

**Railway related Soil Pollution in Europe:
the Status Quo**

**SBNS
Utrecht
the Netherlands**

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Railway related Soil Pollution in Europe

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0 Summary

0.1 European legislation

- 1 The European legislation in the field of soil pollution is developing rapidly.

0.2 Railway related soil pollution

- 2 Countries within the European Union have different insight in the degree of soil pollution in general and on railway related pollution in particular.
- 3 To be able to influence the process of policy making and subsequent implementation of measures, it is important for European railway companies to develop a common vision on the treatment of soil pollution on their properties.

0.3 Vision of UIC

- 4 Soil pollution as well as the remediation of polluted sites is one of the actual topics the UIC Platform on Energy, Environment and Sustainability is dealing with.
- 5 The UIC Soil Network proposed to describe the state of the art concerning the soil pollution on railway properties and its remediation in Europe. The main objective of the research is to contribute to the harmonization of the approach towards polluted railway properties within the European Union.
- 6 The UIC commissioned the Dutch foundation SBNS to investigate and to describe the status quo of railway related soil pollution in the Member States of the European Union.

0.4 Questionnaire

- 7 The SBNS composed a questionnaire with relevant questions for the environmental departments of European railway companies.
- 8 The CEO of the UIC sent a letter to the Directors-General of the European regional assembly of the UIC to request the necessary cooperation of their department for environmental affairs.
- 9 The SBNS sent an email message to the Directors-General with the request to appoint someone to respond to the questionnaire.
- 10 The SBNS sent an email message with the questionnaire to the persons mentioned by the Directors-General.

0.5 Response

- 11 The Directors-General of 28 railway companies were approached. The response was 71 percent.
- 12 From the 28 approached railway companies 16 filled in the questionnaire. This is a response of 57 percent. The response can be judged as sufficient to draw basic conclusions. The results can be regarded as representative for the railway sector in the European Union.

0.6 Railroad characteristics

- 13 The ownership of the railroad land varies. Sometimes it is the state, sometimes it is the company and in some countries both state and company own part of the land.
- 14 The length of the railroad in the sixteen countries varies from 300 - 34,100 km.
- 15 The part of the railroad net that has been electrified in the sixteen countries varies from 4 - 100 percent.

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0.7 Legislation on soil pollution

- 16 In half of the countries requirements for soil protection are a regular part of the license of railroad related activities.
- 17 In more than half of the countries there is (some) legislation on soil remediation in force for railroad and railroad related activities.
- 18 Within half of the companies a warning system for soil pollution is used.
- 19 About one third of the companies can provide examples of railroad operations being restricted or cancelled because of soil pollution.
- 20 More than two third of the companies can give examples showing authorities prescribing an investigation of soil pollution or a soil remediation before a railroad operation.

0.8 Inventory

- 21 In more than two third of the countries sites with soil pollution – including railroad properties - have been inventoried systematically.
- 22 The number of inventoried polluted sites varies highly between the different countries: from about 10 to over 18,000.
- 23 The total number of inventoried polluted railway sites in nine countries is about 25,500, with a mean of about 2,800.
- 24 As important causes of the pollution the storage or transfer of fuel and the storage of other materials were mentioned.

0.9 Research

- 25 In most of the countries sites with soil pollution in the railroad area were subject to research in the field and in the laboratory.
- 26 The number of polluted railroad sites which were subject to research varies highly between the different countries: from 1 to about 4,500.
- 27 More than half of the companies mention that the research happened according to documented standard procedures.

0.10 Remediation

- 28 In the majority of the countries formerly polluted sites in railroad area have been remediated.
- 29 The number of polluted railroad sites that were remediated varies highly between the different countries: from 1 to over 900.
- 30 The total number of polluted railroad sites which were subject to remediation in thirteen countries is about 1,100.
- 31 Almost one third of the railway companies mentions that remediation took place as part of a remediation program.

0.11 Costs

- 32 The most pollutions have been categorized in the cost class < € 100,000, followed by the cost class € 100.000 – 1,000,000.
- 33 The calculation of the total costs varies highly between the different railway companies: from € 0.1 million to about € 750 million. The average for 14 railway companies is about € 165 million.

0.12 Budgets

- 34 Ten companies have an annual budget for investigation and/or remediation.

