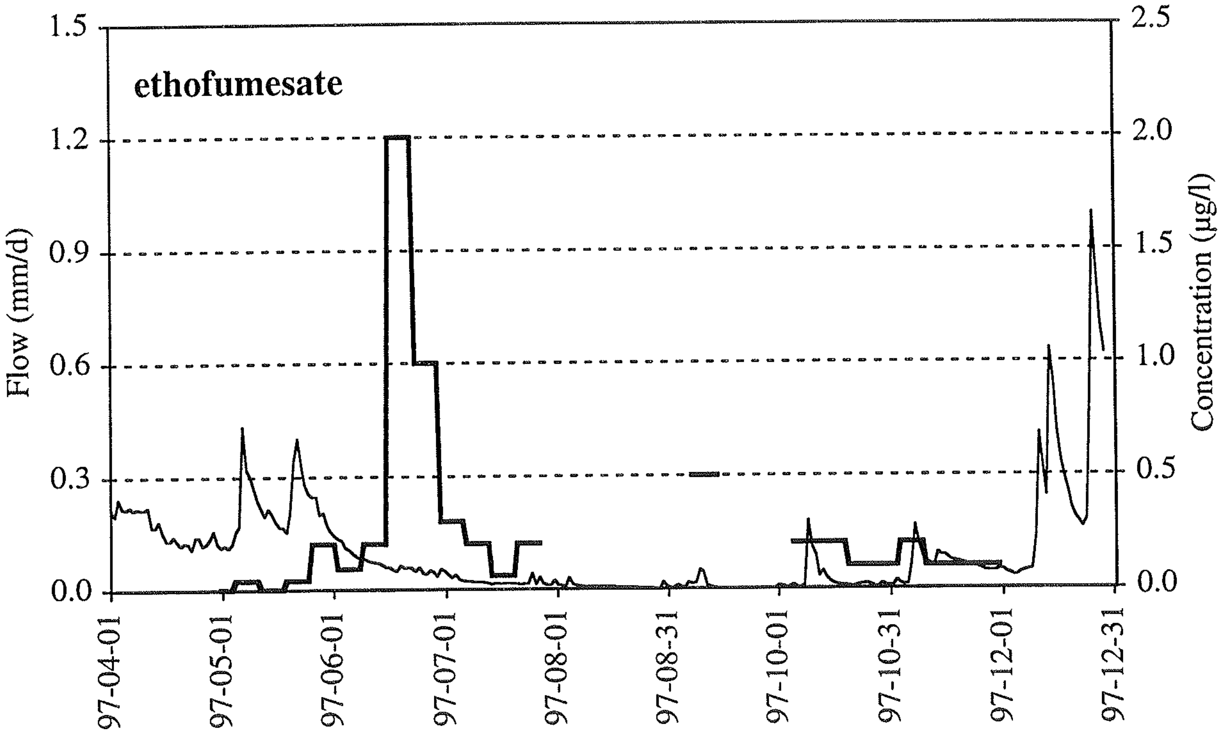


Figure 13. Waterflow and concentration of ethofumesate (bold line) at site UT10 in 1997.

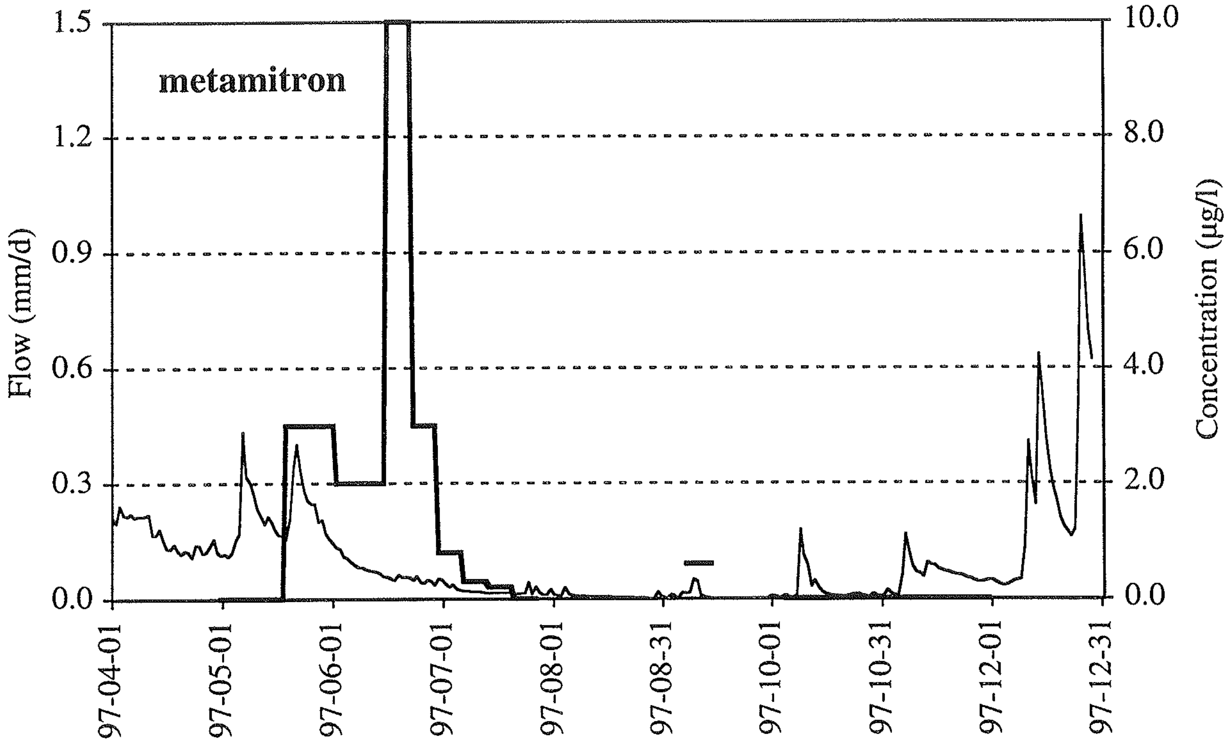


Figure 14. Waterflow and concentration of metamitron (bold line) at site UT10 in 1997.

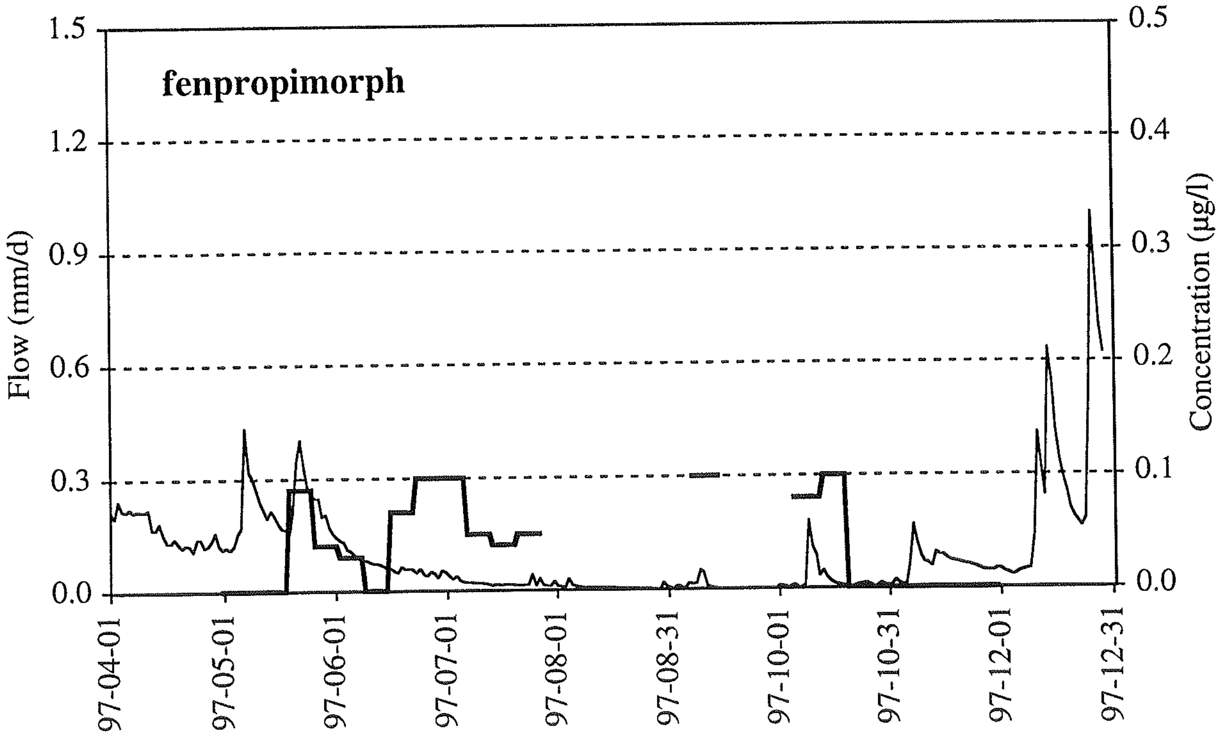


Figure 15. Waterflow and concentration of fenpropimorph (bold line) at site UT10 in 1997.

