BE-159

BERICHTE

Umweltbundesamt

ATRAZINE CONCENTRATIONS IN AUSTRIAN SURFACE WATERS 1992-1998

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Wien, September 1999

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Impressum

Medieninhaber und Herausgeber: Umweltbundesamt GmbH, Spittelauer Lände 5, A-1090 Wien
Eigenvervielfältigung

ISBN 3-85457-518-1

1 SUMMARY

Since systematic monitoring began in 1992 the concentration of atrazine in Austrian rivers has decreased dramatically. This can largely be explained by it having been banned since April 1995. However, atrazine remains present in several Austrian Rivers (the Antiesen, Danube Canal, Feistritz, Krems, Lafnitz, March, Pram, Raab, Strem, Thaya and Wulka) in elevated concentrations. With the exception of the Danube Canal the most likely cause of these inputs is the continued use of atrazine by farmers in parts of these catchments. Most of these catchments are exclusively in Austrian territory and therefore are not subject to inputs from other countries. Those farmers who continue to use atrazine, presumably imported illegally from neighbouring countries, place the law-abiding farmers at a competitive disadvantage. The inputs caused by these farmers also pollute Austria's surface waters, thereby potentially damaging the environment.

2 ZUSAMMENFASSUNG

2.1 Erhöhte Atrazinkonzentrationen im Fließgewässern

Im Oktober 1998 wurde das Umweltbundesamt vom Bundesministerium für Land- und Forstwirtschaft ersucht, einen zusammenfassenden Bericht über die Belastung der österreichischen Fließgewässern mit gefährlichen Stoffen gemäß der EU-Richtlinie 76/464 zwischen 1996-1998 zu erstellen.[1] Diese Auswertung wurde zwischen November 1998 und März 1999 mit den gemäß der Wassergüte-Erhebungsverordnung (WGEV) erhobenen Daten durchgeführt. Die Ergebnisse zeigen, dass die Mehrzahl der Stoffe nur relativ geringfügige Belastungen verursacht. Angesichts des geltenden Verbotes (bzw. der Aufhebung der Zulassung) von Atrazin, das seit April 1995 im Kraft ist, sind jedoch die Konzentrationen von Atrazin höher als man erwarten würde. Aus diesem Grund wurden die Ergebnisse der Atrazinauswertung in diesem Bericht gesondert dargestellt.

2.1.1 Was ist Atrazin?

Atrazin ist ein sehr effektives Herbizid, das sowohl in der Landwirtschaft als auch in der generellen Unkrautkontrolle verwendet wird. In der österreichischen Landwirtschaft wird es normalerweise zwischen April und Juli auf Mais gespritzt. Im Vergleich mit anderen ähnlichen Herbiziden ist Atrazin relativ billig.

2.1.2 Warum und wie ist es verboten?

Bislang sind für Atrazin keine negativen Auswirkungen beim Menschen nachgewiesen. Die Substanz steht dennoch im Verdacht, krebserregende zu sein. Für verschiedene Tierarten und für Pflanzen ist Atrazin wesentlich gefährlicher. Atrazin wird für aquatische Organismen als sehr toxisch klassifiziert. Algen und andere Wasserpflanzen gelten als am empfindlichsten. Für Krebstiere (Crustazeen) und Regenwürmer ist Atrazin etwas weniger toxisch. Die Auswirkungen auf Fische werden als niedrig eingestuft, und auch für Vögel gilt Atrazin als weniger toxisch. Bodenorganismen werden nicht beeinflusst.

Ende 1993 wurde Atrazin in Österreich durch die Verordnung über ein Verbot bestimmter gefährlicher Stoffe in Pflanzenschutzmitteln verboten. Dieses Verbot betraf sowohl die Verwendung von Atrazin als auch die Herstellung, den Vertrieb und den Handel. Nach seiner Aufhebung aus formalen Gründen ab 1.10.1994 wurde mit 1.4.1995 die Zulassung aufgehoben. Atrazin wurde aus der Liste des zugelassenen Pflanzenschutzmittel entfernt.

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[1] UBA(1999) Belastung der Österreichischen Fließgewässer mit „gefährlichen Stoffen“ (entspr. Richtlinie 76/464/EWG), BE-155

2.1.3 Grenzwerte für Atrazin

Gemäß der Verordnung des Bundesministers für Umwelt, Jugend und Familie über den Gehalt an Pestiziden im Trinkwasser ist es verboten, Trinkwasser mit einem Atrazingehalt größer als 0,1 µg/l abzugeben. Dieser Wert ist deutlich niedriger als der von der WHO vorgeschlagene Wert von 2 µg/l. Gemäß der Grundwasserschwellenwertverordnung sollte die zuständige Behörde Sanierungsgebiete ausweisen, wenn den Wert von 0,1 µg/l im Grundwasser entsprechend den Bestimmungen dieser Verordnung überschritten wird. Für Fließgewässern sind noch keine Grenzwerte festgestellt. In der vorliegenden Studie wird daher der Grenzwert für Trinkwasser von 0,1 µg/l zur Interpretation herangezogen welcher auch dem Schwellenwert für Grundwasser entspricht.

2.1.4 Atrazinkonzentrationen in österreichischen Fließgewässern

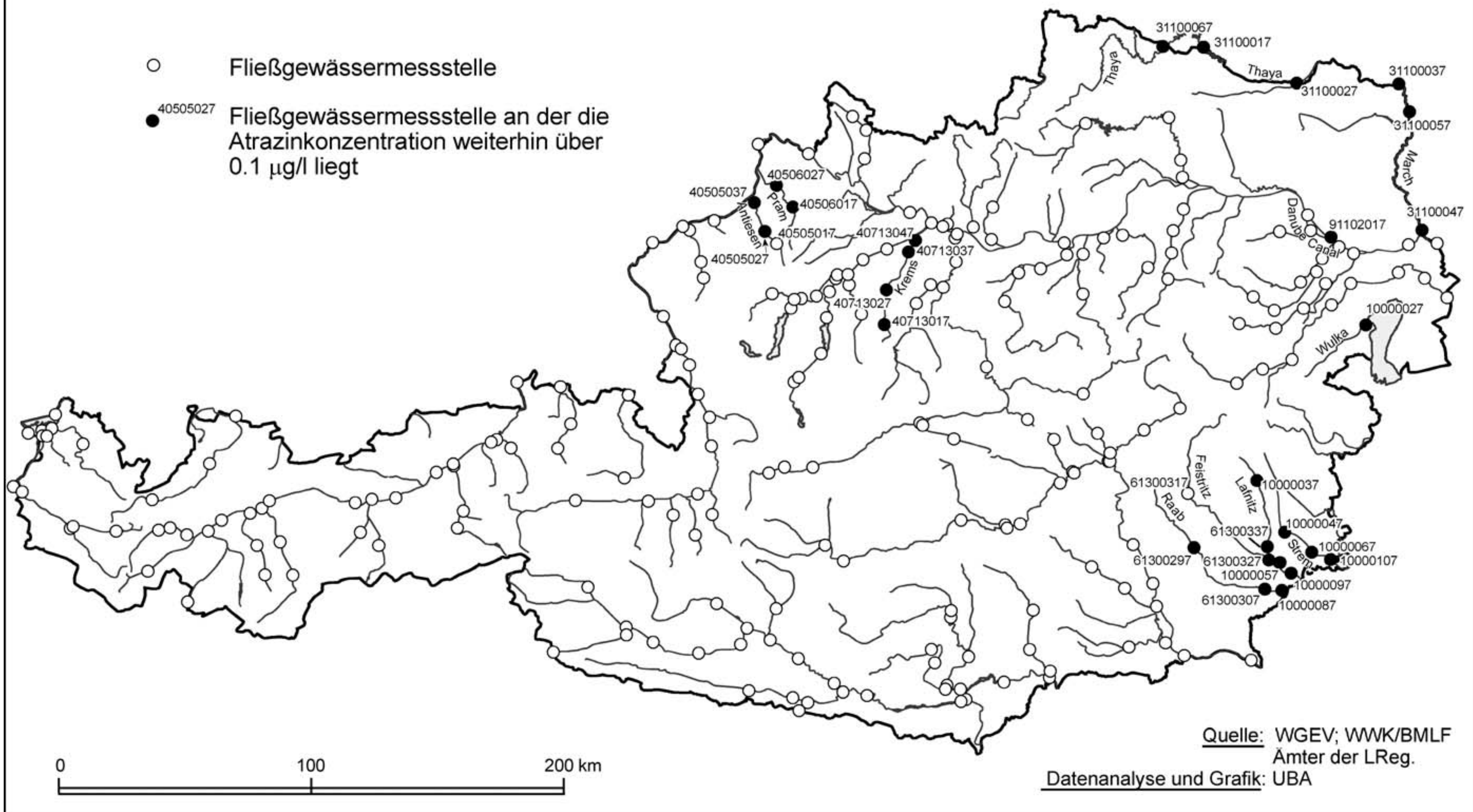
Seit 1992 zeigen die Ergebnisse eine bedeutende Abnahme der Messungen, in denen der Atrazingehalt größer als 0,1 µg/l ist. Diese Abnahme ist besonders stark zwischen 1994 und 1995, was vermutlich das Wirksamwerden des Atrazinverbotes widerspiegelt. Seitdem ist die Zahl der Überschreitungen relativ konstant geblieben. Die Überschreitungen sind insbesondere an bestimmten Messstelle aufgetreten (siehe nachstehende Karte).

2.1.5 Warum sind diese Werte aufgetreten?

Die Frage ist natürlich, warum es noch die festgestellten erhöhten Werte gibt. In Anbetracht der Tatsache, dass vor dem Verbot die Landwirtschaft die Hauptmenge an Atrazin in Österreich verwendet hat, ist es gerechtfertigt, diese Branche genauer zu betrachten. Mit Ausnahme des Donaukanals treten die erhöhten Werte and den Fließgewässern zwischen April und Juli auf, was den Anwendungszeiten von Atrazin in der Landwirtschaft entspricht und was nicht mit einem Atrazineintrag in der Vergangenheit erklärt werden kann. Atrazin wurde (und wird ?) vor allem im Maisanbau verwendet. In der vorliegenden Auswertung wurden die Einzugsgebiete der Flüsse mit der Maisanbaufläche in Beziehung gesetzt. Dieser Vergleich zeigt, dass mit Ausnahme des Donaukanals und des Marchgebiets jene Gebiete, wo Mais einen hohen Anteil ausmacht, meist auch jene Gebiete sind, wo Atrazin noch in erhöhten Konzentrationen vorliegt.

Auch andere mögliche Quellen von Atrazin wie Grundwassereinträge, Luftdeposition, Speicherung im Boden oder Sedimenten und industrieller Verbrauch wurden in Betracht gezogen. Im Marchgebiet ist es durchaus wahrscheinlich, dass ein großer Teil aus den Nachbarländern stammt, insbesondere weil im österreichischen Teil dieses Einzugsgebietes die Maisanbaufläche relativ gering ist. Die erhöhten Werte im Donaukanal sind schwer zu erklären. Es gibt kaum Landwirtschaft im Einzugsgebiet, und die erhöhten Werte traten vom Jänner bis April auf, was nicht den Anwendungszeiten in der Landwirtschaft entspricht. Eine mögliche Erklärung ist, dass Atrazin noch in Kleingärten, Freizeitflächen oder Friedhöfen verwendet wird. Außer im Marchgebiet und im Donaukanal ist die österreichische Landwirtschaft wahrscheinlich die Hauptquelle der gegenwärtig gemessenen, auffälligen Erhöhungen der Atrazinkonzentration.

Abbildung 1: Fließgewässermessstellen an denen Atrazinkonzentrationen weiterhin über 0.1 µg/l liegen



2.1.6 Woher kommt das Atrazin, das noch in der Landwirtschaft verwendet wird?

Die wahrscheinlichste Hypothese ist, dass Atrazin illegal importiert wird. Außer im Deutschland und Italien ist Atrazin in allen Nachbarländer zugelassen.

2.1.7 Konsequenzen der Anwendung von Atrazin

Die Konsequenzen der Anwendung von Atrazin sind zweifach. Erstens führt sie zu einer Belastung der Umwelt. Zweitens ergeben sich Wettbewerbsverzerrungen in der Landwirtschaft, weil Atrazin viel billiger als vergleichbare legale Produkte ist.

2.2 Schlussfolgerungen

Ein Teil der gemessenen erhöhten Atrazinkonzentrationen dürfte auf eine Verwendung von Atrazin auch nach dem Verbot zurückzuführen sein. Als wahrscheinlichste Quelle ist in den meisten Fällen die Landwirtschaft zu nennen. Da Atrazin in Österreich nicht mehr erhältlich ist, dürften die eingesetzten Mengen aus den Ausland stammen.

Das Umweltbundesamt empfiehlt daher:

- verstärkte Kontrollen an den Grenzen und
- stichprobenartige Überprüfung der Höfe und der Maiskulturen (Bodenprobe, Pflanzenprobe, Probe aus Spritzbrühe) in den betroffenen Gebieten zum potentiellen Ausbringungszeitpunkt.

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3 INTRODUCTION

In October 1998 the Ministry of Agriculture and Forestry asked the Federal Environment Agency to prepare an assessment of the concentrations of dangerous substances in Austrian surface waters between 1996 and 1998. This evaluation was carried out between November 1998 and March 1999 using the data contained in the Austrian Water Quality Databank and showed that for most dangerous substance there were only minor problems. Nevertheless the concentrations of atrazine remain higher than would be expected in several stretches of certain rivers given that its use in Austria has been illegal since April 1995.

This report will first briefly outline the monitoring of Austrian freshwaters and quality standards before presenting a short description of the nature of and problems following atrazine use. The measured concentrations of atrazine in the Austrian rivers where this has been a persistent problem will then be presented along with a discussion of the possible causes. The final section will examine where the atrazine that is being used is being obtained.

4 AUSTRIAN SURFACE WATER QUALITY MONITORING AND REGULATION

In Austria there are different systems of water quality monitoring for lakes and for rivers. These are outlined below.

4.1 Lakes

The water quality of lakes is monitored by the Ministry of Labour, Health and Social Affairs and focuses on public health parameters with a view to compliance with the EU Bathing Waters Directive[2]. At present lakes are not systematically monitored for environmental criterion to the same extent as rivers. However such a system is in the process of being developed.[3]

4.2 Rivers

Although water quality in some rivers has been monitored for many years it is only since the early 1990s that it has been systematically carried out on a national basis. The 1990 amendment[4] to the 1959 Federal Water Law[5] provided for the establishment of this system and it was implemented through the 1991 Statutory Order on Water Quality Monitoring[6]. In accordance with this legislation a comprehensive network of monitoring sites, methods and procedures was established for surface waters. This is commonly referred to as the Wasserguteerhebungs-

[2] Council of the European Union (1975), Council Directive 76/160/EEC of 8 December 1975 concerning the quality of water for bathing, OJ L 376 of 8 December 1975
[3] Chovanec, Umweltbundesamt, personal communication
[4] Federal Government of Austria (1990), Wasserrechtsgesetznovelle, Bundesgesetzblatt für die Republik Österreich 252/90
[5] Federal Government of Austria (1959), Wasserrechtsgesetz, Bundesgesetzblatt für die Republik Österreich 215/59
[6] Federal Government of Austria (1991), Verordnung des Bundesministers für Land- und Forstwirtschaft über die Erhebung der Wassergüte in Österreich, Bundesgesetzblatt für die Republik Österreich 338/91

verordnung or WGEV. The Ministry for Agriculture and Forestry, the Federal Environment Agency and the provincial governments all co-operate in the running of this monitoring network.

Surface waters are generally required to be monitored six times a year at intervals of roughly two months. Since mid-1997 they have generally been monitored 12 times a year. The transboundary stretches of large rivers have been monitored roughly 24 times per year. Additional monitoring programmes are occasionally conducted for particular substances. These often take place in particular locations and are usually limited in time.

The samples from the Austrian water monitoring system are taken and analysed by laboratories contracted to the Austrian provincial or federal government. The results of this analysis are ultimately entered into a database which is managed by the Federal Environment Agency (UBA). These raw monitoring results are made available to the general public via the Federal Environment Agency's world wide web page. A biennial report is also presented on the internet and in paper form.[7]

4.3 Quality Regulation

In 1991 a statutory order on groundwater quality was adopted by the Federal Government.[8] This requires that preventative measures are taken once concentrations of pollutants cross certain threshold values. These values are defined in the order itself and are designed to ensure that action to prevent pollution is taken as early as possible to minimise the water treatment that is needed before water can be supplied to the general public.

Although general guidelines containing quality objectives for Austrian surface waters[9] have existed since 1987 these were intended to be temporary and have no legal force. A piece of legislation for rivers similar to that for groundwater, the draft Statutory Order on River Water Quality (SORWQ), was first drafted by the Federal Ministry for Agriculture and Forestry (BMLF) in 1992. A further draft was produced in August 1995. This has yet to be adopted and it is unlikely that this situation will change in the near future.[10] There are therefore no general legally-binding surface water quality objectives in Austria.

[7] For example Bundesministerium für Land- und Forstwirtschaft (1997) Wassergüte in Österreich Jahresbericht 1996, Wien
[8] Federal Government of Austria (1991), Grundwasserschwellenwertverordnung, Bundesgesetzblatt für die Republik Österreich 502/91
[9] Bundesministerium für Land- und Forstwirtschaft (1987) Vorläufige Richtlinie für die Begrenzung von Immissionen in Fließgewässern, Wien
[10] This is because, in the opinion of the Ministry of Agriculture and Forestry, it is opportune to wait until the European Commission's proposal for a framework directive in the field of water (1997), has been adopted by the Council of Ministers and the European Parliament, something that is unlikely to happen before the end of this year. If the Ministry were not to wait and were to adopt legislation prior to the adoption of the Framework Directive it is highly likely that the legislation would subsequently have to be amended to take account of this Directive thereby causing legal insecurity.

5 METHOD

5.1 Description of Task

In October 1998 the BMLF asked the UBA to prepare an assessment of the concentrations of dangerous substances in surface waters between 1996 and, in so far as the data were available, 1998. The substances to be considered in the evaluation were to be those which are in List I or List II of the Dangerous Substances Directive and for which monitoring data existed. These values were then to be compared with the values in the aforementioned latest draft of the SORWQ. This evaluation was carried out between November 1998 and March 1999.[11]

The results of this analysis, in so far as they concern pesticides, are to be found in Table 3.1. This table also shows the number of potential outliers, the identification of which also constituted an integral part of this task. For each monitoring site where a value for a particular parameter exceeded the limit value a bar chart was created. From an analysis of these, including consideration of the results from other monitoring sites on the river, it was possible to identify potential outliers. This was undertaken through a visual inspection of the data, rather than through a statistical method. Despite the potential outliers the quality of the data seems to be sufficient for meaningful analysis.

Table 3.1 shows that it is only for atrazine that more than five percent of the samples exceed the proposed limit value. Hence the reason for this report concentrating on this substance.

[11] Umweltbundesamt (1999) Belastung der österreichischen Fließgewässer mit “gefährlichen Stoffen” (entspr. Richtlinie 76/464/EWG), Bericht im Auftrag des Bundesministeriums für Land- und Forstwirtschaft, in preparation

Table 5.1: Pesticide Parameters investigated in Austrian Surface Waters 1996-1998 (1998 as far as available)

Parameter	Limit Value	Number of Moni-toring Sites	Num-ber of Sam-ples	Number of Sam-ples where limit value is exceeded	% of Sam-ples where limit value is exceeded	Number of Sam-ples with outliers	% of Samples where the limit value is exceeded identified as po-tential outliers	% of Sam-ples identi-fied as po-tential out-liers
2,4-D	0.1 µg/l	22	215	1	0.47	1	100	0.47
Aldrin	0.005 µg/l	32	323	0	0	0	-	0
Atrazine	0.1 µg/l	153	1921	101	5.26	3	2.97	0.16
Bentazone	0.1 µg/l	22	215	0	0	0	-	0
Desethylatrazine	0.1 µg/l	170	2432	52	2.14	0	0	0
Desisopropylatrazine	0.1 µg/l	170	2433	5	0.21	0	0	0
Dieldrin	0.005 µg/l	32	323	0	0	0	-	0
Endosulfan	0.005 µg/l	21	204	0	0	0	-	0
Heptachlor (incl. Heptachlor epox-ide)	0.1 µg/l	21	188	0	0	0	-	0
Hexachlorbenzene	0.005 mg/l	32	323	0	0	0	-	0
MCPA	0.1 µg/l	30	215	0	0	0	-	0
MCPB	0.1 µg/l	22	200	0	0	0	-	0
MCPP	0.1 µg/l	22	215	1	0.47	1	100	0.47
Simazine	0.1 µg/l	153	1922	9	0.47	3	33.33	0.16
Trifluralin	0.01 µg/l	25	226	0	0	0	-	0

6 ATRAZINE: ITS NATURE AND REGULATION

6.1 The Nature and Use of Atrazine

Atrazine is a very effective herbicide that is used both in agriculture and in general weed control, for example along railway lines and road-side verges. It works by inhibiting the ability of certain plants to photosynthesise.[12] In Austria the crop for which it would be used is maize to which it would normally be applied between April and July. Compared to other herbicides atrazine is also relatively inexpensive. It is therefore a highly effective and economically attractive product from the perspective of plant protection.