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- 35 The annual budget varies highly between nine companies: from € 154,000 to € 20 million.
- 36 The sum of the annual budgets in these countries is € 38.2 million, with a mean of € 4.2 million.

0.13 Organization

- 37 More than two third of the companies has a special organization for dealing with polluted sites
- 38 The number of persons involved in the organizations varies highly between the companies: from 0.5 to 27.
- 39 The total number of persons involved in the organizations in eight countries is 43.2.

0.14 Knowledge base

- 40 To the opinion of the majority of companies a knowledge base in the field of railway related soil pollution is very useful or useful.
- 41 More than two third of the companies would like to gather information from such a knowledge base; the remainder would consider to do so.
- 42 More than half of the companies would like to share information with such a knowledge base; the remainder would consider doing so.

0.15 Discussion

- 43 Soil pollution on railroad area is a significant problem in terms of money and time.
- 44 This subject deserves appropriate attention from the management of the railway companies.
- 45 From state-owned enterprises a role model attitude towards sustainable soil use should be expected.
- 46 The legal status of soil pollution varies between the different countries in Europe.
- 47 Cooperation between railway companies from different Member States will lead to more efficiency and more effectiveness.
- 48 Harmonization of the methods used to make an inventory of polluted railroad sites will be necessary to obtain a comparable first impression of this phenomenon.
- 49 The experience with soil remediation between different railroad companies differs greatly.
- 50 A comparison between the methods for research and documentation will be useful.
- 51 It should be interesting to investigate if modern (and cheaper) remediation methods could have been used in cases where classical (more expensive) methods were used.
- 52 There is a good reason and a good base for cooperation and harmonization in the field of soil pollution.
- 53 The extent of the problem of soil pollution on railroad area and the difference in progress with the soil remediation within the different companies, are strong arguments for a common knowledge base.

0.16 Conclusions

- 54 Soil pollution on railroad land in European countries is a significant problem.
- 55 European legislation will certainly lead to the introduction or the adjustment of national laws in the field of soil management.
- 56 Within the Member States of the European Union big differences occur in status quo of the legislation in the field of soil pollution.
- 57 Within the Member States of the European Union big differences occur in the progress of soil remediation.
- 58 Within the Member States of the European Union big differences occur in working methods.
- 59 The support for a common knowledge base is high.

0.17 Recommendations

- 60 Ask the railway companies in the European Union to pay systematically attention to prevention and remediation of polluted soil.

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- 61 Extend the existing cooperation in the field of soil pollution to all railway companies in the European Union.
- 62 Develop a common knowledge base about soil remediation for railroad companies in the European Union.
- 63 Start a project to raise the general awareness of soil pollution on railway properties.
- 64 Start another project to compare working methods for the making of an inventory and for doing research in the field and in the laboratory.

1 Introduction

1.1 European legislation

The European legislation in the field of soil pollution is developing rapidly. The European Soil Strategy and the European Water Framework Directive are of growing importance for the European Member States.

1.2 Railway related soil pollution

Some countries in the European Union have made an inventory of railway related soil pollution. In few of the Member States the field situation has been analyzed extensively. From these investigations it turned out that railway related soil pollution is a significant problem in terms of money and time.

Countries within the European Union have different insight in the degree of soil pollution in general and on railway related pollution in particular. This is caused by differences in national laws in this field or due to other priorities in the available budgets for remediation of soil pollution.

The process of policy making and subsequent implementation of measures can be influenced effectively only when Member States share a common vision on the field of soil pollution. This can only be achieved if there is a common vision on essential parts of the entire field. It is important for European railway companies therefore to develop a common vision on the treatment of soil pollution on their properties.

1.3 Vision of UIC

Soil pollution as well as the remediation of polluted sites is one of the actual topics the UIC¹ Platform on Energy, Environment and Sustainability is dealing with.

The draft of the Soil Directive, which was being prepared in 2007, has gained the attention of European railway companies. Due to the expected effects of the Directive for the railway sector, environmental officials of seven railway companies within the European Union have united themselves in the UIC Network on soil pollution and remediation. Participants are Austrian, Belgian, Dutch, French, German, Latvian and Swedish Railways. The network is creating a platform for exchanging knowledge and supports individual railway societies with expertise and expert meetings.

