How Dutch drinking water production is affected by the use of herbicides on pavements

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Abstract About forty per cent of drinking water in The Netherlands is produced from surface water. Dutch water companies, that have to rely on this source, are dealing with major water quality problems due to the use of herbicides on pavements. Voluntary measures and bans have had only limited effect on the reduction of emissions of herbicides that runoff from pavements into surface water in The Netherlands. The effects on the production of drinking water from surface water should play a role in the authorisation of pesticides. Stricter regulations, including mandatory emission reduction measures and certification, are necessary. The enforcement of existing Dutch surface water pollution laws should solve part of the problem. Due to the international nature of most of the surface water used for drinking water supply, it is necessary that other countries take measures as well. European legislation brings a solution closer if implemented well and seriously enforced. The threat of strict legislation keeps pressure on the transition towards decreasing the dependence on chemicals for weed control on pavements.
Keywords Diffuse pollution; drinking water; herbicide runoff; regulations; water quality

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Introduction

Research shows that only 1.4% in 1999 and 5.6% in 2000 of the surface water monitoring locations in The Netherlands are meeting the drinking water standard for pesticides (Dommering, 2002). Almost every measurement that exceeds the 0.1 microgram per litre standard is due to the presence of herbicides. Even though the vast majority of herbicides is used for weed control in crop growing, it is the minority use on pavements that causes the most problems for water supply. As it is only less than 1% of the total amount of pesticides used in The Netherlands, chemical weed control on pavements is low on the pesticide policy agenda. Due to the impact on water quality, this type of herbicide use is very high on the water policy agenda.

Weed control on pavements is cheaper when herbicides are sprayed than mechanical alternatives, but it is the consumer that pays for the environmental impact through the water bill. From 1991 to 2000 Dutch water companies have spent €244 Million due to the presence of pesticides in their resources (Puijker *et al*., 2001). One kilogram of herbicide, when used on a paved area, causes somewhere between €45 and €255 of damage to drinking water companies each year (Saft and Staats, 2002). Instead of taking all sorts of end-of-pipe measures, Dutch water companies want this type of pollution to stop at its source. The consumer of drinking water or the tax payer should not have to pay for the affected water quality. The bill should go to the ones that benefit from herbicide use. The only sustainable solution is ending the emission of herbicides to surface water.

The intake of surface water is at stake

The Netherlands produces about forty per cent of its drinking water from surface water. The points of intake are shown on Figure 1. Most of the abstracted surface water originates from the international rivers Meuse and Rhine. The areas which are supplied with drinking water, originating from these rivers, include the country's three major cities Amsterdam,

Rotterdam and The Hague. In 1993 the intake of surface water from the river Meuse for the city of Rotterdam had to stop for 49 days, because levels of Diuron were exceeding the intake criterion. Drinking water production for the Rotterdam region had to rely on what was left in the reservoirs. At the end of this unprecedented incident, the reservoirs were drained to a 17 day reserve. A lot of media attention made sure this problem scored high on the National political agenda in little time. Immediately after the intake of surface water from the river Meuse had to stop, intensive research was started. One of the objectives was to find out how this problem could occur and where most of the pollution was coming from. Surprisingly it was not the agricultural use of this herbicide that was responsible for the main part of the high levels that were found.

Next to agricultural uses, Diuron was also a very popular herbicide amongst municipalities and other organisations that manage paved areas. It was used for preventive weed control, sprayed on the pavement before any weeds were developing. However, with the first shower of rain after application a significant part of the active ingredient ended up in the river Meuse.

Figure 1 Points of intake of surface water for the production of drinking water in The Netherlands (modified from Dommering, 2002)

High runoff of herbicides used on pavements

That a small amount of herbicides can cause a big problem is confirmed by a study carried out by Alterra in the Bommelerwaard region (Merkelbach *et al*., 1999). Non-agricultural use of herbicides, which is only 1% of the pesticides that were applied in the region, caused 76% of the emission to surface water, as is shown in Table 1.