6.2 The Environmental Fate of Atrazine

Microbial decomposition is considered to account for much of the degradation of atrazine in soil. Although it is considered to have an average half life of 45 days in soil this can extend to beyond 115 under certain conditions. This rate is affected by factors such as moisture, temperature and pH. In soils atrazine has been classified as being of elevated to medium mobility, however this is dependent to a large extent on the composition of soil[13]. In sandy soils the mobility is greater because in clayey soils it is more readily adsorbed. Organic matter content is also important. In surface waters the half-life of atrazine is longer than in the soil and in groundwater it can be fairly stable.[14]

6.2.1 The Effects on Humans

Although, as with most substances, if consumed directly in sufficient quantity, atrazine can be toxic to humans it usually has no adverse effects. There remains a question mark over its carcinogenic properties.

6.2.2 The Effects on Animals and Plants

The effects on wildlife are more significant than those on humans. Atrazine is classified as being very toxic for aquatic organisms. The most susceptible are algae and aquatic plants. For crustaceans and earthworms atrazine is slightly less toxic. The effects on fish are considered to be low and those on birds to be less toxic. Soil micro-organisms do not seem to be affected.

6.3 The Regulation of Atrazine

Atrazine was an authorised plant protection product in Austria until the end of 1993 when its use was banned by the Statutory Order of the Ministry of Environment, Youth and the Family concerning the banning of certain dangerous substances in plant protection products.[15] This Statutory Order banned the use of atrazine as well its production, distribution, and trade. Following its annulment on legal grounds by

[12] Comfort, S.D.; Roeth F. W. (1993) Questions and Answers about Atrazine, Internet Page of the Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln
[13] United States Environmental Protection Agency (1998) Technical Factsheet on Atrazine, http://www.epa.gov/OGWDW/dwh/t-soc/atrazine.html
[14] World Health Organisation (1996) Guidelines for Drinking Water Quality, Volume II, 2nd edition
[15] Federal Government of Austria (1997), Verordnung über ein Verbot bestimmter gefährlicher Stoffe in Pflanzenschutzmitteln, BGBl. Nr. 97/1992 ST0036

a ruling of the Constitutional Court from 1.10.1994 this ban was reinstated from 1.4.1995[16], albeit with the ban being effected through the removal of atrazine from the list of authorised plant protection products. The effects of these regulations and the annulment on atrazine consumption can be seen in Table 4.1 below. The use of atrazine in 1995 reflects the period between the annulment of the ban and its reinstatement.

Table 6.1: Consumption of Atrazine in Agriculture 1991 to 1995 (tonnes)[17]

Year	Atrazine consumption (tonnes)
1991	406
1992	305
1993	282
1994	0
1995	5

According to the Statutory Order of the Minister of Health, Sport and Consumer Protection concerning the concentration of pesticides in drinking water[18] it is forbidden to supply water for human consumption with an atrazine concentration greater than 0.1 µg/l. This is therefore much stricter than the World Health Organisation's guideline value of 2 µg/l.[19] The Statutory Order of the Minister for Agriculture and Forestry concerning the threshold values for groundwaters[20] lays down a level of 0.1 µg/l beyond which remediation measures should be taken by the appropriate authority.

7 ATRAZINE IN AUSTRIAN RUNNING WATERS 1992-1998

Given that the data in the WGEV commence before the ban was put in place it should be possible to see a considerable reduction in concentrations over time. Table 5.1 presents a summary of these results for the main river catchments and the Danube Canal where atrazine concentrations have exceeded the level of 0.1 µg/l. The cut-off date for this information being in the database for evaluation was 29th March 1999.

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16 Bundesgesetz: Änderung des Pflanzenschutzmittelgesetzes, BGBl. Nr 300/1995, ST0092
17 Bundesministerium für Umwelt, Jugend und Familie (1996) Pflanzenschutzmittel-Wirkstoffstatistik, Ing. Karl Markt, personal communication
18 Federal Government of Austria (1991) Verordnung des Bundesministers für Umwelt, Jugend und Familien über den Gehalt an Pestiziden im Trinkwasser, BGBl. Nr 448/1991
19 World Health Organisation, op. cit.
20 Bundesministerium für Land- und Forstwirtschaft (1991) op. cit.

Table 7.1: Atrazine Samples

Catchment Zone	Year													
	1992		1993		1994		1995		1996		1997		1998[21]	
	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	0.1 µg/l
Danube Canal	12	**6**	10	**1**	11	**4**	6	**1**	12	**0**	12	**3**	0	**0**
Inn below its confluence with the Salzach	0	**0**	44	**12**	67	**12**	34	**7**	33	**4**	176	**8**	108	**3**
March	35	**30**	38	**24**	36	**21**	30	**13**	53	**26**	52	**32**	6	**1**
Rabnitz and Raab	58	**19**	40	**11**	60	**16**	58	**12**	86	**3**	60	**6**	5	**4**
Traun	102	**4**	44	**13**	66	**15**	39	**4**	23	**3**	315	**3**	197	**2**
Other	637	**30**	444	**14**	431	**8**	323	**9**	277	**1**	474	**2**	410	**0**
Total	844	**89**	610	**75**	671	**76**	490	**46**	484	**37**	1089	**54**	725	**10**

The results show that there has been a significant decrease in the number of samples containing atrazine concentrations over 0.1 µg/l and that this reduction was particularly marked between 1994 and 1995. This most probably corresponds to the banning of atrazine from 1.4.1995. Although it may at first sight seem as if there has been a further reduction between 1997 and 1998 this should be treated with caution as in 1998 only five samples are available for the River March catchment as opposed to over 50 in the two previous years. This is significant because in 1996 and 1997 the majority of samples in which the limit value was exceeded in Austria were in this catchment. When this is taken into consideration the number of times the limit value has been exceeded can be seen to have remained relatively constant since 1995.

The monitoring sites at which atrazine concentrations still regularly exceed the 0.1 µg/l level, or where the monitoring results at the crucial times of year are absent are shown in Figure 1 below. For each of the measuring points a table has been drawn up indicating the number of samples taken per year and the number of which exceeded the 0.1 µg/l limit. A bar chart has also been produced for each measuring point. In a small number of cases more than one sample was taken per month. In this case the value displayed in the bar chart reflects the higher of the values. In the bar charts it is also important to note that a value of zero does not necessarily mean that no atrazine was in the water. In some cases, although atrazine was detected, its concentration was too low to be determined and hence the value of zero was inserted.

[21] For some of the catchments the samples taken had, as of 29.3.1999, yet to be processed by the responsible laboratory. This explains the lack of an adequate number of samples in some of the catchments.

7.1 Why are elevated concentrations of Atrazine still being found?

Given that agriculture was the most significant user of atrazine prior to the ban both in terms of the quantity and extent of its use it is natural to assume that it is the main culprit in its continuing presence in surface waters. This section will first examine other possible pathways that may be responsible for the continuing elevated levels before looking more closely at the agricultural composition of the areas under suspicion.

7.1.1 Groundwater Inflow

In many of the regions where atrazine has been detected in surface waters elevated concentrations are also to be found in groundwaters. Indeed the groundwater threshold value for atrazine of 0.1 µg/l was exceeded in 22.9 % of the samples taken between 1991 and May 1996[22], particularly in the eastern provinces. This is shown in Figure 2 below which shows the areas identified as requiring remediation measures against atrazine pollution. Due to the time lag between the atrazine leaving the soil rooting zone and it arriving in the upper layer of groundwater the concentrations in groundwater usually reflect past agricultural practices. Although the time lag has been measured as being as little as 3 years for water alone in some parts of Austria[23], the general lag is likely to be considerably longer. The inputs from groundwater to surface water could be considered to be a potential source of the elevated atrazine concentrations in surface waters. These groundwater concentrations, which, due to the time lag before atrazine in leachate reaches an aquifer probably result from atrazine applications prior to the ban, could be considered to be a source of the elevated concentrations in freshwaters.

However, it is highly unlikely that groundwater inflow is responsible for the elevated concentrations that continue to be in evidence because groundwater concentrations of pollutants tend to be fairly constant while the concentrations of atrazine in the rivers concerned have fluctuated (see later figures) with some values being very low and others being much higher. This would suggest that groundwater inputs are not responsible for these elevated levels.

[22] Bundesministerium für Land- und Forstwirtschaft (1997) Wassergüte in Österreich, Jahresbericht 1996

[23] Fank J.; Zojer H; Stichler W (1999) Die Schneescmelze 1996 als ^{18}O-Tracerversuch an der Lysimeteranlage in Wagna, in Klotz. D; und Seiler. K.-P, bestimmung der Sickerwassergeschwindigkeit in Lysimetern, GSF Forschungszentrum für Umwelt und Gesundheit Bericht 01/99

Figure 1: River Monitoring Sites at which Atrazine Concentrations continue to be registered > 0.1 µg/l

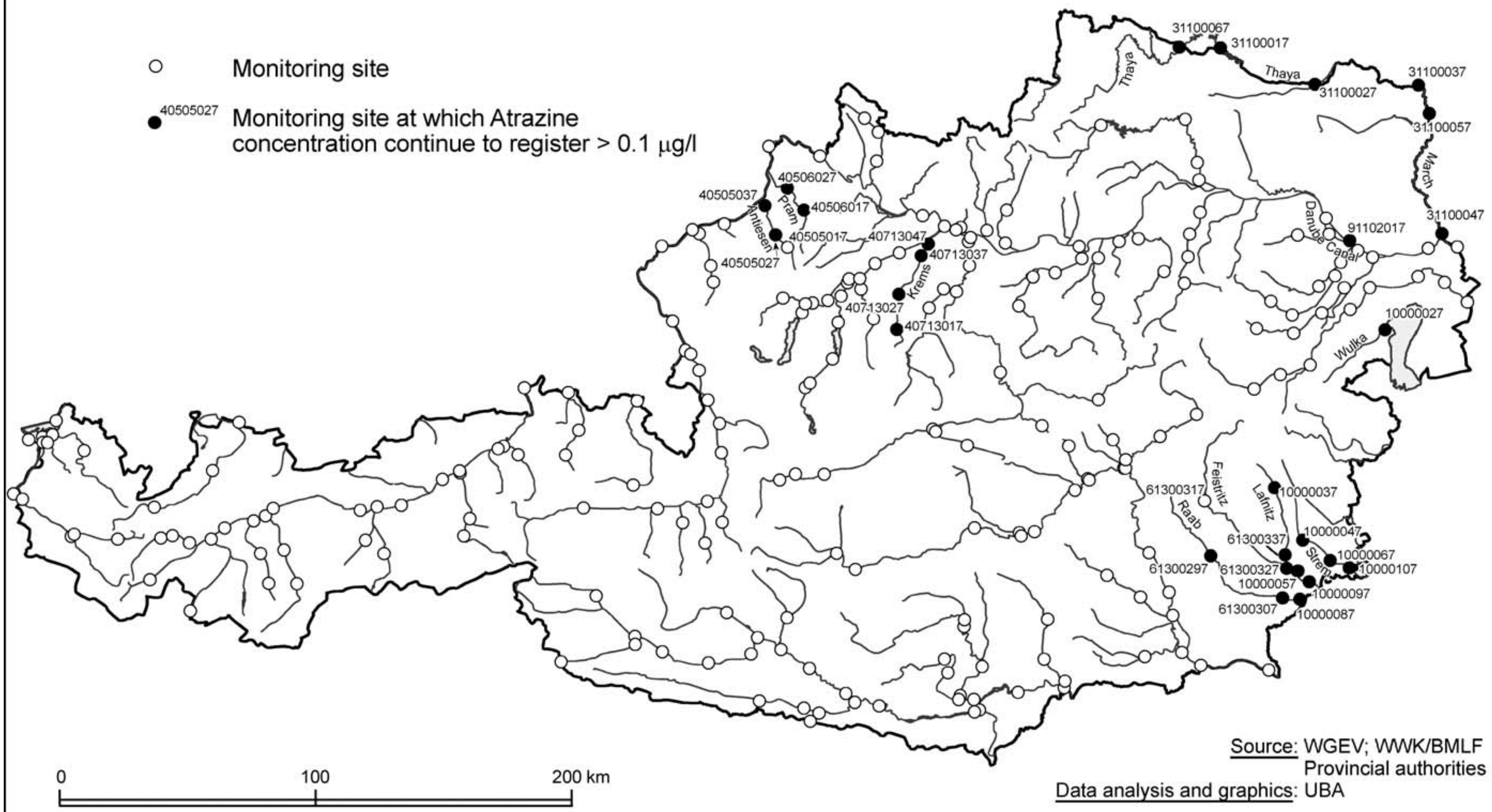
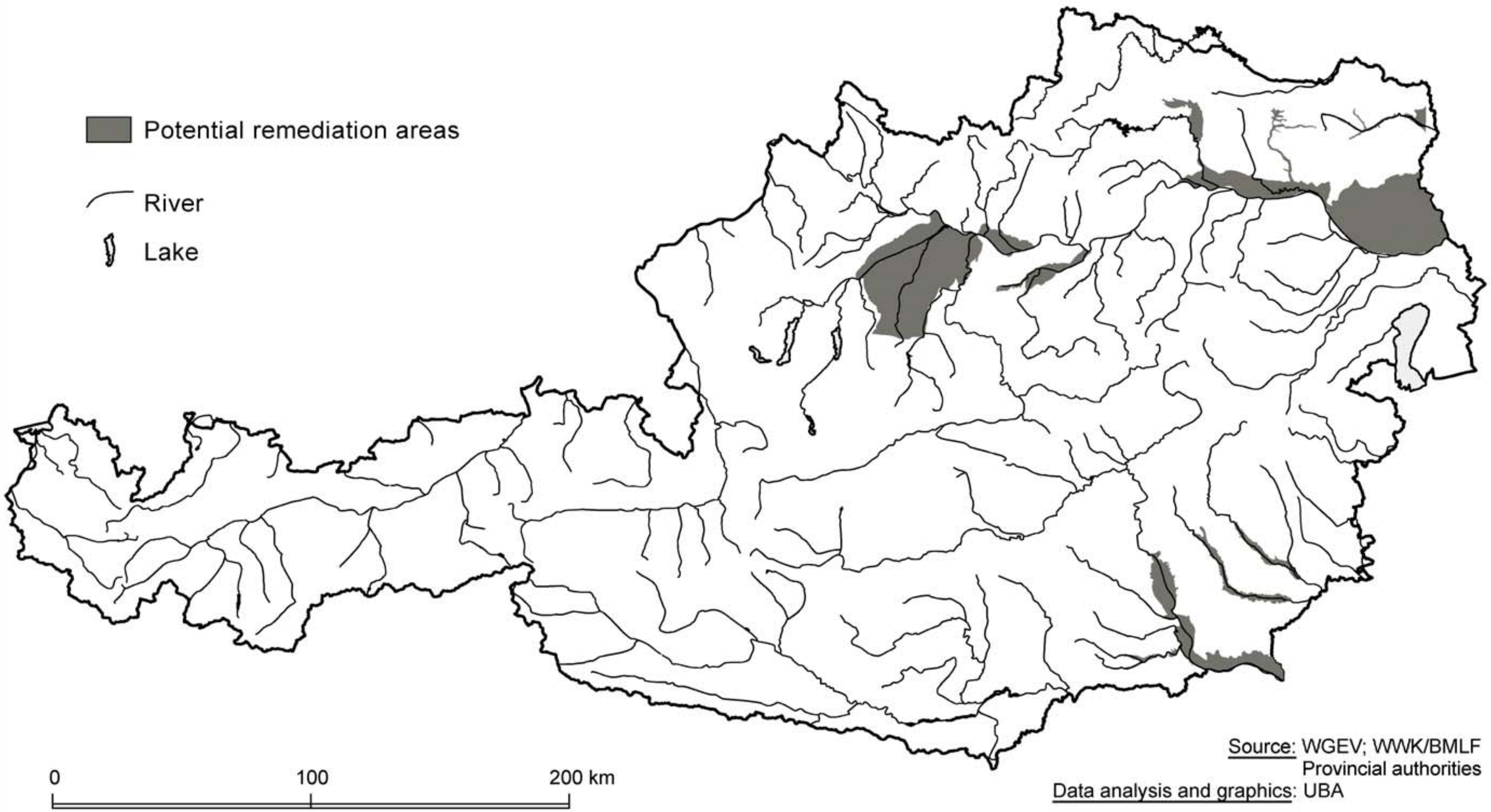


Figure 2: Potential Groundwater Remediation Areas for Atrazine
(Monitoring Period July 1995 to June 1997)



7.1.2 Atmospheric Deposition

Atrazine has been detected in wet deposition in areas of Austria far from those where it would normally be applied and in concentrations that exceed 0.1 µg/l[24]. Although these results only extend to the end of 1995, and as a result are not sufficient to determine whether the atrazine ban has had a noticeable effect or not, it is clear that atrazine is mobile. This could imply that wet deposition could play a role in contributing to the elevated concentrations of atrazine in some surface waters.

However, although the concentrations found in the above study were elevated, it could be hypothesised that the airborne concentrations would decrease following the atrazine ban in the same way as have concentrations in surface waters. This would imply that the impact of elevated atrazine concentrations in these waters through wet deposition is likely to be largely insignificant when compared with other inputs. Nevertheless the possibility of transboundary inputs from other countries where atrazine is still used remains.

7.1.3 Inputs from soil retention or from sediments

It has been found that in certain soils with an elevated clay content atrazine can be stored in the soil for very long periods without degrading[25]. When this is eventually released it will be in the form of atrazine and could contribute to surface water concentrations. However, the mechanisms involved are still poorly understood. Inputs from these soils would, in any case, be localised in their effect and they are likely to contribute only marginally to any concentration and then in only a background role.

There is no evidence to suggest that inputs from river sediments are significant. Sediments are most likely to be activated during periods of high flow. Data from such periods in Austria do not exhibit higher concentrations and if anything the evidence suggests that the concentrations at times of high flow are lower, presumably as a result of dilution.

7.1.4 Inputs from Transboundary Rivers

Of the monitoring sites considered only those along the March and Thaya could have been influenced by water-borne inputs from other countries. In both the Czech and Slovak republics the use of atrazine has not been banned and so could be being used. The likelihood of this being a possible source of pollution is discussed further below.

---

[24] Götz B.; Sattelberger R.;(1999): Anorganische und organische Inhaltsstoffe in der nassen Deposition. Ergebnisse eines österreichweiten Regenmonitoring-Programms von 1990 - 1996. UBA-Report in Vorbereitung. Wien.

[25] Amt der Steiermärksichen Landesregierung (1996) Steiermaärkischer Bodenschutzbericht 1995, Bodenzustandsinventur der Bezirke Leibnitz, Feldbach und Radkersburg

7.1.5 Industrial use of Atrazine

Apart from agriculture the other user of atrazine that could be considered significant is the Austrian Railway Company (ÖBB). However although they used atrazine as part of a herbicide mixture until 1989 they have not used it since.[26] It is therefore very unlikely that they influence the levels of atrazine currently being found. The potential use of atrazine in recreational areas and cemeteries is very difficult to assess and one can only assume that as this would be undertaken under the supervision of the local authorities the application would comply with national legislation.

7.1.6 Agriculture

Atrazine can enter surface waters indirectly via groundwater, by diffuse surface run-off following application, or through the outflows of waste water treatment plants, of these groundwater inputs are likely to be largely insignificant. Inputs to waste water systems are likely to come from point source inputs, usually in the farmyard as a result of machinery cleansing. A study in Germany[27] has shown that the inputs to surface waters from point sources through waste water treatment plant outflows are more significant than surface run-off in terms of their respective contribution to atrazine concentrations. As a result the following breakdown per river will pay attention to the percentage of inhabitants in the local communities who are connected to the sewerage system as well as to the local agriculture, in particular the cultivation of maize. The information on urban waste water collecting systems will be taken from UBA (1996)[28], which is based on information from 1991. It is unlikely that the situation will have changed significantly since then. The information on maize cultivation is on the political "Bezirk" (district) level and is taken from the Austrian Statistical Office (Östat) data for 1995. This information is shown in Figure 3 below. For the analysis of maize cultivation the percentage of maize in the area of land used for arable farming will be considered. This is more relevant that the whole agricultural area as it is likely that when maize is cultivated it will be on the relatively flat land adjacent to a river rather than on the valley slopes.

7.1.6.1 Rivers Antiesen and Pram

As can be seen from Table 5.2 the very elevated concentrations of the early 1990s, which reached up to 1.62 µg/l in 1993, are no longer in evidence. Nevertheless concentrations regularly exceed the 0.1 µg/l limit and the peak values, of up to 0.19 µg/l, appear to correspond to periods of the year in which atrazine would normally be applied.