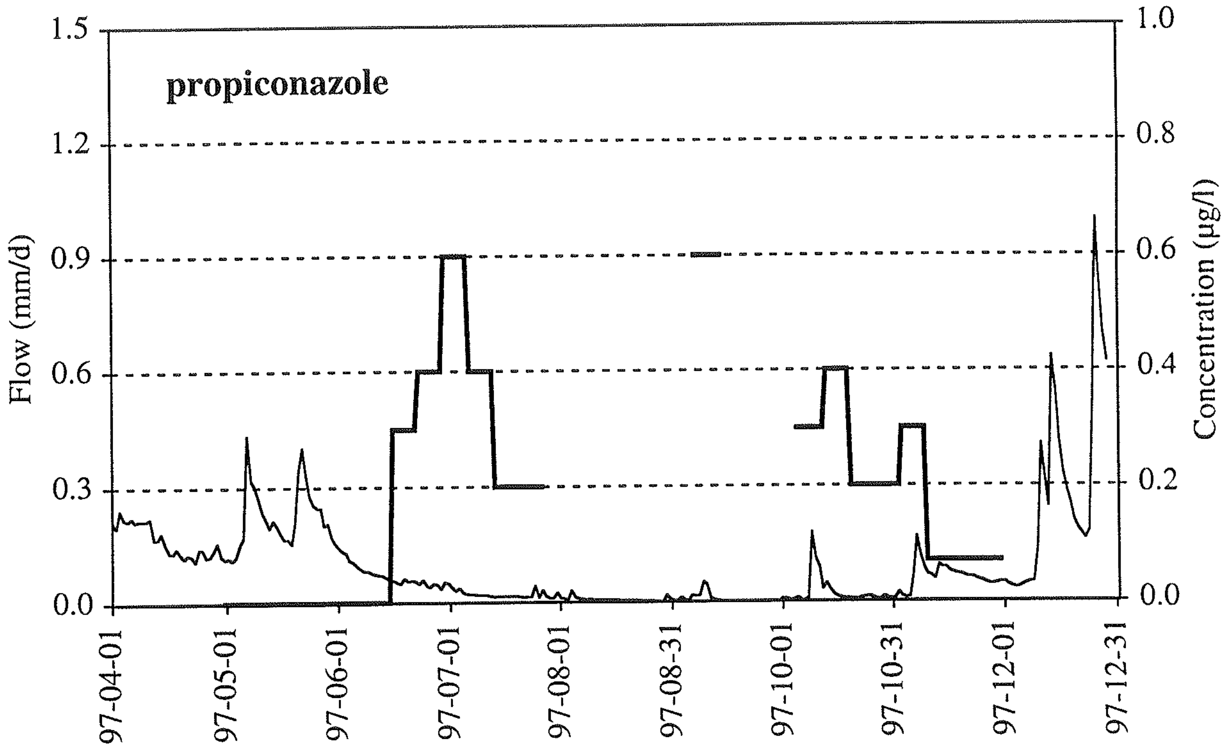


Figure 16. Waterflow and concentration of propiconazole (bold line) at site UT10 in 1997.

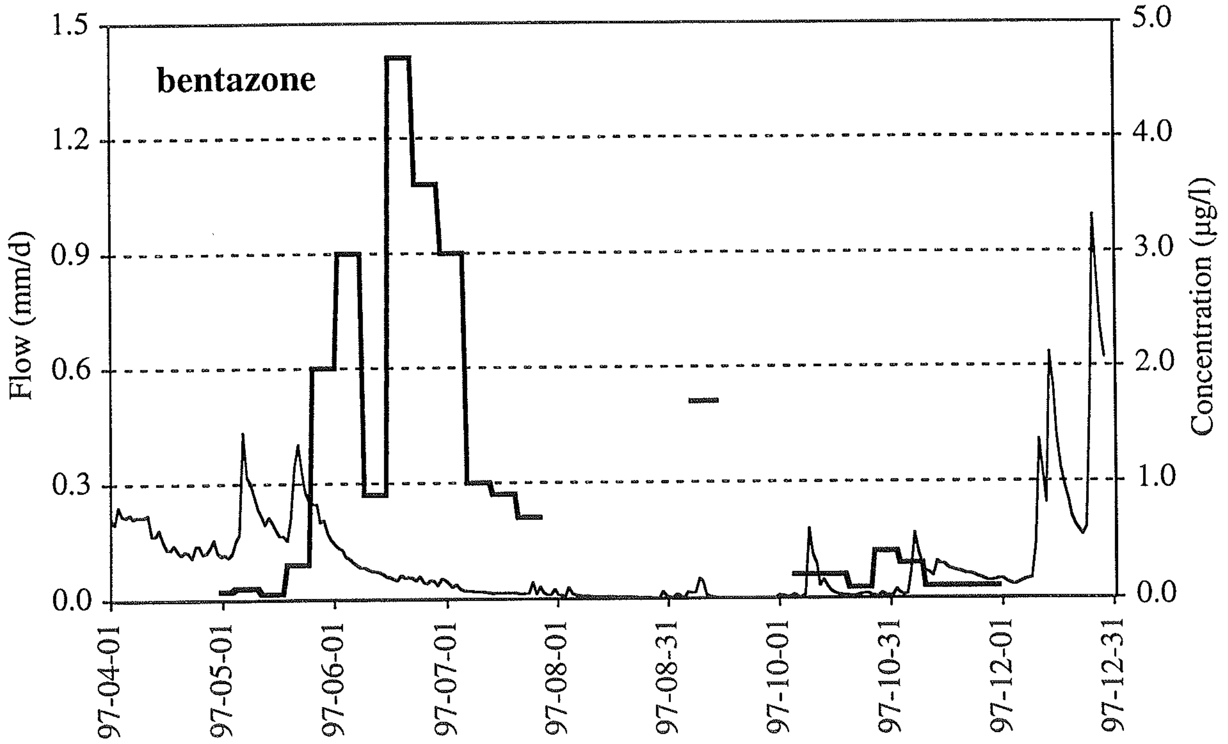


Figure 17. Waterflow and concentration of bentazone (bold line) at site UT10 in 1997.

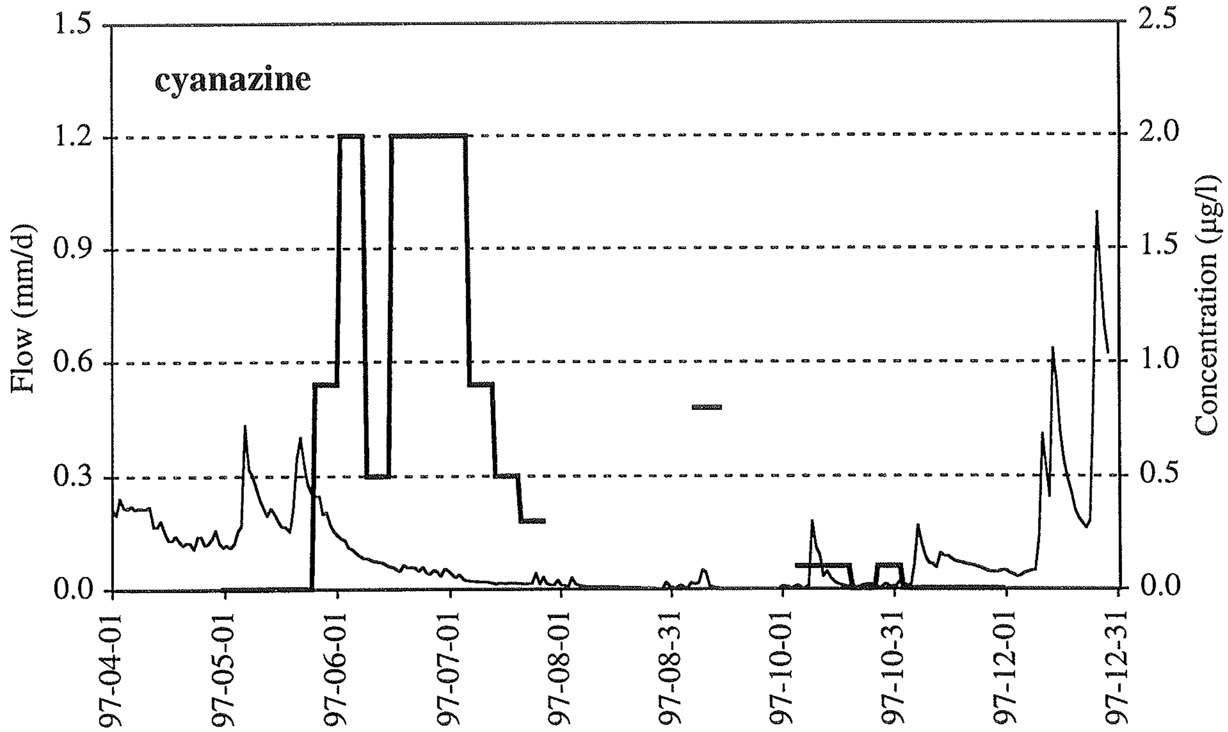


Figure 18. Waterflow and concentration of cyanazine (bold line) at site UT10 in 1997.

