National Institute
for Public Health
and the Environment

Report 607633002/2008

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EU-wide control measures to reduce pollution from WFD relevant substances

Copper and zinc in the Netherlands

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This investigation has been performed by order and for the account of Ministry of Housing, Spatial Planning and the Environment, The Hague, the Netherlands, within the framework of the project Cases diffuse sources

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Abstract

EU-wide control measures to reduce pollution from WFD relevant substances
Copper and zinc in the Netherlands

In the underlying study it is investigated which sources are responsible for copper and zinc emission to the Dutch surface waters. A significant portion of the discharge to surface water is introduced via international rivers.
One of the conclusions of this report is that action still needs to be taken to control a number of copper and zinc sources. One of the sources not yet under control is the emission by leaching from agricultural soils. The leaching rate from agricultural soils is difficult to control, due to the amount of heavy metals which already have accumulated in the soils by historical application of manure.

Additional measures are necessary in order to control a number of copper and zinc sources which emit to the Dutch surface waters. This is concluded from the underlying study of the RIVM on copper and zinc discharge to surface water in the Netherlands. A significant part of the discharge is introduced via international rivers. Emission sources situated in the Netherlands are diverse. Traffic, households, building materials, industry and agriculture are examples of these sources.

For most of the Dutch emission sources measures have been taken nationally or at Community level to reduce their discharge or emission. For a number of emission sources more research is needed to find feasible measures or alternatives. For example, more research is needed on copper baths which are applied to disinfect cattle hooves.
The amount of copper and zinc leaching from agricultural soils is the most complex to reduce. The historical application of manure has caused substantial accumulation of copper and zinc in the rural area.

Key words:
copper, zinc, Community law, Dutch policy, emission, load, measures

Rapport in het kort

Europese maatregelen om vervuiling door stoffen onder de Kaderrichtlijn Water te reduceren
Koper en zink in Nederland

Op nationaal en Europees niveau zijn extra maatregelen nodig om een aantal koper- en zinkbronnen die het Nederlandse oppervlaktewater belasten onder controle te krijgen. Dit blijkt uit een onderzoek van het RIVM naar de nationale belasting van het oppervlaktewater door deze zware metalen. Een groot deel van de koper- en zinkemissies in de Nederlandse oppervlaktewateren komt via de grote rivieren uit het buitenland. In Nederland zelf zijn diverse bronnen verantwoordelijk voor de koper- en zinkvervuiling. Voorbeelden zijn verkeer, huishoudens, bouwmaterialen, industrie en landbouw.

Voor de meeste bronnen zijn al maatregelen getroffen, nationaal of door de Europese Unie. Voor een aantal bronnen is meer onderzoek nodig, zoals voor koperbaden om hoeven van vee te desinfecteren. Verder onderzoek is nodig om hiervoor praktische alternatieven of maatregelen te vinden. De hoeveelheid koper en zink die uit landbouwgronden komt, is het moeilijkst te verminderen. Dit komt doordat jarenlang gebruik van mest heeft geleid tot een aanzienlijk hoeveelheid koper en zink in de landbouwgronden.

Trefwoorden:
koper, zink, Europese wetgeving, Nederlands beleid, emissie, belasting, maatregelen

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Acknowledgements

This report is part of the project 'Cases of diffuse source pollution' (RIVM-project 607633). We want to acknowledge J. Appelman (Ministry of Housing, Spatial Planning and the Environment, The Hague, the Netherlands) for supporting this RIVM project. M. Zijp, D. Sijm and G. Lommers are acknowledged for their thorough comments on this report.
The underlying report has been realised in cooperation with several fellow-workers of the Laboratory of Ecological Risk Assessment of the RIVM (National Institute for Public Health and the Environment of the Netherlands). These collegues are acknowledged for their contribution: E. van der Grinten, H. den Hollander, M. Mesman, P. van Beelen and S. Lukàcs.
Several experts have been approached to comment on the results of this research concerning their own field of expertise. R. Fleuren (RIVM), A. Smits (CTGB) and J.W. Andriessen (CTGB) gave input on biocides, P. Zuijdervliet (ProRail) on overhead wiring, A. Boersma on the risk reduction strategy of zinc, R. Luit (RIVM) on REACH, A. Versteegh (RIVM) on drinking water, R. Eikelboom (VROM) and A. Verschoor (RIVM) on building materials and K. van der Hoek (RIVM), M. Oonk (LNV) and E. Deckers (LNV) on animal feed and manure.

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Contents

Summary

The Water Framework Directive (WFD) requires that EU Member States implement the necessary measures with the aim of reaching good chemical and ecological water quality. In the Netherlands, copper and zinc are considered to be substances causing significant environmental damage. Therefore, they are appointed as priority substances for national policy. The aim of the present study was to distinguish the major emission sources of copper and zinc to Dutch surface waters, to evaluate all European legislation that handles these major sources of copper and zinc and to study the implementation of the copper and zinc related European legislation in Dutch legislation.

Eur-Lex ('The access to European Union law') was used to search for relevant European legislation. After peer reviewing the Community legislation and on the basis of information on major pollution sources, Community legislation was selected for further investigation. 'Traffic and transport', 'Sewer systems and sewage treatment' and 'Agriculture' were the three sectors accounting for the largest load of copper and zinc to surface water in the Netherlands. For copper, these three sectors cover 83% of the total load taking place in the Netherlands and for zinc 88%. Transboundary pollution introduced by international rivers constitutes major copper and zinc sources (70-80% and 42-75% of total load, respectively), but these are not under national control.

Copper and zinc are mostly emitted by diffuse sources. Only few point sources need further attention. For most sources, their contribution to local copper and zinc concentrations is unknown or not traced back within the underlying study. This complicates the choice for the most effective measure.
Agriculture is one of the major emission sources of copper and zinc in the Netherlands. The contribution of copper baths could be minimized by application of alternatives or registration of the copper sulphate solution. The need and proportionality of additional measures need to be investigated and reflected on.
For copper brake lining ('Traffic and transport'), product policy may be formulated at EU-level. Analysis and comparison of environmental pressure of alternative brake linings need to be carried out in order to be able to appoint the most environmental friendly product. For zinc in tyres, research needs to be carried out on the alternatives for zinc. If possible, European law needs to be developed to restrain zinc levels in tyres. ZOAB asphalt has been demonstrated to reduce the discharge of traffic-related copper and zinc. Therefore, on a national scale, application of this type of road surface needs to be considered for construction of new roads and renovation of existing roads. However, ZOAB as collection site of tyre and brake wear needs regular cleaning to remove the wear.
For applications of metal in construction works (discharged via 'Sewer systems and sewage treatment'), investigation needs to point out which material or alternative application is most environmentally friendly. Possibilities for local treatment of discharged rainwater need further investigation.

It was concluded that for the establishment of effective and proportionate measures, the relative contribution to copper or zinc levels in surface waters of all emission sources should be estimated. The present analysis is based on emission data at national level, but for choosing the most effective measures, the local sources need to be identified and quantified.
The import of copper and zinc via the major rivers needs to be solved in international context and is beyond the control of the Netherlands. Since all Member States have to comply with the environmental Community legislation, the import is expected to decrease the next decades.
For most emission sources, measures are in development or are already in place with the aim to reduce copper and zinc emission to surface waters. Many uncertainties exist about effects of measures, the present and future bioavailability of the discharged substances and the contribution of the individual sources to the local zinc and copper concentrations.

1 Introduction

The Water Framework Directive (WFD, directive 2000/60/EC) requires the European Commission to
i) avoid long-term deterioration of freshwater quality and quantity,
ii) to establish environmental quality standards (EQS) for the Priority Substances (PS) and the Priority Hazardous Substances (PHS) and
iii) to come forward with Community-wide control measures to reduce pollution from the PS, or to phase out emissions, discharges and losses of the PHS.
Member States are obliged to implement the necessary measures to prevent deterioration of surface water bodies (Article 4 of the WFD) due to releases of priority and priority hazardous substances and (re-)gain good chemical water status. Member states are also requested to aim at a good ecological water status. Annex V of the WFD describes that identification of pollution by all priority substances, as well as pollution by all other substances being discharged in significant quantities into the water body ('other relevant substances'), belong to the quality elements of the classification of ecological status. Member States shall ensure that for surface water, the highest ecological and chemical status possible is achieved, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution. This indicates that the Member States are fully responsible for the three aims described in this paragraph.

The WFD provides some guidance for identification of the pressures in Annex II paragraph 1.4 and for taking measures in the articles 10 ('Combined approach for point and diffuse sources'), 11 ('Programme of measures') and 16 ('Strategies against pollution of water'). This guidance is dedicated to both diffuse and point sources. In the Communication published together with the proposed daughter directive on priority substances (COM/2006/398), the European Commission has indicated that a wide range of instruments is already available and that numerous legislative proposals and decisions have been made since the publication of the WFD. Instruments to comply with the Environmental Quality Standards (EQS) mentioned in the Communication are for instance Directive 91/414/EEC (e.g. to review plant protection products authorisation) or Directive 96/61/EC (e.g. review permits under the Integrated Pollution Prevention Control-directive, IPPC). The Communication also states that although marketing and use restrictions are regulated at European level 'Member States may also, under certain strict conditions laid down in the Treaty, introduce national provisions to restrict marketing and use because of risk to the aquatic environment.'

In the Netherlands, copper and zinc are identified as the so-called 'other relevant substances'. These substances are released to Dutch surface waters and monitoring data indicate that the environmental concentrations exceed the environmental quality standards at various locations. Consequently, the Netherlands are obliged to take measures in order to reduce the imput of these metals. Although various instruments have been mentioned in the WFD, the Communication (COM/2006/398) and the accompanying impact assessment, it is questioned if all these measures will result in compliance for copper and zinc. Previous studies indicate that diffuse sources contribute for a significant percentage to the total load of these metals in surface waters and these sources are covered by Community legislation to a limited extent. Article 12 of the WFD states that issues which can not be dealt with at Member State level may be reported to the Commission and any other Member State concerned and may be accompanied by recommendations for the resolution of it.

The present study aims to identify the various sources, to link these to national and European legislation and indicate if further measures at Community or national level are necessary.

The following approach is followed throughout the study:

a. limited identification and evaluation of sources in the Netherlands
b. investigation if European legislation is available for the major sources
c. investigation how this is applied in Dutch legislation
d. research if there are any failures of compliance/infringement procedures
e. search on how enforcement is carried out and do they lead to problems for this substance
f. evalution of possible alternative approaches

The present study is focused on emissions and discharge to surface waters. Groundwater or soil are only taken into account if discharge to these lead to significant emissions to surface water.
Points d and e have already been investigated in preceeding studies on polycyclic aromatic carbons (PAHs) and cadmium (Janssen et al., 2008; Vos et al., 2008). For copper and zinc, no new information in addition to the results described in the PAHs- and cadmium-reports, were found. Therefore, these subjects are not repeated within the present study. For information on failures of compliance or on enforcement, one is referred to Janssen et al. (2008) and Vos et al. (2008).

2 Methods

2.1 Identification of emission sources

The emissions of compounds to water are the so-called source emissions. Only a part of these emissions reach the surface water directly. A large part originates from effluents, overflows and rainwater sewer systems and reaches the water via municipal sewer systems. Parts of the pollutants remain behind in the purification sludge after waste water treatment. See Figure 1 for a schematic overview of the emissions to water and its relation to the actual load to surface water (text and figure copied from Koch et al., 2001).

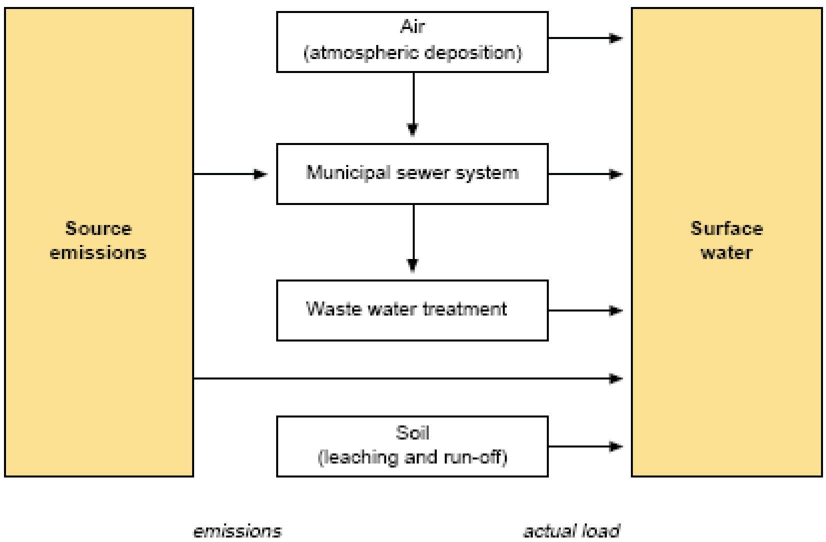


Figure 1. Schematic overview of the emissions to water and its relation to the actual load to surface water (copied from Koch et al. (2001).

The identification of sources of copper and zinc load to Dutch surface waters was performed on basis of data of the year 2005 provided by the Dutch emission inventory authority situated in the Netherlands Environmental Assessment Agency (PBL). The database contains both data on emissions as well as data on loads to water, specified by emission source. The present study mainly made use of data on loads to water, since water loads represent the actual amount of heavy metals reaching the surface waters. For discharges of sewer treatment plants, the so-called indirect emissions were charted. Additional information was sought on the internet. The emission sources contributing for more than 10% to the total water load taking place in the Netherlands were selected for further study in European and Dutch legislation.

2.2 Identification of European legislation

Eur-Lex ('The access to European Union law': http://europa.eu.int/eur-lex/) was searched for Community legislation. Search terms used in Eur-Lex were 'copper' and 'zinc'. With the EUROVOC descriptors the search was tuned in onto the legislation relevant for the current study. Legislation falling in the EUROVOC categories 'Environment' (EUROVOC descriptor 52), 'Transport' (EUROVOC descriptor 48) and 'Agriculture, forestry and fisheries' (EUROVOC descriptor 56) were submitted to a first scan for legislation relevant to reduce copper and zinc emissions.
During the study, additional searches were carried in Eur-Lex to check if no information was missed by the abovementioned search. For instance, an additional search was carried out for antifouling using the search terms 'coatings', antifouling and biocides within the EUROVOC descriptor number 4821 'Maritime and inland waterway transport'.

Only acts in force were investigated in detail. Analysis of content of the legislation was preferably carried out on the basis of the consolidated versions, when available. Search terms were applied in the 'Simple Search'-option in order to search in all types of legislation, in both title and content.

Additional consulted sources were the Risk Assessment Reports for zinc and its compounds (European Chemical Bureau, 2008) and the Risk Reduction Strategy for zinc and zinc compounds (Risk and Policy Analysts Limited, 2006). The selected legislation was submitted to a rough categorization on environmental compartment and type of control measure.

After appointing the main Dutch pollution loads (i.e. contributing more than 10% to total load), the Community legislation covering these main loads were chosen to study their implementation in the Dutch legal system.