From the two monitoring sites in the River Antiesen where elevated atrazine concentrations have consistently been found it can be said that the atrazine inputs to the river are occurring beneath the Hohenzell (40505017) monitoring site. In this part of the catchment the percentage

[26] ÖBB, personal communication

[27] Seel, P.; Knepper, T. P.; Gabriel, S.; Weber, A.; Haberer, K.; (1996) Kläranlagen als Haupteintragspfad für Planzenschutzmittel in ein Fließgewässer – Bilanzierung der Einträge, Vom Wasser, 86, 247-262

[28] Umweltbundesamt (1996) Flächennutzungs- und flächenbezogene Daten der österreichischen amtlichen Statistiken mit wasserwirtschaftlicher Relevanz, UBA Wien

of people in each commune who are connected to the sewerage system in the immediate vicinity of the river is between 60 and 100 percent. In 1991 maize was grown on 25-30 % of the arable area in the catchment.

The concentrations in the River Pram are generally slightly higher at the monitoring site at Riedau (40506017) than at Taufkirchen (40506027). This may indicate that the main input of atrazine occurs above Riedau. In the catchment as a whole the percentage of people in each commune who are connected to the sewerage system varies from 0-20 % to 80-100 % with the higher connection rates generally being nearer to the river itself. In 1991 maize was grown on 25-30 % of the arable area.

Figure 3: Maize Cultivation in Austrian Regions with Atrazine Problems in Surface Waters

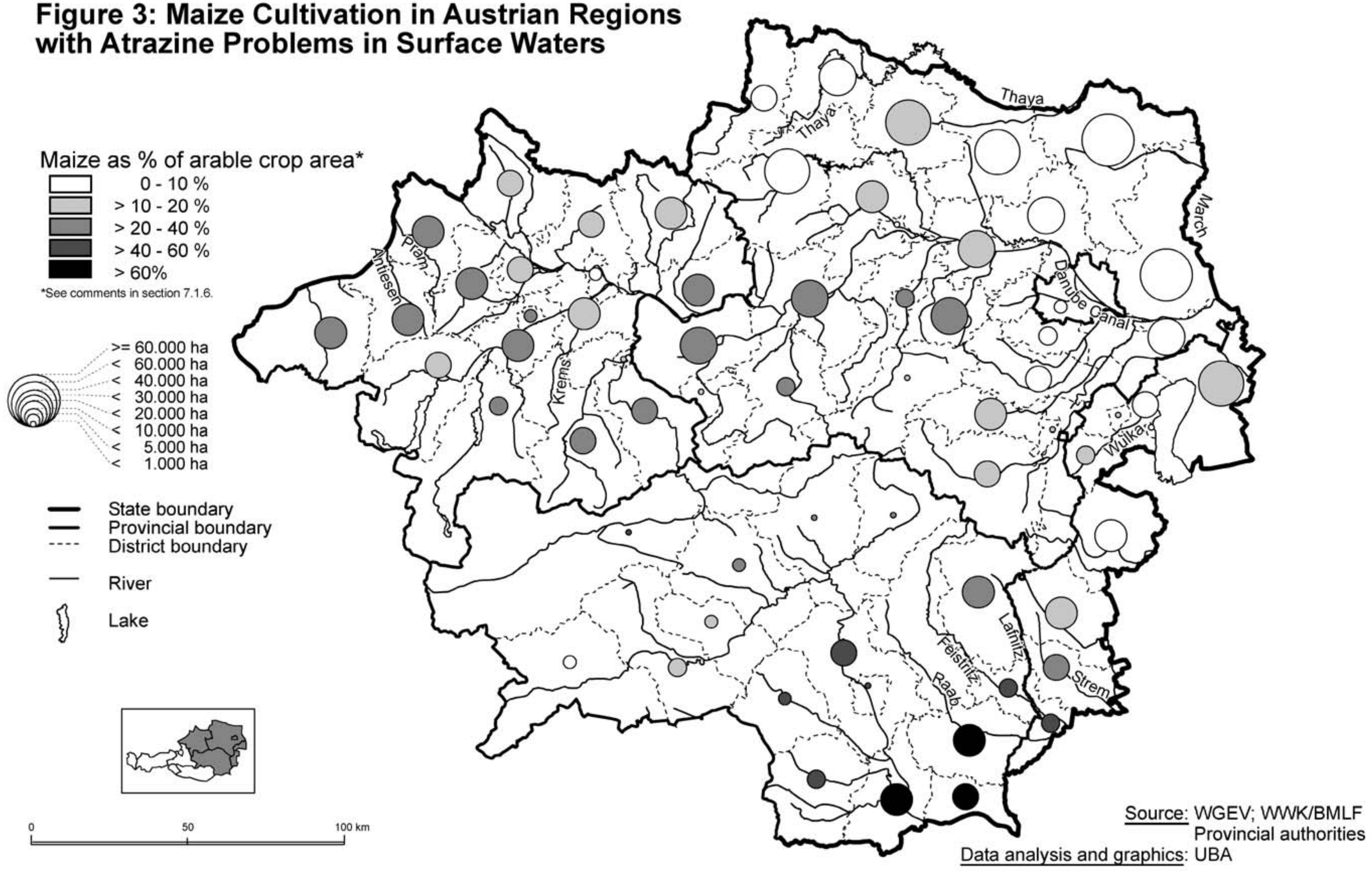
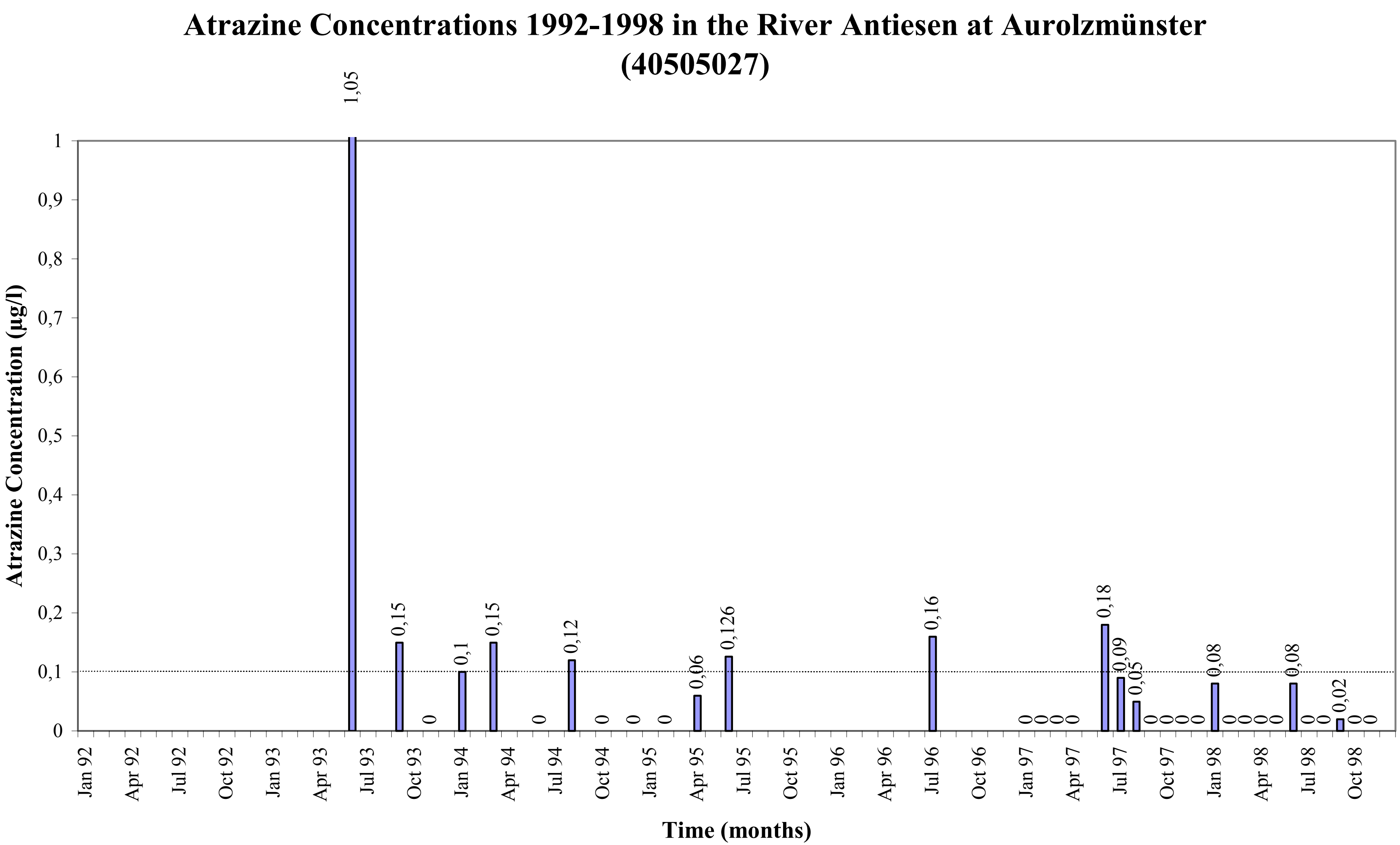


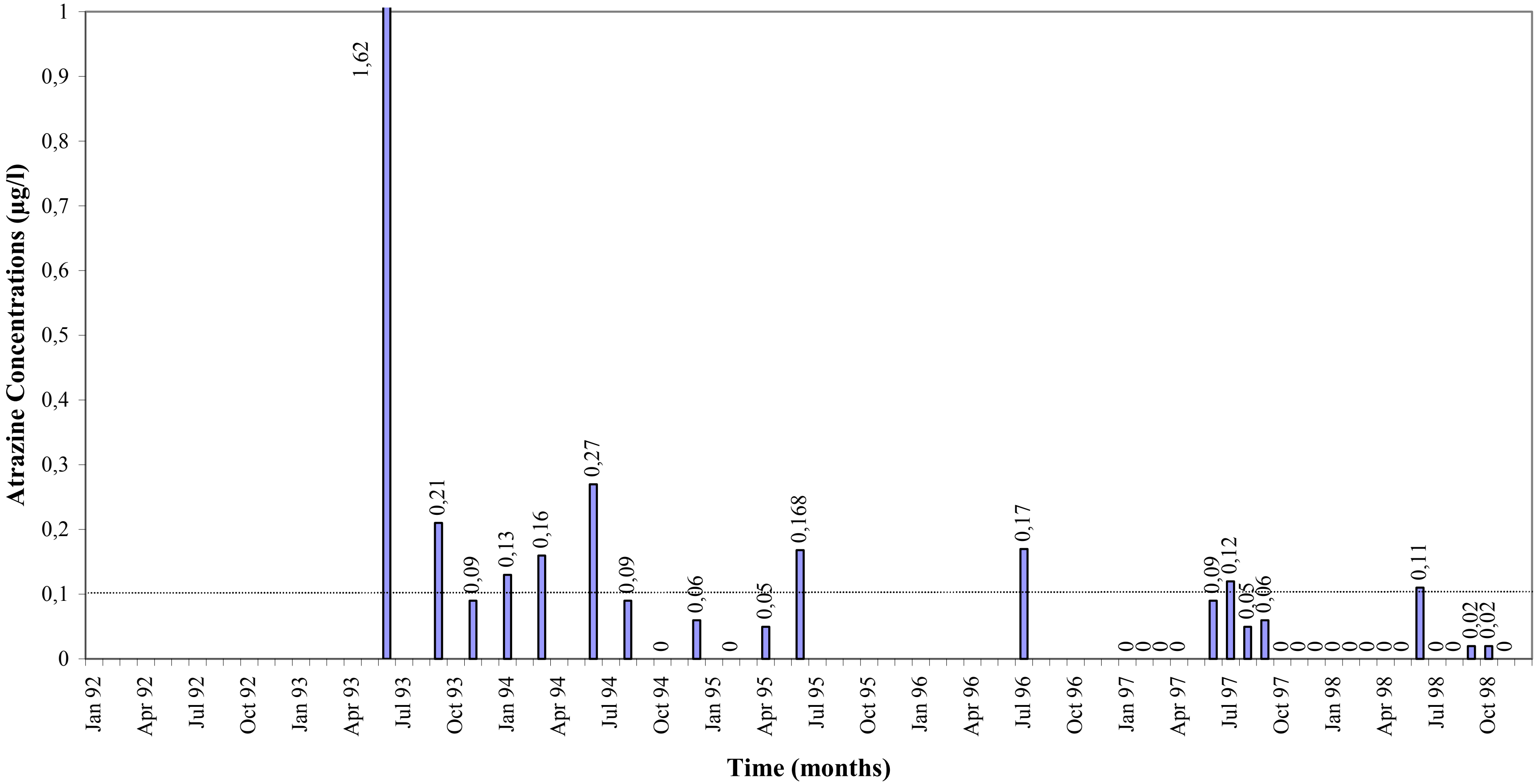
Table 7.2: Rivers Antiesen and Pram

River (Monitoring Site)	Year													
	1992		1993		1994		1995		1996		1997		1998	
	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	0.1 µg/l
Antiesen(40505027)	0	**0**	3	**2**	6	**2**	3	**1**	1	**1**	11	**1**	11	**0**
Antiesen(40505037)	0	**0**	3	**2**	6	**3**	3	**1**	1	**1**	11	**1**	11	**1**
Pram (40506017)	0	**0**	3	**3**	6	**3**	3	**1**	1	**1**	12	**2**	11	**1**
Pram (40506027)	0	**0**	3	**2**	6	**2**	3	**1**	1	**1**	12	**3**	11	**1**

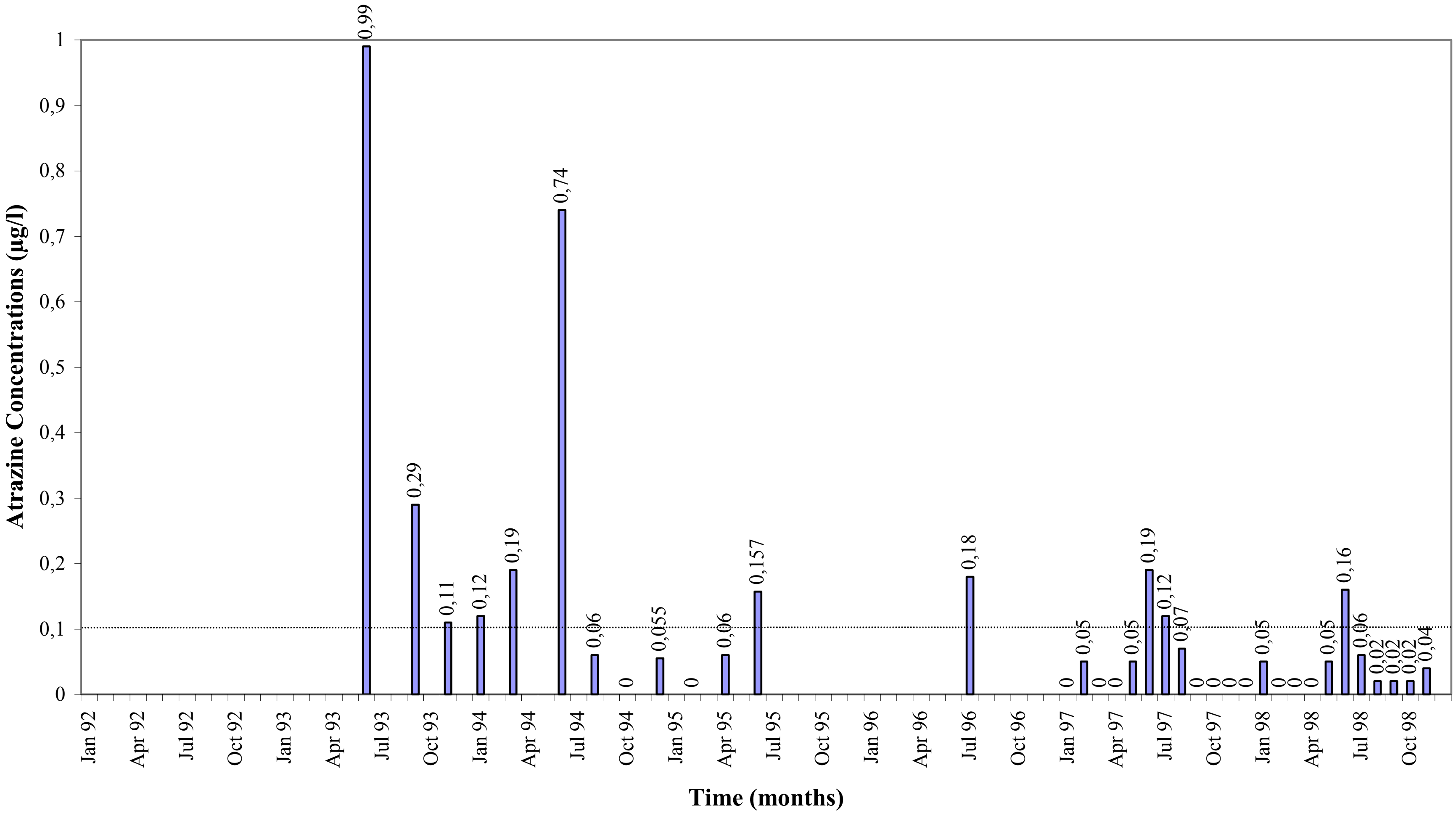
In these two catchments, therefore, it is likely that the inputs of atrazine are from a combination of point and diffuse inputs.


Atrazine Concentrations 1992-1998 in the River Antiesen at Aurolzmünster
(40505027)
Atrazine Concentration (µg/l)
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1,05
0,15
0
0,1
0,15
0
0,12
0
0
0
0,06
0,126
0,16
0 0 0 0
0,18
0,09
0,05
0 0 0 0
0,08
0 0 0 0
0,08
0 0
0,02
0 0
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98
Time (months)

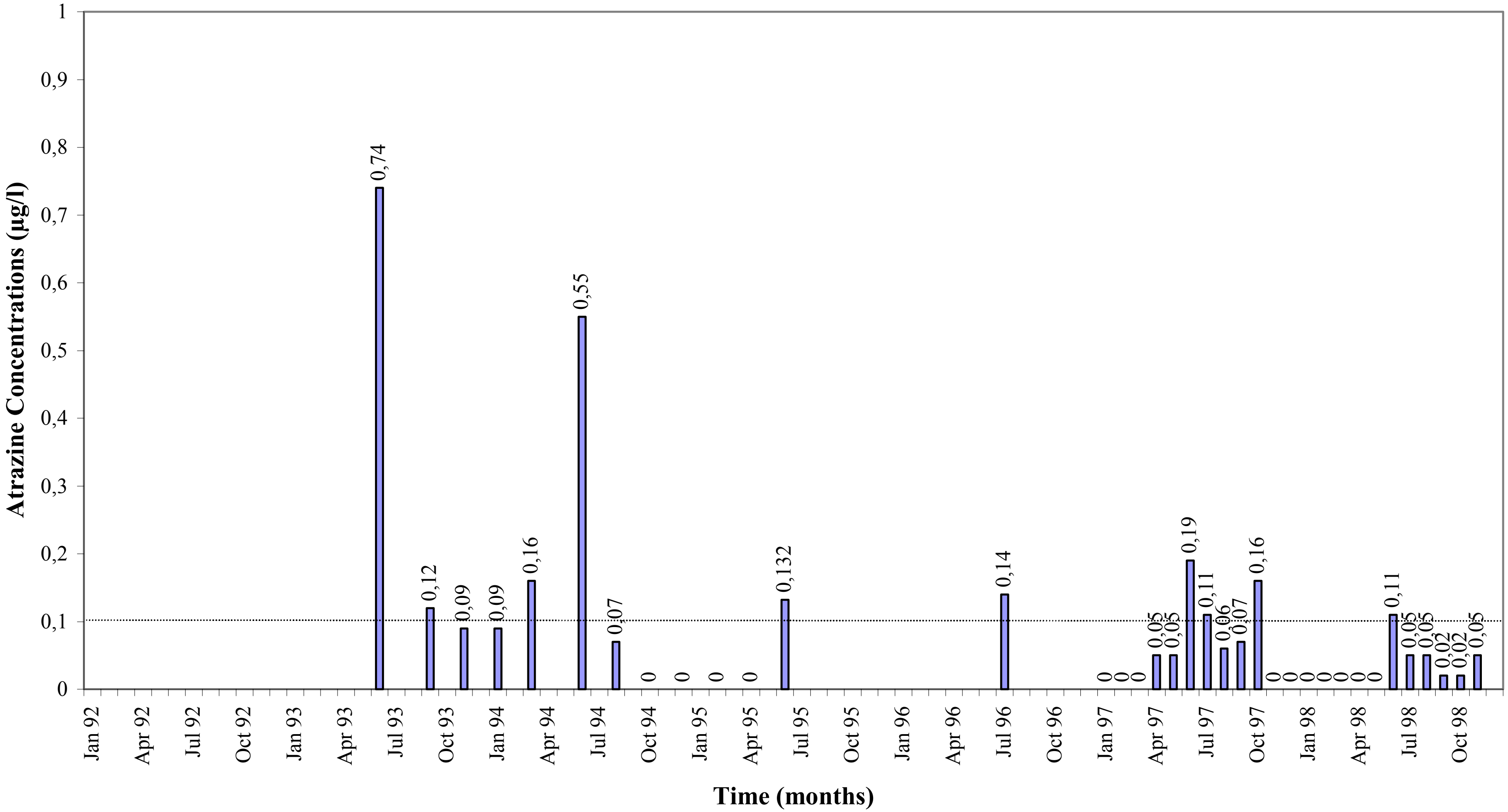
Atrazine Concentrations 1992-1998 in the River Antiesen at Antiesenhofen (40505037)



Atrazine Concentrations 1992-1998 in the River Pram at Riedau (40506017)



Atrazine Concentrations 1992-1998 in the River Pram at Taufkirchen (40506027)



7.1.6.2 March and Thaya

From the results presented below in Table 5.3 it is evident that the very high values of the early 1990s, reaching as high as 1.7 µg/l, are no longer in evidence. Generally it would seem that the levels are not increasing and in some instances are decreasing. However, the absence of available data at most of the monitoring sites during 1998 hinders the detection of a trend. Furthermore the failure on certain occasions to monitor during the times of year when atrazine would be applied also makes analysis more difficult.