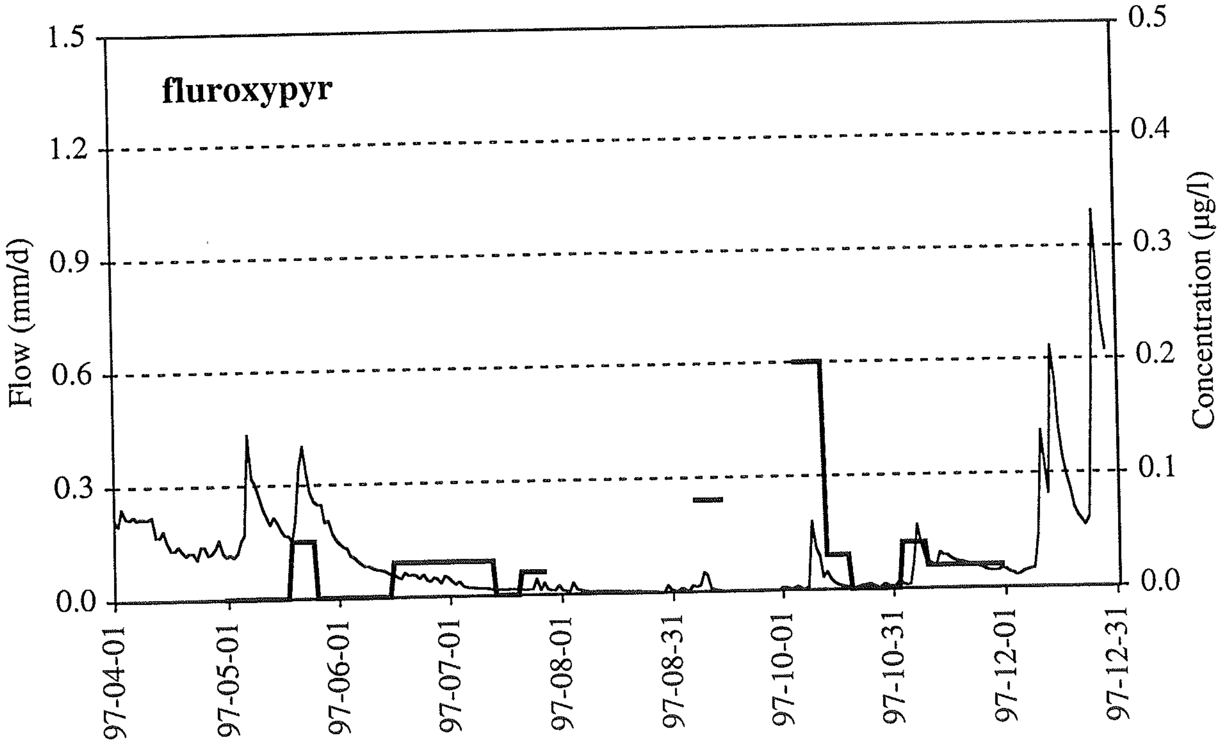


Figure 19. Waterflow and concentration of fluroxypyr (bold line) at site UT10 in 1997.

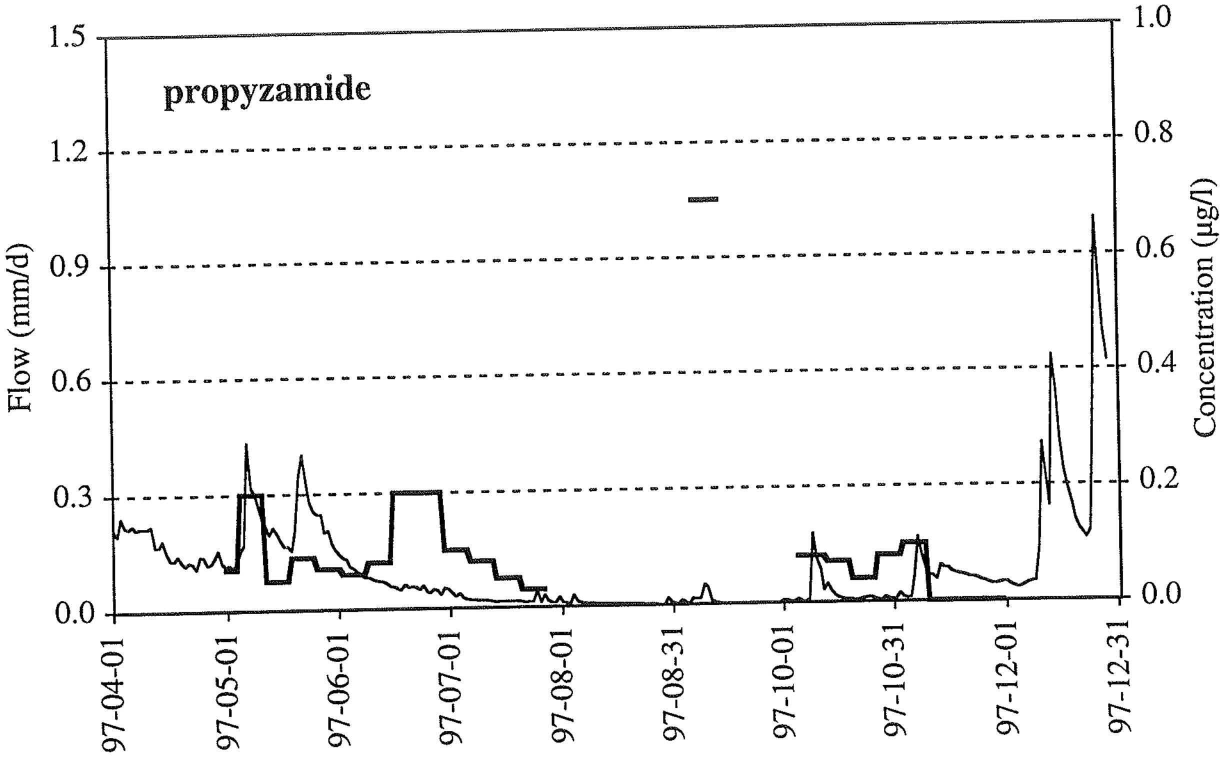


Figure 20. Waterflow and concentration of propyzamide (bold line) at site UT10 in 1997.

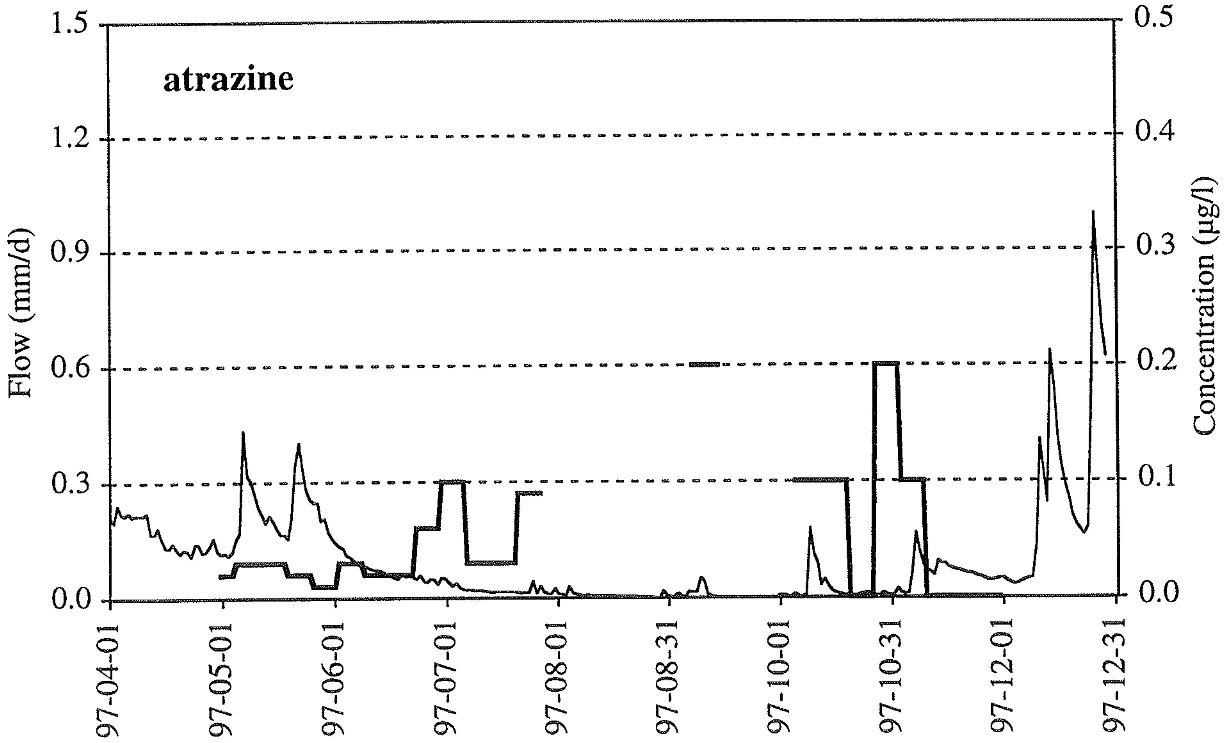


Figure 21. Waterflow and concentration of atrazine (bold line) at site UT10 in 1997.