The Soil Network proposed to describe the state of the art concerning the soil pollution on railway properties and its remediation in Europe. It is expected that all European railway companies face the same huge problems and thus require a special position in (inter)national legislation.

The objectives of the research are:

1. To formulate a set of recommendations to be presented by the UIC and the CER² to the Member States via the communication means of the EU and thus contribute to

¹ Union Internationale des Chemins de fer (International Union of Railways).

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the harmonization of the approach towards polluted railway properties within the European Union.

2. To enhance consciousness within the member railways and within the Member States which give less attention to the soil pollution of railway sites.
3. To contribute to the harmonization of the approach towards polluted railway properties within the European Union.
4. To enlarge the possibilities of European subsidies for the approach of polluted railway sites within the European Union.
5. To reinforce the European network.
6. To upgrade to European standards the knowledge concerning the pollution of railway sites of colleagues who have been lacking access to the knowledge so far.

The European Regional Assembly of the UIC agreed with an initial study of the subject within the different European railway companies. This is part of a more comprehensible strategy for sustainable land-use by the railways. The first step is to establish the present status by means of a survey.

The UIC commissioned the Dutch foundation SBNS³ to investigate and to describe the status quo of railway related soil pollution in the Member States of the European Union.

1.4 *Guide to read*

This report describes the results of the investigations of the SBNS.

Chapter 2 describes the method that has been used and chapter 3 mentions the response. The results are presented in chapter 4 and discussed in chapter 5. The conclusions and the recommendations follow in the chapters 6 and 7.

² Community of European Railways.

³ The SBNS is a Dutch organization founded by the Dutch Ministry of Environment, the Dutch Ministry of Traffic and the (privatized) Dutch Railways. The task of the SBNS is to investigate and remediate polluted railway sites.

2 Method

2.1 Questionnaire

The SBNS composed a questionnaire with relevant questions about the status quo and the approach of railway related soil pollution for the environmental departments of European railway companies.

To facilitate statistical processing the possibility was given as much as possible to choose from several elaborated answers (the “multiple choice” approach).

2.2 Addressees

Mr. Luc Aliadière - CEO of the UIC - sent a letter⁴ to the Directors-General of the European regional assembly of the UIC to draw their attention to the survey and to request the necessary cooperation in particular of their department for environmental affairs.

The SBNS sent an email message to the Directors-General with the letter of Mr. Luc Aliadière, a further explanation about the subject and the request to appoint someone to respond to the questionnaire. If necessary, the message was repeated by email, fax or telephone.

The SBNS sent an email message with the questionnaire to the persons mentioned by the Directors-General. If necessary, the message was repeated by email, fax or telephone.

⁴ Date: February 12th 2008.

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3 Response

3.1 Persons in charge

The Directors-General of **28** railway companies – both Infrastructure managers as well as Operators - were approached. From these 28 companies **20** answered the question which person will be charged with the questionnaire. This is a response of **71** percent.

3.2 Questionnaires

From the **28** approached railway companies **16** filled in the questionnaire. This is a response of **57** percent.

The respondents have been listed in the table below.

Table 1: Overview of respondents.

Nr.	Country	Company	Website	Person
1	Austria	ÖBB-Holding AG	www.oebb.at	anton.bichelmaier@oebb.at
2	Belgium	NMBS/SNCB Holding	www.b-rail.be	koen.vandekerckhove@b-holding.be
3	Bulgaria	National Railway Infrastructure Company	www.rail-infra.bg	v.tomov@rail-infra.bg
4	Czech	České dráhy, a.s.	www.cd.cz	holeckovam@gr.cd.cz
5	Finland	Finnish Rail Administration	www.rkh.fi	arto.hovi@rkh.fi
6	France	SNCF	www.sncf.com	vincent.auriat@sncf.fr
7	Germany	Deutsche Bahn AG	www.bahn.de	rolf.gerhardt@bahn.de
8	Greece	EDISY S.A.	www.ose.gr	v.makadasis@osenet.gr
9	Latvia	Latvian Railway Concern	www.ldz.lv	maris.poikans@ldz.lv
10	Luxembourg	Société nationale des Chemins de fer Luxembourgeois	www.cfl.lu	doris.horvath@cfl.lu
11	Norway	Jernbaneverket	www.jernbaneverket.no	alb@jbn.no
12	Romania	Compania Națională de Căi Ferate "CFR" SA	www.dgmarket.ro	aurora.smarandescu@cftr.ro dorina.culda@clj.cfr.ro
13	Spain	Administrador de Infraestructuras Ferroviarias	www.adif.es	pperezc@adif.es
14	Sweden	Banverket	www.banverket.se	niklas.lowegren@banverket.se
15	Swiss	SBB AG	mct.sbb.ch	astrid.naegeli@sbb.ch
16	The Netherlands	SBNS	www.sbns.nl	j.fokkens@sbns.nl

3.3 Evaluation

The responses of **71** and **57** percent can be judged at first sight as moderately.