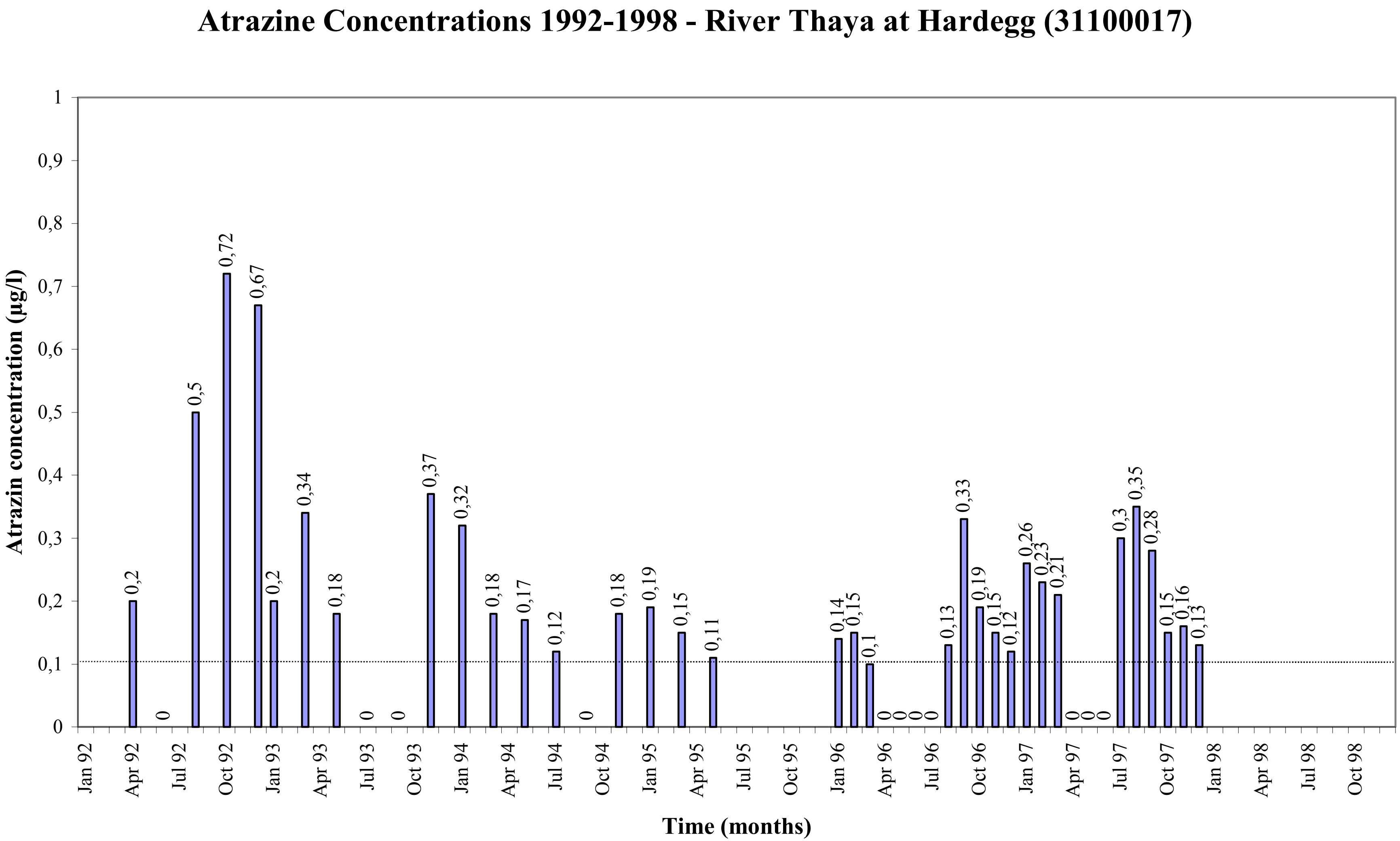
Table 7.3: Rivers March and Thaya

River (Monitoring Site)	Year													
	1992		1993		1994		1995		1996		1997		1998	
	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	0.1 µg/l
Thaya 31100017	5	**4**	6	**4**	6	**5**	3	**3**	12	**7**	12	**9**	0	**0**
Thaya 31100027	6	**6**	6	**4**	6	**4**	3	**2**	12	**8**	6	**4**	0	**0**
Thaya 31100037	6	**6**	6	**5**	3	**2**	3	**1**	11	**6**	11	**7**	0	**0**
March 31100047	12	**10**	11	**7**	11	**5**	12	**3**	6	**1**	12	**5**	0	**0**
March 31100057	6	**4**	6	**2**	5	**3**	3	**2**	10	**4**	11	**7**	0	**0**
Thaya 31100067	0	**0**	2	**2**	4	**2**	6	**2**	2	**0**	0	**0**	6	**1**

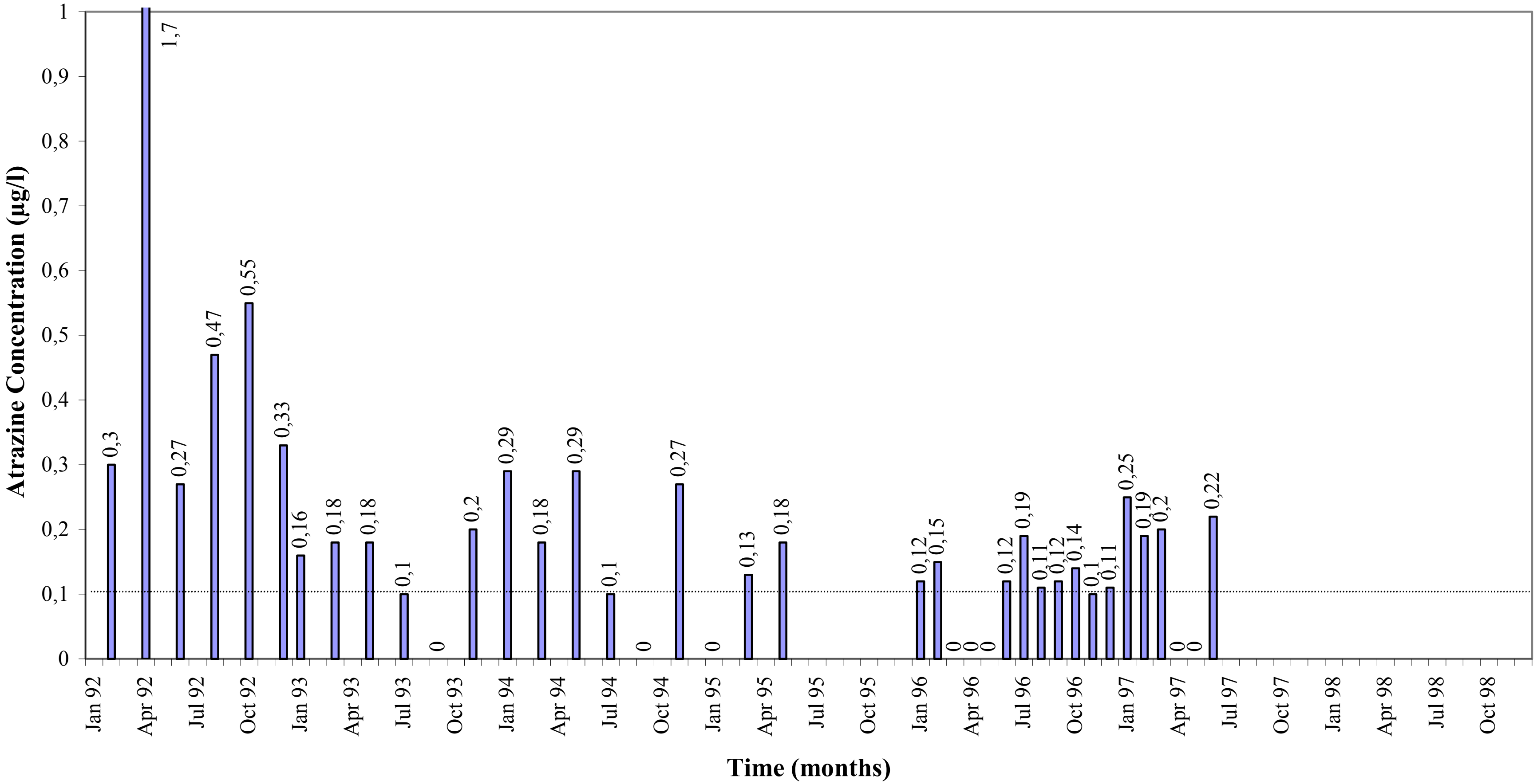
15 % of the catchment of the March and Thaya is situated in Austrian territory[29]. In this area the agriculture is, with the exception of the Waldviertel, intensive. However, maize production is relatively unimportant and in 1995 only constituted more than 10 % of the agricultural area in one Bezirk (Horn – 10.08 %). The percentage of connections to the sewerage system varies between 40 and 100 % with levels generally being greatest in the most agriculturally intensive areas of the Marchfeld and Pulkau valley and least in the less intensive areas such as the Waldviertel.

From the analysis produced it is difficult to identify areas in the Austrian catchment where the atrazine in these rivers may be originating as the maize cultivation is lower than in the catchments of other Austrian rivers exhibiting atrazine pollution. In addition available information on the agricultural systems and atrazine use in the Czech and Slovak parts of the catchment is scant. It is therefore difficult to assess the contribution that these parts of the catchment might make to the total concentration.

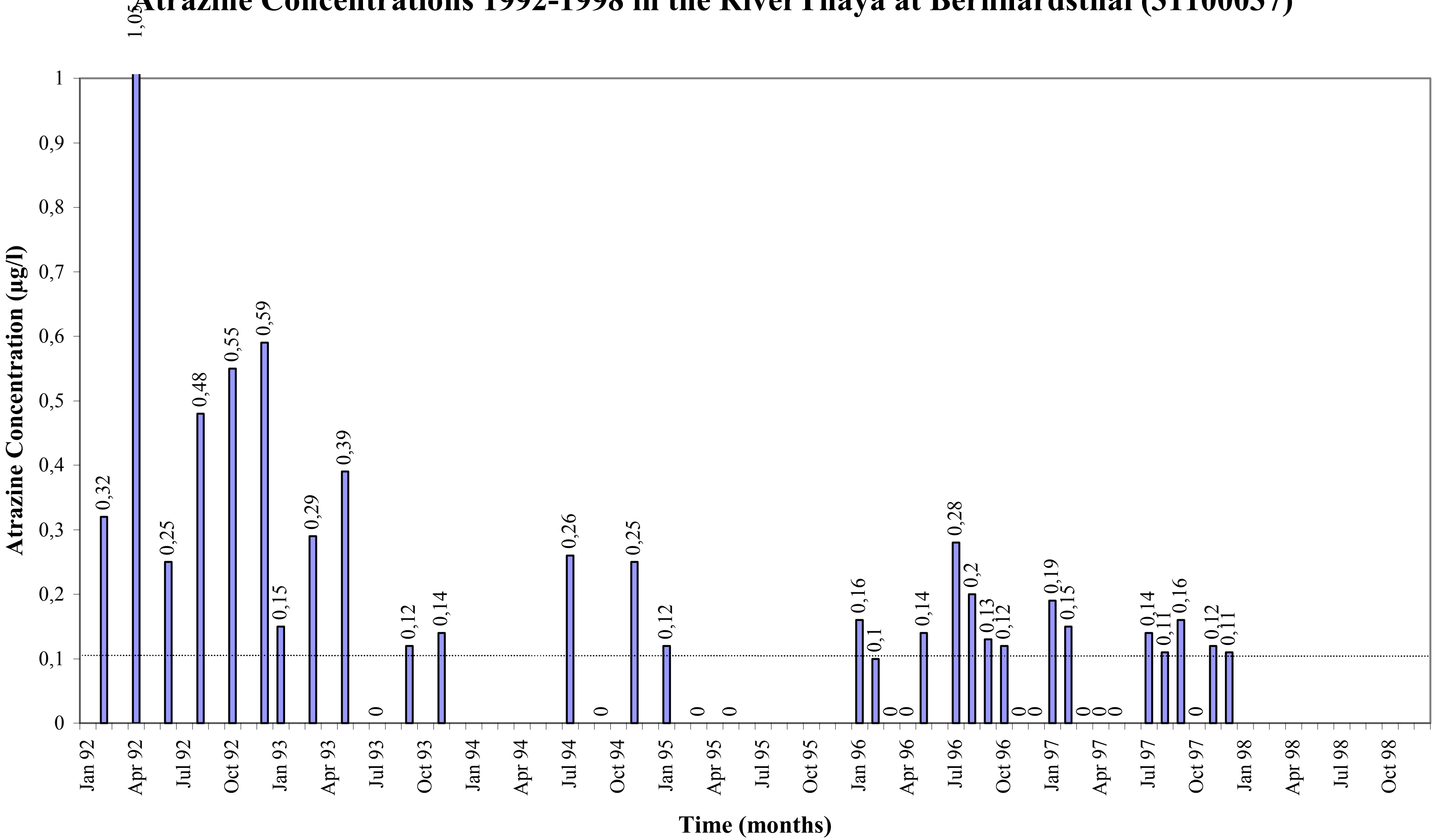
[29] Bundesministerium für Land- und Forstwirtschaft (1997) Wassergüte in Österreich, Jahresbericht 1994, p D75


Atrazine Concentrations 1992-1998 - River Thaya at Hardegg (31100017)
Atrazin concentration (µg/l)
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0,2
0
0,5
0,72
0,67
0,2
0,34
0,18
0
0
0,37
0,32
0,18
0,17
0,12
0
0,18
0,19
0,15
0,11
0,14
0,15
0,1
0
0
0
0
0,13
0,33
0,19
0,15
0,12
0,26
0,23
0,21
0
0
0
0,3
0,35
0,28
0,15
0,16
0,13
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98
Time (months)

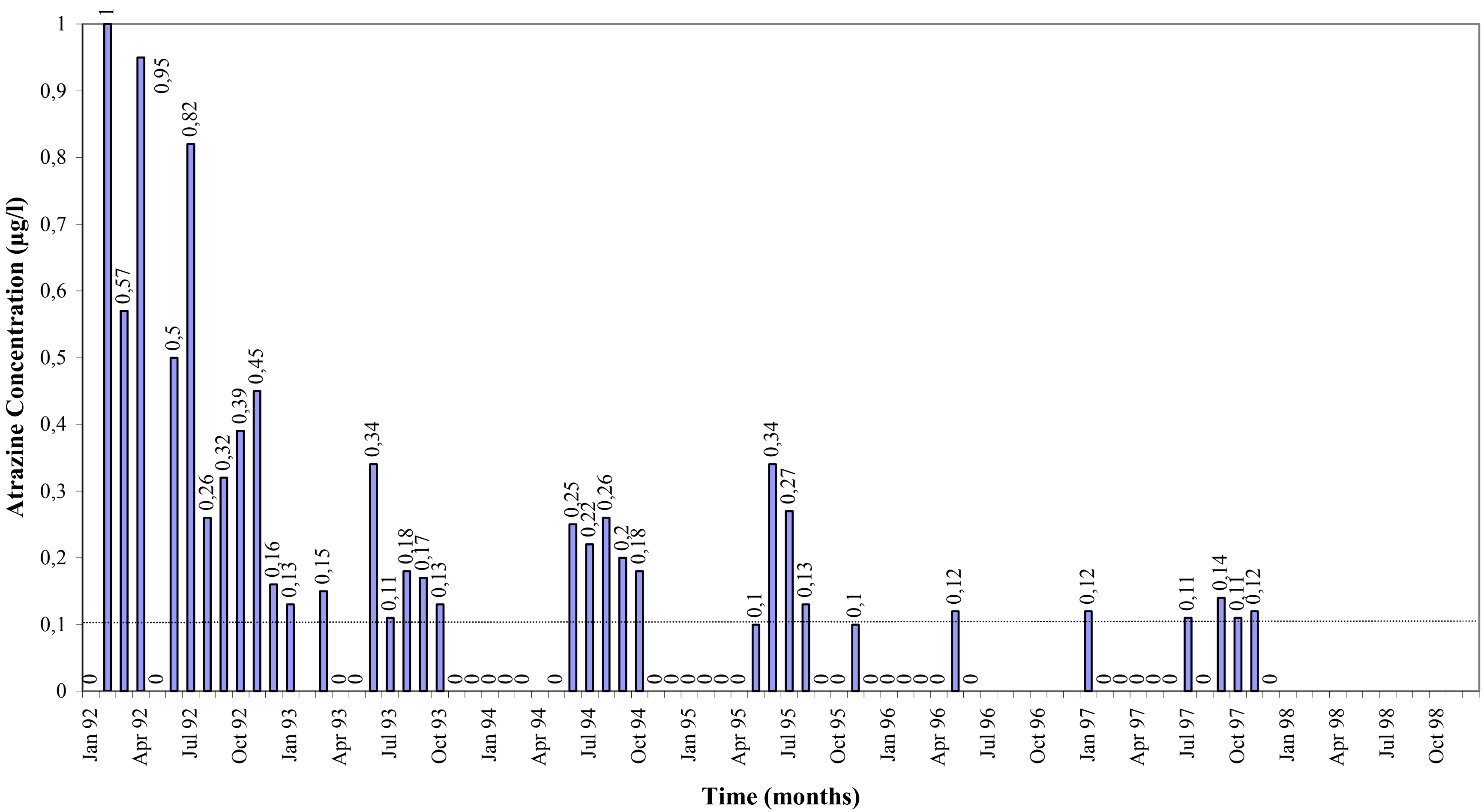
Atrazine Concentrations 1992-1998 in the River Thaya at Laa an der Thaya (31100027)



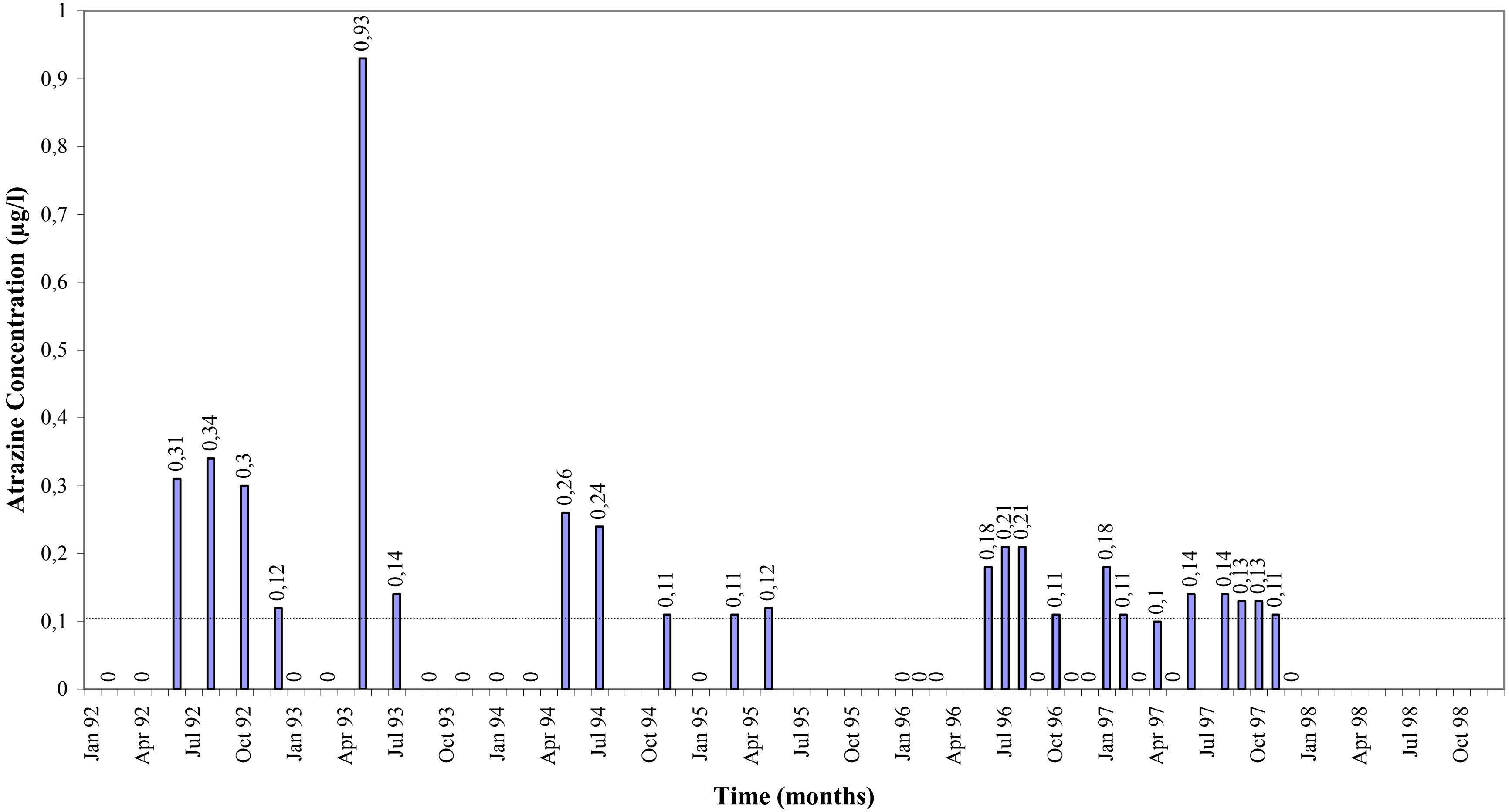
Atrazine Concentrations 1992-1998 in the RiverThaya at Bernhardsthal (31100037)