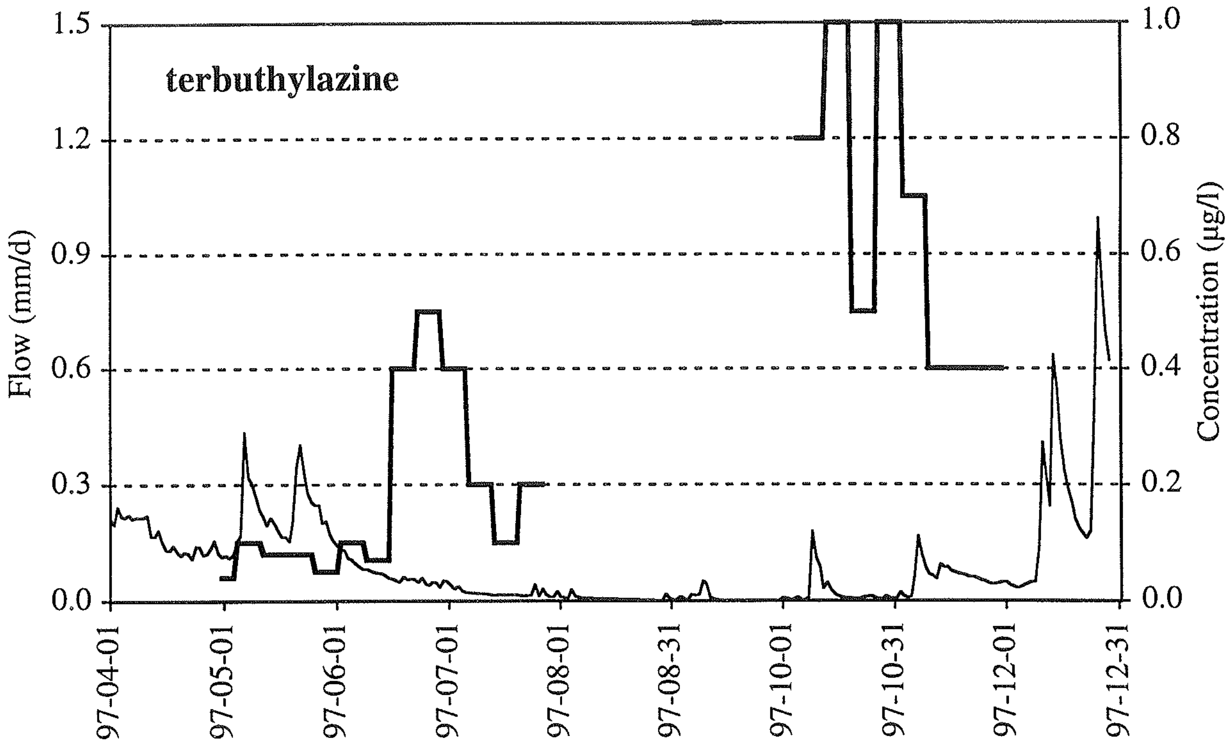


Figure 22. Waterflow and concentration of terbuthylazine (bold line) at site UT10 in 1997.

Table 6. Losses of applied pesticides in water at site UT10 in 1997 and average loss during previous time periods (1995-1996 and 1992-1994)

Substance	1997			1995-1996			1992-1994
	May-Sep	May-Nov	Oct-Nov	May-Sep	May-Nov	Oct-Nov	May-Sep
bentazone	(4.60%)	(4.70%)		0.08%	0.12%		0.16%
chloridazon	0.00%	0.00%		0.02%	0.02%		0.28%
clopyralid	0.00%	0.75%		0.00%	0.00%		0.05%
cyfluthrin	0.00%		0.00%	0.13%	0.13%		0.27%
deltamethrin	0.00%	0.00%		0.00%	0.00%		0.00%
dichlorprop	0.03%	0.04%		0.29%	0.29%		0.16%
diflufenican	n.u.		0.02%			0.02%	
esfenvalerate	0.00%	0.00%		0.00%	0.00%		0.02%
ethofumesate	0.03%	0.04%		0.08%	0.09%		0.11%
fenpropimorph	0.004%	0.005%		0.01%	0.01%		0.02%
fluroxypyr	0.03%	0.06%		0.08%	0.19%		0.05%
isoproturon	0.18%		0.02%	0.01%		0.03%	0.02%
lambda-cyhalothrin	0.00%	0.00%		0.00%	0.00%		0.00%
MCPA	0.01%	0.01%		0.07%	0.07%		0.11%
mecoprop	0.04%	0.04%		0.19%	0.28%	0.03%	0.10%
metamitron	0.03%	0.03%		0.03%	0.03%		0.07%
metazachlor	n.u.		0.01%			0.05%	
methabenzthiazuron	0.00%	0.01%		0.00%	0.00%		0.06%
phenmedipham	0.00%	0.00%		0.00%	0.00%		0.00%
pirimicarb	n.u.		n.u.	0.01%	0.02%		0.07%
propiconazole	0.02%	0.03%		0.02%	0.03%		0.08%
tribenuron-methyl	0.03%	0.03%		n.a.			
Average all pest.	0.02%	0.06%	0.01%	0.05%	0.07%	0.03%	0.07%

n.u. = not used; n.a. = not analysed.

Transport and loss

Calculated monthly transported quantities and total seasonal losses of each pesticide during 1997 are presented in **Appendix** 7. Total load of pesticides transported in water leaving the area during May-November in 1997 was *ca.* 0.45 kg, which was less than during any of the previous sampling seasons (**Figures 23 and 24**). This was possibly due to the warm and dry weather, with total flow volume during the 1997-sampling season (May-November) being the smallest recorded since the start of the investigation in 1990.

Losses for single pesticides were generally less than 0.1% of the applied amount and the average loss was 0.02% during May-September and 0.06% during May-November (**Table 6**). These losses were comparable with those registered previously. The average loss of single pesticides at the same site during May-September 1992-1994 amounted to 0.07% and during May-September 1995-1996 to 0.05%.

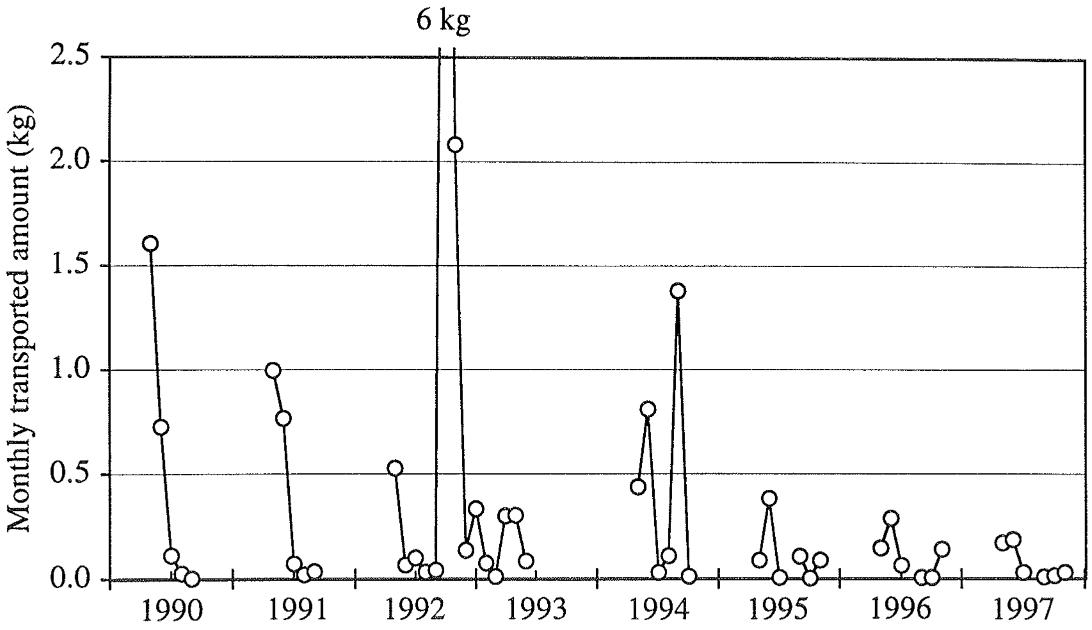


Figure 23. Total amount of pesticides transported each month in stream flow during sampling periods at site LU12 (1990-1991) and UT10 (1992-1997).