2.3 Identification of Dutch legislation and policy

After selection of the European legislation covering the largest portion of copper and zinc load to the Dutch surface waters, Dutch legislation implementing this legislation was sought on the Dutch government website www.wetten.overheid.nl which offers an open directory of Dutch legislation and policy. Search terms used were the selected European legislation codes. Additionally, the Dutch translations of 'copper' and 'zinc' were searched for in order to identify national derogations from Community law. After summarizing the relevant Dutch legislation, experts on this Dutch law were consulted to gain understanding of the implementation of Community law into Dutch legislation.
Additional searches were carried out on the Internet to identify additional national measures. Search terms depended on the subject. Consulted experts are acknowledged in the Acknowledgements of this report.

3 Emission sources

3.1 Sources of copper

Introduction of copper by the international river the Meuse in the Netherlands was estimated to be 22,931 kg, by the Rhine 281,596 kg and by the Scheldt 16,836 kg in the year 2005 (Van Duijnhoven, 2007). In total, the amount of copper introduced in the Netherlands by the international rivers is twice as much as that introduced within the Dutch borders (30% of total load occurred in the Netherlands). Others estimate import of copper via international rivers to be more than 80% of the total load (RIVM, 2007a).

The main Dutch sources of copper load to surface water in 2005 can be distinguished in several sectors (Figure 2). Traffic and transport, Sewer systems and sewage treatment and Agriculture are the three sectors with the largest load to surface water. Load imported by the major rivers Rhine and Meuse was estimated to constitute 83% of the total load (RIVM, 2007a).

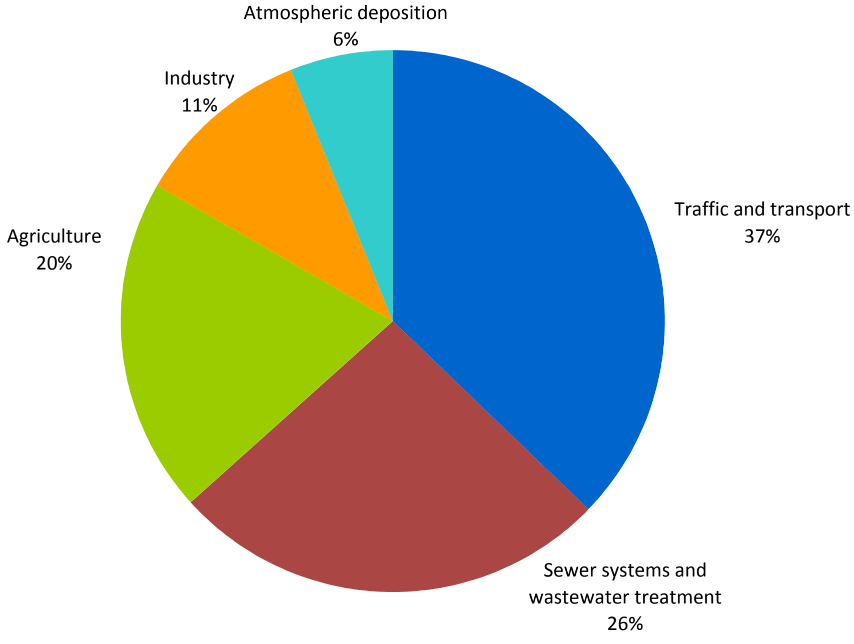


Figure 2. Copper load to surface water in the Netherlands, on the basis of MNP Registration data of the year 2005

In Table 1, the pollution sources situated in the Netherlands are further defined and quantified on basis of the Netherlands Environmental Assessment Agency-data. The categories marked in yellow were selected for further study on relevant European and Dutch legislation.

The largest subcategory for traffic and transport concerns the antifouling coatings used in shipping. Rainwater sewers and sewage treatment plants effluents and washout and surface runoff from agriculture are the other main subcategories.

Table 1. Dutch sources of copper load to surface water in kg copper in the year 2005. The sources of pollution marked in yellow were selected for further study for measures in Community and Dutch legislation

Copper sources	load [kg copper annually]	section
Atmospheric deposition (to surface water excl. sea)	**6200**	
Traffic and transport	**38371**	
maritime shipping/fishing vessels - inland/harbour - coatings	18195	4.1.1
recreational shipping - antifouling	14310	4.1.1
railway - wear overhead wiring/current collection	3354	4.1.2
traffic - wear of brakes	1797	4.1.3
traffic - wear of tyres	684	
traffic - wear of roads	26	
traffic - oil leakage	5	
Sewer systems and wastewater treatment	**26622**	**4.2**
rain water sewers	12485	
effluents sewage treatment plants	12235	
storm water overflows	1841	
water and wastewater treatment plants - process emission	61	
Agriculture (washout and surface runoff)	**20554**	**4.3**
Industry	**10959**	
metal electronics	7536	**4.4**
chemical industry	2555	**4.4**
metal industry	507	
paper industry	221	
other industries (e.g. abattoirs, meat products, dairy)	77	
chemical manure compounds	63	

In Figure 3, discharge to sewage treatment systems is quantified per contributing source. According to Vermij and De Poorter (2007), corrosion of copper water pipes in households accounts for 90% of the copper emission to sewage water of households. Thus, corrosion of water pipes is the largest source of copper to sewage treatment plants. Copper content of rainwater sewers depends on the region the sewers lay in (Boogaard and Lemmen, 2007). Copper concentration is elevated in residential districts compared to copper level in rainwater systems of roads, which at its turn, is elevated compared to levels in industrial areas. Emission registration data did not distinguish sources contributing to rainwater systems.

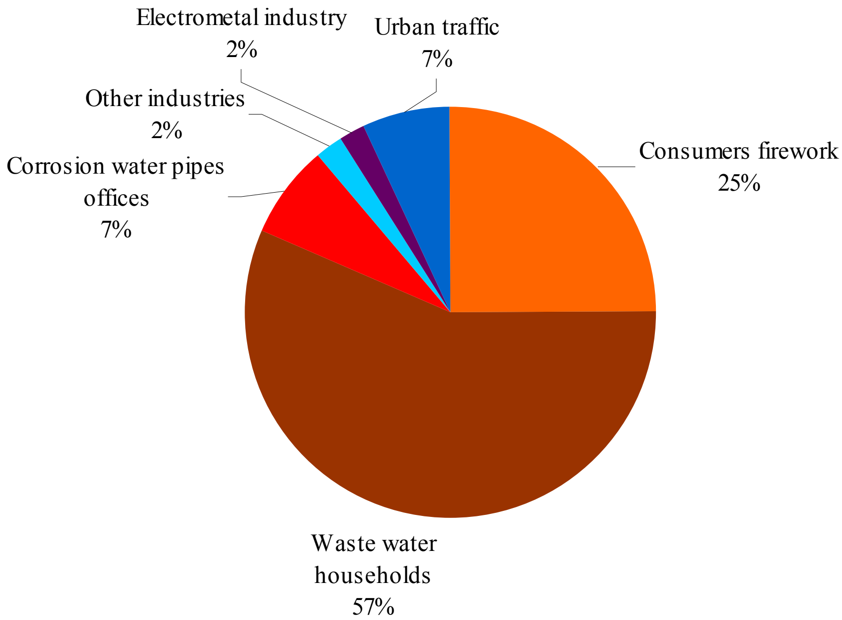


Figure 3. Discharge to sewage treatment systems in the Netherlands, on basis of MNP Registration data of the year 2005

Copper load originating from agriculture was specified as 'washout and surface runoff' by the Netherlands Environmental Assessment Agency. Copper load coming from agriculture is due to application of manure, fertilizers and pesticides and due to the use of copper baths for treating hooves of animal stock. Manure contains copper due to copper containing fodder and copper baths. From the current available data, copper load originating from manure, fertilizers and pesticides cannot be quantified. However, relevant data is presented on the website of Milieu- en Natuurcompendium (www.milieuennatuurcompendium.nl/). Copper emission by agriculture is for more than 80% (82-84%, in the years 2005 and 2006) due to use of copper containing manure. Research of the Dutch Centre for Agriculture and Environment ('Centrum van Landbouw en Milieu', CLM, 2006) estimated that contribution of copper baths to copper content of manure is approximately 45%. Use of inorganic fertilizers contributed for less than 10% and the application of pesticides less than 5%. Therefore, the present study focused on manure, animal feed and copper baths.

Atmospheric deposition to surface water (excluding atmospheric deposition to the sea) is only 6% of total load of copper to surface water in the Netherlands. The origin of atmospheric deposition can be transboundary, but very little data is available on sources of this atmospheric deposition. Through Dutch emission data to air an impression can be given of the Dutch contribution of copper to atmospheric deposition and its sources. In Table 2 and Figure 4 it is shown that the source of Dutch copper emission to air is mainly traffic and transport (88% of total emission to air). In Table 3 and Figure 5 is shown that the main source of emission to air in the traffic and transport category is wear of brakes (88%).

Table 2 and Figure 4. Contribution of emission sources to emission to air in the year 2005 (Netherlands Environmental Assessment Agency)

Emission to air	emission [kg copper annually]
Waste disposal	88
Chemical Industry	148
Consumers	9146
Drinking water supply	0
Energy (generation of electricity)	160
Trade, Services and Government	9
Agriculture	14
Other Industry	0
Refineries	2
Traffic and Transport	69538

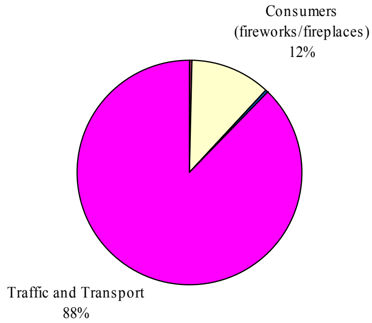
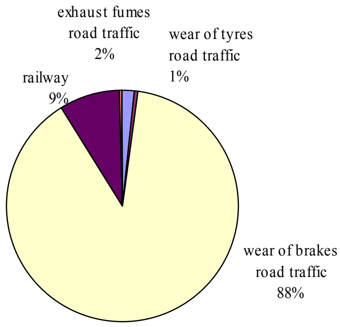


Table 3 and Figure 5. Contribution of emission sources to emission by subcategory traffic and transport in 2005 (Netherlands Environmental Assessment Agency)

Traffic and Transport	emission [kg copper annually]
Road traffic exhaust fumes	1204
Road traffic wear of tyres	379
Road traffic wear of brakes	61801
Road traffic wear of roads	15
Railway	6020
Shipping exhaust fumes	72
Shipping zinc anodes	47



3.2 Sources of zinc

Introduction of zinc by the international river the Meuse is estimated to be 175,844 kg, by the Rhine 1,355,856 kg and by the Scheldt 99,774 kg in the year 2005 (Van Duijnhoven, 2007). This is three times the amount that is introduced in the Netherlands in the surface waters (25% of total load occurs in the Netherlands). Other information sources estimate the Dutch contribution to zinc load in Dutch surface waters to 58% (RIVM, 2007b).

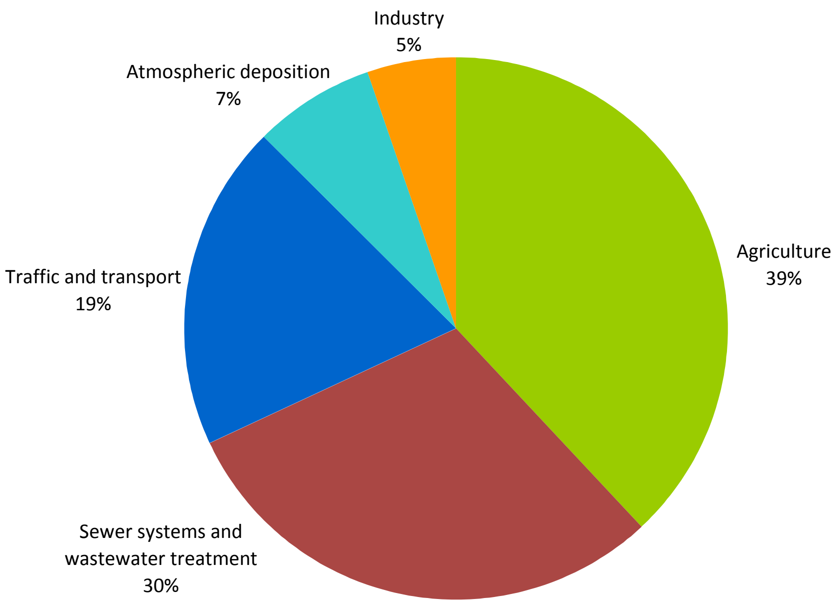


Figure 6. Zinc load to surface water in the Netherlands, on basis of MNP Registration data of the year 2005

Main Dutch sources of zinc load to surface water in 2005 were divided over several sectors. Agriculture, sewer systems and sewage treatment and traffic and transport are the three sectors with the largest load to surface water (Figure 6).

In Table 4, the Dutch sources discharging to surface water are further defined and quantified. The categories marked in yellow were selected for further study for relevant European and Dutch legislation.

The largest subcategory for agriculture is washout and runoff. For sewer systems and wastewater treatment rainwater sewers and STP effluents are the main subcategory. For traffic and transport, zinc anodes and wear of tyres are the largest subcategories.

Table 4. Dutch sources of zinc load to surface water in kg zinc in 2005. The sources of pollution marked in yellow were selected for further study for measures in Community and Dutch legislation

Zinc sources	load [kg zinc annually]	section
Atmospheric deposition (to surface water excl. sea)	**28593**	
Agriculture	**150857**	
washout and surface runoff	146848	4.3
Hunting, lead and zinc emissions	2850	
corrosion galvanized steel greenhouse farming	1156	
other (e.g. pesticide use)	3	
Sewer systems and wastewater treatment	**118722**	4.2
effluents sewage treatment plants	85047	
rainwater sewers	29230	
storm water overflows	4208	
water and wastewater treatment plants - process emission	237	
Traffic and transport	**76622**	
zinc anodes (sluice valves, maritime/inland shipping, fishing vessels)	53623	4.1.4
traffic - wear of tyres	20339	4.1.5
corrosion galvanized steel road construction	2071	
traffic - wear of brakes	180	
inland shipping - propeller shaft grease	136	
traffic - oil leakage	124	
traffic - wear of roads	77	
maritime shipping/fishing vessels - inland/harbour - coatings	57	
recreational shipping - antifouling	15	
Industry	**21162**	
chemical industry	15492	4.4
metal industry	2886	4.4
paper industry	1293	

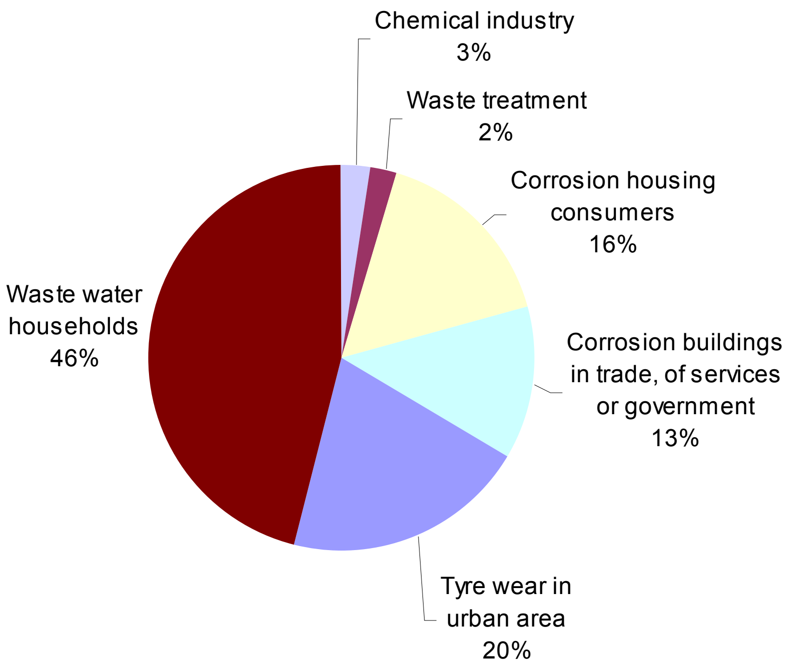


Figure 7. Discharge to sewage treatment systems in the Netherlands, on basis of MNP Registration data of the year 2005

Figure 7 shows the contribution of sources discharging to sewage treatment plants. According to Vermij and De Poorter (2007), approximately 40% of household wastewater is due to corrosion of roof gutters, 40% originates from human excretion and 20% originates from consumer products. According to the Risk Assessment Report (European Chemical Bureau, 2008), emissions from consumers are built up of corrosion from housing roofs (± 40%), private sewage from consumers (± 50%) and other applications (± 10%). Thus, approximately half of the zinc emitted to the sewer system treatment plants originates from construction products.
Zinc levels in rainwater sewers depend on the route the rainwater has traveled. Zinc levels are elevated by wash off from roads and are the highest in industrial areas (Boogaard and Lemmen, 2007). Emission registration data did not distinguish sources contributing to rainwater systems.