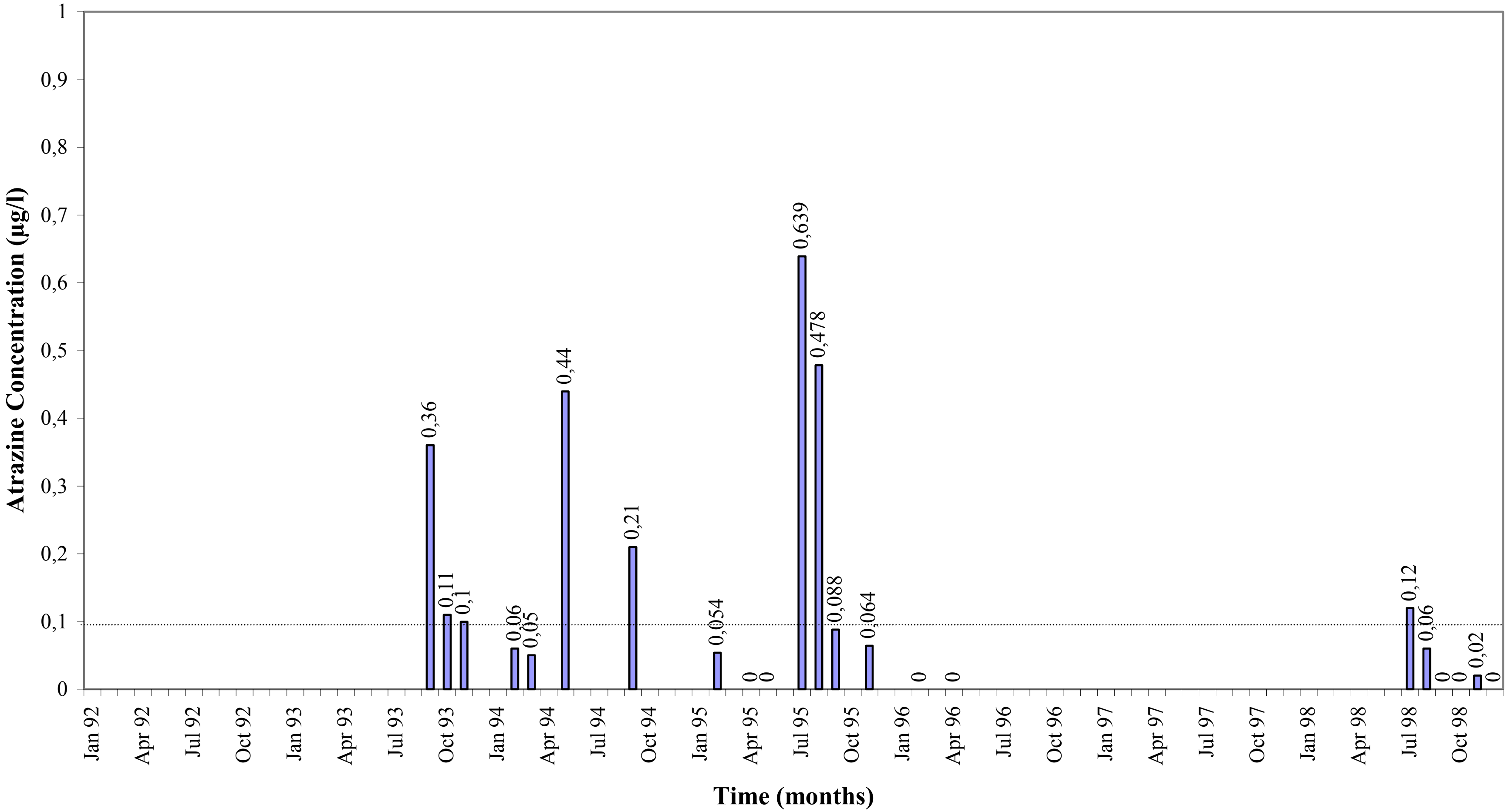
Atrazine Concentrations in the River March at Engelhardstetten (31100047)



Atrazine Concentrations 1992-1998 in the River March at Hohenau (31100057)



Atrazine Concentrations 1992-1998 in the Thaya at Drosendorf (31100067)



7.1.6.3 Rivers Feistritz, Lafnitz, Raab, Strem and Wulka

It can be seen from Table 5.4 and the diagrams below that although the very elevated concentrations of the early 1990s, which rose to levels of 3.05 µg/l, are no longer in evidence the levels in many of these rivers remain elevated. It is also important to note the absence of results for 1998 at many of the monitoring sites where the limit value was exceeded in 1997 and that at other monitoring sites where the limit value was exceeded in 1998 the levels were not exceeded in 1997. This would suggest that problems are persisting.

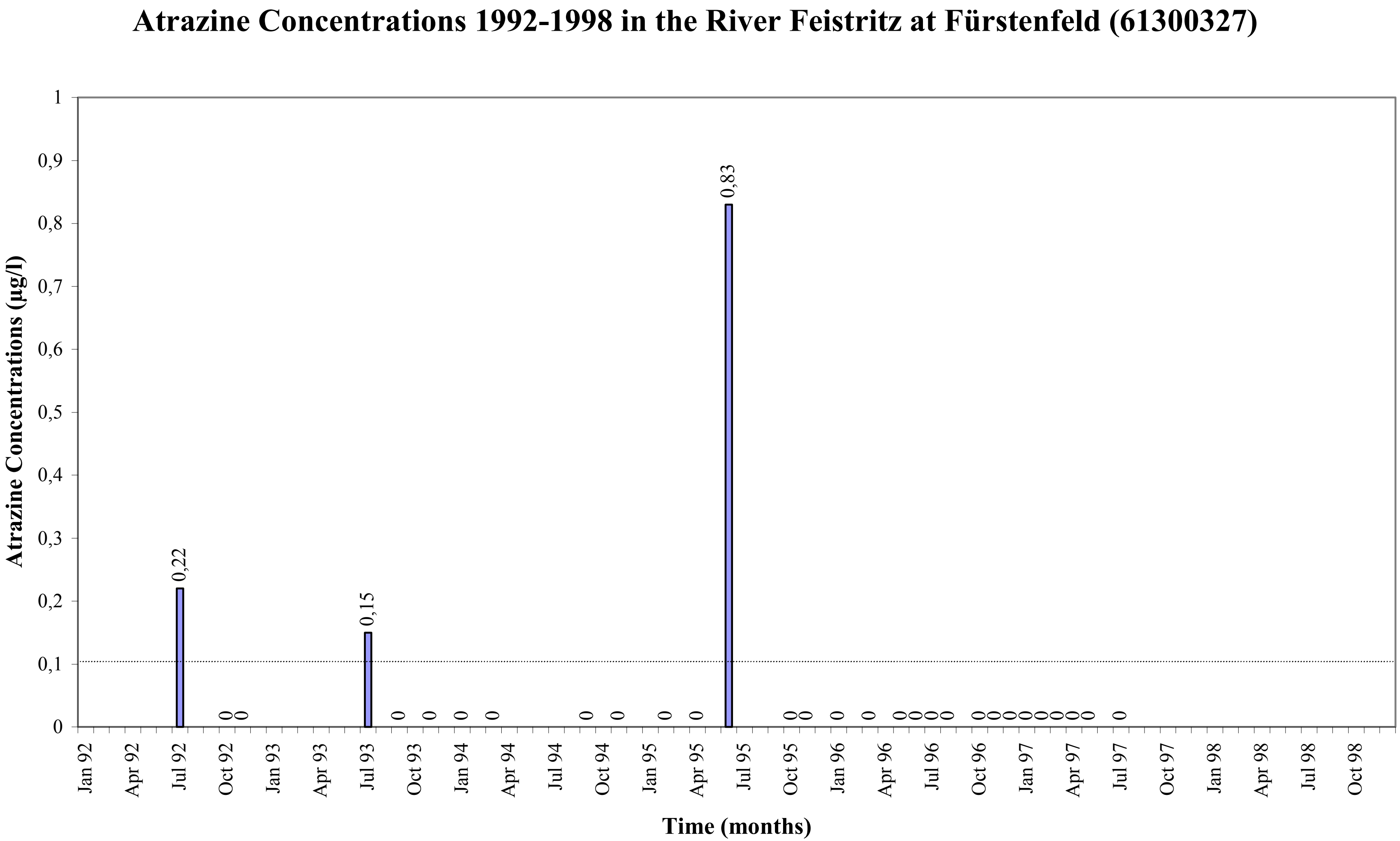
For the River Feistritz it is clear from the results of the monitoring sites that the inputs are likely to occur downstream of Anger (61300317) as the atrazine concentrations at this site are negligible. The region downstream of this site is characterised by small farmers farming intensively. Maize accounts for between 30 and 60 percent of the agricultural area. In addition the percentage of connections to the sewerage system is low at between 0-20 %. This would suggest that the main input is from surface run-off.

In the River Lafnitz the inputs occur downstream of Hammerkastell. The agricultural use is similar to that of the Feistritz catchment but the percentage of connections to the sewerage system is generally higher. The cultivation of maize accounts for between roughly 15 and 35 percent of the agricultural area in the catchment.

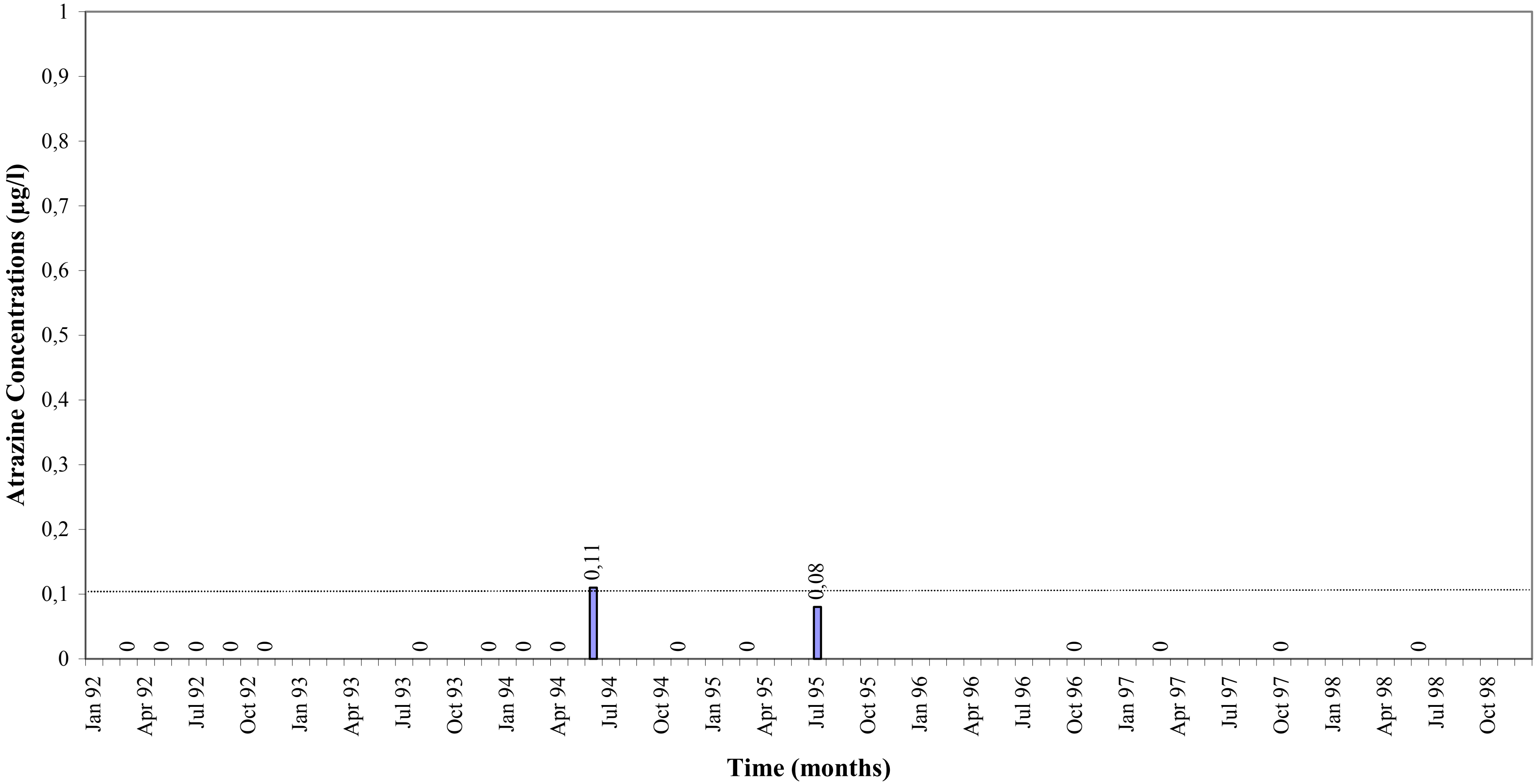
Table 7.4: Rivers Feistritz, Lafnitz, Raab, Strem and Wulka

River (Monitoring Site)	Year													
	1992		1993		1994		1995		1996		1997		1998[30]	
	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	0.1 µg/l
Feistritz (61300327)	3	**1**	3	**1**	5	**0**	6	**1**	9	**0**	6	**0**	0	**0**
Lafnitz (10000037)	5	**0**	2	**0**	4	**1**	2	**0**	1	**0**	2	**0**	1	**0**
Lafnitz (61300337)	3	**1**	3	**1**	5	**0**	6	**1**	9	**0**	6	**1**	0	**0**
Lafnitz (10000057)	5	**1**	2	**0**	4	**1**	2	**1**	1	**0**	2	**0**	1	**1**
Lafnitz (10000097)	6	**2**	6	**2**	3	**1**	6	**0**	12	**0**	7	**1**	0	**0**
Raab (61300297)	3	**1**	3	**0**	5	**0**	6	**0**	9	**1**	6	**0**	0	**0**
Raab (61300307)	3	**2**	3	**2**	5	**0**	6	**1**	9	**0**	6	**0**	0	**0**
Raab (10000087)	6	**3**	3	**1**	6	**2**	6	**1**	12	**0**	7	**1**	0	**0**
Strem (10000047)	5	**1**	2	**0**	4	**1**	2	**1**	1	**0**	2	**0**	1	**1**
Strem (10000067)	5	**2**	2	**1**	4	**4**	2	**2**	1	**0**	2	**1**	1	**1**
Strem (10000107)	6	**4**	6	**2**	6	**4**	6	**2**	12	**2**	6	**2**	0	**0**
Wulka (10000027)	5	**1**	2	**1**	4	**2**	2	**2**	1	**0**	2	**0**	1	**1**

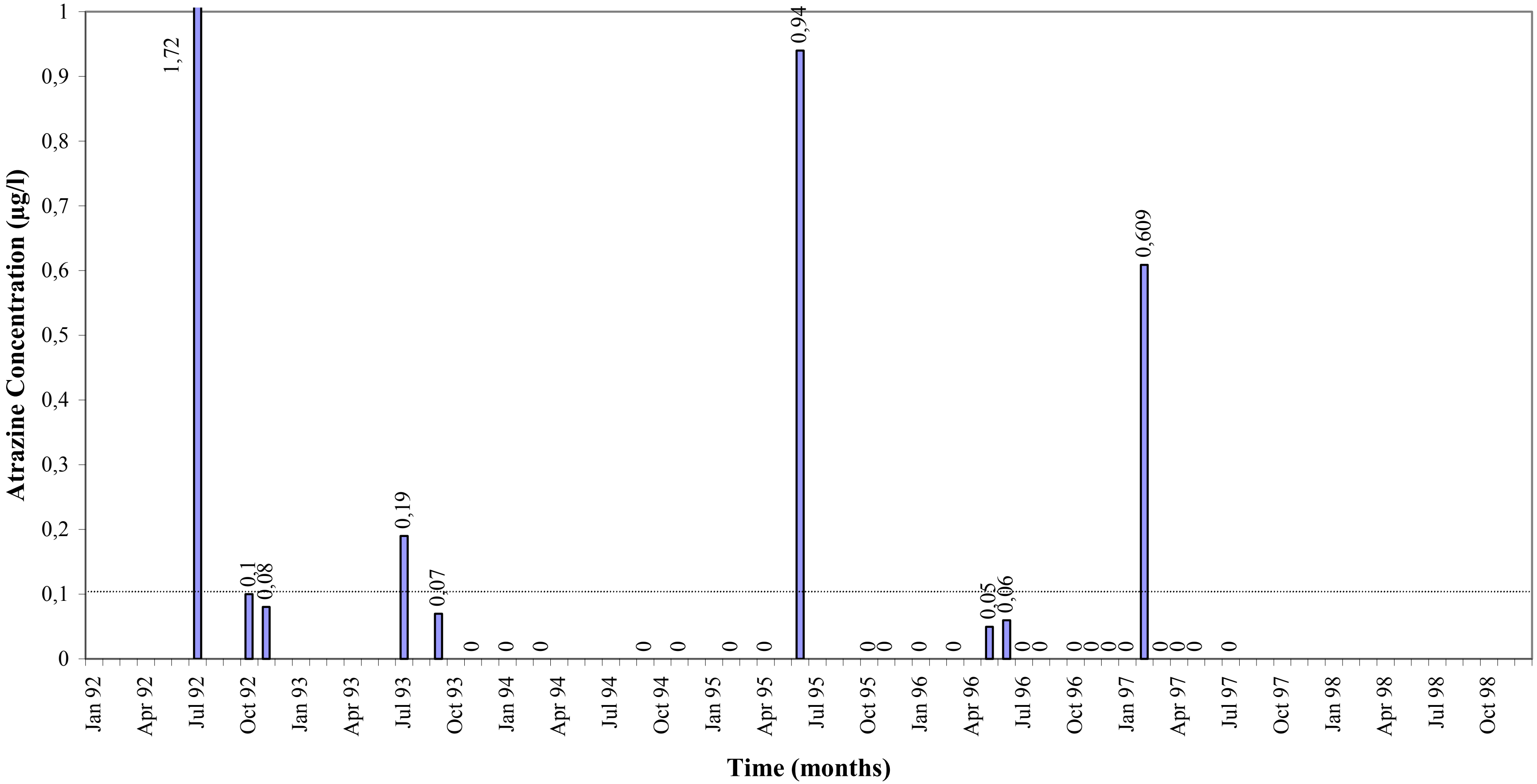
[30] see footnote 22 above


Atrazine Concentrations 1992-1998 in the River Feistritz at Fürstenfeld (61300327)
Atrazine Concentrations (µg/l)
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0,22
0,15
0,83
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98
Time (months)