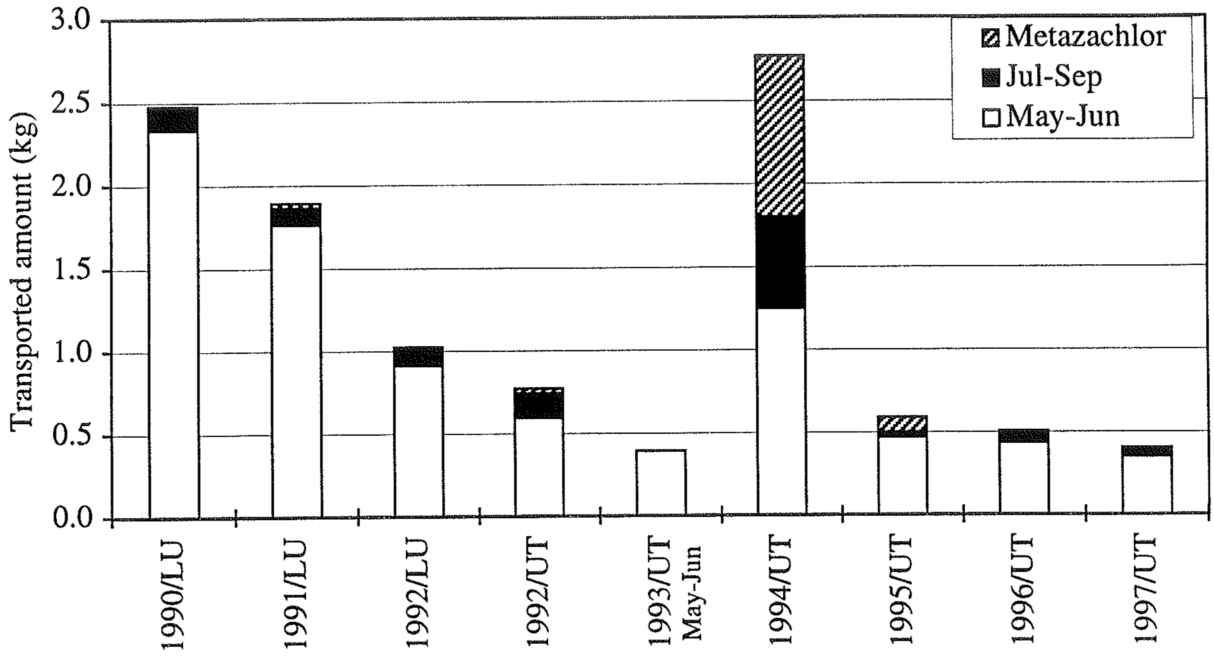


Figure 24. Total amount of pesticides transported during May-September at site LU12 1990-1992 and UT10 1992-1997. The columns are divided to show the different time periods, May-June and July-September, and also include transport of metazachlor occurring in stream flow after its application in August/September.

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APPENDICES

Contents

Appendix 1. Used amount of pesticides, area treated, average dose and application period in area draining to UT10 during autumn 1996

Autumn 1996	**Total amount**	**Total area**	**Av. dose**	**Spraying period**	
Active ingredient	**(kg)**	**(ha)**	**(kg/ha)**	**Start**	**End**
diflufenican	17.7	218.0	0.08	96-10-06	96-10-15
glyphosate	65.9	68.2	0.97	96-08-20	96-10-15
isoproturon	211.0	219.5	0.96	96-10-06	96-10-15
metazachlor	13.1	8.7	1.50	96-08-10	96-10-05
	307.7	280.5	1.10		

Herbicides	307.7	280.5	1.10
Fungicides			
Insecticides			

Appendix 2. Used amount of pesticides, area treated, average dose and application period in area draining to UT10 during spring and early summer 1997

Spring/summer 1997	Total amount	Total area	Av. dose	Spraying period	
Active ingredient	**(kg)**	**(ha)**	**(kg/ha)**	**Start**	**End**
aclonifen	4.3	3.8	1.14	97-05-25	97-05-26
azoxystrobin	10.0	40.0	0.25	97-06-30	97-06-30
bentazone	2.0	4.1	0.48	97-05-10	97-05-25
chloridazon	60.6	36.4	1.67	97-04-10	97-06-07
clopyralid	0.2	1.4	0.12	97-07-03	97-07-03
cycloxydim	7.4	31.0	0.24	97-05-25	97-07-03
cyfluthrin	0.1	5.7	0.01	97-05-15	97-05-15
deltamethrin	0.3	40.5	0.008	97-06-25	97-06-30
dichlorprop-P	32.3	60.4	0.53	97-05-14	97-06-01
esfenvalerate	2.1	144.4	0.01	97-05-12	97-08-02
ethofumesate	49.1	266.3	0.18	97-05-10	97-06-22
fenpropimorph	75.6	295.6	0.26	97-05-04	97-06-30
fluroxypyr	4.0	48.6	0.08	97-04-25	97-06-23
glyphosate	2.7	3.7	0.72	97-07-03	97-07-03
isoproturon	9.4	12.5	0.75	97-05-24	97-05-24
lambda-cyhalothrin	0.8	158.8	0.005	97-05-13	97-06-30
MCPA	42.1	77.0	0.55	97-05-14	97-06-01
mecoprop-P	65.6	142.9	0.46	97-04-26	97-06-15
metamitron	542.6	276.3	1.96	97-05-01	97-06-22
methabenzthiazuron	11.2	6.4	1.75	97-04-05	97-04-05
phenmedipham	124.2	276.3	0.45	97-05-07	97-06-22
propiconazole	25.2	295.6	0.09	97-05-04	97-06-30
quinmerac	1.4	4.7	0.30	97-04-10	97-04-10
thifensulfuron-methyl	0.4	99.4	0.004	97-04-25	97-05-24
tribenuron-methyl	1.2	210.6	0.006	97-04-05	97-06-15
	1074.7	711.9	1.51		
Herbicides	960.6	542.1	1.77		
Fungicides	110.8	309.4	0.36		
Insecticides	3.2	323.2	0.01		

Appendix 3. Used amount of pesticides, area treated, average dose and application period in area draining to UT10 during autumn 1997

Autumn 1997 **Active ingredient**	**Total amount (kg)**	**Total area (ha)**	**Av. dose (kg/ha)**	**Spraying period Start**	**End**
cyfluthrin*	0.3	10.0	0.03	97-09-03	97-09-03
cycloxydim	3.7	20.4	0.18	97-09-05	97-09-20
diflufenican	5.2	53.9	0.10	97-09-19	97-10-25
glyphosate	54.5	53.0	1.03	97-08-25	97-10-13
isoproturon	52.1	53.9	0.97	97-09-19	97-10-25
metazachlor	33.1	31.5	1.05	97-09-05	97-09-20
sulfur*	222.0	46.5	4.77	97-08-20	97-09-19
	370.9	194.9	1.90		

Herbicides	148.6	138.4	1.07
Fungicides	222.0	46.5	4.77
Insecticides	0.3	10.0	0.03

* Applied in sugar beet

Appendix 4. List of active ingredients used in the catchment during autumn 1996 and during 1997 and trade names of the commercial products

Active ingredient	Trade name
aclonifen	Fenix
azoxystrobin	Amistar
bentazone	Basagran 480
chloridazon	Fiesta T
	Pyramin DF
clopyralid	Ariane S
	Matrigon
cycloxydim	Fokus Ultra
cyfluthrin	Baytroid 050 EC
deltamethrin	Decis
dichlorprop-P	Duplosan Super
diflufenican	Cougar
esfenvalerate	Sumi-alpha 5 FW
ethofumesate	Partner
	Tramat 50 SC
fenpropimorph	Tilt Top 500 EC
fluroxypyr	Ariane S
	Starane 180
glyphosate	Avans 330
	Roundup Bio
	Roundup Dry
isoproturon	Arelon Flytande
	Cougar
	Tolkan
lambda-cyhalothrin	Karate 2.5 EW
MCPA	Ariane S
	Duplosan Super
	Hormotex 750
	MCPA 750
mecoprop-P	Duplosan Meko
	Duplosan Super
	Mekoprop-P
metamitron	Goltix WG
metazachlor	Butisan S
methabenzthiazuron	Tribunil
phenmedipham	Betanal OF
	Betanal SC
	Kemifam Flow
propiconazole	Tilt Top 500 EC
quinmerac	Fiesta T
sulfur	Kumulus DF
thifensulfuron-methyl	Harmony Plus
tribenuron-methyl	Express 50 T
	Harmony Plus