Herbicides, applied on pavements for weed control, wash off easily during rainfall. Research was done by Alterra to find out how much of the applied herbicide ends up in surface water with the rain that washes off (Beltman *et al*., 2001). During four field experiments, Alterra studied the runoff of herbicides Atrazine, Amitrol and Glyphosate from 100 square metres of a concrete brick pavement. After treatment with the herbicides, the pavement was sprinkled for two to three hours with a realistic high rainfall intensity for The Netherlands of 10 milligrams per hour.

The figures in Table 2 might even be underestimated, as higher herbicide runoff can occur due to:

- The presence of hard surfaces which have less joints than the concrete brick pavement in the experiment;
- Higher intensity of rainfall during only a few minutes, something which is very common in The Netherlands in springtime.

Rain water that washes off the pavement, will eventually end up in surface water. Sometimes indirectly through the sewage system, sometimes directly in the case of a separated sewage system. Even though sewage might flow through a treatment plant before it reaches surface water, levels of herbicides will not drop significantly since most sewage treatment plants have no specific pesticide removal capacity. Also groundwater quality is at stake as more and more municipalities are restoring groundwater recharge by disconnecting pavements from sewage systems. When herbicides are applied to the surface above, groundwater quality can be affected.

Examples of reducing chemical weed control

Over the past ten years Dutch pesticide policy was striving for specific goals in what is called the "public green sector":

- Reduction of dependence on pesticides;

Table 1 Calculated use and emission to surface water in the Bommelerwaard Region in 1995 grouped by user (Source: Merkelbach *et al*., 1999)

Groups of users	Use (kilograms)	Share of total use	Emission (kilograms)	Share of total emission
Non-agricultural uses	370	1%	90.6	76%
Greenhouses	4,660	14%	15.8	13%
Fruit	15,850	47%	9.1	8%
Stock breeding	7,555	22%	2.0	2%
Other agricultural uses	5,573	16%	1.3	1%
Total	34,008	100%	118.8	100%

Table 2 Amitrol, Atrazine and Glyphosate runoff from bricks in four field experiments (in grams, Source: Beltman *et al*., 2001)

Experiment	Amitrol			Atrazine			Glyphosate		
	Applied	Runoff		Applied	Runoff		Applied	Runoff	
1	33.5	2.4	7.3%	6.7	3.5	36.2%	19.2	2.1	11.1%
2	36.0	2.6	7.2%	7.6	3.3	43.8%	20.9	2.5	11.8%
3	29.8	2.8	9.3%	15.9	2.8	17.8%	29.3	3.5	11.9%
4	37.2	8.3	22.4%	18.0	6.1	33.6%	26.5	6.1	23.1%

- Reduction of the use of pesticides by 43% (in weight);
- Reduction of the emission of pesticides to the environment by 90%;
- Better circumstances for the workers that have to apply pesticides.

Even though an evaluation is not yet available, it is clear that perhaps the goal for reduction of pesticide use has been met, but the goal for emission of pesticides was not. The use of herbicides on pavements has not declined enough yet.

When its members were being confronted with high levels of herbicides in their sources, The Netherlands' Waterworks Association VEWIN started communication and other projects, aimed at the reduction of herbicide use on hard surfaces. In the 1990s VEWIN supported pilot projects for the testing of detection spray systems like SelectSpray, mounted on quads driving over paved areas. Also preventive methods were sponsored, like pavement designs that leave no space for weeds to grow. In 1997 a book was published, under a title that translates to "Get Poison off the Streets". This book gives managers of urban and industrial areas several tools for non-chemical weed control and puts the emphasis on communication (Sluijsmans *et al*., 1997). At the end of May 2002 a manual for chemical free maintenance of public green and pavements was introduced (Spijker *et al*., 2002). The manual is an initiative of three Provincial governments and was tested in ten cities. It describes a step-by-step process towards chemical free weed control in the city and gives the tools for a tailor-made approach (further details may be found in the paper prepared for this conference by Baardwijk in these proceedings entitled "Policies for conversion to non-chemical weed control at municipalities").