Zinc load coming from agriculture is mostly due to application of manure. According to data presented on the website of Milieu- en Natuurcompendium, zinc emission by agriculture is due to use of manure for 82% in the years 2005 and 2006. Use of inorganic fertilizers contributed for 2-3% and the use of pesticides less than 10% to the total load by agriculture. Therefore, the present study was only focused on the use of manure. Manure contains zinc due to its presence in animal feed. Either zinc oxide or zinc sulphate is added to animal feed as a source of the essential trace element zinc. A large proportion of the zinc in feed given to the animals is not absorbed (20-50%). This fraction will pass straight into the manure. From the absorbed fraction a large portion will be excreted after transformation in the animal body (20-50%). The remaining fraction (approximately 15%) will be concentrated in the various animal tissues. It is assumed that 85% of the zinc in animal feed will end up in the manure (FEFAC/EUROSTAT/ZOPA, 1999 in European Chemical Bureau, 2008).

Atmospheric deposition to surface water (excluding atmospheric deposition to the sea) is only 7% of total load of zinc to surface water in the Netherlands. The origin of atmospheric deposition can be transboundary, but very little data is available on sources of this atmospheric deposition. Through Dutch emission data to air an impression can be given of the Dutch contribution of zinc to atmospheric deposition and its sources.

In Table 5 and Figure 8 it is shown that the sources of Dutch zinc emission to air are mainly traffic and transport (45% of total emission to air) and other industry (36% of total emission to air). In Table 6 and Figure 9 is shown that the main source of emission to air in the traffic and transport category is road traffic exhaust fumes (56%), followed by wear of tyres (29%) and wear of brakes (15%). The 'other industry' subcategory consists for 98% of metal industry.

Table 5 and Figure 8. Contribution of emission sources to air in 2005

Emission to air	emission [kg zinc annually]
Waste disposal	6
Chemical Industry	4952
Consumers	4804
Drinking water supply	0
Energy (generation of electricity)	418
Trade, Services and Government	28
Agriculture	7778
Other Industry	33047
Refineries	481
Traffic and Transport	40068

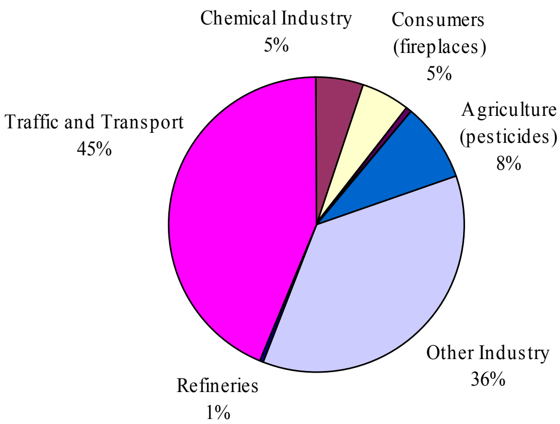
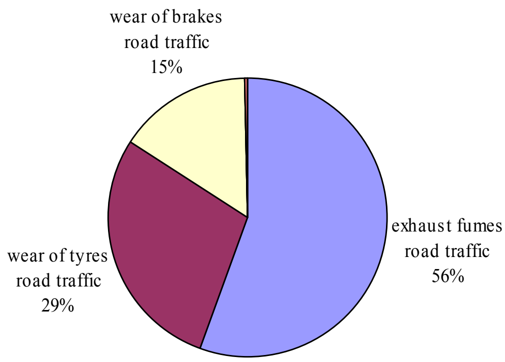


Table 6 and Figure 9. Contribution of emission sources to water in the subcategory traffic and transport in 2005

Traffic and Transport	emission [kg zinc annually]
Road traffic exhaust fumes	22294
Road traffic wear of tyres	11447
Road traffic wear of brakes	6180
Road traffic wear of roads	43
Railway	1
Shipping exhaust fumes	61
Shipping zinc anodes	42



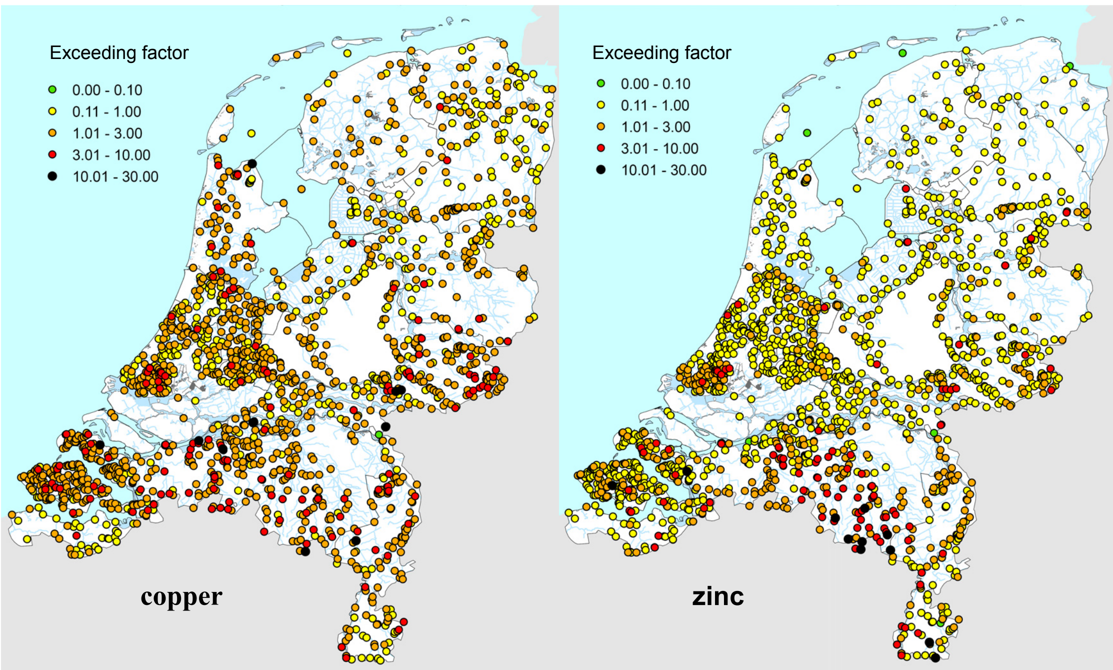
For zinc sources, emission and discharges in the Netherlands one is also referred to the risk assessment report of the European Chemical Bureau (2008). The Netherlands were Rapporteur for zinc and its compounds under the Existing Substances Regulation. Many of the data gathered came from that country.

3.3 Levels in Dutch surface waters

De Nijs et al. (2008) calculated the factor that monitoring data exceed the Dutch Environmental Quality Standard MPC (Maximum Permissible Concentration), using annual 90 percentile for 2005 and 2006 monitoring data. The present MPC for copper is 1.5 µg/l dissolved fraction and 3.8 µg/l total fraction, for zinc 9.4 µg/l dissolved fraction and 40 µg/l total fraction. In Figure 10, the higher of the two exceeding factors for 2005 and 2006 is shown. The MPC value lies between the yellow and orange categories. Copper exceeds the MPC on 59% of the locations, zinc on 21% of the locations. For copper there is no specific geographical pattern shown in Figure 10, MPC exceedings are found country-wide. For zinc exceeding factors are markedly higher in the region of eastern Brabant, which can be associated with historic pollution by zinc smelters.

At present, a new implementing regulation is in process including new criteria for zinc and copper. Currently, for the dissolved fraction of zinc, an Annual Average (AA) concentration of 7.8 µg/l for Inland Waters and 3 µg/l for Other Waters and a Maximum Allowable Concentration (MAC) for Inland Waters of 15.6 µg/l are proposed for all waters. For copper, a new AA-concentration for Inland waters is in development. Given these new criteria the number of exceedences of the AA of copper are expected to decrease strongly to less than 1% of the locations (data 2005 and 2006). The number of exceedences of zinc will remain more or less the same: at 50% of the locations the AA will be exceeded and at 40% of the locations the MAC. In the future regulation it is permitted to correct monitoring data for background concentration and for bioavailability, when the AA is exceeded. When these two factors are applied, even less problems with copper and zinc in surface waters are indicated.

Figure 10. Maximal exceeding factors of MPC (Maximum Permissible Concentration), using annual 90 percentile for 2005 and 2006 monitoring data and the current MPCs. Copied from De Nijs et al. (2008). Left: copper, right: zinc.



4 Assessment of European and national law concerning major sources of copper and zinc

Traffic and transport, sewer systems and sewage treatment and agriculture were the three sectors accounting for the largest load of copper and zinc to surface water in the Netherlands. For copper, these three sectors cover 83% of the total load and for zinc 88%. Therefore, European legislation covering these three sectors was selected to study its relevance to the reduction of copper and zinc pollution.

The search for relevant European legislation containing words related to copper and zinc resulted in 1526 hits in Eur-Lex. Using the EUROVOC descriptors ‘ Environment’, ‘ Agriculture’ and ‘Transport’ in the previous selection, resulted in 449 hits, which can be viewed in Appendix I. These 449 hits were scanned for relevancy in the sense that the legislation searched for should deal with the major pollution sources of copper and zinc mentioned above. Further research was carried out using the consolidated versions of the directives and regulations concerned.
The three sectors accounting for the largest loads of copper and zinc to surface water in the Netherlands (>10% of total load) are evaluated in sections 4.1 to 4.5 for European legislation and Dutch policy.

In the Netherlands, environmental legislation is built on the legislative framework ‘Wet milieubeheer’ (Enviromental Management Act). This basic law describes the legal instruments to protect the environment. The most important instruments are environmental plans, programmes, quality specifications, permissions, general regulations and enforcement. Details of this framework law are described in decrees (‘Besluiten’ or ‘Algemene Maatregelen van Bestuur’). On their turn, details of these decrees can be filled in with regulations (Regelingen).

In sections 4.1 to 4.5, relevant legislation for the specific sources of copper and zinc are described. In sections 5.1 to 5.4, these measures are discussed and possible solutions are described. In Table 7, an overview is given of the legislation treated in these sections.

Table 7. Overview of investigated EU and Dutch policy as investigated within the present study.

Sources	**Existing legislation** EU	**Additional policy** Netherlands	**Section**
Traffic and transport			
Antifouling	Biocides directive 98/8/EC	Wet gewasbeschermingsmiddelen en biociden	4.1.1
Copper overhead wiring	Directive 94/68/EC on high-speed rail systems		4.1.2
Copper brake lining			4.1.3
Zinc anodes		Research program	4.1.4
Zinc in tyres	Directive End-of-Life Vehicles 2000/53/EC	Research program	4.1.5
Sewage treatment plants and sewer systems			
Construction works	Construction Products Directve 89/106/EEC Research group ScorePP	Wet op de Ruimtelijke Ordening Bouwbesluit Besluit Bodemkwaliteit Activiteitenbesluit Besluit lozing afwalwater huishoudens	4.2.1.1
Copper waterpipes	Drinkingwater directive 98/83/EC	Waterleidingbesluit	4.2.1.2
Rain runoff		Activiteitenbesluit	4.2.2
		Besluit lozingen buiten inrichtingen	4.2.3
Sewage treatment plants	IPPC 96/61/EC E-PRTR 166/2006 (EC)	Licence procedure CIW mixing zone model	4.2.3
Agriculture			
Animal feed	Directive 87/153/EEC and 70/524/EEC on additives Regulation 1831/2003 on additives	Inspection program of animal fodder Conventant for animal fodder Research program	4.3.1
Manure	IPPC 96/61/EC E-PRTR 166/2006 (EC)	Uitvoeringsbesluit Meststoffenwet Milieutoets toelating meststoffen	4.3.2
Copper baths		Stimulation program	4.3.3
Chemical and metal industry	IPPC 96/61/EC E-PRTR 166/2006 (EC) REACH	Activiteitenbesluit	4.4

4.1 Traffic and transport

4.1.1 Antifouling on maritime shipping/fishing vessels and recreational shipping

Copper compounds are allowed to be used in products for the preservation of wood and in antifouling paints when assessed according to the Biocidal Product Directive 98/8/EC and included in Annex 1 of the Directive. The Biocidal Product Directive aims to harmonise the European market for biocidal products and their active substances. At the same time it aims to provide a high level of protection for humans, animals and the environment. If active substances are included in the Annex to the Biocides directive, Member States have to perform a risk assessment at the national level on the products containing these actives. Active substances of biocides, which have not been evaluated at EU-level or are not in the process of being evaluated at EU-level, may not be used in biocides anymore. At present, copper is in the progress to be evaluated at EU-level by France. Since national law is established for antifouling, national law is still leading until the European risk assessment has been terminated.

National policy
In the Netherlands, biocides are regulated by the Act 'Wet gewasbeschermingsmiddelen en biociden' on plant protection products and biocides. September 1999, the Board for the Authorisation of Plant Protection Products and Biocides ('College voor de toelating van gewasbeschermingsmiddelen en biociden') decided that the use of copper-containing antifouling was only permitted on seagoing ships for professional use, marine and military vessels because of unacceptable environmental impact. However, the manufactures of paints gave notice of appeal against this prohibition. Subsequently, Dutch and European jurisdiction found the decision of the Board for the Authorisation of Plant Protection Products and Biocides not to be correctly justified and the ban on copper-containing antifouling paints in fresh waters in the Netherlands has been withdrawn. The Board for the Authorisation of Plant Protection Products and Biocides is in the process of revising the risk assessment. Thus, at present copper-containing antifouling is allowed to be used on both seagoing ships for professional uses and boats for non professional use. Due to the former ban on copper-containing antifouling, at present this antifouling is on the market at only low amounts. This is expected to remain so. Moreover, the Netherlands makes efforts to re-effectuate the prohibition of copper-containing antifouling (VROM, 2007), hereby eliminating emission of copper by vessels used for recreation.