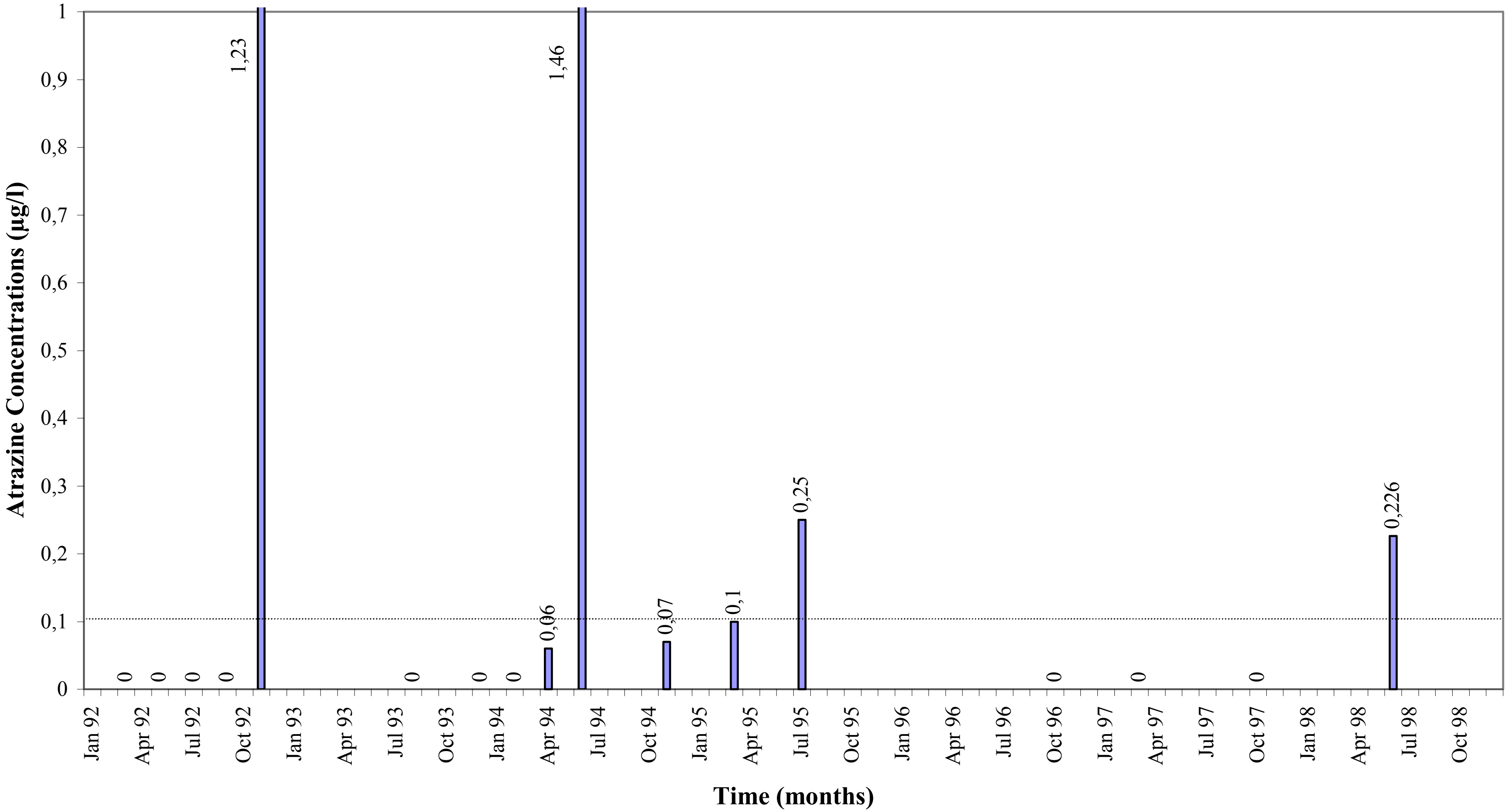
Atrazine Concentrations 1992-1998 in the River Lafnitz at Hammerkastell (10000037)

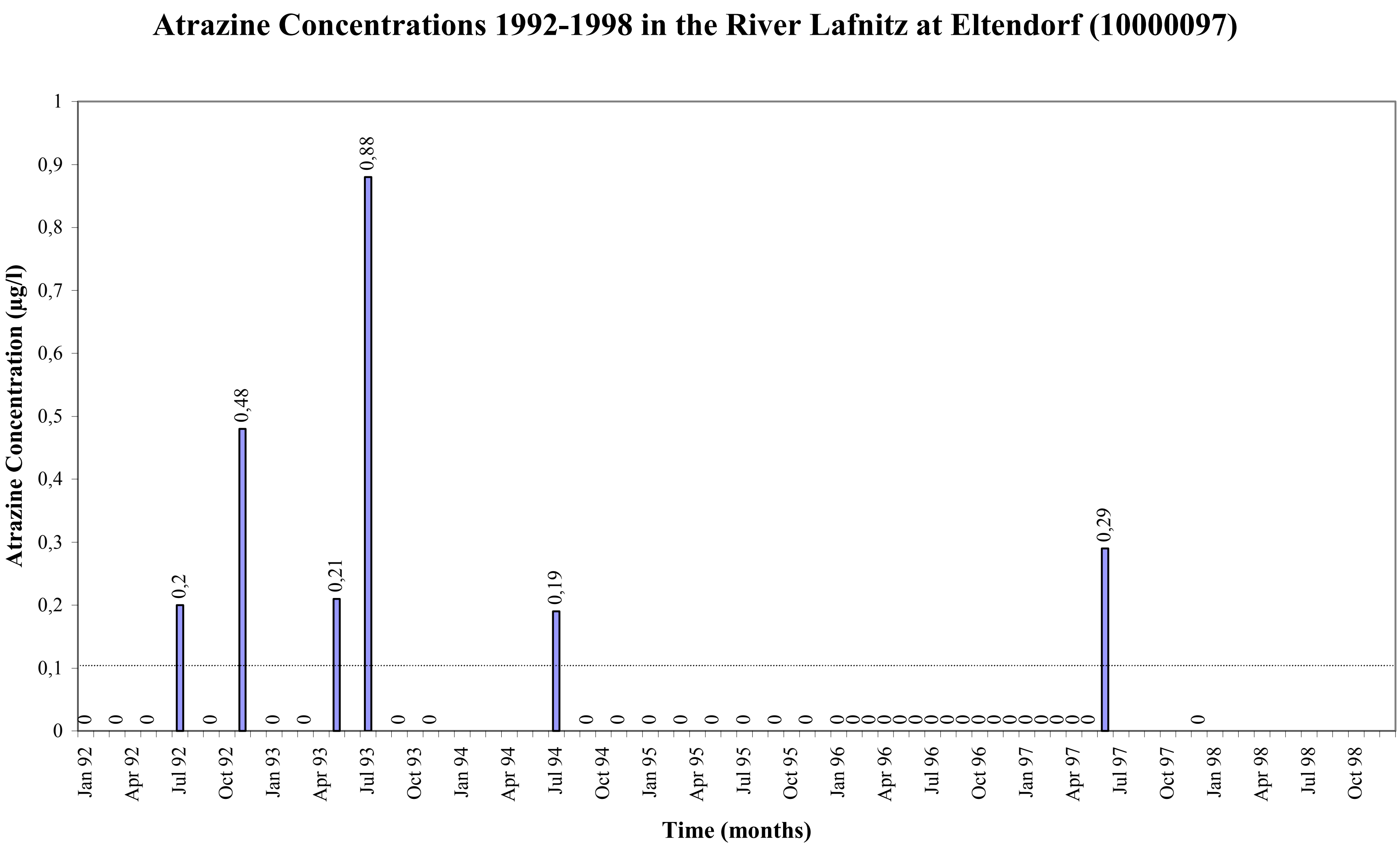


Atrazine Concentrations 1992-1998 in the River Lafnitz at Altenmarkt bei Fürstenfeld (61300337)



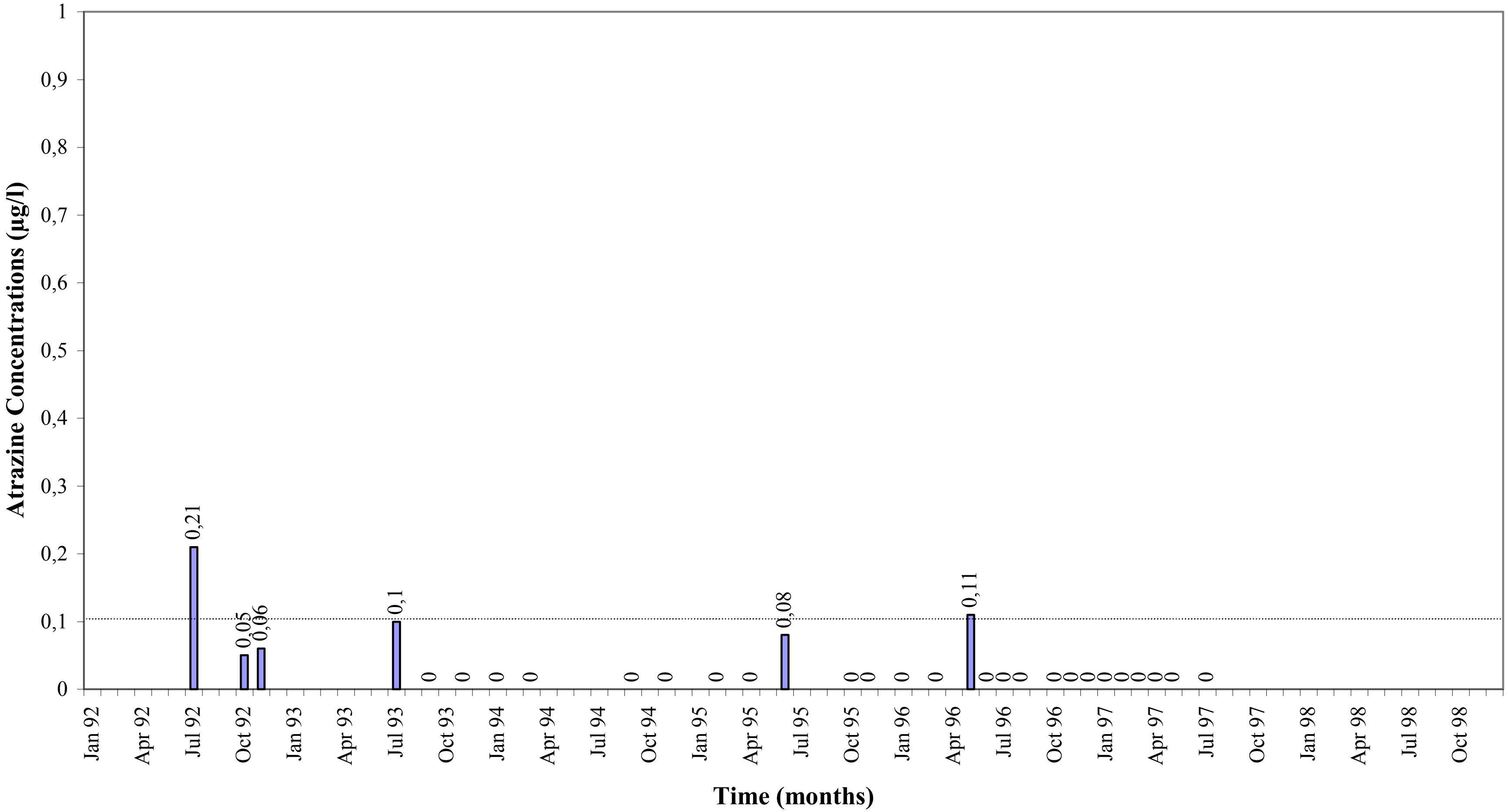
Atrazine Concentrations 1992-1998 in the River Lafnitz at Dobersdorf (10000057)



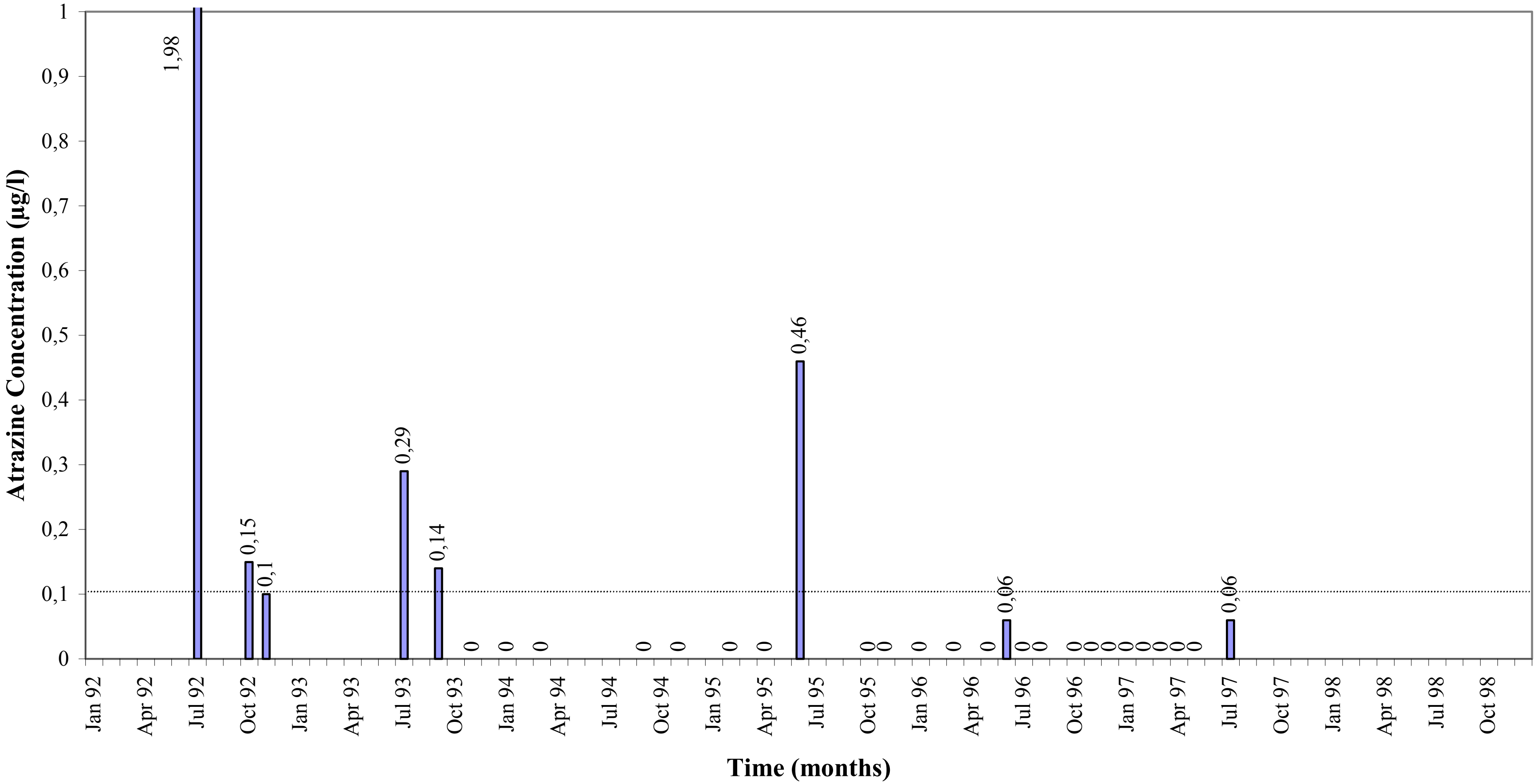

Atrazine Concentrations 1992-1998 in the River Lafnitz at Eltendorf (10000097)
Atrazine Concentration (µg/l)
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0,2
0,48
0,21
0,88
0,19
0,29
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98
Time (months)

In the Raab catchment, although atrazine has been detected at all the monitoring sites since the ban, the main inputs appear to be downstream of Hohenbrugg (613000307). Again the agricultural structure is similar to that in the Feistritz and Lafnitz catchments with significant maize cultivation at between roughly 40 and 70 percent of the agricultural area. The percentage of connections to the sewerage system is varied but on average is roughly between 40 and 60.

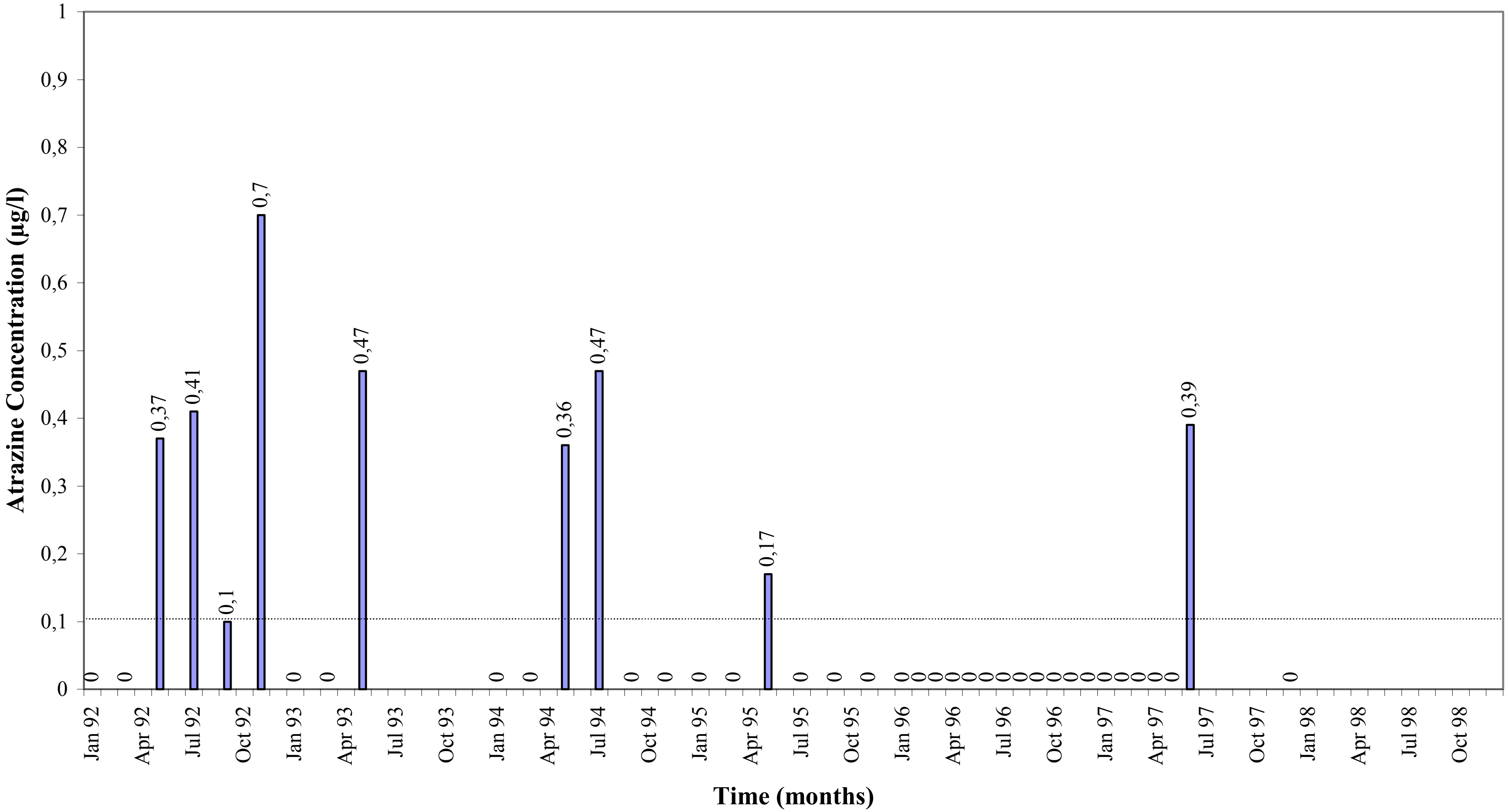
Atrazine Concentrations 1992-1998 in the River Raab at Gleisdorf (61300297)



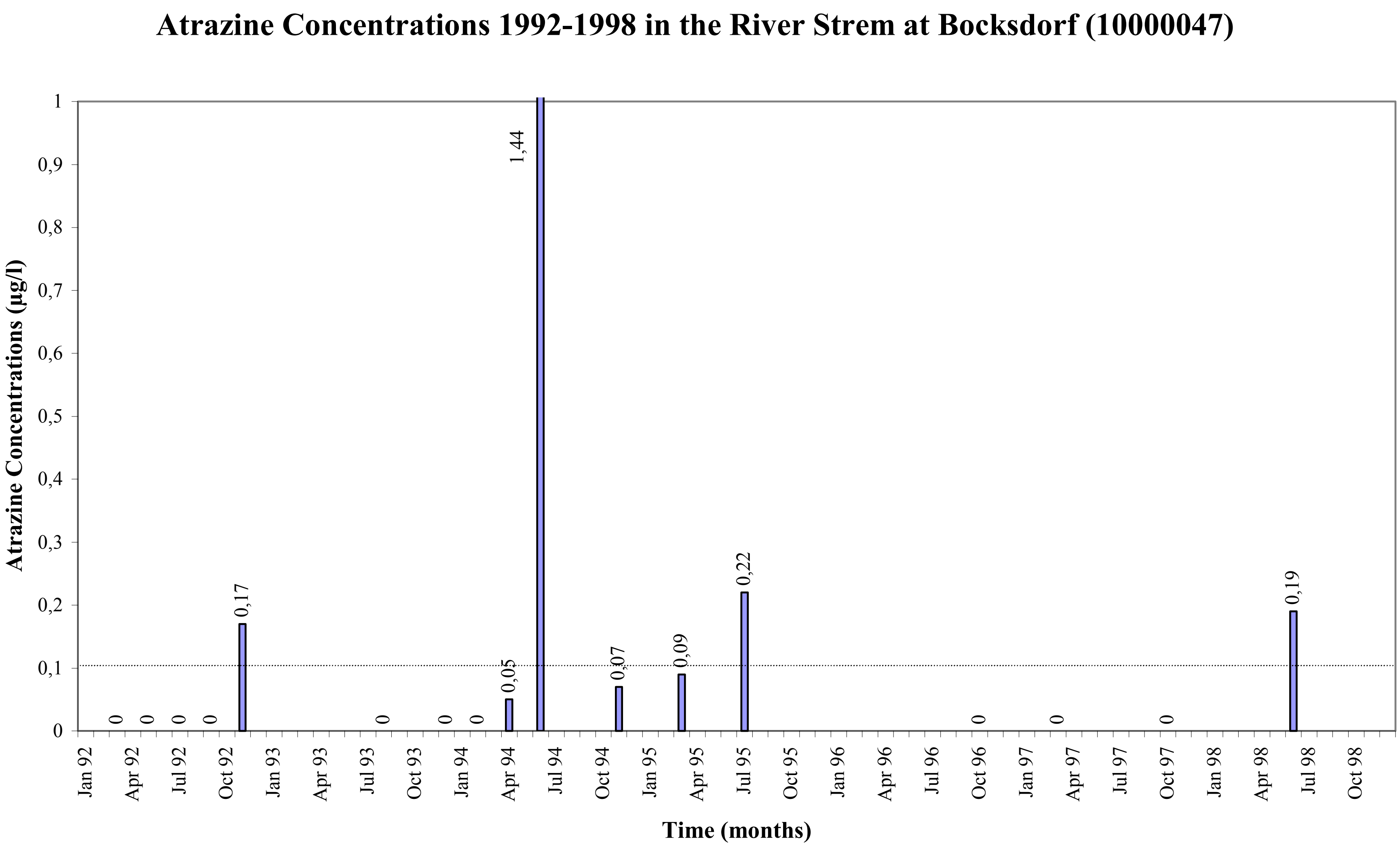
Atrazine Concentrations 1992-1998 in the River Raab at Hohenbrugg Weinsb. (613000307)