Reviewing however that:

- the English language was in some cases a barrier for effective communication;
- not every railway company has a person in charge of the subject soil pollution;

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the response can be judged as sufficient to draw basic conclusions.

Because significant differences can be observed in the level of attention for soil pollution and the approach of this subject within these 16 companies, the results can be regarded as representative for the railway sector in the European Union.

4 Results

4.1 Introduction

In this chapter the results will be presented and illustrated.

The abbreviations of the countries as used in the figures are indicated in Table 2.

Table 2: Abbreviations used for countries.

Nr.	Country	Abbreviation
1	Austria	AT
2	Belgium	BE
3	Bulgaria	BG
4	Czech	CZ
5	Finland	FI
6	France	FR
7	Germany	DE
8	Greece	GR
9	Latvia	LV
10	Luxembourg	LU
11	Norway	NO
12	Romania	RO
13	Spain	ES
14	Sweden	SE
15	Swiss	CH
16	The Netherlands	NL

Deutsche Bahn (Germany) could not respond the questions completely, because of confidentiality.

4.2 General

4.2.1 Legal status railroad companies

In many countries of the EU, the railways nowadays operate as normal business enterprises, although they remain to be state-owned. Only in the UK the railways were privatised, in the late 80's of the former century.

The ownership of the land varies: sometimes it is the nation, sometimes it is the company and in some countries both state and company own part of the land (see Figure 1).

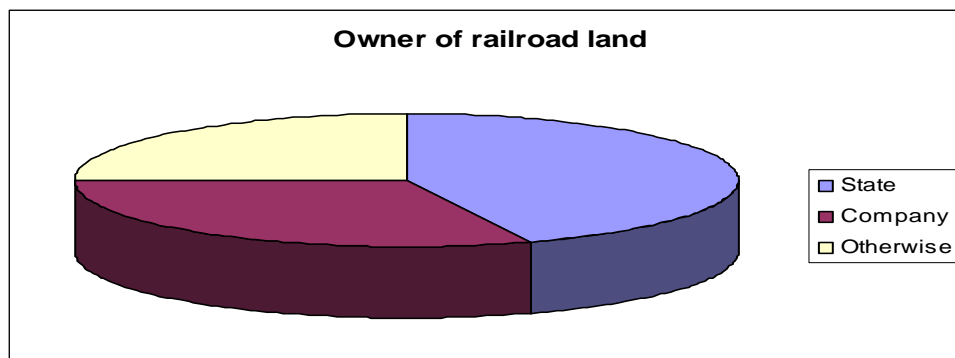


Figure 1: The ownership of the railroad land.

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4.2.2 Rail road characteristics

The length of the railroad in the sixteen countries varies from 300 - 34,100 km (see Figure 2). The total length amounts to 157,380 km.

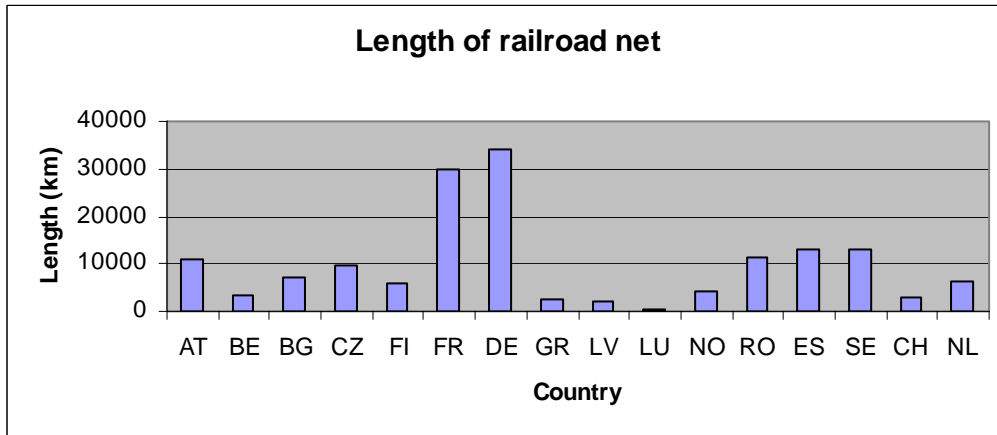


Figure 2: Length of railroad net in 16 countries.