The greatest driving force behind emission reduction measures is the threat of banning all pesticides for application on pavements. The Dutch Board for the Authorisation of Pesticides CTB now forbids the use of Glyphosate without the use of SelectSpray and spot wise application of Glyphosate on hard surfaces (CTB, 2002). Meanwhile Monsanto, producer of several Glyphosate based herbicides, and VEWIN are co-funding the development of a decision support system for rational weed control on hard surfaces which is carried out by Plant Research International PRI (Kortenhoff *et al*., 2001).

How to make transitions stick

One of the questions that keeps coming back from critics of non-chemical weed control is that the environmental impact of mechanical methods might be worse than spraying herbicides. Brushing, burning and steaming weeds costs a lot of energy and causes noise, dust and other nuisances to the public. This is why the Institute for Inland Water Management and Waste Water Treatment RIZA ordered the University of Amsterdam to carry out a life cycle analysis and risk assessment for weed control on pavements (Saft and Staats, 2002). The main conclusion of this study is that chemical weed control is the poorest choice from an environmental impact point of view, as is shown in Figure 2. But herbicide use is also the cheapest method, it does not lead to a nuisance to the majority of the public and it is user-friendly for the workers.

In the 1990s several Dutch municipalities stopped applying herbicides on pavements, a few have quit the use of pesticides altogether. This has not always led to lasting success. Some cities transformed quietly to chemical free weed control, others cities involved the general public, trying to explain to worried citizens that plants growing between tiles do not necessarily have to be killed. If people still want to remove them they can get free hand steamers or special tile knives. In a few cities people started spraying the footpaths in front of their houses themselves after the city had stopped. This is why communication plays a key role.

More and more municipalities, which had stopped applying herbicides on pavements, are now reintroducing the herbicide spray for budgetary reasons. In order to try to make

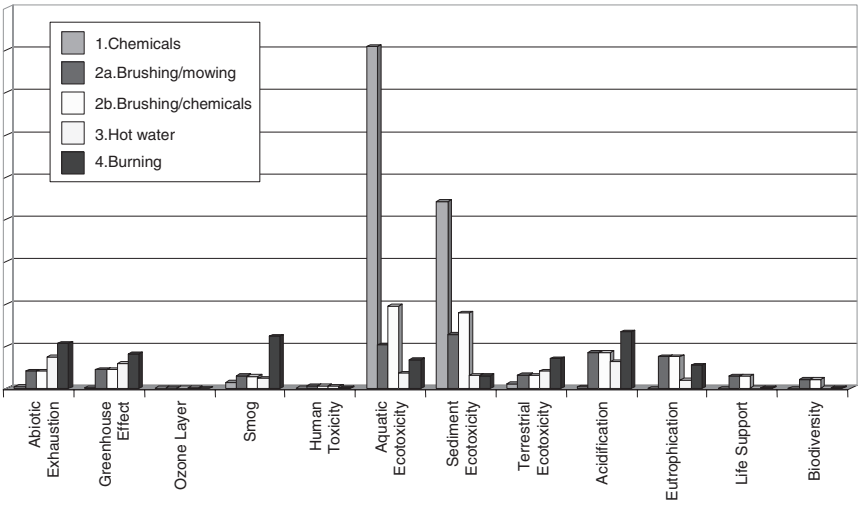

Figure 2 Environmental impact scores of five weed control methods for pavements (from Saft and Staats, 2002)

cities stick to the most sustainable weed control methods VEWIN is working together with the *Milieukeur* foundation to set up a certification system in accordance with the new Dutch pesticide policy. The idea behind this initiative is that a municipality which has received *Milieukeur*, the Dutch hallmark of environmental quality, will be more likely to stick to its example behaviour under the pressure of losing their certificate. In the long term VEWIN wants the certificate to become a condition for the use of chemical weed control: only certified municipalities can buy and apply herbicides on pavements.

Water quality problems in transboundary rivers ask for international solutions

Diuron was banned in The Netherlands in June 1999, after which the Dutch contribution to Diuron load in the river Meuse dropped considerably, shown in Table 3 (Schrap, 2001).

Despite this improvement, the yearly load of Diuron in the river Meuse at the intake point for the Rotterdam water supply shows little reduction, as can be derived from Figure 3. The use of Diuron in countries upstream has not shown a similar decrease as in The Netherlands.