Trade name	Type	Class	Active ingredient	Quantity g/l or g/kg
Amistar	FU	2L	azoxystrobin	250
Arelon Flytande	H	2L	isoproturon	500
Ariane S	H	2L	MCPA	200
			fluroxypyr	40
			clopyralid	20
Avans 330	H	2L	glyphosate	330
Basagran 480	H	2L	bentazone	480
Baytroid 050 EC	IN	2L	cyfluthrin	50
Betanal OF	H	2L	phenmedipham	160
Betanal SC	H	2L	phenmedipham	160
Butisan S	H	2L	metazachlor	500
Cougar	H	2L	isoproturon	500
			diflufenican	100
Decis	IN	2L	deltamethrin	25
Duplosan Meko	H	2L	mecoprop-P	600
Duplosan Super	H	2L	dichlorprop-P	310
			MCPA	160
			mecoprop-P	130
Express 50 T	H	2L	tribenuron-methyl	500
Fenix	H	2L	aclonifen	600
Fiesta T	H	2L	chloridazon	360
			quinmerac	60
Fokus Ultra	H	2L	cycloxydim	100
Goltix WG	H	2L	metamitron	700
Harmony Plus	H	2L	thifensulfuron-methyl	330
			tribenuron-methyl	170
Hormotex 750	H	2L	MCPA	750
Karate 2.5 EW	IN	2L	lambda-cyhalothrin	25
Kemifam Flow	H	2L	phenmedipham	160
Kumulus DF	FU	2L	sulfur	800
Matrigon	H	2L	clopyralid	100
MCPA 750	H	2L	MCPA	750
Mekoprop-P	H	2L	mecoprop-P	600
Partner	H	2L	ethofumesate	500
Pyramin DF	H	2L	chloridazon	650
Roundup Bio	H	2L	glyphosate	360
Roundup Dry	H	2L	glyphosate	440
Starane 180	H	2L	fluroxypyr	180
Sumi-alpha 5 FW	IN	2L	esfenvalerate	50
Tilt Top 500 EC	FU	2L	fenpropimorph	375
			propiconazole	125
Tolkan	H	2L	isoproturon	500
Tramat 50 SC	H	2L	ethofumesate	500
Tribunil	H	2L	methabenzthiazuron	700

H = Herbicide; FU = Fungicide; IN = Insecticide

Appendix 5. Pesticide concentrations (μg/l) in time integrated water samples from site UT10 1997

ISCO UT10								
Date	aclonifen	atrazine	atrazine-desethyl	BAM	benazolinethylester	bentazone	chloridazon	clopyralid
97-05-04	<0.05	**0.02**	<0.1	<0.05	<0.05	**0.07**	<0.1	<0.04
97-05-11	<0.05	**0.03**	<0.1	<0.05	<0.05	**0.1**	<0.1	<0.04
97-05-18	<0.05	**0.03**	<0.1	<0.05	<0.05	**0.05**	<0.1	<0.04
97-05-25	<0.05	**0.02**	<0.1	<0.05	<0.05	**0.3**	<0.1	<0.04
97-06-01	<0.1	**0.01**	**(0.02)**	**(0.04)**	<0.1	**2**	<0.2	<0.04
97-06-08	<0.05	**0.03**	<0.1	<0.05	<0.05	**3**	<0.1	<0.1
97-06-15	<0.1	**0.02**	**(0.02)**	<0.05	<0.1	**0.9**	<0.2	<0.05
97-06-22	<0.1	**0.02**	**(0.02)**	**(0.04)**	<0.1	**4.7**	<0.2	<0.05
97-06-29	<0.1	**0.06**	**0.06**	**0.1**	<0.1	**3.6**	<0.2	<0.05
97-07-06	<0.1	**0.1**	**0.03**	**(0.04)**	<0.1	**3**	<0.2	<0.2
97-07-13	<0.1	**0.03**	**(0.02)**	**(0.04)**	<0.1	**1**	<0.2	<0.5
97-07-20	<0.1	**0.03**	**0.03**	**(0.04)**	<0.1	**0.9**	<0.2	<0.2
97-07-27	<0.1	**0.09**	**0.03**	**0.06**	<0.1	**0.7**	<0.2	<0.1
	Low flow situation!							
97-09-07	Start!							
97-09-14	n.a.	**0.2**	**0.1**	**0.2**	<0.1	**1.7**	<0.2	<0.3
	Low flow situation!							
97-10-05	Start!							
97-10-12	n.a.	**0.1**	**0.09**	**0.2**	<0.1	**0.2**	<0.2	**0.05**
97-10-19	n.a.	**0.1**	**0.08**	<0.1	<0.1	**0.2**	<0.2	**0.08**
97-10-26	n.a.	<0.1	**0.07**	<0.1	<0.1	**0.09**	<0.2	<0.04
97-11-02	n.a.	**0.2**	**0.1**	<0.1	<0.1	**0.4**	<0.2	<0.1
97-11-09	n.a.	**0.1**	**0.09**	<0.1	<0.1	**0.3**	<0.2	**0.1**
97-11-30*	n.a.	<0.05	**0.06**	**(0.07)**	<0.05	**0.1**	<0.3	**0.08**

* = This sample was collected during 971110-971130

n.a. = not analysed

Appendix 5. Pesticide concentrations (µg/l) in time integrated water samples from site UT10 1997

ISCO UT10									
Date	cyanazine	cyfluthrin	2,4-D	deltamethrin	dichlobenil	dichlorprop	diflufenican	dimethoate	diuron
97-05-04	<0.2	<0.2	<0.02	<0.1	<0.05	**0.02**	<0.05	<0.1	<0.2
97-05-11	<0.2	<0.2	<0.02	<0.1	<0.05	<0.02	<0.05	<0.1	<0.2
97-05-18	<0.2	<0.2	<0.02	<0.1	<0.05	<0.02	<0.05	<0.1	<0.2
97-05-25	<0.2	<0.2	<0.02	<0.1	<0.05	**0.09**	<0.05	<0.1	<0.2
97-06-01	**0.9**	<0.2	<0.02	<0.1	<0.02	**0.1**	<0.1	<0.1	<0.05
97-06-08	**2**	<0.2	<0.02	<0.1	<0.05	**0.3**	<0.05	<0.1	<0.2
97-06-15	**0.5**	<0.2	<0.02	<0.1	<0.02	**0.4**	<0.1	<0.1	<0.05
97-06-22	**2**	<0.2	**0.06**	<0.1	<0.02	**1**	<0.1	<0.1	**(0.04)**
97-06-29	**2**	<0.2	**0.02**	<0.1	<0.02	**0.2**	<0.1	<0.1	**0.3**
97-07-06	**2**	<0.2	<0.02	<0.1	<0.02	**0.1**	<0.1	<0.1	**0.1**
97-07-13	**0.9**	<0.2	<0.02	<0.1	<0.02	**0.01**	<0.1	<0.1	**(0.02)**
97-07-20	**0.5**	<0.2	<0.02	<0.1	<0.02	<0.02	<0.1	<0.1	<0.05
97-07-27	**0.3**	<0.2	<0.02	<0.1	<0.02	**0.02**	**(0.07)**	<0.1	**0.4**
97-09-07									
97-09-14	**0.8**	<0.2	<0.02	<0.1	<0.05	**0.5**	**0.1**	<0.1	**0.06**
97-10-05									
97-10-12	**0.1**	<0.2	**0.5**	<0.1	<0.05	**0.05**	**0.1**	<0.1	**0.06**
97-10-19	**0.1**	<0.2	<0.02	<0.1	<0.05	**0.02**	**0.1**	<0.1	<0.1
97-10-26	<0.1	<0.2	**(0.01)**	<0.1	<0.05	<0.02	**0.08**	<0.1	<0.1
97-11-02	**0.1**	<0.2	<0.02	<0.1	<0.05	**0.02**	**0.06**	<0.1	<0.2
97-11-09	<0.1	<0.2	<0.02	<0.1	<0.05	**0.03**	**0.07**	<0.1	**0.08**
97-11-30*	<0.05	<0.2	<0.02	<0.1	<0.1	<0.02	**(0.04)**	<0.1	**0.05**

Appendix 5. Pesticide concentrations (µg/l) in time integrated water samples from site UT10 1997