The part of the railroad net that has been electrified varies from 4 - 100 percent (see Figure 3), with an average in the sixteen countries of 56 percent.

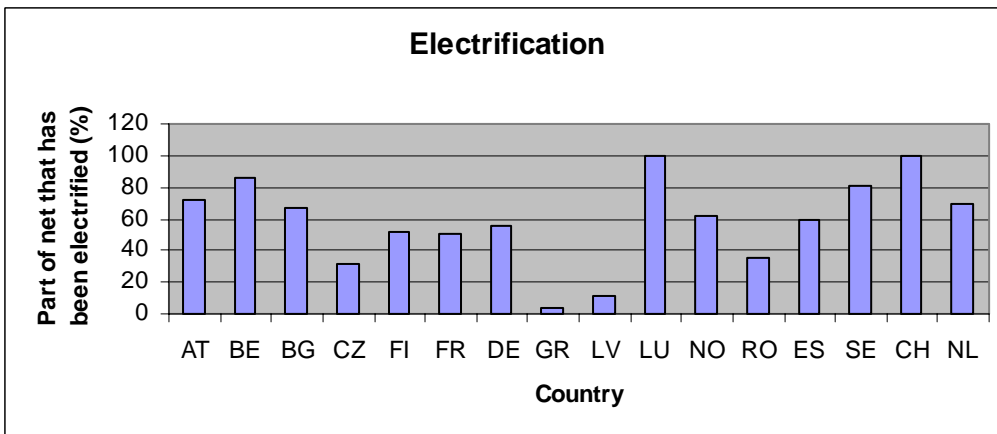


Figure 3: Degree of electrification of railroad nets in 16 countries.

4.3 Legislation

4.3.1 Soil protection

In half of the countries requirements for soil protection are a regular part of the license of railroad related activities (see Figure 4).

4.3.2 Soil remediation

In more than half of the countries there is (some) legislation on soil remediation in force for railroad and railroad related activities (see Figure 5).

4.3.3 Warning system

Within half of the companies a warning system for soil pollution is used (see Figure 6).

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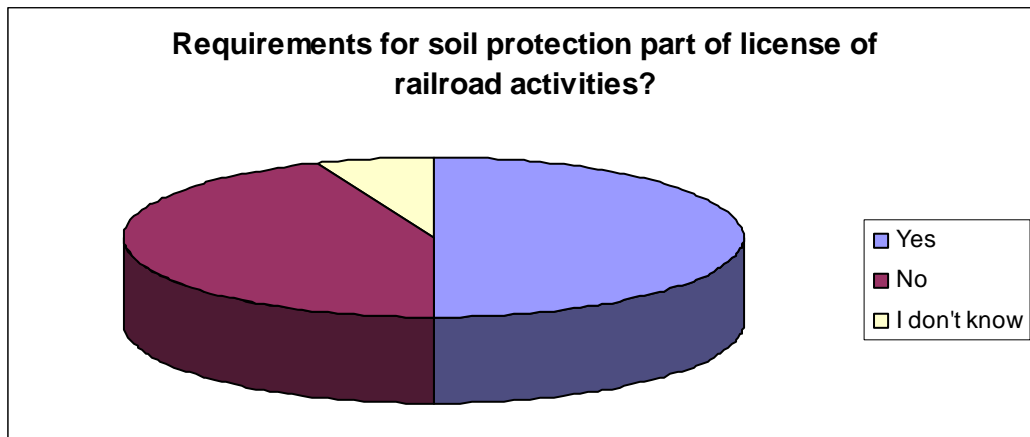


Figure 4: Number of countries with soil protection being part of licence of railroad activities.