In the Dutch policy program for biocides (Beleidsprogramma Biociden; Ministerie van VROM, 2006), it is reported that the development of less harmfull and more effective alternatives for copper-containing antifouling will be stimulated.

Research carried out by the Inspectorate of the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM-Inspectie) showed that compliance of the biocides legislation generally is well performed on marine vessels (VROM-Inspectie, 2005).

4.1.2 Copper overhead wiring of rail ways

The overhead wiring of trains contains copper, which is subject to corrosion. When searching for 'contact wire', directive 94/68/EC on the interoperability of the trans-European high-speed rail system was allocated in Eur-Lex. In the annex to the directive the contact wire material is prescribed. Permissible materials for contact wires are copper and copper-alloy. The contact wire has to comply with the requirements of EN 50149:2001 clauses 4.1 to 4.3 and 4.5 to 4.8. A European expert group has been assembled which will discuss the EN 50149 requirements set by directive 94/68/EC in order to enable application of alternative materials besides copper (alloys) in overhead wiring.
For convential railways, a technical specification interoperability (TSI) is being formulated at present. This TSI for convential railways is expected to enter into force in 2010. The TSI Convential Rail will refer to the EN 50149 requirements, hereby requiring copper to be the major constituent of overhead wiring of contact wires.

National policy
According to European law, contact wires need to fulfill EN 50149-demands. Thus, alternative materials in overhead wiring are not allowed to be applied in high-speed rail systems.

The Ministry of Transport, Public Works and Water Management (V&W) had initiated an investigation of possible alternative alloy compositions (VROM, 2007). This research has not resulted in realistic alternatives.

4.1.3 Wear of copper brake lining

Copper is used in brake lining. No European legislation regulating copper content of brakes was found, also after an additional search in Eur-Lex. Also at the national level, no legislation for the reduction of copper pollution by brake lining is available.

National policy

In 'Uitvoeringsprogramma diffuse bronnen waterverontreining' (Execution program diffuse source pollution water; VROM, 2007), copper in brake lining is stated to be a subject which has to be taken on at European level in order to establish a level-playing-field. Also innovative research should preferably be carried in European association. However, at present, no research on the subject is running.

4.1.4 Zinc anodes

No Community law on sacrificial zinc anodes was found during the search in Eur-Lex. Also, additional searches on the internet did not provide Community legislation on the subject.

National policy

In the project 'Hand in eigen boezem' of the Ministry of Transport, Public Works and Water Management (V&W) and of the Directorate-General for Public Works and Water Management ('Rijkswaterstaat') the alternatives for zinc anodes are investigated. The first published results are expected this year. 'Rijkswaterstaat' will determine if aluminium anodes can replace zinc anodes during regular maintenance (VROM, 2007). Aluminium anodes appear to work better compared to zinc anodes in freshwater and therefore gain popularity. It is estimated that 25% of the inland ships apply zinc anodes, 50% aluminium anodes and 25% magnesium anodes. In brackish or marine water, zinc anodes are mostly used (Van den Roovaart and Van Duijnhoven, 2007).

4.1.5 Zinc in tyres

Vehicles release zinc in substantial amounts to the environment due to corrosion of tyres. Tyres contain 8-25 g zinc per kg. Zinc from tyres enters the environment by mechanical wear during the lifetime as a tyre. Elevated zinc concentrations are found along roadsides and beneath stockpiles of old car tyres. Blok (2005) estimated the zinc emission from tyres based on car sales statistics and travelled distances (see Table 8).

Table 8. Summary of source estimation for zinc release by tyre wear by a distance-travelled approach (copied from Blok, 2005)

Vehicle category	Cars	Vans	Trucks
Number of tyres per vehicle	4	4	10[a]
Average distance per tyre life (km)	40,000	65,000	150,000
Wearing rate (mg Zn/vehicle km)	0.83	1.25	7
Vehicle km in NL ($\times 10^9$ km/year)	89.7	12.6	4.4
Vehicle numbers in NL ($\times 10^6$)	5.87	0.5	0.093
Average distance per vehicle ($\times 10^3$ km/year)	15.3	25	47
Zn emission in NL (tons/year)	74	16	31

Trucks 42%×12, Busses 9%×7, Freight+trailers 49%×9 (CBS, 2002; Brink, 1996, 2000).

[a] Busses have 6 – 8 tyres, trucks with trailer 12 tyres, freight cars 6–8 (av. 7) and with trailer 10–12 (av. 11), the average of 10 has been chosen on the basis of relative mileages in NL.

Due to Community legislation (Directive 2000/53/EC on End-of-Life Vehicles) rubber is increasingly recycled. Emission of zinc from recycling products is a potential risk. Especially when rubber is shredded or granulated to small particles and exposed in the open air, considerable amounts of zinc appear to leach. An example is the use of rubbergranulate on artificial turf soccer fields, where estimated zinc in the infiltrating rainwater water are estimated between 0.1 and 1 mg/l. The construction layers of lava and sand reduce the actual risk for groundwater or drainage water. Due to adsorption of the zinc the effect of rubber granulates is retarded for decades (Verschoor, 2008).

Surprisingly, no Community legislation setting quality standards for zinc content of tyres were found (search terms ‘zinc’ and ‘tyres’). In Annex V to Corrigendum to Regulation No 124 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of wheels for passenger cars and their trailers, corrosion tests are demanded to evaluate e.g. zinc corrosion of buses. However, no quality limits for zinc corrosion of tyres are established in Community law. There are several directives concerning waste of tyres (e.g. 2000/53/EC on end-of-life vehicles), but these do not regulate zinc content of tyres during production.

National policy

In the Innovation and Research program heavy metals and environment (‘Innovatie en Onderzoeksprogramma zware metalen en milieu’) was searched for alternatives for zinc in tyres. Reduction of the amount of zinc oxide in tyres or replacement of zinc oxide by nano-zinc oxide appears to be possible as well as an alternative system of vulkanisation. The research program has not lead to final conclusions. In the Execution Program Diffuse Source Pollution of Water (‘Uitvoeringsprogramma Diffuse bronnen waterverontreiniging’; VROM, 2007) it is proposed to continue the search for practical and environmentally friendly alternatives.

4.2 Sewage treatment plants and sewer systems

Sewage treatment plants contribute to zinc and copper load to surface waters for 30% and 26%, respectively. Copper waterpipes are responsible for 90% of copper to the sewage treatment plants. Approximately 40% of zinc discharge to sewage treatment plants is household wastewater originally,

40% is due to human excretion and 20% originates from consumer products (Vermij and De Poorter, 2007).
The major application of construction metals is in buildings and houses. Disconnection of roof run-off from the sewer system results in a high exposure of soil and groundwater, exceeding environmental quality standards for copper and zinc. Runoff from construction metals results in increasing concentrations of copper and zinc in surface water, groundwater and soil. That is the conclusion of scenario calculations for the runoff from roofs and gutters, wallfronts, crash barriers and water pipes (Verschoor and Brand, 2008). The impact of construction metals strongly depends on the way they are applied. Most important are the amount of runoff water and the drainage methods.
The effect of rainwater sewer with a direct discharge to surface water is depending on the waterflux and dimensions of the receiving surface water. Disconnection of roof runoff from the sewer system results in a high exposure of soil and groundwater, exceeding environmental quality standards for copper and zinc.
Results of Verschoor and Brand (2008) are summarized in the tables below.

Table 9. Increase of zinc and copper concentration in stagnant surface water[1], caused by roof runoff (from: Verschoor and Brand, 2008).

	Δ[Cu] (μg/L)	Δ[Zn] (μg/L)
Gutter	17	35
Roof 45°	370	770
Roof 45° + gutter	390	800
Wall front	73	150

[1] Roof run-off is diluted by rainfall from other paved surfaces, but is not diluted by a flowing river or stream.

Table 10. Increase of zinc and copper concentration by direct discharge of a residential area in ditches, canals and rivers[2] caused by roof run-off (from: Verschoor and Brand, 2008).

	$\Delta[Cu^{2+}]$ µg/L			$\Delta[Zn^{2+}]$ µg/L		
	Ditch	**Canal**	**River**	**Ditch**	**Canal**	**River**
Gutter	**5**	**0.7**	0.1	**10**	1	0.2
Roof 45° + gutter	**108[1]**	**15[1]**	**2**	**224**	**32**	4

In order to reduce the load to water, measures can be taken at three levels:

1. Maximum values for metal leaching from construction materials may be set.
2. Rain coming from building materials is often collected. At the collection site, quality demands can be set to soil, surface water or sewer systems. Treatment of sewer water may be demanded or discharge via certain routes prohibited.
3. Rainwater is mostly collected by the municipalities and then discharged. At the point of discharge, e.g. rainwater sewer or sewage treatment plant, regulations can be drawn on place of discharge and on water treatment.

(www.duurzaambouwen.senternovem.nl, consulted September 2008)

General Dutch policy

The Dutch Act on pollution of surface waters ('Wet verontreiniging oppervlaktewateren') forbids emitting polluting or dangerous substances in surface waters. The executive authority designates emission permits. This act on pollution of surface waters can be activated for both point as diffuse pollution sources and thus for corrosion of building materials and pollution by rainwater. The Act on environmental management ('Wet milieubeheer') establishes the European emission and substances policy. The act regulates discharges to the sewer system. Municipalities are responsible for the collection of wastewater coming from households and businesses and for the transport of this wastewater to waste water treatment plants. The Act on Soil Protection ('Wet Bodembescherming') handles the protection, reduction and elimination of changes of soil which imply reduction or threat of the functional characteristics of the soil for humans, plants or vertebrates by laying down the precautionary principle.

4.2.1 Demands to construction products

4.2.1.1 Construction works

The Construction Products Directive (89/106/EEC) arranges that works applying construction products fulfill the essential requirements set out in terms of objectives in Annex I to the Construction Products Directive. Harmonized standards are the technical specifications adopted by CEN, Cenelec or both, on mandates given by the Commission in conformity with Directive 83/189/EEC. In Annex I to the Construction Products Directive, requirements for hygiene, health and the environment are listed in general terms:

The construction work, must be designed and built in such a way that it will not be a threat to the hygiene or health of the occupants or neighbours, in particular as a result of any of the following:

- the giving-off of toxic gas;
- the presence of dangerous particles or gases in the air;

[2] Computed with CIW-mixing zone model. Ditches: 5 m wide, 1 m deep and 0.15 m^3/s waterflux, canals: 25 m wide, 2 m deep and 2 m^3/s waterfluc, rivers: 50 m wide, 2.6 m deep and 25 m waterflux. Residential area of 2000 houses/km^2.

- the emission of dangerous radiation;
- pollution or poisoning of the water or soil;
- faulty elimination of waste water, smoke, solid or liquid wastes;
- the presence of damp in parts of the works or on surfaces within the works.'

The Construction Products Directive does not contain litteral requirements for copper and zinc. However, the Construction Products Directive requires following the harmonized standards in conformity with Directive 83/189/EEC. For instance, by Revised Mandate M136 to CEN/CENELEC concerning the execution of standardization work for harmonized standards on construction products in contact with water intended for human consumption (April 2006), pipes are allowed to be copper or copper alloys (coated or uncoated).

At present, a research group funded by the European Commission is aiming to identify sources of WFD Priority Substances in urban areas and to develop strategies for limiting the release of Priority Substances (ScorePP, www.scorepp.eu). Currently, however, no information from the project is available yet. Although ScorePP is focused on Priority Substances under the WFD, it is expected that emission control of Priority Substances simultaneously will reduce emissions of copper and zinc in urban areas.

National policy

In 'Uitvoeringsprogramma Diffuse Bronnen waterverontreining' (VROM, 2007), it is reported that the Netherlands do not want to put up national demands to the application of metals used in contruction works until 2009. Both existing zinc and copper applications will not be removed. However, measures can be taken locally on basis of the Act on surface water pollution ('Wet verontreining oppervlaktewateren'; see the paragraph above in this section at 'General national policy') and the Decree on Soil Quality (see below). At present, the Order in Council 'Bouwbesluit' concerning building regulations does not prescribe limiting conditions for the use of zinc in building constructions. However, steel construction elements with zinc coating need to fulfill sustainability requirements NEN-EN-ISO 1461, EN-ISO 12944 and NPR 7452. In article 3.43 of the 'Bouwbesluit' is ordered that during the building of new houses, rainwater should be kept separated from wastewater.

The Act on spatial planning (Wet op de Ruimtelijke Ordening, WRO) obliges municipalities to display their draft land use plan to the waterboards. These land use plans must contain information on the expected effects on waterbodies.

The Decree on soil quality 'Regeling bodemkwaliteit' establishes quality standards for content and emission from stony materials, including for copper and zinc. Soil quality standards are developed per soil function (housing, industry, major projects) and for the application of dredging and for application in surface water and on sediment. A marginal burdening is accepted when it does not exceed a level of 1% of the concentration of the target value of an inorganic substance in 1 m of the soil within a period of 100 years ('immission value').

The Soil Quality Decree gives quality criteria for the application and re-use of stony materials and earth used as building materials. No difference is made between primary materials, secondary materials and waste materials.

For building metals it is investigated how these score on the generic emission limits for stony construction materials. On basis of the results of the investigation it will be decided if generic emission limits for metal construction materials need to be developed as well.

4.2.1.2 Copper waterpipes

An important source of copper in STP's is corrosion of drinking water pipes. Verschoor and Brand (2008) estimated that copper drinking waterpipes, after purification[3] by municipal waste water systems, add 1.0-2.1 μg copper/l in typical canals and small rivers (25 m wide, 2 m deep, flux 2 m^3/s). Discharge in smaller streams such as ditches would result in higher concentrations, in larger rivers in lower concentrations. In mixed sewer systems (rainwater and municipal waste water) direct discharge occasionally occurs during extreme rainwater events. In that case the purification is negligible, and the emission of copper from drinking waterpipes can add 7-12 μg/l to the local surface water[4].

By Mandate M136 to CEN/CENELEC waterpipes are allowed to be of copper or copper alloys (coated or uncoated).
The Drinking Water Directive 98/83/EC establishes a quality standard in water intended for human consumption for copper of 2.0 mg/l. For zinc no quality standard was established.
Copper waterpipes are not assessed for risks for human health and the environment under the Biocides directive 98/8/EC, because their purpose is water transport and are not intended to control harmful organisms (pers. comm. CTGB). Copper-silver ionisation is a form of chemical control of *Legionella*. This use is not yet authorised, but in the policy letter on differentiated enforcement of copper-silver ionisation ('beleidsbrief gedifferentieerd handhaving koperzilverionisatie') conditions for use are described (VROM-website, http://www.wweni.nl/pagina.html?id=36188).