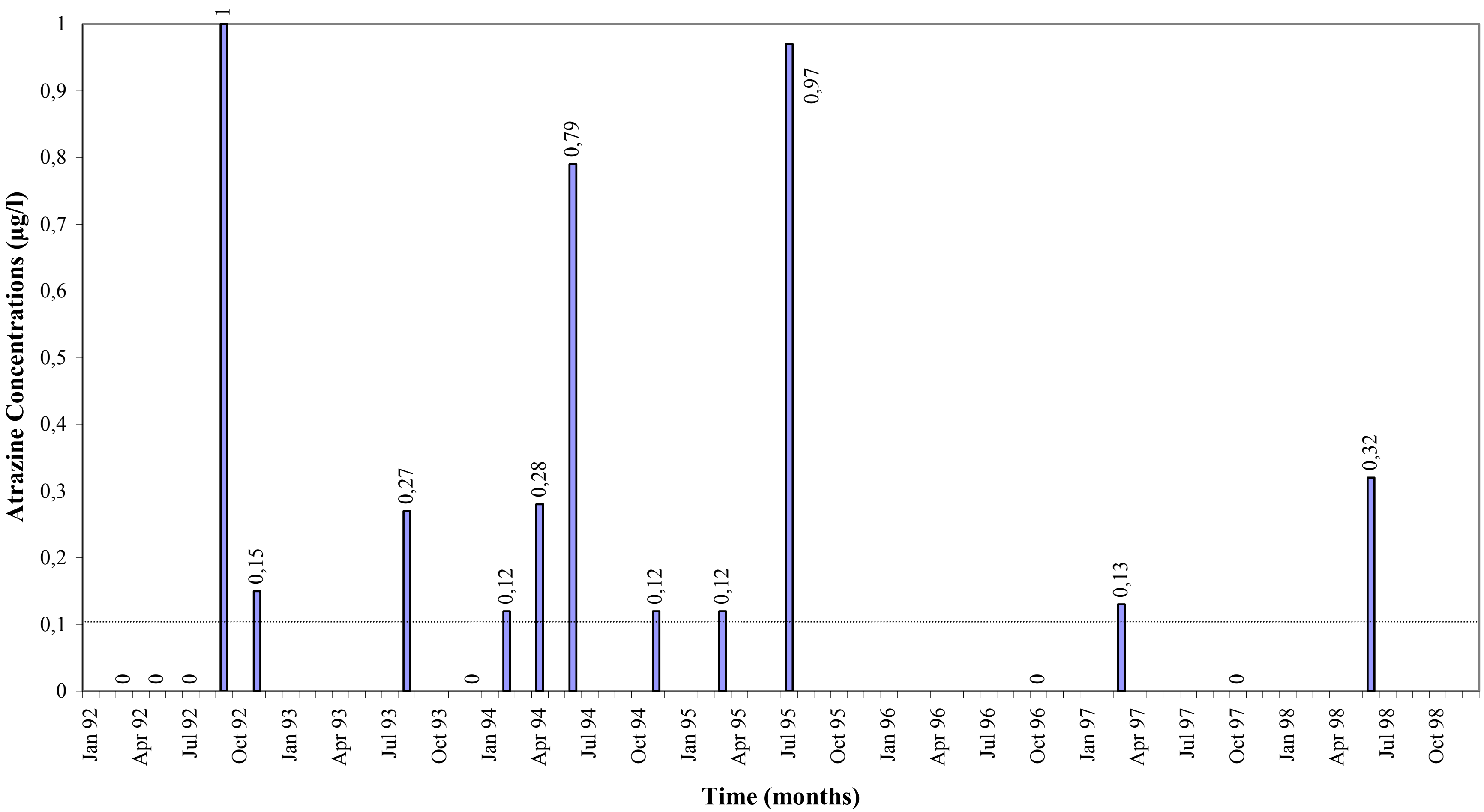
Atrazine Concentrations 1992-1998 in the River Raab at Vossenwehr (10000087)



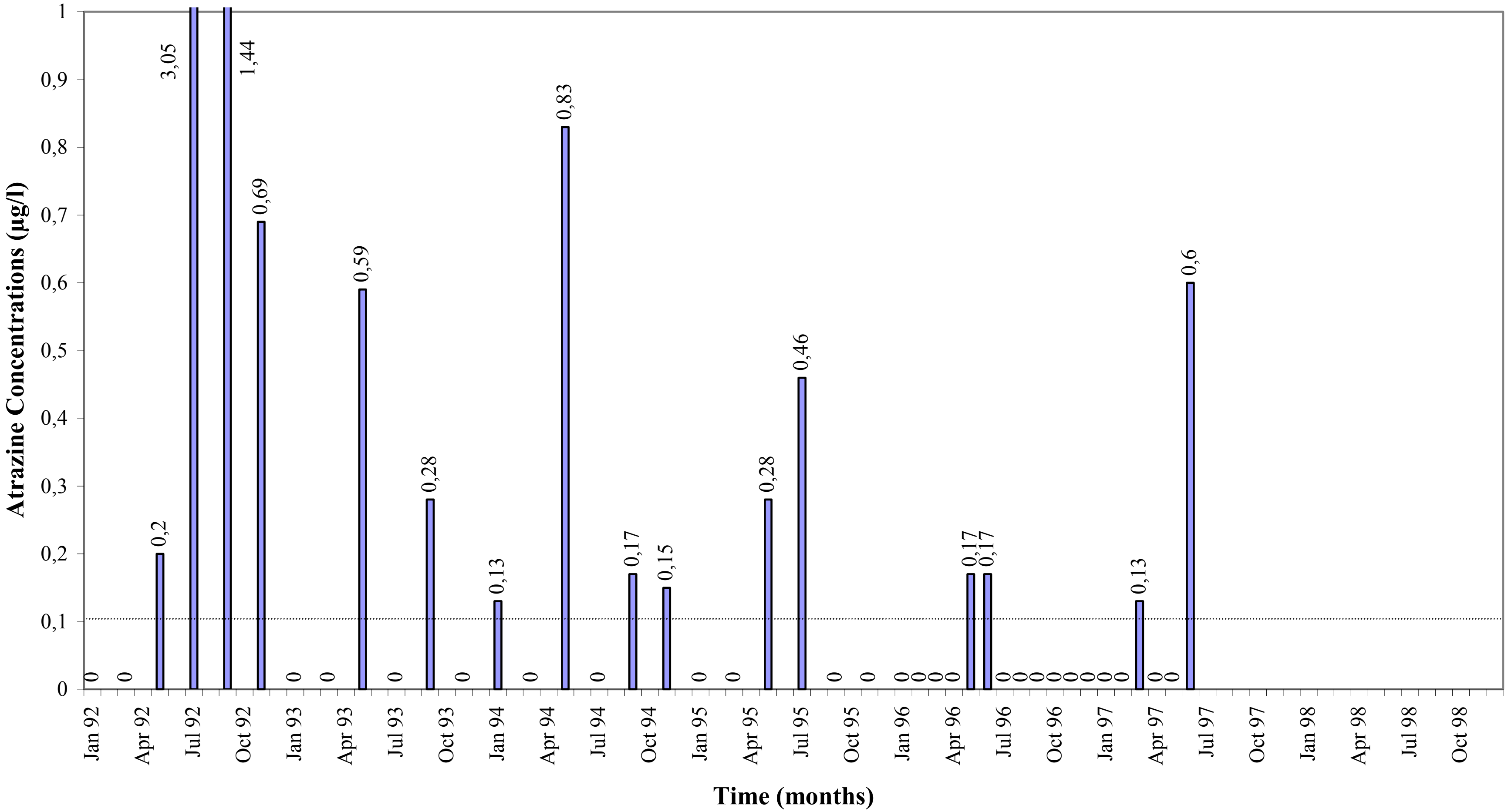
From the three monitoring sites on the River Strem it would appear that atrazine is still being used throughout the catchment; indeed the values remain particularly elevated. Again, the agricultural structure is similar to that of the Feistritz, Lafnitz and Raab catchments with between 15 and 22 percent of the agricultural land in the catchment being taken up with maize. In addition, the recent increase in cultivation near to river banks in this catchment would raise the likelihood of herbicides entering the river. The percentage of connections to the sewerage system is relatively elevated for this region being in the range of 60-80.


Atrazine Concentrations 1992-1998 in the River Strem at Bocksdorf (10000047)
Atrazine Concentrations (µg/l)
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0
0
0
0
0,17
0
0
0
0,05
1,44
0,07
0,09
0,22
0
0
0
0,19
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98
Time (months)

Atrazine Concentrations 1992-1998 in the River Strem at Güssing (10000067)

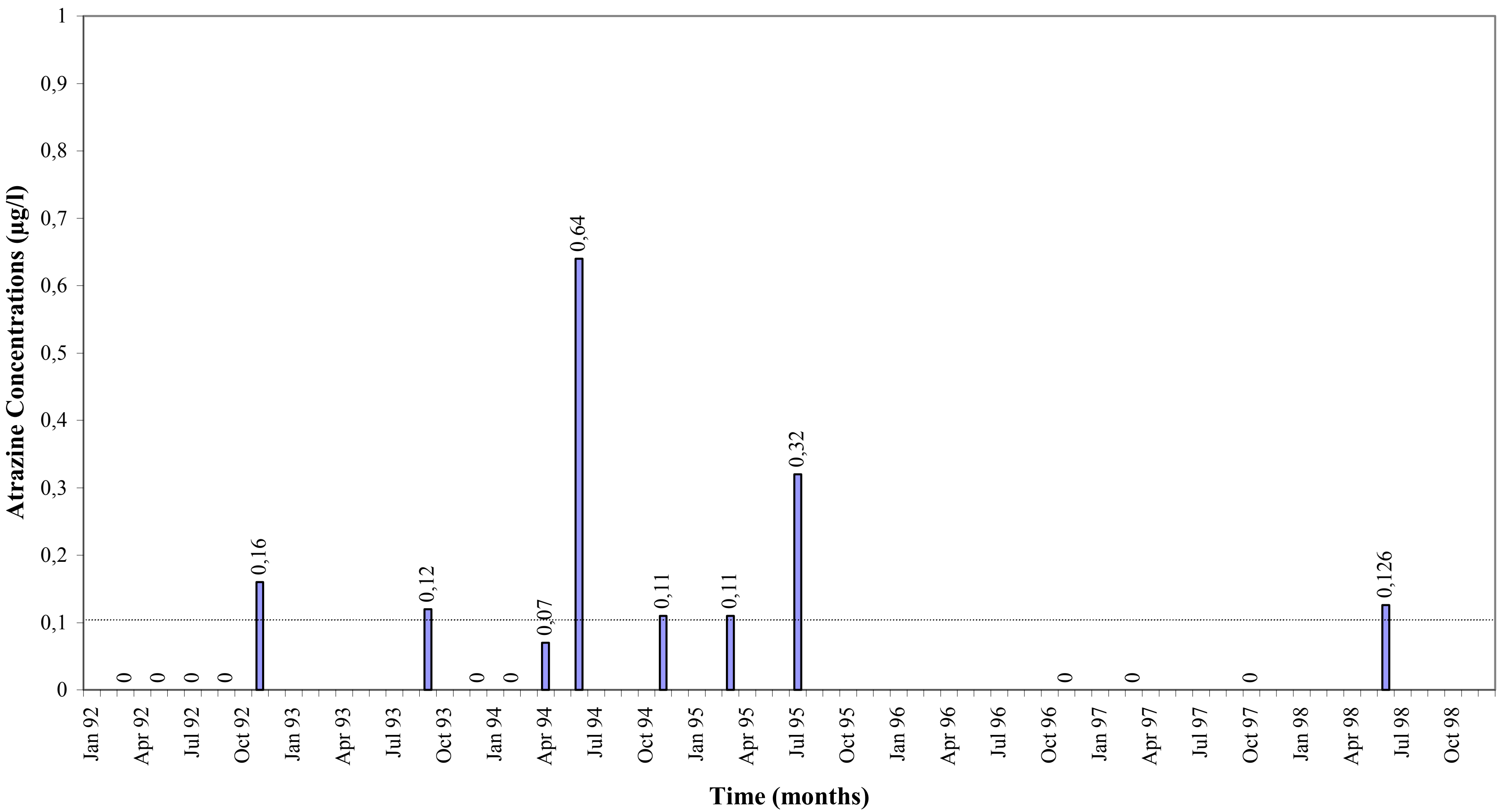


Atrazine Concentrations 1992-1998 in the River Strem at Heiligenbrunn (10000107)



From the one monitoring site on the River Wulka, which is at the point at which it flows into Lake Neusiedl, it is clear that the concentrations of atrazine remain over 0.1 µg/l. This catchment contains arable crops as well as maize and wine with maize cultivation only constituting up to 15 % of the agricultural area. The percentage of connections to the sewerage system in the catchment is elevated at between 80-100. It is therefore probable that the main source of inputs in this catchment is through the urban waste water system.

Atrazine Concentrations 1992-1998 in the Wulka at Wulkamündung (10000027)



Therefore in these five catchments, given the existence of intensive maize cultivation, it is likely that the elevated atrazine concentrations are due to agricultural use. The likelihood that these inputs are from point sources rather than surface run-off is difficult to assess given the variation in the percentage of connections to the sewerage system.

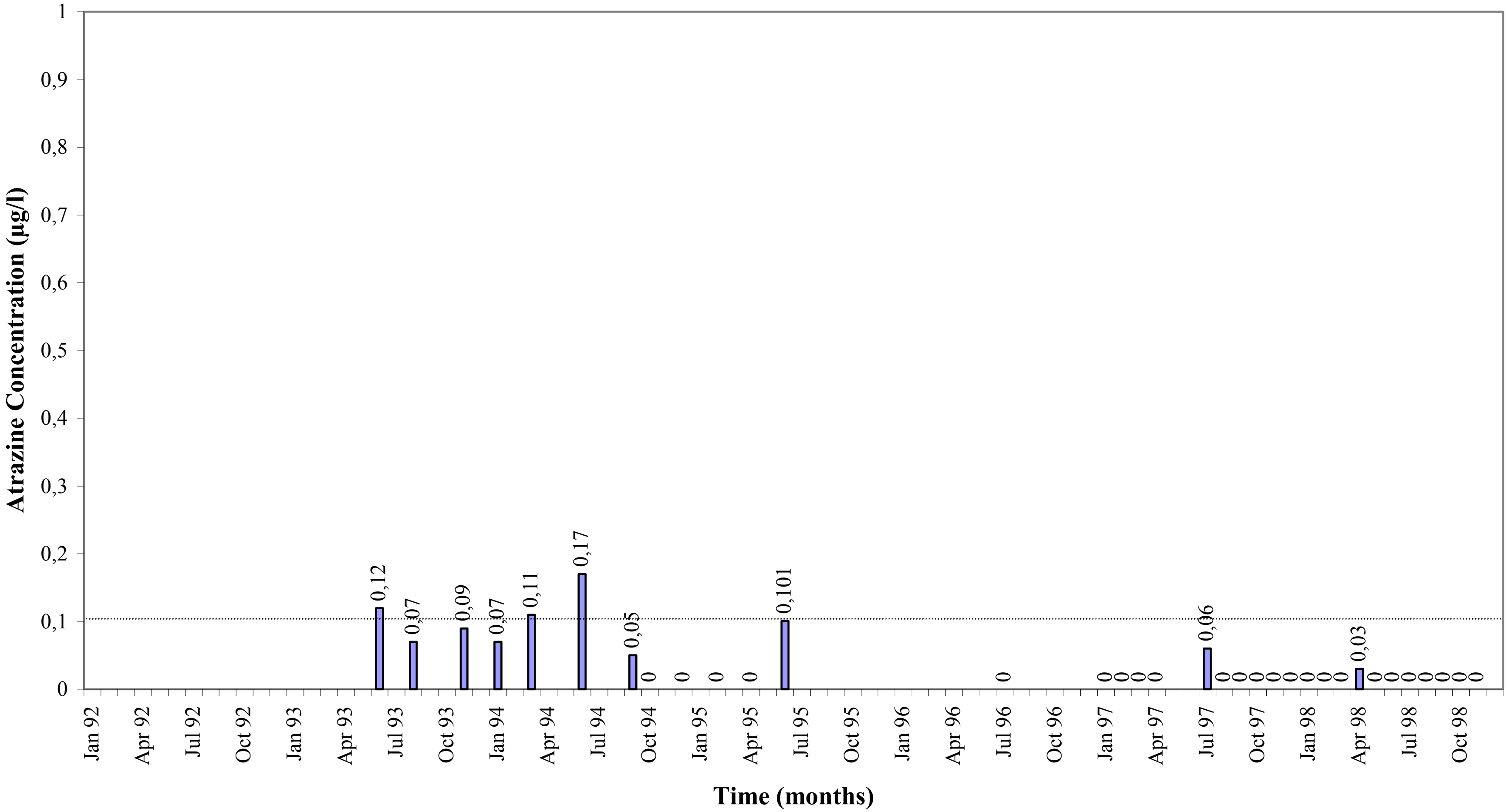
7.1.6.4 River Krems

In the Traun catchment it is only in the River Krems that concentrations remain elevated at up to 0.25 µg/l although they do appear to have decreased since 1995. This can be seen from Table 5.5 and the diagrams below. These figures also show that it is only in the lower reaches, downstream of Kremsmünster (40713027), that elevated atrazine concentrations are still present. Furthermore, given that the concentrations at Neuhofen (40713037) are generally a little higher than those at Ansfelden (40713047) it is likely that the inputs of atrazine are occurring upstream of the former, and have been diluted by the time they reach the latter. Maize cultivation constitutes between 8 and 30 percent of the agricultural area. The percentage of connections to the sewerage system varies between 20 and 80. It is therefore likely that a combination of diffuse and point source inputs contribute to the high concentrations.