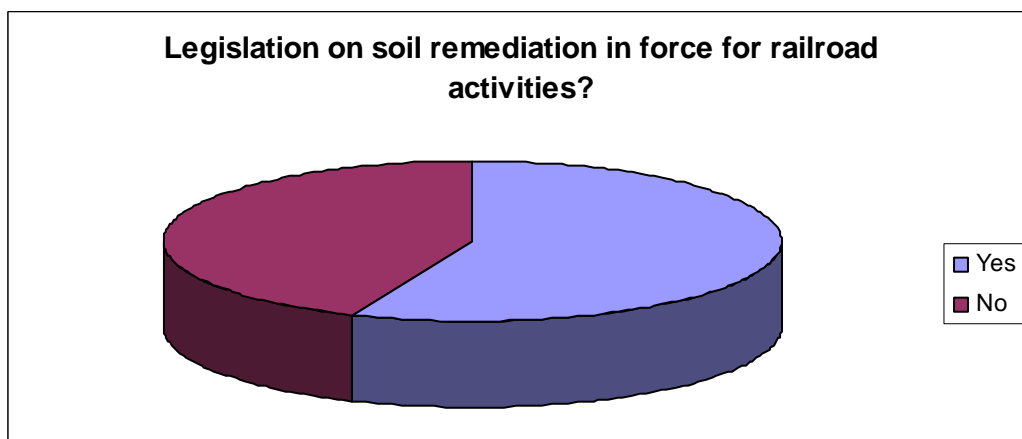


Figure 5: Number of countries with legislation on soil remediation in force for railroad activities.

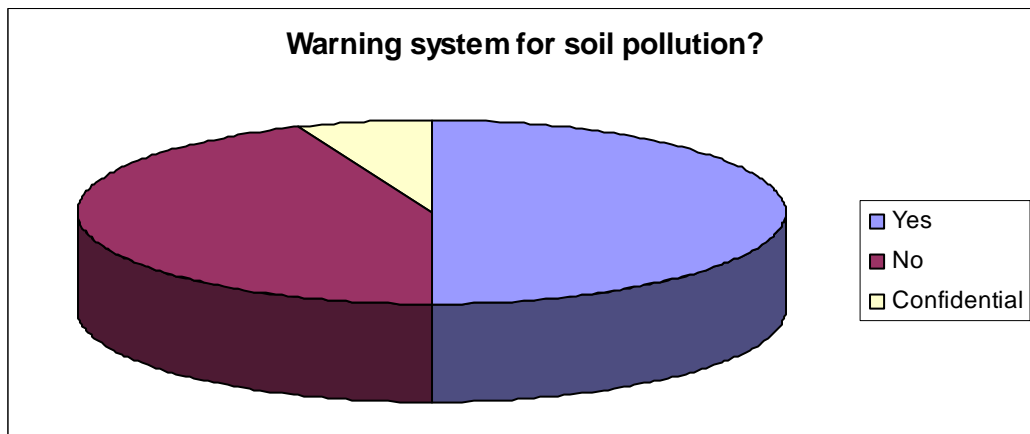


Figure 6: Number of countries with a warning system for soil pollution.

4.3.4 Restrictions

About one third of the companies can provide examples of railroad operations being restricted or cancelled because of soil pollution (see Figure 7).

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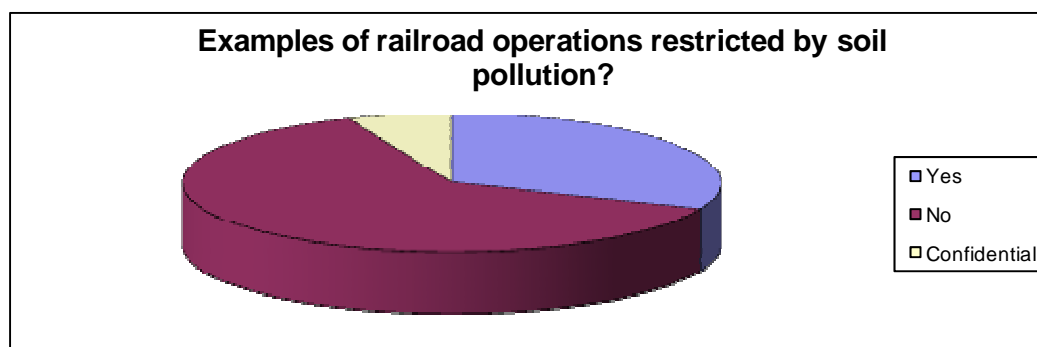


Figure 7: Number of countries giving examples of railroad operations restricted by soil pollution.