<u>National policy</u>
The decree on pre-packaged water 'Warenwetbesluit Verpakte waters' requires mineral water to fulfil the demands of 98/83/EC. The decree on water supply systems 'Waterleidingbesluit' establishes a copper quality standard of 1.0 mg/l for water produced for human consumption. For zinc, no quality demand is set. Thus, Dutch law provides a stricter quality standard concerning copper in water intended for human consumption in comparison with Community law.

4.2.2 Quality demands to collected rain runoff

<u>National policy</u>
The relatively new Order in Council on environmental management of installations and activities 'Activiteitenbesluit' or 'Besluit algemene regels voor inrichtingen milieubeheer' and contains the precautionary principle that pollution of surface water, groundwater and soil by installations need to be prevented. The Order in Council regulates discharges of rainwater and of household wastewater directly to surface water, but also to soil and sewer systems. This Order in Council prescribes emission limits for several installations for several categories of substances. Discharge of rainwater on the sewer system is considered to be undesirable due to the generally low pollution rate of rainwater. However, Decree Orders can be established for activities suspected to cause problems in the environment by rain discharge to the surface water.

The Order in Council on discharges by households 'Besluit lozing afvalwater huishoudens' regulates e.g. discharges of rainwater to soil and groundwater, sewer systems and surface water. The Order in Council regulates that no individual permits need to be obtained for discharges of households. This includes discharges of rain (including snow and hail). However, discharges which disturb the functioning of sewer systems or sewage treatment plants or which negatively affect the quality of soil or surface water are prohibited. In paragraph 5.4 of the Communication to the Order in Council on discharges by households (Staatsblad, 2007), preference is noted to redistribute rainwater locally. General rules are laid down for the rainwater discharge to soil or surface water by households. For the

[3] An average purification efficiency of 92% was realized in the period 1981-2005.
[4] Assuming typical canal or river dimensions of 25 m wide, 2 m deep and 2 m^3/s flux.

general applications of building materials by households (zinc gutter and lead roof application), the establishment of general rules is not considered to be opportune. For unusual applications, the environment may need protection. The competent authorities then may put up measures, which may be tailor-made.
Policy is focused on the development of emission-low construction metals and discouragement of application of leaching construction metals by local authorities. In the period until 2009 it is evaluated if Community measures are feasible and if additional national policy is needed.

4.2.3 Demands at point of discharge

Sewage water treatment plants with a capacity exceeding 100,000 population equivalents fall under the European Pollutant Release and Transfer Register (E-PRTR, 166/2006 (EC)). Since the E-PRTR is a regulation, it does not need implementation in national law. See for more information on the implementation of IPPC (96/61/EC) and E-PRTR, the reports on PAHs or cadmium (Janssen et al., 2008; Vos et al., 2008).
The Best Available Techniques Reference Documents (BREFs) included sector-specific decriptions of wastewater treatment technologies. If applicable, figures on the pollutant concentrations achievable in wastewater with the individual techniques are given. However, no emission limits are prescribed.

National policy
In the Netherlands, the sewage treatment plants fall under the Act on Environmental Management and the Act on pollution of surface waters. The sewage treatment plants have to follow Best Available Techniques-guidances and monitoring checks their processing.
Industrial discharges and discharges of sewage treatment plants are controlled by a licence procedure. In order to obtain a permit an environmental risk assessment must be performed using the Dutch CIW-mixing zone model (CIW, 2000). Surface water concentrations are computed depending on discharge flux and concentration, and the dimensions of the receiving surface water. Discharge at the end of a mixing zone should not contribute more than 0.1*MPC or 10% increase to the local background concentation. This is considered to be a standstill approach. Within the mixing zone concentrations above the serious risk level are not permitted.

Rainwater originating from paved roads will be settled in the future Order in Council 'Besluit lozingen buiten inrichtingen'. This Order in Council is expected to enter into force in 2009 and may contain emission limits for copper and zinc (see section on building materials above). At present, the competent authorities may put up regulations establishing quality demands. When rainwater is polluted, the Act on the pollution of surface waters ('Wet verontreiniging oppervlaktewater') demands a permit for the discharge.

4.3 Leaching and surface run-off in agriculture

Copper and zinc load to surface waters mainly originates from animal manure, which at its turn is caused by the metals' presence in animal fodder. Copper in manure is also due to the use of copper baths for disinfection of hooves. In the Risk Reduction Strategy for zinc (Risk and Policy Analysts Limited, 2006) is indicated that for the terrestrial ecosystem no need for further testing, further information or for risk reduction measures is needed, because the Risk Assessment Reports for zinc (European Chemical Bureau, 2008) show that at present there are no existing risks from zinc in agricultural soils. Groundwater and surface water were beyond the scope of the Risk Assessment Report. It is also considered that existing legislation relating to sludge and manure management (Directives 86/278/EEC and 91/676/EEC and Regulation 1831/2003 (EC)) provide an adequate framework to address and prevent any future risks to zinc accumulation in soil. However, agriculture is

expected to be a significant emission source to surface and groundwater, contributing to 40% of total load to surface waters. Dutch research indicates that if the present situation (copper and zinc content of manure remains similar) is maintained, that leaching from agricultural soil will increase (Bonten et al., 2008)
The Risk Assessment Reports for zinc (European Chemical Bureau, 2008) show the net accumulation (in g/ha/year) for various soil types and land uses in the Netherlands. The data come from De Vries et al. (2004) and were shown to be representative for other North-Western Europe countries having similar intensive agriculture activities. Whereas zinc via manure inputs in the Netherlands may be among the highest in Europe, the total inputs do not deviate as much from other European Countries, most likely due to the fact that inputs from sludge are much higher in most other countries.

Table 11. Average fluxes of zinc for the various land use and soil types in 2000. Both leaching and accumulation refer to the plough layer (0-10 cm for grassland and 0-30 cm for arable land; copy of Table 3.2.49 **from Risk Assessment Reports for zinc (European Chemical Bureau, 2008))**

Land use	Soil type	Zn flux ($g.ha^{-1}.yr^{-1}$)			
		Input	Uptake	Leaching	Accumulation
Grass	Sand	938	700	228	10
	Sand calcareous	853	510	66	277
	Clay	969	474	34	460
	Clay calcareous	885	390	16	479
	Loess	1013	636	117	260
	Peat	889	455	126	308
Arable	Sand	1039	392	377	271
	Sand calcareous	868	319	86	463
	Clay	911	347	43	521
	Clay calcareous	899	238	19	642
	Loess	993	405	178	410
	Peat	836	317	271	248
All		926	425	152	349

The time period it will take before the critical zinc limit in soil is reached in the Netherlands is also indicated in the Risk Assessment Reports for zinc (European Chemical Bureau, 2008). It shows that the average time periods to reach critical levels for grassland range from 161 years for peat soil to 589 years for clay soil. For arable land longer time periods are estimated: 444 years (sand) to 1704 years (loess). Spijker et al. (2007) confirm the occurrence of zinc accumulation in Dutch agricultural soils, together with copper accumulation, by anthropogenic factors.

Table 12. Percentage of plots at which the steady-state zinc concentration exceeds the critical zinc concentration for a present, subsoil and standard background zinc concentration (copy of Table 3.4.73 from Risk Assessment Reports for zinc (European Chemical Bureau, 2008))

Soil type	% of plots exceeding critical Zn limit					
	Grass land			Arable land		
	Present Zn content	Subsoil Zn content	Standard approach	Present Zn content	Subsoil Zn content	Standard approach
Sand	1.3	3.3	1.9	1.7	6.6	3.1
Sand calcareous	0	100	100	57	94	63
Clay	70	93	80	61	79	66
Clay calcareous	99	100	100	96	99	98
Loess	6.2	96	20	0.57	95	76
Peat	45	81	72	20	30	23
All	42	56	51	52	59	55

4.3.1 Animal feed

A short list of European legislation was found concerning copper and zinc in animal feed:

- Directive 1999/29/EC lays down maximum levels of certain substances in animal nutrition and is repealed by directive 2002/32/EC. However, no restrictions to copper or zinc are laid down in these directives.
- Regulation 882/2004 (EC) sets the rules for the organisation of inspection in the field of animal feed and food stuffs.
- In directive 87/153/EEC fixing guidelines for the assessment of additives in animal nutrition the guidelines for environmental risk assessment of additives in animal nutrition are laid down. Copper is specifically mentioned as a substance, which may give reason to suspect that the environment is endangered by its presence in animal nutrition. At which level copper may cause harm to the environment is not specified.
- Regulation 1831/2003 (EC) on additives for use in animal nutrition establishes a Community procedure for authorising the placing on the market and use of feed additives and lays down rules for the supervision and labelling of feed additives and premixtures to protect human health and the environment. Council Directive 70/524/EEC on additives in feeding stuffs requires Member States to provide that only those additives which are listed in Annex I to the directive may be incorporated in feeding stuffs and only subject to the requirements set out therein. Several copper and zinc additives are listed in Annex I to directive 70/524/EEC. Maximum content of the copper and zinc additives is laid down for several categories of livestock and differentiated per animal density.

National policy

Directive 87/153/EEC is implemented in articles 101 and 103 ‘Regeling diervoeders’, hereby establing the guidelines for environmental risk assessment of animal nutrition.
Regulations 1831/2003 (EC) and 882/2004 (EC) do not need implementation in national law. Article 77 ‘Regeling diervoeders’ prohibits acting against demands laid down in articles 3 (sections 1, 3 and 4) and 16 of the Regulation. Hereby is prohibited the placing on the market, the processing and use of feed additives not covered by the Regulation. Labelling and packaging have to be in accordance to the description laid down in Regulation 1831/2003 (EC). The control program animal fodders ‘Het Controleprogramma diervoeders’ establishes the Dutch inspection plan of animal fodder.

In article 16 of ‘Kaderwet diervoeders’ it is prohibited to im- or export animal feed not complying with Regulation 1831/2003 (EC).

In the Convenant for animal fodder (‘Veevoederconvenant’) is decided that producers of fodder have to reduce copper and zinc levels in fodder.

The Ministry of Agriculture, Nature Management and Fisheries (‘Ministerie van Landbouw, Natuur en Voedselkwaliteit’, LNV) has commissioned to carry out research on possibilities to reduce copper and zinc pollution via animal fodder. During this research, effects of reduced copper and zinc on animal wellbeing and health will be evaluated as well as the influence of copper and zinc content of manure on the soil and surface water ecosystems. The first results are expected to be available mid 2009.

4.3.2 Manure

European legislation concerning zinc and copper in manure found during the search in Eur-Lex are listed below:

- Regulation 2092/91 (EEC) on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs does not contain any limitations for copper and zinc content of livestock manure. It does prescribe maximum application of nitrogen via manure and maximum application rate of copper as fungicide in organic production.
- Commission Decision 2005/880/EC granted a derogation requested by the Netherlands pursuant to Council Directive 91/676/EEC for the purpose of allowing a higher amount of livestock manure than that provided for in Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources. The requested derogation concerns the intention of the Netherlands to allow the application of 250 kg nitrogen per hectare per year from livestock manure in farms with at least 70% grassland. Commission Decision 2005/880/EC concerns copper and zinc emission indirectly, since manure contains copper and zinc, at levels depending on feed, cattle and environmental circumstances. See for more information Vos et al. (2008).

Although not specifically mentioning copper and zinc, the Integrated Pollution Prevention Control-directive (IPPC, 96/61/EC) also concerns emission of copper and zinc by agricultural practice. Greater agricultural installations with pigs or poultry fall under the IPPC and orders measures to prevent or reduce emissions to water, soil and air. Schakel (2007) estimated that 30% of the agricultural installations did not fulfil the BAT-requirements in time (deadline was 31 October 2007). Cattle farming does not fall under the IPPC-installations.

<u>National policy</u>

The decree on agricultural quality ‘Landbouwkwaliteitsbesluit’ refers to Regulation 2092/91 (EC). The decree directly refers to Regulation 2092/91 (EC) for the rules to be followed during organic production of agricultural products.
No limits to heavy metal concentrations in animal manure are implemented in Dutch law.

4.3.3 Copper baths

No European legislation related to copper bath were found, also not during an additional search using combined search terms such as disinfection, hooves and copper.

<u>National policy</u>

March 2008, the Ministry of Agriculture, Nature Management and Food Quality and the Ministry of Housing, Spatial Planning and the Environment (VROM) started the program SPADE, a stimulation program for agricultural biodiversity and sustainable soil management. The Dutch Organisation for Agriculture and Farming ('Land- en Tuinbouw Organisatie Nederland', LTO) and the Dutch Contact Group for Agricultural Youth ('Nederlands Agrarisch Jongeren Kontakt', NAJK) took the initiative of the program. Copper in hoove baths is one of the subjects of SPADE. The copper sulphate solution used in the hooves baths is chemical waste, but in practice the bath solutions are not treated as chemical waste but is mixed with animal manure. In order to increase awareness among agriculturists of the environmental pressure copperbaths are causing, extension education is developed and cattle farmers are informed about alternatives for the baths.

4.4 Chemical and metal industry

The chemical and metal industry are regulated at Community level by the Integrated Pollution Prevention Control-directive (IPPC, 96/61/EC) and the European Pollutant Release and Transfer Register-Regulation (E-PRTR, 166/2006 (EC)). For the chemical industry, installations of all capacities are regulated by the IPPC. For the metal industry, a number of capacity thresholds are set, below which the specific installations do not fall under the regime of the IPPC and E-PRTR.

Annex I to the IPPC:

Production and processin of metals
2.1. Metal ore (including sulphide ore) roasting or sintering installations
2.2. Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2,5 tonnes per hour
2.3. Installations for the processing of ferrous metals:
(a) hot-rolling mills with a capacity exceeding 20 tonnes of crude steel per hour
(b) smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW
(c) application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour
2.4. Ferrous metal foundries with a production capacity exceeding 20 tonnes per day
2.5. Installations
(a) for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes
(b) for the smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals
2.6. Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m^3.

Metals and their compounds are listed in Annex III to the IPPC as to indicate that metals and their compounds need to be taken into consideration when establishing emission limits.

Annex II to 166/2006 (EC) (European Pollution Release Transfer Register; E-PRTR) lists threshold levels for reporting to the national authoraties of releases to air of 100 kg/year, to water of 50 kg/year and to land of 50 kg/year for copper and its compounds. For zinc and its compounds, threshold-reporting levels are established of 200 kg/year to air, to water of 100 kg/year and to land of 100 kg/year.

REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals, Regulation 1907/2006 (EC)) also applies to the chemical and metal industry. REACH the registration of some 30,000 chemical substances over a period of 11 years. The registration process requires the manufacturers and importers to generate data for all chemicals substances produced or imported into the EU above one tonne per year. The registrants must identify appropriate risk management measures and communicate them to the users. REACH will allow the further evaluation of substances where there are grounds for concern and foresees an authorisation system for the use of substances of very high concern. Thus, also for copper and zinc applications, use and production needs to be safe for the environment and human health.