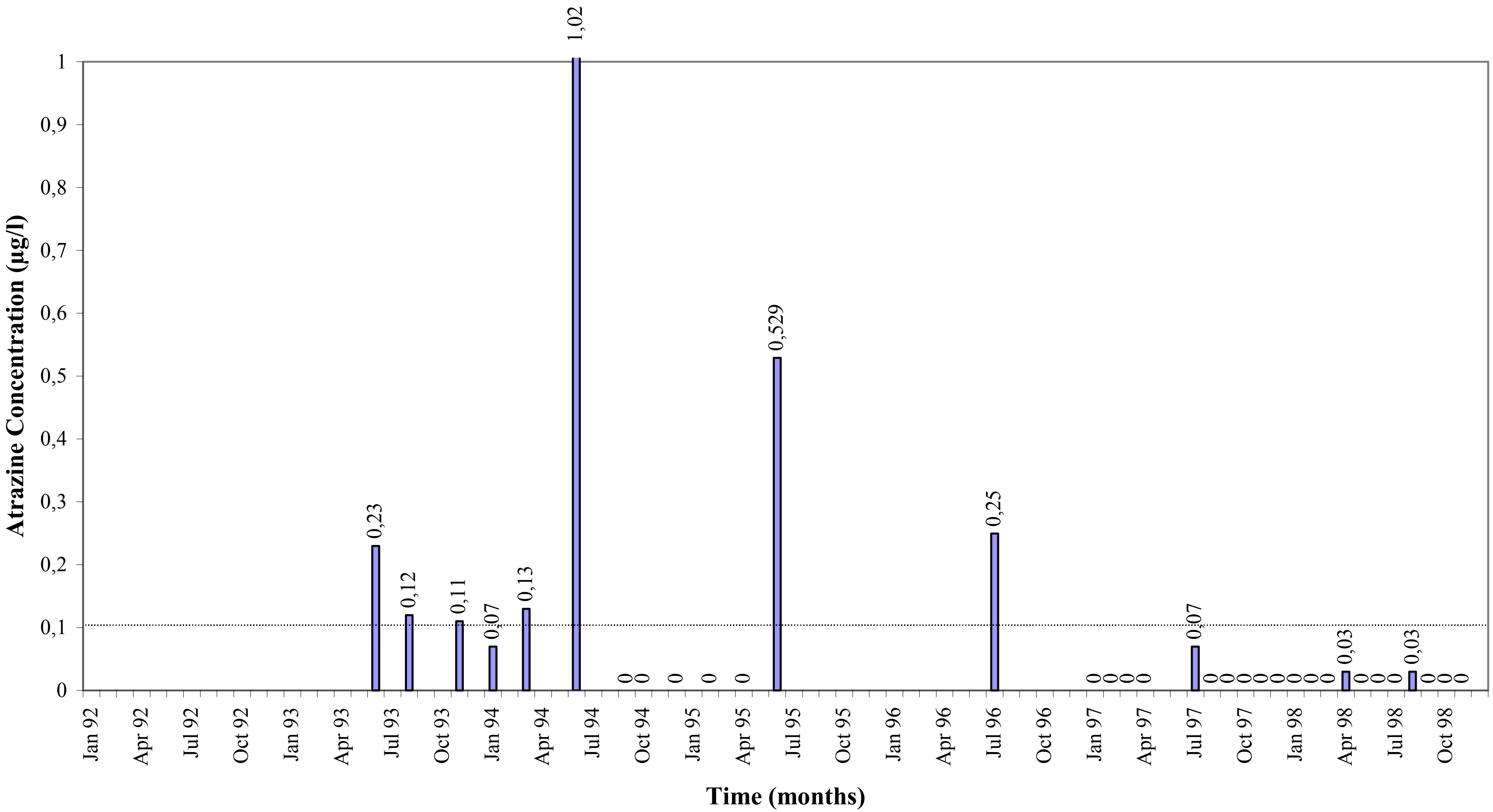
Table 7.5: River Krems

River (Monitoring Site)	Year													
	1992		1993		1994		1995		1996		1997		1998	
	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	>0.1 µg/l	Samples	0.1 µg/l
Krems (40713017)	0	**0**	3	**1**	6	**2**	3	**1**	1	**0**	15	**0**	16	**0**
Krems (40713027)	0	**0**	3	**3**	6	**2**	3	**1**	1	**1**	15	**0**	16	**0**
Krems (40713037)	0	**0**	3	**2**	6	**5**	3	**1**	1	**1**	15	**1**	16	**2**
Krems (40713047)	0	**0**	3	**3**	6	**4**	3	**1**	1	**1**	15	**1**	16	**1**

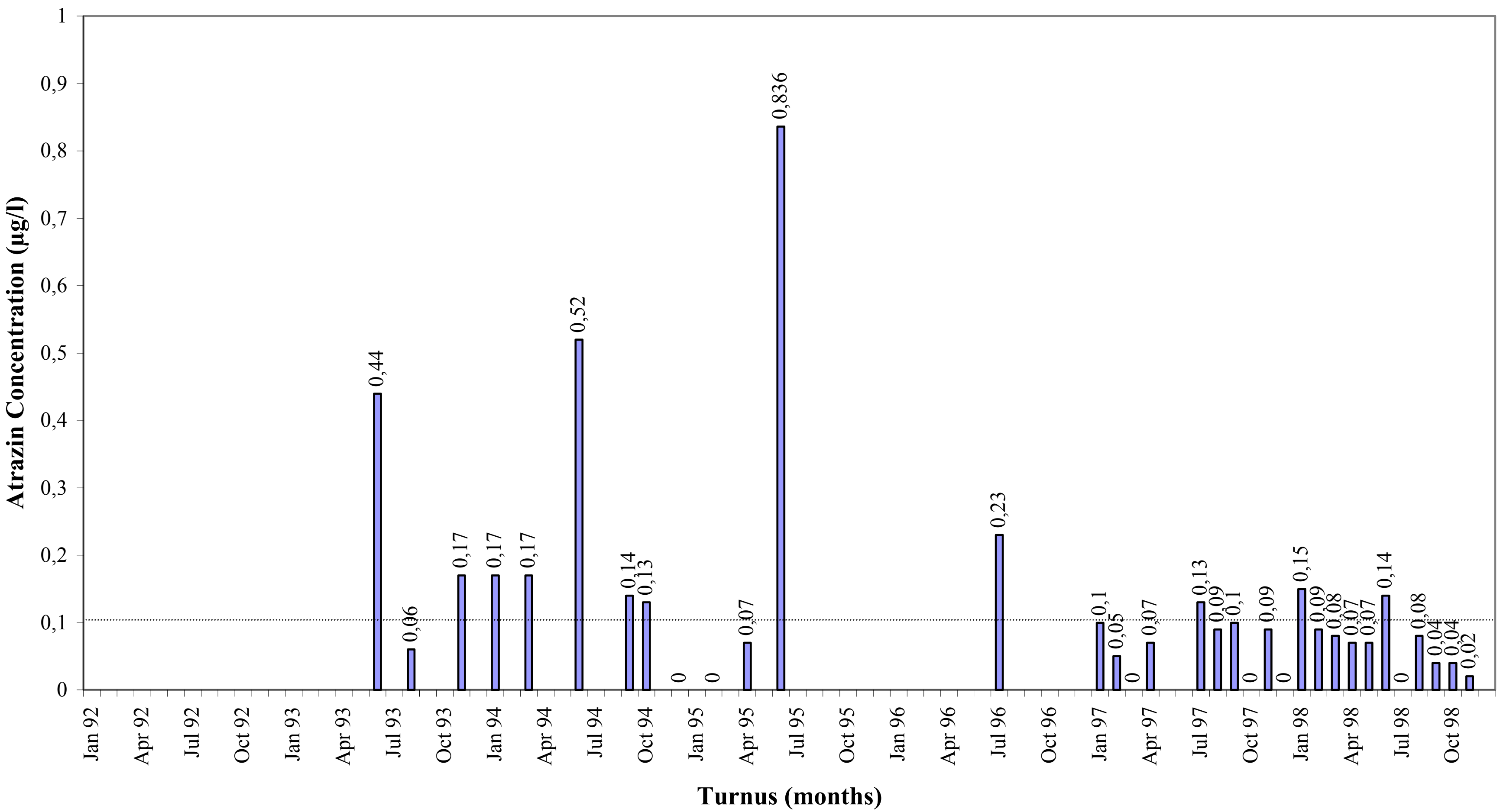
Atrazine Concentrations 1992-1998 in the River Krems at Kirchdorf (40713017)



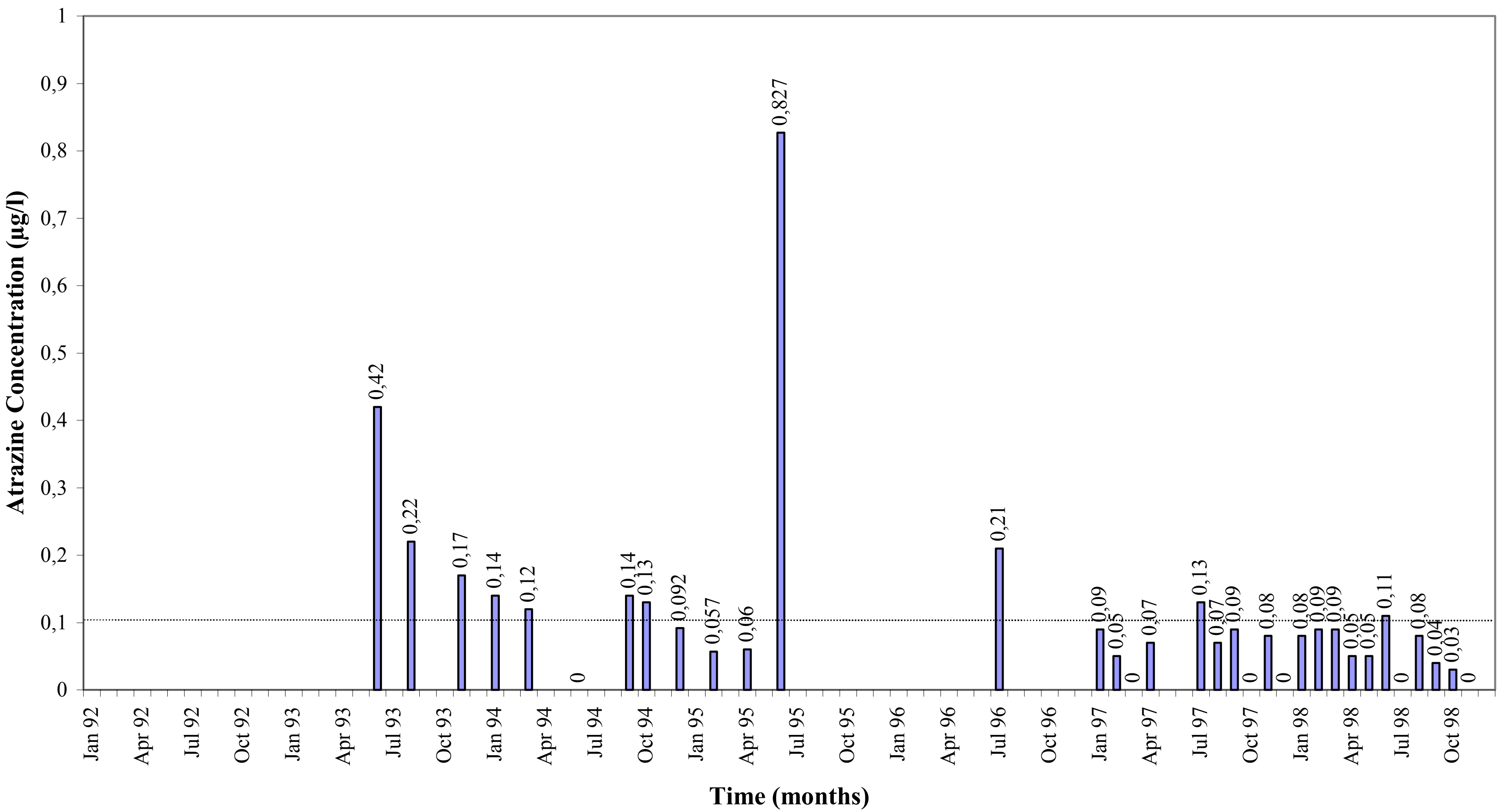
Atrazine Concentrations 1992-1998 in the River Krems at Kremsmünster (40713027)



Atrazine Concentrations 1992-1998 in the River Krems at Neuhofen (40713037)

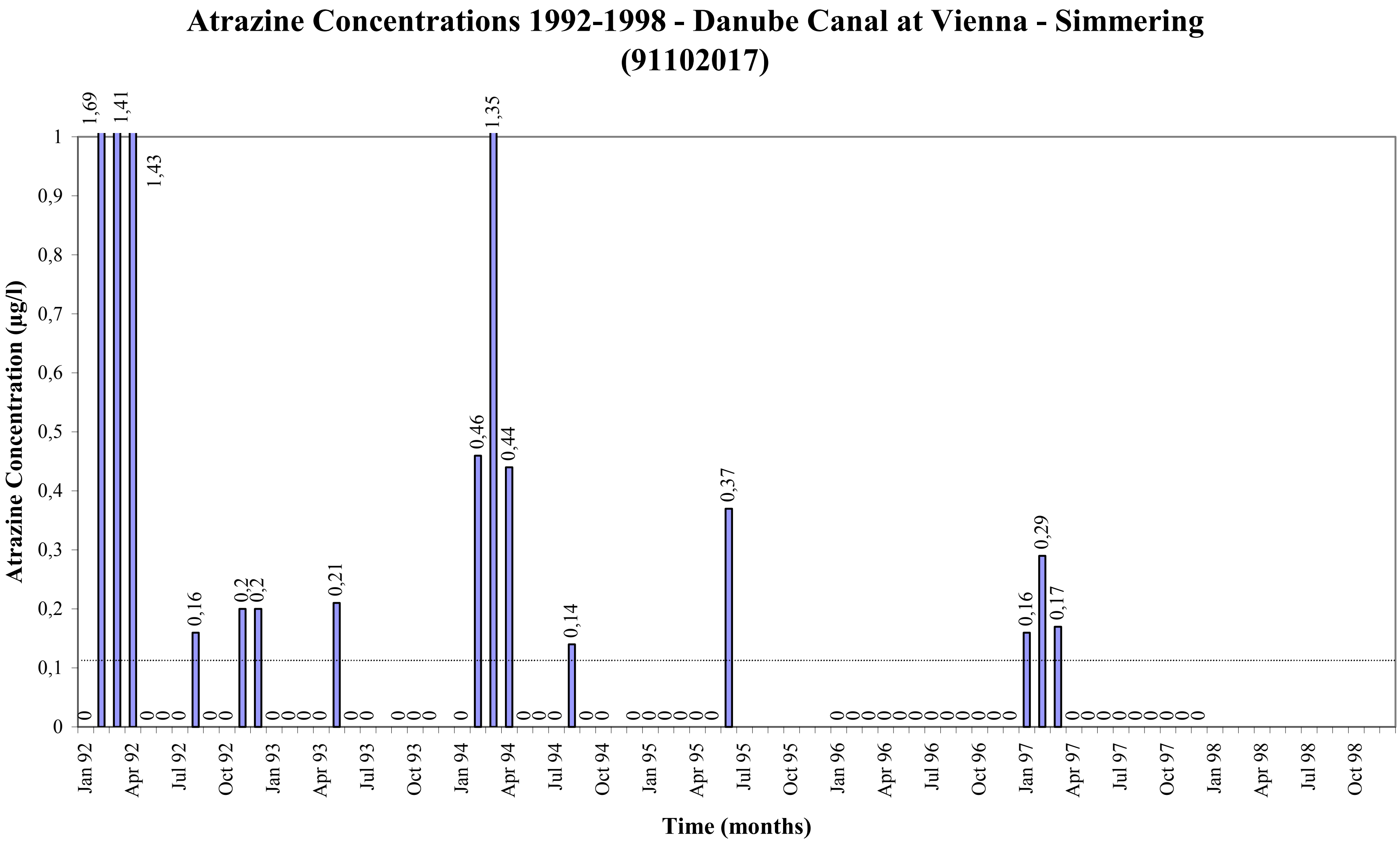


Atrazine Concentrations 1992-1998 in the River Krems at Ansfelden (40713047)



7.1.6.5 Danube Canal

The concentrations of atrazine in the Danube Canal have diminished over the period from 1992 to 1997 (The 1998 data have yet to be made available by the laboratory concerned). Nevertheless the peak values remain elevated at levels up to 0.29 µg/l in the last year that was measured. The amount of agriculture in the vicinity of the Danube Canal is negligible which would indicate that the inputs are from herbicide use in recreational and amenity areas (for example recreational parks, cemeteries and allotments). In principle this could be via either surface run off or urban waste water inputs, however given the nature of the Canal the former is unlikely. In addition the time at which the elevated levels occur, namely from January to April, is not when agricultural use would normally peak. This would substantiate the conclusion that it is not agriculture which is responsible for these elevated levels.


Atrazine Concentrations 1992-1998 - Danube Canal at Vienna - Simmering
(91102017)
Atrazine Concentration (µg/l)
Time (months)
1,69
1,41
1,43
1,35
0,46
0,44
0,37
0,29
0,21
0,2
0,2
0,16
0,14
0,16
0,17
Jan 92
Apr 92
Jul 92
Oct 92
Jan 93
Apr 93
Jul 93
Oct 93
Jan 94
Apr 94
Jul 94
Oct 94
Jan 95
Apr 95
Jul 95
Oct 95
Jan 96
Apr 96
Jul 96
Oct 96
Jan 97
Apr 97
Jul 97
Oct 97
Jan 98
Apr 98
Jul 98
Oct 98

7.2 Conclusion

Whilst there is little doubt that, with the exception of the Danube Canal, the main cause of the seasonally elevated atrazine concentrations is agriculture it is almost impossible to prove this definitively. The presence of atrazine in waters at the times when it would normally be applied in agriculture, the fact that, with the exception of the March and Thaya, these waters correlate well with the areas of maize cultivation and the absence of other possible explanations all lead to this conclusion. Other potential inputs, such as from soils, the reactivation of sediments or atmospheric inputs could have a contributing role although this would only be in terms of background levels. It is not clear what amount of the input is accounted for by inputs via the urban waste water system and what is through surface run-off.

Along the Thaya and March it is less clear from where in Austria the inputs come, if at all. The maize cultivation in this region is usually under five percent of the agricultural area used for arable crops. Inputs from the other countries in the catchment may account for a significant proportion of the concentrations.

7.3 How can the Users of Atrazine be located?

Given that agriculture is suspected of being the main contributor to the continued elevated concentrations of atrazine in Austrian waters the question becomes one of how these farmers can be located in order to prevent them from continuing to use the substance. As the atrazine from agricultural sources could be coming from either waste water treatment plants or surface run off, and given the number of potential locations where this could be taking place it is unrealistic to monitor everywhere. A first step may be to try to ascertain what proportion of the atrazine is coming from the waste water system by means of experiments similar to those conducted in Germany. This could enable the list of potential suspects to be narrowed down. In addition, the undertaking of random soil sampling in areas of maize cultivation in those parts of the catchments where atrazine is suspected of being used could also be fruitful.

Another way to attempt to prevent the use of atrazine would be to locate the source of the farmers' supplies. Here there are essentially three possibilities, each of which is considered below.

7.3.1 Using up of old Stocks by the Farmer

Following the final implementation of the ban in April 1995 it is possible that farmers still had stocks of atrazine on their farms. This is perhaps more likely for smaller farms, which may have had to purchase certain minimum quantities, rather than large farmers who would be unlikely to tie up capital in stocks when this was not necessary. In the case of the small farmer it is likely that by 1998 these stocks would have been exhausted. Therefore it is likely that if a farmer is still using atrazine it is being obtained from another source. In the case of the "Danube Canal" it may be that allotment holders are still using old atrazine supplies.

7.3.2 Wholesalers disposing of stocks

In the same way as the farmers may have still have had stocks left when the ban came into force so might wholesalers. It is possible, but probably very difficult to verify, that these wholesalers may have supplied farmers with their remaining stocks after the deadline.

7.3.3 Stocks missing during transit

According to article 3 of the 1997 Plant Protection Law[31] substances which are not authorised are not allowed to be imported unless they are being stored for export to other countries where atrazine is authorised. It is possible, although again very difficult to assess, that during transit and storage in Austria stocks go missing.

7.3.4 Imports from countries where Atrazine is not banned

Another possibility is that atrazine is being imported into Austria illegally and subsequently used in Austria. Table 5.6 shows the status of atrazine in the significant nations bordering Austria. From this it is clear that there is ample scope for atrazine to be imported. Moreover in the EU it is only in Austria, Denmark, Finland, Germany and Sweden that atrazine is definitively not allowed to be sold, hence atrazine could be imported from the other countries. Illegal imports are the most likely source of the atrazine supplies in Austria.

Table 7.6: Status of Atrazine in Countries neighbouring Austria[32]

Country	Atrazine banned	Since when
Czech Republic	No	
Germany	Yes	March 1991
Hungary	No	
Italy	No (but suspension of sales)	(since March 1990)
Slovakia	No	
Slovenia	No	
Switzerland	No	

[31] Republik Österreich (1997) Pflanzenschutzmittelgesetz, Bundesgesetzblatt für die Republik Österreich, 19.6.1997
[32] Novartis (1999) Personal Communication

8 CONCLUSION

From the analysis of the data it is clear that atrazine concentrations in some stretches of Austrian surface waters remain elevated despite the introduction of the ban on atrazine use in 1995. From the discussion above it appears that at the vast majority of monitoring sites where such levels occur the most likely source of this pollution is the continued use of the herbicide in agriculture. The catchments where elevated concentrations are still being found generally still contain some maize production. It is likely therefore that maize production is the most significant source of the continued elevated atrazine concentrations. It is not clear whether the inputs themselves occur from surface run-off or from point source inputs through the sewerage system.

The continued use of atrazine by some farmers represents a significant problem in three respects:

- Environment – it was banned in 1995 on the grounds of its perceived risk to the environment. Its continued presence therefore poses a threat to that environment.
- Unfair Competition – those farmers who continue to use it have a competitive advantage over those that do not as it is cheaper than comparable, permitted alternatives.
- A Basic Disrespect for the Law – the failure to comply with the law represents an affront to the Austrian authorities.

The UBA would recommend therefore that the following measures be taken:

- Customs checks be intensified to eliminate illegal imports.
- Random spot checks on farms in the areas under suspicion, especially those under maize cultivation (soil samples, plant samples, samples of the pesticide mixture used), at the times when atrazine would normally be applied.