ISCO UT10								
Date	esfenvalerate	ethofumesate	fenpropimorph	fluroxypyr	hexazinon	isoproturon	l-cyhalothrin	MCPA
97-05-04	<0.1	<0.05	<0.03	<0.03	<0.1	**0.1**	<0.05	<0.02
97-05-11	<0.1	**(0.04)**	<0.03	<0.03	<0.1	**0.2**	<0.05	<0.02
97-05-18	<0.1	<0.05	<0.03	<0.03	<0.1	**0.1**	<0.05	<0.02
97-05-25	<0.1	**0.04**	**0.09**	**0.05**	<0.1	**0.1**	<0.05	**0.05**
97-06-01	<0.1	**0.2**	**(0.04)**	<0.03	<0.03	**0.1**	<0.1	**0.06**
97-06-08	<0.1	**0.09**	**0.03**	<0.04	<0.1	**0.2**	<0.05	**0.1**
97-06-15	<0.1	**0.2**	<0.05	<0.03	<0.03	**0.5**	<0.1	**0.2**
97-06-22	<0.1	**2**	**0.07**	**0.03**	<0.03	**0.4**	<0.1	**0.5**
97-06-29	<0.1	**1**	**0.1**	**0.03**	<0.03	**1**	<0.1	**0.06**
97-07-06	<0.1	**0.3**	**0.1**	**0.03**	<0.03	**0.4**	<0.1	**0.04**
97-07-13	<0.1	**0.2**	**0.05**	**0.03**	<0.03	**0.2**	<0.1	<0.02
97-07-20	<0.1	**0.06**	**(0.04)**	<0.04	<0.03	**0.2**	<0.1	<0.03
97-07-27	<0.1	**0.2**	**0.05**	**0.02**	<0.03	**0.1**	<0.1	**0.03**
97-09-07								
97-09-14	<0.1	**0.5**	**0.1**	**0.08**	<0.1	**0.4**	<0.1	**0.09**
97-10-05								
97-10-12	<0.1	**0.2**	**0.08**	**0.2**	<0.1	**0.1**	<0.1	<0.02
97-10-19	<0.1	**0.2**	**0.1**	**0.03**	<0.1	**0.1**	<0.1	<0.02
97-10-26	<0.1	**0.1**	<0.1	<0.03	<0.1	**0.7**	<0.1	<0.02
97-11-02	<0.1	**0.1**	<0.1	<0.05	<0.1	**0.3**	<0.1	<0.02
97-11-09	<0.1	**0.2**	<0.1	**0.04**	<0.1	**0.3**	<0.1	<0.02
97-11-30*	<0.1	**0.1**	<0.05	**0.02**	<0.05	**0.8**	<0.1	<0.02

Appendix 5. Pesticide concentrations (µg/l) in time integrated water samples from site UT10 1997

ISCO UT10							
Date	mecoprop	metamitron	metazachlor	methabenzthiazuron	phenmedipham	pirimicarb	propiconazole
97-05-04	**0.04**	<0.2	<0.1	<0.2	n.a.	<0.05	<0.1
97-05-11	**0.05**	<0.2	**0.1**	<0.2	n.a.	<0.05	<0.1
97-05-18	**0.05**	<0.2	<0.1	<0.2	n.a.	<0.05	<0.1
97-05-25	**0.4**	**3**	<0.1	<0.2	n.a.	<0.05	<0.1
97-06-01	**0.6**	**3**	<0.1	<0.1	<1	<0.03	<0.1
97-06-08	**0.2**	**2**	**0.1**	<0.2	n.a.	**(0.04)**	<0.1
97-06-15	**0.3**	**2**	<0.1	<0.1	<1	<0.03	<0.1
97-06-22	**1**	**10**	<0.1	<0.1	<1	**(0.02)**	**0.3**
97-06-29	**0.5**	**3**	**0.1**	<0.1	<1	**0.04**	**0.4**
97-07-06	**0.3**	**0.8**	<0.1	<0.1	<1	**(0.02)**	**0.6**
97-07-13	**0.2**	**0.3**	**0.1**	<0.1	<1	**(0.02)**	**0.4**
97-07-20	**0.05**	**0.2**	<0.1	<0.1	<1	**(0.02)**	**0.2**
97-07-27	**2**	<0.4	<0.1	<0.1	<1	**(0.02)**	**0.2**
97-09-07							
97-09-14	**0.2**	**0.6**	**0.1**	**0.1**	<1	**0.06**	**0.6**
97-10-05							
97-10-12	**0.04**	<0.2	**0.1**	**0.08**	<1	<0.05	**0.3**
97-10-19	**0.02**	<0.2	**0.1**	<0.2	<1	<0.05	**0.4**
97-10-26	**0.02**	<0.2	**0.06**	<0.2	<1	<0.05	**0.2**
97-11-02	**0.03**	<0.2	**0.07**	<0.2	<1	**0.06**	**0.2**
97-11-09	**0.05**	<0.2	**0.1**	<0.2	<1	**0.05**	**0.3**
97-11-30*	**0.05**	<0.3	**0.1**	**0.1**	<1	<0.05	**0.07**

Appendix 5. Pesticide concentrations (µg/l) in time integrated water samples from site UT10 1997

ISCO UT10							
Date	propyzamide	prosulfocarb	simazine	terbuthylazine	tribenuron-methyl	Sum pest	Av. flow (l/s)
97-05-04	**0.07**	<0.1	<0.08	**0.04**	<0.01	**0.4**	11
97-05-11	**0.2**	<0.1	<0.08	**0.1**	<0.01	**0.8**	24
97-05-18	**0.05**	<0.1	<0.08	**0.08**	<0.01	**0.4**	19
97-05-25	**0.09**	<0.1	<0.08	**0.08**	<0.01	**4.3**	26
97-06-01	**0.07**	<0.1	<0.02	**0.05**	<0.01	**7.2**	20
97-06-08	**0.06**	<0.1	<0.08	**0.1**	<0.01	**8.3**	11
97-06-15	**0.08**	<0.1	<0.02	**0.07**	<0.01	**5.2**	7
97-06-22	**0.2**	<0.1	**(0.02)**	**0.4**	**0.04**	**22.9**	5
97-06-29	**0.2**	<0.1	**0.03**	**0.5**	**0.03**	**13.3**	5
97-07-06	**0.1**	<0.1	<0.02	**0.4**	**0.05**	**8.5**	4
97-07-13	**0.08**	<0.1	**(0.01)**	**0.2**	**0.02**	**3.8**	2
97-07-20	**0.05**	<0.1	<0.02	**0.1**	<0.01	**2.4**	1
97-07-27	**0.03**	<0.1	<0.02	**0.2**	<0.01	**4.5**	2
97-09-07							
97-09-14	**0.7**	<0.1	**0.04**	**1**	<0.01	**8.2**	2
97-10-05							
97-10-12	**0.08**	<0.1	<0.03	**0.8**	<0.01	**3.4**	5
97-10-19	**0.07**	<0.1	<0.05	**1**	<0.01	**2.7**	2
97-10-26	**0.04**	<0.1	<0.05	**0.5**	<0.01	**1.9**	1
97-11-02	**0.08**	<0.1	<0.05	**1**	<0.01	**2.7**	1
97-11-09	**0.1**	<0.1	<0.05	**0.7**	n.a.	**2.6**	5
97-11-30*	<0.05	<0.1	<0.1	**0.4**	n.a.	**2.0**	6

Appendix 6. Monthly time weighted mean concentrations (TWMC) at site UT10 during May-November 1997

	TWMC (µg/l) 1997 at UT10							
Substance	May	Jun	Jul	Aug	Sep	Oct	Nov	May-Nov
aclonifen	0.00	0.00	0.00	-	-	-	-	
atrazine	0.02	0.03	0.06	-	0.20	0.09	0.04	0.07
atrazine-desethyl	0.00	0.03	0.03	-	0.10	0.08	0.07	0.05
BAM	0.01	0.04	0.05	-	0.20	0.05	0.05	0.07
bentazone	0.50	3.01	1.34	-	1.70	0.21	0.17	1.15
chloridazon	0.00	0.00	0.00	-	0.00	0.00	0.00	
clopyralid	0.00	0.00	0.00	-	0.00	0.04	0.08	0.02
cyanazine	0.17	1.61	0.89	-	0.80	0.07	0.01	0.59
cyfluthrin	0.00	0.00	0.00	-	0.00	0.00	0.00	
2,4-D	0.00	0.02	0.00	-	0.00	0.14	0.00	0.03
deltamethrin	0.00	0.00	0.00	-	0.00	0.00	0.00	
dichlobenil	0.00	0.00	0.00	-	0.00	0.00	0.00	
dichlorprop	0.04	0.45	0.03	-	0.50	0.02	0.01	0.18
diflufenican	0.00	0.00	0.02	-	0.10	0.09	0.05	0.04
diuron	0.00	0.08	0.13	-	0.06	0.02	0.05	0.06
esfenvalerate	0.00	0.00	0.00	-	0.00	0.00	0.00	
ethofumesate	0.06	0.78	0.19	-	0.50	0.15	0.12	0.30
fenpropimorph	0.03	0.05	0.06	-	0.10	0.05	0.00	0.05
fluroxypyr	0.01	0.02	0.02	-	0.08	0.06	0.02	0.04
isoproturon	0.12	0.51	0.22	-	0.40	0.30	0.65	0.37
lambda-cyhalothrin	0.00	0.00	0.00	-	0.00	0.00	0.00	
MCPA	0.02	0.20	0.02	-	0.09	0.00	0.00	0.06
mecoprop	0.23	0.50	0.65	-	0.20	0.03	0.05	0.28
metamitron	1.26	4.09	0.31	-	0.60	0.00	0.00	1.04
metazachlor	0.02	0.05	0.03	-	0.10	0.08	0.10	0.06
methabenzthiazuron	0.00	0.00	0.00	-	0.10	0.02	0.07	0.03
phenmedipham	-	0.00	0.00	-	0.00	0.00	0.00	
pirimicarb	0.00	0.02	0.02	-	0.06	0.01	0.02	0.02
propiconazole	0.00	0.18	0.34	-	0.60	0.28	0.13	0.26
propyzamide	0.10	0.13	0.06	-	0.70	0.07	0.03	0.18
simazine	0.00	0.01	0.00	-	0.04	0.00	0.00	0.01
terbuthylazine	0.07	0.26	0.22	-	1.00	0.81	0.51	0.48
tribenuron-methyl	0.00	0.02	0.02	-	0.00	0.00	-	0.01
Sum pest	2.68	12.10	4.68	-	8.23	2.68	2.22	5.43