National policy

The IPPC is fully implemented in the Environmental Management Act ‘Wet Milieubeheer’ and in the Act on pollution of surface waters ‘Wet verontreiniging oppervlaktewateren’. Since the E-PRTR is a regulation, it does not need implementation in national law. The decree on the execution of PRTR ‘Uitvoeringsbesluit EG-verordening PRTR en PRTR-protocol’ establishes a monitoring and registration system as described in the PRTR-Regulation. The Act on environmental management ‘Wet Milieubeheer’ determines that no installations are allowed to be built without a permit when these fall under the jurisdiction of the IPPC.

The metal industrial installions not covered by IPPC and E-PRTR are regulated by ‘Besluit algemene regels voor inrichtingen’/’Activiteitenbesluit’. This decree establishes emission limits to air for dust and copper for specific industrial activities. All categories of metal industry need to minimize dust emission to air. The ‘Activiteitenbesluit’ compels to apply the Best Available Techniques (BAT) for the metal industry. For several categories of metal industry, copper and zinc emission limits to water are laid down without any capacity thresholds.
The regulation ‘Regeling aanwijzing BBT-documenten’ pinpoints which BREF-documents (BAT Reference documents) should be considered when granting permits. Thus, businesses are obliged to apply Best Available Techniques (BAT) and competent authorities need to consider BREF-documents and other relevant documents when composing permits. The competent authorities may deviate from applying BREF when well founded. Deviations must be clarified in the permit.
The ‘Wet verontreiniging oppervlaktewateren’ regulates local industrial discharges on the surface water. Article 1 of the act forbids emitting waste in any form to surface waters without a permit. It is laid down that Orders of Council can be established with exemptions. In addition, Orders of Council are formulated to lay down emission thresholds and demands to permits. Thus, all discharges to water by Dutch installations are covered by the Act on Environmental Management and the Act on pollution of surface waters.

In the act on the execution of REACH ‘Uitvoeringswet EG-verordening registratie, evaluatie en autorisatie van chemische stoffen (REACH)’ is stated in general terms that the REACH-Regulation is inserted in the ‘Wet Milieubeheer’. In the Dutch decree ‘Besluit instelling Bureau REACH’, the Bureau REACH is established and is appointed the responsibilities resulting from the REACH Regulation.
Article 9.3 of the Dutch Environmental Management Act ‘Wet Milieubeheer’ appoints the Ministry of VROM (Ministry of Housing, Regional Development and the Environment) as competent authority and prohibits activities conflicting with REACH-provisions. Article 18.3 to 18.18 regulates the enforcement of the REACH-Regulation. Several public authorities are appointed for enforcement and to apply penalty payments.

4.5 Legislation for the protection of specific watertypes

Several Community directives have been established for the protection of specific types of waterbodies or watertypes:

- Council Directive 2006/113/EC on the quality required of shellfish waters
- Directive 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life
- Directive 2006/11/EC of the European Parliament and of the Council of 15 February 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community
- Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances and the new groundwater directive 2006/118/EC
- Drinking water Directive 98/83/EC (see section 4.2 for a description)

In the Shellfish Water Directive 2006/113/EC, it is demanded that the concentrations of copper and zinc are so limited that no harmful effects on the shellfish and their larvae occur. A minimum half yearly monitoring frequency is prescribed. The Shellfish Water Directive demand is copied into the decree on quality demand and monitoring of water 'Besluit kwaliteitseisen en monitoring water'.

Directive 2006/44/EC establishes mandatory and guiding quality demands to salmonid and cyprinid waters, differentiated for classes of hardness, for both copper and zinc. For copper, a mandatory value of 30 µg/l is dictated. For zinc, only indicative values are reported, i.e. 300 µg/l for salmonid waters and 1000 µg/l for cyprinid waters. In the Decree on quality demands and monitoring water 'Besluit kwaliteitseisen en monitoring water' quality demands for salmonid and cyprinid waters are laid down. These quality standards are 200 µg/l for zinc and 30 µg/l for copper. Thus, national law on salmonid and cyprinid waters are stricter compared to Community law.
The Dutch decree does not refer to Community directive 2006/44/EC but to directive 78/659/EEC which is the precedent of 2006/44/EC.

Both copper and zinc are listed in List II of Directive 2006/11/EC, hereby requiring reduction of the pollution in inland surface water, territorial waters and internal coastal waters. In order to reduce pollution, Member States have to draw up programmes and emission standards. In the Environmental Management Act 'Wet Milieubeheer' it is demanded to act in accordance with directive 2006/11/EC when establishing emission limits. In the Dutch statutory regulation concerning environmental quality demands on dangerous substances in surface waters 'Regeling milieukwaliteitseisen gevaarlijke stoffen oppervlaktewateren' the pollution reduction programmes are laid down for e.g. copper and zinc.
At present, a regulation ('AmvB-Doelstellingen') is being established into Dutch law. When the 'AmvB-Doelstellingen' comes into force, the 'Regeling milieukwaliteitseisen gevaarlijke stoffen oppervlaktewateren' will be withdrawn.

In the Groundwater Directive 80/68/EC, zinc and copper are listed as list II-substances, for which Member States need to limit introduction into groundwater as to prevent pollution of groundwater. Member States have to take all necessary measures to prevent pollution of the groundwater with these List II-substances. On 22 December 2013, directive 80/68/EC will be no longer into force. Directive 2006/118/EC takes over the 80/68/EC provisions. In this new Groundwater directive, zinc and copper are no longer listed as substances for which developing a threshold level should be considered. In the Netherlands is chosen to lay down threshold levels per groundwater body. For copper and zinc, threshold levels will be developed in 2009.

5 Discussion

From the evaluation in chapter 4, it may be concluded that Dutch policy is formulated for all major emission sources of copper and zinc in the Netherlands. Below, European and Dutch policy is discussed and potential measures are brought forward.
Both European and Dutch policy contain provisions protecting the environment in general terms ('prior-consent'). For instance, the Water Framework Directive obliges Member States to 'implement the necessary measures to prevent deterioration of the status of all bodies of surface water' and to 'protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status'. Similary, the Act on environmental management ('Wet milieubeheer') demands that everyone takes care of the environment sufficiently ('Een ieder neemt voldoende zorg voor het milieu in acht'). In the decree on activities ('Activiteitenbesluit'), it is prohibited to discharge to surface water, soil or sewage system unless a number of requirements are fulfilled. Such general provisions in both European and Dutch law provide protection of the whole environment.

5.1 Traffic and transport

5.1.1 Antifouling on maritime shipping/fishing vessels and recreational shipping

At present, the national policy on copper-holding antifouling is leading, since the European risk assessment for the copper-active substances under Biocides directive 98/8/EC has not been terminated yet. First results are not expected this year. The Netherlands are in the process to ban copper-antifouling. Doing so the country is ahead of European risk assessment under the Biocides directive.
Use of copper antifouling has been found to result in elevated copper concentrations at least in harbours of Finland, the United Kingdom and the United States of America (California Department of Pesticide Regulation, http://www.cdpr.ca.gov/docs/emon/surfwtr/caps.htm, consulted September 2008). From the reported data, it may be extracted that at some monitoring points the environmental quality standard may be exceeded. For the Dutch situation, this should be investigated at those relevant sites, where the Dutch quality standard is exceeded.

5.1.2 Overhead wiring of rail ways

At present, directive 94/68/EC on the interoperability of the trans-European high speed rail system is in force, prescribing copper and copper-alloys as contact wire material by laying down the requirements of EN 50149:2001. The Dutch railway systems comply with the European requirements.

Overhead wiring is generally constructed from a copper alloy. The technical requirements determine the copper content of the overhead wiring. These technical requirements concern flexibility, abrasiveness and conductance. Alternative alloys containing for instance aluminium do not result in workable, practical overhead wirings. In the implementation program of diffuse source pollution of the Netherlands ('Uitvoeringsprogramma diffuse bronnen', VROM, 2007), an innovative research program on overhead wiring is proposed, stimulated by the government.

Research within the Netherlands indicated that copper emission from the overhead wiring of the rail systems comply with environmental quality standards and emission limits (www.hslzuid.nl). However, the Dutch implementation program to reduce diffuse source pollution states that emission by overhead wiring is approximately 1% (of the total copper emission) nationally. This emission is considered to be released in concentrated areas. A compliance with emission limits does not necessarily imply any absence of local environmental risk. In the specific case of copper emission by wiring further study would be advisable.

The Netherlands fulfill European requirements to high-speed rail systems and are stimulating research on innovative systems for overhead wiring. However, also the contribution of copper emission by railway systems to Dutch surface water has to be cleared and need further investigation. In EU-law, the spectrum of materials which are allowed to be applied in overhead wiring should be expanded besides copper alloys.

5.1.3 Wear of copper brake lining

For copper emission due to wear of brake lining, no European or Dutch legislation is in force.

The brake wear is mostly released as small particles, which will end up at the asphalt cover of roads. Through run-off this may end up in soil and water along the roads. Former research showed that application of Very Open Asphalt Concrete (‘Zeer Open Asfalt Beton’, ZOAB) reduces emission of heavy metals to soil and water with a factor of 11 to 40 in comparison to Compact Asphalt Concrete (‘Dicht-Asfalt-Beton’, DAB; Van den Roovaart, 2000). ZOAB is cleaned twice a year, hereby collecting the dirt containing metals. In Van Bohemen and Janssen van de Laak (2003), a comprehensive overview of effects of road surface, infiltration systems and vegetation is given. During construction of new roads or for renovation of existing roads, application of ZOAB should be considered in order to reduce copper emissions by brake wear.
Additionally, alternatives for copper in brake lining should be investigated. Alternative brake linings without copper already exist, but these probably contain other metals, such as antimone and barium. In Germany, ceramic brake linings are on the market, but these are relatively expensive compared to the copper or the semi-metal ones.
In ‘Uitvoeringsprogramma diffuse bronnen watervervuiling’ (VROM, 2007), it is noted that innovative research should be performed to tackle this emission source and to propose environment friendly alternatives. Research for environment friendly alternatives should be stimulated, nationally and European wide. At present, no such research has been initiated yet.

Copper emission due to wear of brake lining takes place Europe wide (and worldwide)(e.g. Van der Gon et al., 2007). At European level, product policy should be formulated for brake linings. Analysis and comparison of environmental pressure of alternative brake lines need to be carried out in order to be able to appoint the most environmental friendly product. Nationally, application of ZOAB needs to be considered for construction of new roads and renovation of existing roads. In addition, the relative contribution of brake lining wear to copper concentrations in Dutch surface waters with elevated copper concentrations need to be investigated in order to estimate the extent of the environmental pressure by copper brake linings and in order to develop proper emission reducing measures.

5.1.4 Zinc anodes

No Community law directly focused on this subject is in place. A search on internet indicated that zinc anodes are marketed worldwide. However, from the information gathered within the present study it is not clear if emission by zinc anodes is a typically Dutch environmental problem or plays a significant role in other European Member States as well.

In the project ‘Hand in eigen boezem’ of the Ministry of Transport, Public Works and Water Management (V&W) and of the Directorate-General for Public Works and Water Management (‘Rijkswaterstaat’) the alternatives for zinc anodes are investigated. Aluminium anodes appear to work better compared to zinc anodes in freshwater and therefore gain popularity. Aluminium anodes are expected to cause lower risks to the environment compared to the zinc ones (Rijkswaterstaat, 2007). Another alternative for zinc anodes might be the ‘impressed current’. These impressed current systems are not applied on inland vessels at great scale due to technical and financial reasons (Van den Roovaart, 2002). However, in 2000 the application of the impressed current-system is taken up in the ‘VAMIL’- regulation, which is a financial supporting system of the inistry of VROM, reducing the financial contra-agruments to apply the impressed current-system.

In conclusion, the Netherlands are in the process to tackle pollution by zinc anodes. Alternatives are investigated and should be compared for their potential effects to the aquatic environment. The relative contribution of zinc anodes to total zinc load to surface waters with elevated zinc concentrations (e.g. harbours) needs to be quantified in order to assess the extent of the environmental problem caused by these anodes.

5.1.5 Vehicles, zinc in tyres

No Community legislation on zinc levels in tyres was found within the present study. However, considering the broad presence of cars throughout the European Union, action at Community level in the field of product policy is therefore considered to be appropriate.
REACH covers the production and use of zinc-containing tyres, depending on the import of production tonnage (see section 4.4).
The Netherlands commissioned research for alternatives for zinc in tyres, but the research program has not lead to final conclusions. According to Hulsekotte et al. (2007), alternatives for zinc are available but these are more toxic. The Ministry of Transport, Public Works and Water Management (V&W) has developed a subsidy program for e.g. product innovation such as tyres containing less zinc (VROM, 2007).
Additional research is needed in order to clarify the contribution of zinc emission due to tyre wear locally. Moreover, the environmental pros and cons of alternatives for zinc in tyres need to be investigated and compared.

5.2 Sewage treatment plants and sewer systems

5.2.1 Building materials

5.2.1.1 Construction works

Both national and local policy aiming to reduce emissions by building materials are put up in the Netherlands. The Netherlands intend to develop generic emission limits for e.g. copper and zinc. Evaluation per individual permit is considered to be undesirable. It is not clear yet if these emission demands will be taken up in legislative tools or be laid down in guidances for local authorities in order to support the formation of permits. A regulation containing emission demands will have to be notified to the European Commission.
As national policy, the intention is expressed to stimulate the harmonisation of European guidance on how to estimate environmental risks.

According to Hulsekotte et al. (2007), coating of existing and new zinc building materials is an effective and feasible measure to reduce zinc emission. Coating of building materials may not be 100% effective on the long-term, because it needs periodically maintaince, for which the owners are responsible. Copper roofs and housefronts plating can be replaced by e.g. roof tiles, slates and synthetic materials (www.senternovem.nl, consulted September 2008). At new construction or renovation, these materials can be applied instead of the copper and zinc materials. National policy may be put up to discourage the application of copper and zinc emitting materials.

In the Netherlands several legislative tools have been drawn up in order to regulate this emission source. At present, it is still being investigated if existing policy should be expanded.
Copper and zinc construction materials need to be assessed at first instance on basis of their impact on the environment. Methods to assess environmental risks need to be developed in order to support competent authorities in this process. Since construction products are applied European-wide, risk assessment is preferably carried out according to harmonized EU-guidance.

5.2.1.2 Copper waterpipes

According to Hulsekotte et al. (2007), corrosion of copper drinking water piping is the major contributor of copper for most RWZI's in the Netherlands (see also Verschoor and Brand, 2008). Reduction of drinking water hardness is expected to contribute little to reduction of corrosion of the copper water pipes.

Synthetic waterpipes are available as an alternative for copper waterpipes. Plastic waterpipes have been under discussion, since formation of biofilm and consequently, increasing the risk of development of pathogens within the pipes was expected (Veenendaal and Van der Kooij, 1999; Gezondheidsraad, 2003: in RWS, 2003). However, recent research has shown that application of alternative materials in water pipes do not lead to deviating biofilm development compared to copper piping, as long as the temperature regime is maintained within certain ranges (Van der Kooij et al., 2005). In Germany plastic waterpipes are applied at large scale and also in the Netherlands they are applied in newly built houses (www.senternovem.nl and several websites of construction work parties). Installation of synthetic waterpipes is cheaper than installation of copper ones and the synthetic material itself is also cheaper than the copper alloys (Natuur en Milieufederatie, 2005). Since more and more experience is built up with the application of synthetic waterpipes it is expected that market forces will stimulate the application of the synthetic waterpipes.