VEWIN is pleased that the Flemish Government has passed a new law that prohibits pesticide use by all public services, unless they have produced a reduction plan in which the use in specific situations is well motivated. These plans have to be presented before July 1st

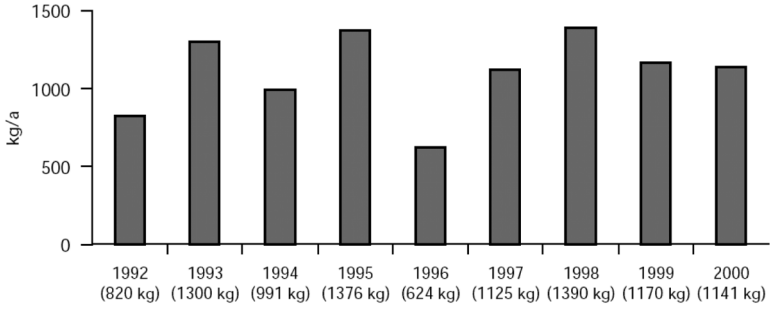

Figure 3 Yearly loads of Diuron in the River Meuse at the intake point of Waterwinningbedrijf Brabantse Biesbosch WBB (from Schrap, 2001)

Table 3 Calculated contributions to the seasonal load of Diuron in the River Meuse (April to August, in kilograms, Source: Schrap, 2001)

River	1998		1999	2000	
Meuse (when entering The Netherlands)	374		651	570	
Jeker	25		31	68	
Geul	24		10	16	
Geleenbeek	34		35	10	
Roer	28		28	47	
Neerbeek	4		3	6	
Groote Moolenbeek	3		1	1	
Niers	15		17	13	
Other Limburg streams	24		13	15	
Dieze	120		242	66	
Keizersveer Pumping station	5		24	4	
Total	656		1,055	816	
•From Belgium	405	62%		638	78%
•From The Netherlands	212	32%		123	15%
•From Germany	39	6%		55	7%

2003 and have to be approved by the Flemish Government, otherwise all applications are banned on January 1st 2004. VEWIN hopes similar measures will be taken in France and the Wallonian part of Belgium as well, which will help improving the quality of the river Meuse.

Banning one herbicide usually leads to the increased use of another. Since Diuron and Simazine can no longer be used for weed control on pavements in The Netherlands, herbicides based on the active ingredient Glyphosate are now practically the only ones left. As Glyphosate has been placed on Annex I of Council Directive 91/414/EEC for the authorisation of plant protection products, it will stay on the European market for many years (European Commission, 2001). Figure 4 shows that Glyphosate exceeds levels of 0.1 micrograms per litre every now and then where its metabolite AMPA (aminomethylphosphonic acid) is almost continuously present in levels well above the drinking water standard.

There is some discussion on the relevance of metabolites like AMPA, both on National and European level. As long as the Dutch Inspectorate for drinking water enforces the 0.1 microgram per litre standard for metabolites, AMPA is very relevant for water companies. Also a discussion was held on whether most of the AMPA found in Dutch surface water is

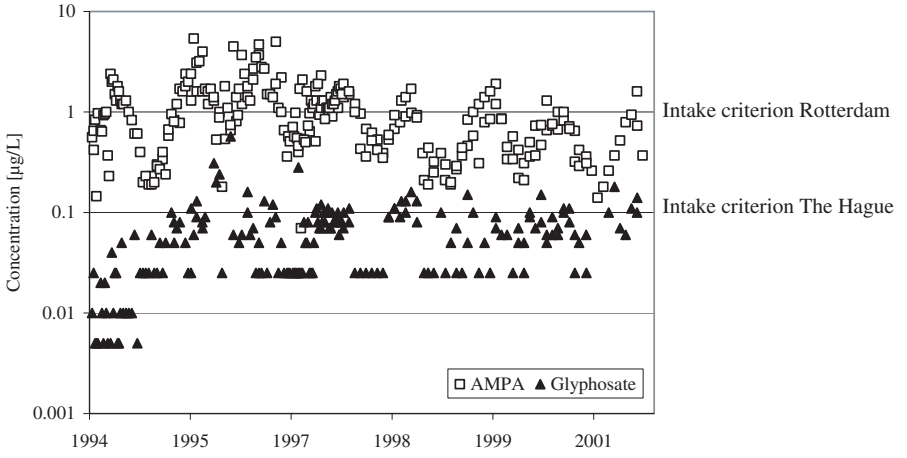

Figure 4 Concentrations of Glyphosate and its metabolite AMPA in the River Meuse (Sources: Duinwaterbedrijf Zuid-Holland DZH and Waterwinningbedrijf Brabantse Biesbosch WBB)