Appendix 7. Transported quantities and loss as percentage of applied amounts at UT10 1997

Date	aclonifen	atrazine	atrazine-desethyl	BAM	benazolinethylester	bentazone	chloridazon	clopyralid	cyanazine
Transport (g)									
May	0.0	1.3	0.2	0.5	0.0	31.4	0.0	0.0	11.0
Jun	0.0	0.5	0.3	0.4	0.0	49.2	0.0	0.0	27.6
Jul	0.0	0.4	0.2	0.2	0.0	9.2	0.0	0.0	6.1
Aug	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sep	n.a.	0.2	0.1	0.2	0.0	1.9	0.0	0.0	0.9
May-Sep	**0.0**	**2.4**	**0.8**	**1.3**	**0.0**	**91.6**	**0.0**	**0.0**	**45.6**
Oct	n.a.	0.5	0.5	0.7	0.0	1.1	0.0	0.3	0.5
Nov	n.a.	0.3	1.0	0.8	0.0	2.1	0.0	1.2	0.0
Oct-Nov	**n.a.**	**0.9**	**1.4**	**1.4**	**0.0**	**3.2**	**0.0**	**1.5**	**0.5**
May-Nov	**n.a.**	**3.3**	**2.3**	**2.8**	**0.0**	**94.8**	**0.0**	**1.5**	**46.1**
Applied (kg)									
Spring	4.3	0.0	m	m	0.0	2.0	60.6	0.2	0.0
Autumn	0.0	0.0	m	m	0.0	0.0	0.0	0.0	0.0
Loss (%)									
May-Sep	0% / n.a.	n.u.			n.u.	4.60%	0.00%	0.00%	n.u.
May-Nov						4.70%	0.00%	0.75%	
Oct-Nov		n.u.			n.u.				n.u.

m = metabolite
n.a. = not analysed
n.u. = not used

Appendix 7. Transported quantities and loss as percentage of applied amounts at UT10 1997

Date	cyfluthrin	2,4-D	deltamethrin	dichlobenil	dichlorprop	diflufenican	dimethoate	diuron	esfenvalerate
Transport (g)									
May	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
Jun	0.0	0.3	0.0	0.0	7.5	0.0	0.0	1.0	0.0
Jul	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.6	0.0
Aug	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sep	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.1	0.0
May-Sep	**0.0**	**0.3**	**0.0**	**0.0**	**11.0**	**0.2**	**0.0**	**1.7**	**0.0**
Oct	0.0	1.6	0.0	0.0	0.2	0.5	0.0	0.2	0.0
Nov	0.0	0.0	0.0	0.0	0.1	0.7	0.0	0.8	0.0
Oct-Nov	**0.0**	**1.6**	**0.0**	**0.0**	**0.3**	**1.2**	**0.0**	**1.0**	**0.0**
May-Nov	**0.0**	**1.9**	**0.0**	**0.0**	**11.3**	**1.4**	**0.0**	**2.7**	**0.0**
Applied (kg)									
Spring	0.1	0.0	0.3	0.0	32.3	0.0	0.0	0.0	2.1
Autumn	0.3	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0
Loss (%)									
May-Sep	0.00%	n.u.	0.00%	n.u.	0.03%	n.u.	n.u.	n.u.	0.00%
May-Nov			0.00%		0.04%				0.00%
Oct-Nov	0.00%	n.u.		n.u.		0.02%	n.u.	n.u.	

Appendix 7. Transported quantities and loss as percentage of applied amounts at UT10 1997

Date	ethofumesate	fenpropimorph	fluroxypyr	hexazinon	isoproturon	l-cyhalothrin	MCPA	mecoprop	metamitron
Transport (g)									
May	3.7	1.9	0.8	0.0	7.2	0.0	1.5	15.0	83.4
Jun	10.7	0.7	0.2	0.0	7.6	0.0	3.3	7.3	62.7
Jul	1.1	0.4	0.1	0.0	1.4	0.0	0.1	2.9	2.3
Aug	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sep	0.5	0.1	0.1	0.0	0.4	0.0	0.1	0.2	0.7
May-Sep	**16.1**	**3.1**	**1.2**	**0.0**	**16.6**	**0.0**	**5.0**	**25.4**	**149.0**
Oct	1.0	0.4	0.7	0.0	0.9	0.0	0.0	0.2	0.0
Nov	1.8	0.0	0.4	0.0	10.0	0.0	0.0	0.7	0.0
Oct-Nov	**2.8**	**0.4**	**1.0**	**0.0**	**10.9**	**0.0**	**0.0**	**0.9**	**0.0**
May-Nov	**18.8**	**3.4**	**2.2**	**0.0**	**27.5**	**0.0**	**5.0**	**26.3**	**149.0**
Applied (kg)									
Spring	49.1	75.6	4.0	0.0	9.4	0.8	42.1	65.6	542.6
Autumn	0.0	0.0	0.0	0.0	52.1	0.0	0.0	0.0	0.0
Loss (%)									
May-Sep	0.03%	0.004%	0.03%	n.u.	0.18%	0.00%	0.01%	0.04%	0.03%
May-Nov	0.04%	0.005%	0.06%			0.00%	0.01%	0.04%	0.03%
Oct-Nov				n.u.	0.02%				

Appendix 7. Transported quantities and loss as percentage of applied amounts at UT10 1997

Date	metazachlor	methabenzthiazuron	phenmedipham	pirimicarb	propiconazole	propyzamide	prosulfocarb	simazine
Transport (g)								
May	1.5	0.0	0.0	0.0	0.0	6.0	0.0	0.0
Jun	0.9	0.0	0.0	0.4	2.1	2.0	0.0	0.1
Jul	0.1	0.0	0.0	0.1	2.1	0.4	0.0	0.0
Aug	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sep	0.1	0.1	0.0	0.1	0.7	0.8	0.0	0.0
May-Sep	**2.6**	**0.1**	**0.0**	**0.6**	**4.9**	**9.1**	**0.0**	**0.2**
Oct	0.5	0.3	0.0	0.0	1.6	0.4	0.0	0.0
Nov	1.5	1.1	0.0	0.2	1.8	0.3	0.0	0.0
Oct-Nov	**2.0**	**1.4**	**0.0**	**0.2**	**3.4**	**0.7**	**0.0**	**0.0**
May-Nov	**4.6**	**1.5**	**0.0**	**0.8**	**8.3**	**9.9**	**0.0**	**0.2**
Applied (kg)								
Spring	0.0	11.2	124.2	0.0	25.2	0.0	0.0	0.0
Autumn	33.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Loss (%)								
May-Sep	n.u.	0.00%	0.00%	n.u.	0.02%	n.u.	n.u.	n.u.
May-Nov		0.01%	0.00%		0.03%			
Oct-Nov	0.01%*			n.u.		n.u.	n.u.	n.u.

* Loss is calculated for Sep- Nov

Appendix 7. Transported quantities and loss as percentage of applied amounts at UT10 1997

Date	terbuthylazine	tribenuron-methyl	Sum pest	Av. flow (l/s)
Transport (g)				
May	4.4	0.0	172.6	21.1
Jun	3.7	0.2	188.6	6.8
Jul	1.4	0.1	29.5	1.9
Aug	n.a.	n.a.	n.a.	0.5
Sep	1.1	0.0	9.0	0.5
May-Sep	**10.5**	**0.3**	**399.8**	**6.1**
Oct	4.5	0.0	16.4	2.0
Nov	6.8	n.a.	31.6	5.8
Oct-Nov	**11.3**	**0.0**	**48.0**	**3.9**
May-Nov	**21.8**	**0.3**	**447.8**	**5.5**
Applied (kg)				
Spring	0.0	1.2	1052.9	
Autumn	0.0	0.0	90.7	
Loss (%)				
May-Sep	n.u.	0.03%		
May-Nov		0.03%		
Oct-Nov	n.u.			

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