The Netherlands have developed several legislative tools to reduce emission from building materials.

5.2.2 Quality demands to collected rain runoff

When rainwater is directly discharged onto surface water, heavy metals may be introduced into the aquatic ecosystem. In the Netherlands, models have been developed to predict heavy metal concentrations in surface waters when rainwater is directly discharged on surface water (Verschoor and Brand, 2008). These models indicate that surface water quality standards are exceeded under certain circumstances, e.g. at high application rate of metal plating and at low flowrate of the receiving water.

As described in section 4.2, Dutch regulations are in place for the discharge of rainwater directly on surface water. Municipalities and Water Boards have to determine if discharge of rainwater on surface water is responsible in practice. An Interactive Decision System for Rainwater ('IBOS Regenwater') is set up to make a sound analysis (www.ibos-regenwater.nl, consulted September 2008).
Municipalities have the possibility to establish municipal sewer policy for processing of rainwater. On basis of the municipal sewer policy, municipalities can enforce measures on industries for separate discharge of rainwater.
Copper and zinc in rain runoff from construction works is mostly bound to particulate matter. This particulate can be easily separated from the water by simple filtration or sedimentation in water tanks. Kiewiet et al. (2001) showed that in runoff of a copper plated roof 60% of the copper is bound to particulate matter. Filtration of the rainwater with zeolite resulted in a purification efficiency of 95%.

Thus, cleaning rainwater from heavy metals originating from building materials seems to require relatively simple techniques. However, the practical site of these techniques needs reflection: this treatment techniques need maintenance. They need to be checked and cleaned periodically. If inspection and maintenance is carried out by an appointed authority, local rainwater purification may be succesfull at long-term. Hillenbrand et al. (2007) summarize a number of decentralized treatments of rain runoff from roofs or streets.

5.2.3 Demands at point of discharge

Sewer treatment plants are indicated to be among the major main emission sources of copper and zinc at several places in the Netherlands (www.emissieregistratie.nl, consulted July 2008). At a national scale, they contribute for 26% to the copper and for 30% to the zinc load.
In the Netherlands, sewage treatment plants have to follow Best Available Techniques-guidances, also below the capacity threshold of the IPPC. Monitoring checks the results of their processing.
The competent authorities for water management often discuss possibilities to increase removal efficiency of sewer treatment plants. In Hillenbrand et al. (2007), a number of advanced municipal treatments are described and discussed. There is no further specific national policy on the quality demands to sewage treatment plants-effluents than the European requirements. It is chosen to generate policy on sewage treatment plants regionally (De Nijs et al., 2008).

Several projects are running which investigate the possibilities to collect human excretion at the emission source and to recycle human excretion. The volume of discharged wastewater is hereby minimized and from the collected excretion, fertilizers or energy can be produced. These new sanitation techniques are already applied in research and pilot projects which are supervised by STOWA (Foundation Applied Research for Water Management: Stichting Toegepast Onderzoek Waterbeheer, http://themas.stowa.nl/Themas/Nieuwe_sanitatie.aspx?rID=846, consulted September 2008).

5.3 Leaching and surface run-off in agriculture

Both copper and zinc from agricultural soils form a significant and persistent problem. In the rural area, leaching of copper and zinc are the major emission sources, leading to concentrations in surface water exceeding the environmental quality standards (references in Bonten and Römkens, 2008; Plette, 2003). According to CBS (2003), nett supply of copper is 200 g copper per hectare and of zinc approximately 545 g per hectare of agricultural land in the Netherlands.
Agricultural soils leach heavy metals to the surface water (and groundwater), but are still charged with heavy metals as well (Van der Bolt et al., 2006). Copper and zinc tend to accumulate in soils and sediments. Immobilisation only occurs through geological processes, which are extremely slow. Van der Bolt et al. (2006) concluded that the present load of heavy metals is only a minor fraction of the total amount of heavy metals in soil, which hardly influences the present leaching to groundwater and surface water. However, the present balance between load and leaching does determine copper and zinc levels in surface waters in the future. If the present manure application rate is remained, heavy metal concentrations of surface waters in rural area will increase, copper at the highest rate (Bonten et al., 2007). Bonten et al. (2008) modelled leaching of copper and zinc (cadmium as well) from agricultural grounds in the Netherlands for several scenarios of agricultural practice. If the current practice is maintained, leaching of copper and zinc will increase. If copper anc zinc content of animal feed is halved, leaching of copper will still increase. Zinc leaching will slightly be reduced. Copper leaching is expected to increase even if copper baths are no longer used and copper and zinc content of animal feed

is halved. Only if no copper is added to agricultural soils copper leaching will decrease the coming years.

It is important to carry out substance flow analyses of agro-ecosystems to get a comprehensive view of actual and potential future problems. There is the problem of reliability of data when making efforts to give the real-time full picture of the extent of the pollution. Heavy-metal balance studies tend to suffer from a lack of good-quality data. For instance, heavy-metal content of animal manure is reported to vary between 2 and 172 mg copper per kg dry weight by different studies. Similarly, zinc content of manure is reported to vary between 15 and 566 mg zinc per kg dry weight. Leaching is one of the most difficult flows to quantify reliably. Therefore, in most mass balance studies, leaching is either neglected or simulated in a simplified manner (Moolenaar and Lexmond, 1999). Delahaye et al. (2003) recommends establishing mass balances on basis of input and output, i.e. on basis of contents of animal feed and output by transport of animals from the agricultural area.
Moolenaar (1999) pleads that generic policies at national and international levels ignore farm characteristics and individual management options. He suggests applying heavy-metal balances at field-scale or per farm, hereby giving farmers specific feedback on effective options for better heavy-metal management. Consequences of and discussion on field-scale analysis and supporting policy are elaborated on in Moolenaar (1999).

From the consulted sources, it can be concluded that the present situation in Dutch agricultural soil is not sustainable. Preventive measures need to be taken in order to prevent further charging of soils with heavy metals. Curative measures are needed in the Netherlands to reduce present and future leaching to ground and surface waters (Bonten et al., 2004 in Van der Bolt et al., 2006). Van der Grift and Griffioen (2006) and Bonten and Römkens (2008) argue that Dutch manure-policy should be directed to the reduction of heavy-metal application as well, in addition to the nutrients nitrogen and phosphorus. Bonten and Römkens (2008) listed the questions which still have to be solved before appropriate measures can be designed for the reduction of copper and zinc emission from agricultural land.

5.3.1 Animal feed

Inspection of copper and zinc content of animal feed showed that animal feed in the Netherlands fulfilled the European requirements (VWA, 2007). Effects of copper content of animal feed need to be investigated in order to clarify to which level copper content of fodder can be reduced without influencing animal welfare and agricultural productivity. When this relationship is clear, effective and proportional measures can be taken. Some surveys indicate that levels of copper and zinc in fodder may be reduced while maintaining the same production levels (e.g. Smolders et al., 2008).

Since agricultural production is linked to copper contents of animal feed, copper content of animal feed needs to be controlled at Union-level in order to maintain level-playing-field.

5.3.2 Manure

General Dutch policy is to control heavy metals in manure through control on animal feed. Additionally, research programs have started up to investigate the effects of reducing copper and zinc content in animal fodder on animal health and emission to the environment.

Establishment of buffer zones can reduce leaching from copper from agricultural soils. However, taking agricultural grounds out of use may lower the acidity of the soil, because liming is then also abandoned. At its turn, lower acidity may mobilise heavy metals resulting in higher leaching rates (Hulsekotte et al., 2007).

Application rate of fertilizers depends on factors such as soil characteristics and type of agricultural activities. Nitrogen input from manure per hectare within Europe is highest in the Netherlands (data from Delahaye et al., 2003). Therefore, it can be assumed that copper and zinc input through manure is also highest in the Netherlands. Römkens et al. (2002) reported that the contribution of arable soils to the total load of cadmium, copper and zinc to Dutch surface waters could be as high as 60%. A short survey showed that zinc and copper accumulation in agricultural fields may also occur in other countries (e.g. in the United States (Brock et al., 2005), Japan (Ogiyama et al., 2006), Sweden (Bengtssona et al., 2006)). Extent of leaching was not reported within these studies.

Emission of copper and zinc due to manure application in agriculture is a complicated problem, leading to environmental problems in the Netherlands. Leaching from agricultural soils will continue to occur for many more years, even if fertilisation with animal manure would cease. At present, policy is directed to the application rate of manure nitrogen. By restricting nitrogen application rate, introduction of heavy metals is reduced simultaneously. However, active policy reducing the application of heavy metals through manure needs to be developed in order to control this important emission source.

5.3.3 Copper baths

In the implementation program for diffuse source pollution of surface water (VROM, 2007), pollution due to copper baths used to desinfect feed of cattle is considered to be a problem which needs to be addressed nationally. In section 4.3.3, the national policy is described. However, copper hoove baths are at least also used in the United States, Canada, Germany and Denmark (short survey on internet). A study of Brock et al. (2005) reported that copper fluid of hoove baths is mixed with manure in the United States as well. Thus, it is expected that copper treatment for the disinfection of hooves is applied worldwide.

Besides the SPADE program, LTO Nederland is developing a multi annual program for the prevention of copper pollution by copper baths and for the application of alternatives by agriculturists. Adjusted life stock houses, use of mats or early detection of hoof problems are among the preventive alternatives for copper baths. Application of alternatives for copper sulphate need to be further investigated and need admission at European level. Additionally, in the Netherlands it is planned to invest in transfer of knowledge (VROM, 2007).

By eliminating pollution by copper baths, emission to soils can be reduced upto 40% (CLM, 2006). Although soils need a minimum copper application for optimum production rates, this emission source seems to be easily eliminated. Since copper baths form a distinct source of copper, this source needs to be taken on nationally and as soon as possible.

5.4 Chemical and metal industry

For the chemical industry installations of all capacities are regulated by the IPPC. For the metal industry several capacity thresholds are set, implicating that not all sizes of the installations are covered by the IPPC and E-PRTR. For further discussion on this matter the reader is referred to the discussion chapters in Vos and De Poorter (2007) and Janssen et al. (2008) on cadmium and polycyclic aromatic hydrocarbons, respectively. See Hillenbrand et al. (2007) for an interesting discussion about the relationship between the IPPC and WFD.

In the Risk Reduction Strategy for zinc and zinc compounds (Risk and Policy Analysts Limited, 2006), it is suggested that the IPPC Directive already applies to all of the industry of concern in terms of implementing emissions controls in relation to the specific local risks as identified in the Risk Assessment Report for zinc and its compounds (European Chemical Bureau, 2008). Box 4.1 of the Risk Reduction Strategy is copied, showing the installations falling under the IPPC-directive, related to zinc emission.

The Risk Reduction Strategy recommends that emission controls are introduced through a combination of existing legislative frameworks for all sectors with identified local risks. For all sectors covered by the IPPC, setting emission limit values for releases of zinc to the aquatic environment in permits issued under the IPPC is recommended. It is also recommended that the results of the zinc risk assessments should be taken into account in the next revision of the BREFs (Best Available Techniques Reference Documents). For sites not covered by the IPPC, the local emissions to the environment should, where necessary, be controlled by national rules. The Water Framework Directive is considered to provide a safety net ensuring that zinc emissions remain at acceptable levels.

In addition, the REACH Regulation rules. The registration process under REACH requires the manufacturers and importers to generate data for all chemicals substances produced or imported into the EU above one tonne per year. The registrants must identify appropriate risk management measures and communicate them to the users. REACH will allow the further evaluation of substances where there are grounds for concern and foresees an authorisation system for the use of substances of very high concern. Import, production and use of copper and zinc containing substances may be subjected to the evaluation procedure under REACH when there is a chance that environment or human health is at risk. In general, REACH is considered to be a strong tool to control emission from production and products. However, the capacity threshold for installations falling under REACH limits the radiance of the regulation.

Box 4.1: Installations listed in Annex I of the IPPC directive

With regard to zincs, the IPPC Directive applies to the following installations:

1. **production and processing of metals**;
2. installations for the **manufacture of glass** including glass fibre with a melting capacity exceeding 20 tonnes per day;
3. installations for the **manufacture of ceramic products** by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding 4 m^3 and with a setting density per kiln exceeding 300 kg/m^3;
4. chemical installations for the **production of basic organic chemicals**, such as: organometallic compounds, basic plastic materials (**polymers**, **synthetic fibres** and cellulose-based fibres), **synthetic rubbers, dyes and pigments** and surface-active agents and surfactants;
5. chemical installations for the **production of basic inorganic chemicals**, such as: non-metals, **metal oxides** or other inorganic compounds such as calcium carbide, silicon, silicon carbide;
6. chemical installations for the **production of** phosphorous-, nitrogen- or potassium-based fertilisers (**simple or compound fertilisers**);
7. chemical installations for the **production of basic plant health products** and of biocides;
8. installations using a chemical or biological process for the **production of basic pharmaceutical products**;
9. industrial plants for the **production of paper and board** with a production capacity exceeding 20 tonnes per day;
10. plants for the **pre-treatment** (operations such as washing, bleaching, mercerisation) **or dyeing of fibres or textiles** where the treatment capacity exceeds 10 tonnes per day; and
11. installations for the **intensive rearing of poultry or pigs** with more than: (a) 40,000 places for poultry (b) 2,000 places for production pigs (over 30 kg), or (c) 750 places for sows: This would include downstream use of zinc feed supplements for some applications (although the downstream use of feed supplements is not described in detail in the eRAR).

In the Netherlands, several installations are the major point sources of copper and zinc locally and possibly lead to local risks to the environment. The present study is not suited to compare the contribution of these industrial activities to emission of copper and zinc in surface waters with emission by other sources at a local scale. However, a number of installations in the Netherlands needs to be investigated in more detail to assess if these installations fall under the jurisdiction of the IPPC or REACH and if these installations have to be subjected to additional reduction measures.

6 General discussion

Zinc and its compounds are on the List of Dutch Priority Substances, together with copper and its compounds. In Dutch policy, special attention is given to the Dutch Priority Substances in order to control their emission. In the Netherlands, transboundary inflow from foreign countries is at present the largest source of pollution for copper. For zinc, approximately 40% enters the Netherlands via the major rivers. The transboundary pollution source cannot be regulated by Dutch policy and needs therefore to be solved in international context.