originating from Glyphosate or other phosphonates. Research shows that Glyphosate is by far the major source of AMPA emissions in The Netherlands (Staats *et al*., 2002).

Can the EU Directive for plant protection products solve water quality problems?

In order to place a herbicide on the European market, thorough research has to be carried out including an environmental impact assessment. When the environmental impact of Glyphosate was assessed for placement on Annex I of Directive 91/414/EEC, the use on hard surfaces had not been taken into account. In its response to a letter VEWIN had sent on this matter, the European Commission's Scientific Committee on Plants stated that assessment of non-agricultural use of herbicides is the responsibility of the admission authorities of the individual member states.

National admission authorities have to use the uniform principles of Directive 91/414/EEC, laid down in Annex IV, when assessing plant protection products which are placed on Annex I. These uniform principles require that environmental impact studies consider the production of drinking water from surface water. Until now no member state of the European Union has implemented this in its pesticide authorisation scheme. In order to reduce herbicide levels in the rivers Rhine and Meuse below the drinking water standard, it is necessary that a drinking water criterion is implemented in the authorisation process of plant protection product, in The Netherlands as well as in other EU member states. Some pressure is being put on the development and implementation of a drinking water criterion by the legal actions VEWIN is taking against the Dutch admission of Glyphosate based herbicides for use on pavements. The Dutch Ministry of Housing, Spatial Planning and the Environment VROM, the Board for the Authorisation of Pesticides in The Netherlands CTB and VEWIN are now working together on this issue (Verhaar, 2001).

Taking surface water based drinking water production into account while authorising pesticides seems to be a hard and difficult task, perhaps more difficult than developing of a purification technique for drinking water, but it is the most sustainable solution.

Can the EU water framework directive solve a herbicide problem?

High levels of pesticides in surface water are a problem for several European water companies. The European Union of National Associations of Water Suppliers and Waste Water Services EUREAU has named the most common problem pesticides for rivers in Europe (EUREAU 2001): Diuron, Isoproturon, Atrazine and related products, Simazine, Mecoprop, MCPA and Chlortoluron.

With the introduction of the EU Water Framework Directive 2000/68/EC came a list of priority substances which emissions to water will have to end or at least reduce (European Parliament, 2000). Four herbicides have made this list: Atrazine as a dangerous substance, and Simazine, Diuron and Isoproturon as priority substances which are now being evaluated on whether they are also to be classified as dangerous. The chemical industry is stating this might be in conflict with what is being put down in the Directive for the authorisation of plant protection products. If these three herbicides are also qualified as dangerous, emissions of all four will have to be phased out in ten years time. This will improve the quality of surface water significantly. VEWIN states that, as long as authorisation of plant protection products does not include a criterion for drinking water produced from surface water, the four herbicides deserve their place on the priority dangerous substances list for water policy.

Conclusions

Voluntary approaches and individual herbicide bans have had little effect on the reduction of emissions of herbicide from pavements to surface water in The Netherlands. European

legislation could solve this water quality problem if enough attention is paid to the dependence of millions of Europeans on drinking water produced from surface water. Water policy and pesticide policy should be better tuned, on European level as well as on national level. The greatest driving force behind emission reduction measures is the threat of banning all pesticides for use on pavements. The threat of strict regulation keeps pressure on transition towards decreasing the dependence on chemicals for weed control.

Expensive high tech purification techniques can be used to keep herbicides out of our drinking water. The cleanup bill is then presented to drinking water consumers, while this bill should be paid by the ones benefiting from the use of herbicides on pavements. The most sustainable solution is to end the emissions to surface water.

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