For copper and zinc, the required reduction of emissions is estimated on basis of the environmental quality standards 40 µg/l for zinc and 3.8 µg/l for copper compounds by Torenbeek and Pelsma (2008). It was concluded that emission needs to be reduced between 20 and 40% in the river basins Eems-Dollard, Northern Rhine and Eastern Rhine. This reduction needs to take place in the whole river basin district, including in the neighbouring countries. Required emission was estimated to be 80 to 100% for the whole river basis districts of Mid-Rhine and Meuse. In the Scheldt district, 80 to 100% of emission reduction was considered to be necessary, which should completely be realized abroad. For zinc, 60 to 100% of emission reduction was considered to be needed throughout the whole river basis districts of all Dutch river basins (including abroad). However, the quality standards are about to be revised and will probably result in a lower number of exceedances of the quality standards for copper and zinc. Moreover, if quality standards of copper and zinc are exceeded, monitoring data are allowed to be adjusted for bioavailability. In the near future, exceedance of copper quality standards will hereby by minimized, but zinc levels in Dutch surface waters are expected to exceed the future quality standards at regular basis. Moreover, it is expected that heavy metal concentrations in the Dutch waterbodies will be elevated in due time due to increased leaching rates from agricultural soils and therefore will continue to cause environmental problems in the Netherlands. In addition, it is expected that the percentage of bioavailable heavy metals will also increase in the future, because measures are taken to force down eutrophication, hereby reducing the compounds in surface water to which heavy metals are bound. The present study is not suited to predict if environmental problems due to the presence of copper and zinc in surface waters persist or when these problems are solved. However, both metals will need constant attention due to their persistence in the environment and their broad application.

The Risk Assessment Report for zinc and zinc compounds (European Chemical Bureau, 2008) indicated that local point sources may cause risk to the environment. Monitoring data showed that environmental concentrations exceeded the environmental quality standard for zinc in some regions. The Risk Assessment Report did not analyse emission per source at the regional level. The Risk Reduction Strategy (Risk and Policy Analysts Limited, 2006) considered that there were significant gaps in knowledge and overall uncertainties regarding the actual contribution of various sources to the measured zinc levels in regional waters. The contribution of natural sources, historical pollution and other pollution sources to the zinc levels in surface water could not be distinguished. Consequently, risk reduction programmes in the Risk Reduction Strategy for zinc and its compounds are only described in general terms. The Risk Reduction Strategy recommends focusing on possible measures on emission reduction at local point sources at first instance. If elevated zinc concentrations persist in regional waters, further information should be collected in order to identify which other sources are responsible. Thus, for diffuse source pollution no measure strategies were proposed.
In Western European, point sources are generally the emission sources, which are already controlled by existing tools. It is mostly diffuse source pollution that is complex to handle. In the present study, the

analysis of pollution data at national level limits the identification of the most suitable control measures as well. The lack of certainty concerning the causes of any regional risks and the outcome of possible emission controls of local risks presents a problem when trying to determine the best strategy for reducing environmental risks. In order to be able to select the most suitable measures and in order to estimate the effectiveness of measures, the contribution of the whole range of diffuse sources to the load to surface waters needs to be quantified locally or regionally.
From most activities, their contribution to copper and zinc concentration locally is unknown or not traced back within the underlying study. For certain industrial activities, monitoring of discharged wastewater is a straightforward method to determine if water quality demands are respected. Modelling of emission by application of building materials indicated that under certain circumstances, copper and zinc discharge to surface waters is undesirably high. Similarly, modeling of leaching from agricultural soils estimated that the present Dutch quality standards for copper and zinc are exceeded. This is confirmed by monitoring data in the field (Bonten et al., 2007). Contribution to copper and zinc levels to local copper and zinc levels of the other pollution sources studied within the underlying investigation are generally unknown, but this uncertainty can be solved by monitoring and modeling.

In sections 5.1 to 5.4, it is indicated where action to reduce copper or zinc emission is required. For a number of emission sources, action at EU-level would be appropriate, for environmental problems occurring mostly in the Netherlands, national action should be undertaken. A number of emission sources could be controlled more sufficiently.
As discussed above, agriculture is one of the major emission sources of copper and zinc in the Netherlands. The contribution of copper baths should be minimized by application of alternatives or obligatory collection of the copper sulphate solution. The need and proportionality of additional measures need to be investigated and reflected on. For copper brake linings, product policy should be formulated at EU-level. Analysis and comparison of environmental pressure of alternative brake linings need to be carried out in order to be able to appoint the most environmental friendly product. Nationally, application of ZOAB needs to be considered for construction of new roads and renovation of existing roads.
For zinc in tyres, European product policy could be developed. Research need to be carried out on the alternatives for zinc and if possible, European law needs to be developed to restrain zinc levels in tyres. This subjects needs to be handled within the Union and not nationally, because of economic interests.
For applications of metal in construction works, harmonized European risk assessment methodology may be developed. In the Netherlands, generic emission limits for stony building materials have been developed. At present, it is investigated if metal materials fulfill emission limits set to stony building materials. On basis of this investigation will be decided if national, generic emission demands need to be developed for metal building materials as well. Possibilities for local treatment of discharged rainwater need further investigation.
For overhead wiring of railways, no suitable alternatives are known at present. At EU-level, only copper alloys are allowed to be applied at high-speed rail systems. The range of materials which may be applied should be broadened in EU-law. Moreover, research should be carried out to clarify the contribution of copper wiring to copper load in soil, groundwater and surface water.
As mentioned before, the major part of copper and zinc in the Dutch surface waters is imported via the major rivers. This pollution is beyond the control of the Netherlands, but need to be tackled in international context. Since all Member States need to comply with European legislative demands to protection of the environment (e.g. WFD), the amount of copper and zinc entering the Netherlands via the international rivers is expected to decrease the coming twenty years.

Conclusions

- In the Netherlands, copper and zinc are mostly emitted by diffuse sources. Only few point sources need further attention.
- The major amount of copper and zinc comes from abroad (70-80% and 42-75%, respectively). This, however, is not under the control of the Netherlands but needs to be solved in European association.
- For most emission sources, measures are in development or are already in place with the aim to reduce copper and zinc pollution of surface waters. Evidently, zinc and copper levels will be lower in most surface waters in the long run and a lower number of exceedances of the quality standards for surface waters will occur. However, many uncertainties exist about effects of measures, the present and future bioavailability, the contribution of the individual sources to the local zinc and copper concentrations.
- Emission from agriculture is mainly due to application of manure and to copper baths. At present, agricultural soil is still further charged with copper and zinc, but this charge is considered to be only a fraction of the historical contamination. Thus, measures reducing the load to soil will only show effect on leaching by soils to groundwater and surface water in the long term. Copper originating from copper baths is relatively simple to control, compared to metal levels in animal feed. National policy is developed to address the problem of copper baths.

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CIW Commissie Integraal Waterbeheer. 2003. Lelystad, the Netherlands.

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Appendix I. Results of search in Eur-Lex

Results of the search in Eur-Lex as described in chapter 4 of this report.

Biocides directive 98/8/EC

2007/565/EC: Commission Decision of 14 August 2007 concerning the non-inclusion in Annex I, IA or IB to Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market of certain substances to be examined under the 10-year work programme referred to in Article 16(2) thereof

Commission Regulation (EC) No 1849/2006 of 14 December 2006 amending Regulation (EC) No 2032/2003 concerning the second phase of the 10-year work programme referred to in Article 16(2) of Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market

Commission Regulation (EC) No 1048/2005 of 13 June 2005 amending Regulation (EC) No 2032/2003 on the second phase of the 10-year work programme referred to in Article 16(2) of Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market

Commission Regulation (EC) No 1451/2007 of 4 December 2007 on the second phase of the 10-year work programme referred to in Article 16(2) of Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market (Text with EEA relevance)

Pesticides 91/414/EEC

2007/442/EC: Commission Decision of 21 June 2007 concerning the non-inclusion of certain active substances in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing these substances (notified under document number C(2007) 2576)

Commission Directive 2005/72/EC of 21 October 2005 amending Council Directive 91/414/EEC to include chlorpyrifos, chlorpyrifos-methyl, mancozeb, maneb, and metiram as active substances

Commission Regulation (EC) No 1112/2002 of 20 June 2002 laying down the detailed rules for the implementation of the fourth stage of the programme of work referred to in Article 8(2) of Council Directive 91/414/EEC

Specific waters

Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters (codified version)

Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters<- repealed by 2006/113/EC

Directive 2006/44/EC of the European Parliament and of the Council of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life

Directive 2006/11/EC of the European Parliament and of the Council of 15 February 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community

Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life

Drinkingwater 98/83/EC

Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances

IPPC and E-PRTR
Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC

Waste
Report from the Commission to the Council and the European Parliament on the implementation of Community waste Legislation Directive 75/442/EEC on waste, Directive 91/689/EEC on hazardous waste, Directive 75/439/EEC on waste oils, Directive 86/278/EEC on sewage sludge and Directive 94/62/EC on packaging and packaging waste - For the period 1998-2000

Fertilizers
Regulation (EC) No 2003/2003 of the European Parliament and of the Council of 13 October 2003 relating to fertilisers
Council Directive 89/530/EEC of 18 September 1989 supplementing and amending Directive 76/116/EEC in respect of the trace elements boron, cobalt, copper, iron, manganese, molybdenum and zinc contained in fertilizers
Commission Directive 87/94/EEC of 8 December 1986 on the approximation of the laws of the Member States relating to procedures for the control of characteristics of, limits for and resistance to detonation of straight ammonium nitrate fertilizers of high nitrogen content

Air
Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Heavy Metals
Commission Regulation (EC) No 1091/94 of 29 April 1994 laying down certain detailed rules for the implementation of Council Regulation (EEC) No 3528/86 on the protection of the Community's forests against atmospheric pollution

Forests
Commission Regulation (EC) No 1737/2006 of 7 November 2006 laying down detailed rules for the implementation of Regulation (EC) No 2152/2003 of the European Parliament and of the Council concerning monitoring of forests and environmental interactions in the Community

Animal feed
Commission Directive 2008/38/EC of 5 March 2008 establishing a list of intended uses of animal feeding stuffs for particular nutritional purposes
Commission Recommendation of 14 December 2005 on the coordinated inspection programme in the field of animal nutrition for the year 2006 in accordance with Council Directive 95/53/EC
Commission Directive 2005/87/EC of 5 December 2005 amending Annex I to Directive 2002/32/EC of the European Parliament and of the Council on undesirable substances in animal feed as regards lead, fluorine and cadmium
Proposal for a Regulation of the European Parliament and of the Council on additives for use in animal nutrition
Commission Regulation (EC) No 473/2002 of 15 March 2002 amending Annexes I, II and VI to Council Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, and laying down detailed rules as regards the transmission of information on the use of copper compounds
Commission Directive 2001/79/EC of 17 September 2001 amending Council Directive 87/153/EEC fixing guidelines for the assessment of additives in animal nutrition

Commission Directive 94/39/EC of 25 July 1994 establishing a list of intended uses of animal feeding stuffs for particular nutritional purposes
Commission Directive 88/485/EEC of 26 July 1988 amending the Annex to Council Directive 82/471/EEC concerning certain products used in animal nutrition
Commission Directive 86/530/EEC of 28 October 1986 amending the Annex to Council Directive 82/471/EEC concerning certain products used in animal nutrition

Feeding stuffs
Commission Regulation (EC) No 358/2005 of 2 March 2005 concerning the authorisations without a time limit of certain additives and the authorisation of new uses of additives already authorised in feeding stuffs
Commission Regulation (EC) No 1334/2003 of 25 July 2003 amending the conditions for authorisation of a number of additives in feeding stuffs belonging to the group of trace elements
Commission Regulation (EC) No 2697/2000 of 27 November 2000 concerning the provisional authorisations of additives in feeding stuffs
Commission Regulation (EC) No 639/1999 of 25 March 1999 concerning the authorisation of a new additive in feeding stuffs
Council Regulation (EC) No 2821/98 of 17 December 1998 amending, as regards withdrawal of the authorisation of certain antibiotics, Directive 70/524/EEC concerning additives in feeding stuffs
Commission Regulation (EC) No 2316/98 of 26 October 1998 concerning authorisation of new additives and amending the conditions for authorisation of a number of additives already authorised in feeding stuffs
Council Directive 96/51/EC of 23 July 1996 amending Directive 70/524/EEC concerning additives in feeding stuffs
Commission Directive 94/41/EC of 18 July 1994 amending Council Directive ted version 70/524 concerning additives in feeding stuffs
Commission Directive 94/17/EC of 22 April 1994 amending Council Directive 70/524/EEC concerning additives in feeding stuffs
Commission Directive 93/107/EC of 26 November 1993 amending Council Directive 70/524/EEC concerning additives in feeding stuffs
Commission Directive 92/64/EEC of 13 July 1992 amending Council Directive 70/524/EEC concerning additives in feeding stuffs
Council Directive 84/587/EEC of 29 November 1984 amending Directive 70/524/EEC concerning additives in feeding stuffs
Council Directive 70/524/EEC of 23 November 1970 concerning additives in feeding-stuffs

Organic production
Commission Regulation (EC) No 592/2006 of 12 April 2006 amending Annex II to Council Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs
Commission Regulation (EC) No 1318/2005 of 11 August 2005 amending Annex II of Council Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs
Commission Regulation (EC) No 2277/2003 of 22 December 2003 amending Annexes I and II to Council Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (Text with EEA relevance)

Marketing and Use-directive 76/769/EEC

Judgment of the Court (Second Chamber) of 15 September 2005 in Joined Cases C-281/03 and C-282/03, Reference for a preliminary ruling from the College van Beroep voor het bedrijfsleven: Cindu Chemicals BV and Others v College voor de toelating van bestrijdingsmiddelen (Directive 76/769/EEC — Dangerous substances — Ability of the Member States to lay down additional conditions for the placing on the market and use of a biocidal product the use of whose active substance is restricted by the directive — Wood preservatives containing coal-tar distillates (carbolineum and creosote) — Wood preservatives containing copper, chrome and arsenic)

Sewage sludge

Council Directive of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. Directive 86/278/EEC limits the application of sludge on land by the amount of metals that accumulate in soil. The copper and zinc content must remain below a limit concentration expressed in mg/kg dry matter in a representative soil. In alkaline soils the limits values can be 50% higher. For crops exclusively used for animal consumption these limits values can also be increased. The limit values for copper are between 50 and 140 mg/kg dry matter, whereas the limit values for zinc are between 150 and 300 mg/kg dry matter in soil. Limit values in sewage sludge used in agriculture are 1000 to 1750 mg/kg dry matter for copper and 2500 to 4000 mg/kg dry matter for zinc (Annexes I A, I B and I C to 86/278/EEC). The sewage sludge directive is implemented in Dutch law by the 'Uitvoeringsregeling Meststoffenwet': regulation concerning the execution of the act on fertilizers. Article 21 of 'Uitvoeringsregeling Meststoffenwet' orders that the sampling frequency of sewage sludge has to follow the rules ordered by directive 86/278/EEC. In Annex III to 'Besluit gebruik meststoffen' (Order in Council on the use of fertilizers), maximum content of 15 mg/kg dry matter plus 0.6*(percentage of lutum and organic matter) for copper and maximum content of 50 mg/kg dry matter plus 1.5*(2 times the percentage of lutum and 1 time the percentage organic matter) for zinc in agriculture soils is established. The maximum content of copper and zinc remains below the maximum contents as prescribed in directive 86/278/EEC.

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