The examples refer to:

- spill of dangerous goods,
- building and construction projects,
- ballast and
- protection of groundwater.

4.3.5 Investigation

More than two third of the companies can give examples showing authorities prescribing an investigation of soil pollution or a soil remediation before a railroad operation (see Figure 8). The examples mainly refer to new developments (tracks, buildings) including the acquisition of polluted land and to accidents.

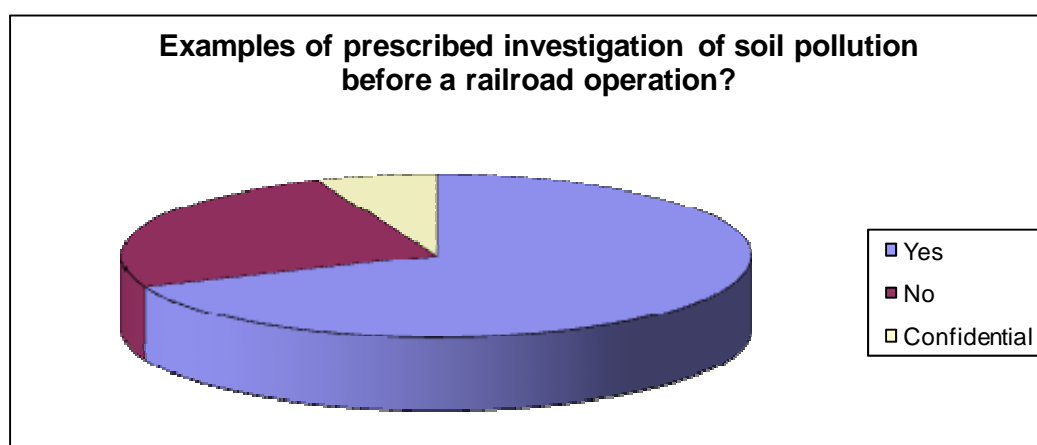


Figure 8: Number of countries giving examples of prescribed investigation of soil pollution before a railroad operation.

4.4 Inventory

4.4.1 Number of inventoried sites

In more than two third of the countries sites with soil pollution have been inventoried systematically (see Figure 9). In none of these countries a distinction was made between railroad area and other area.

In one country there are initiatives for a systematic inventory of sites with soil pollution on railroad area on the short term.

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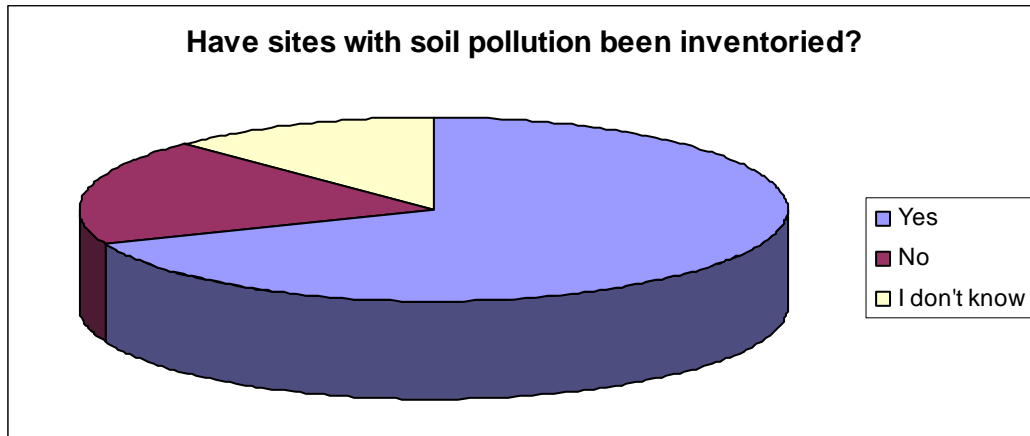


Figure 9: Number of countries with an inventory of polluted sites.

The number of inventoried polluted sites varies highly between the different countries: from about 10 to over 18,000 (see Figure 10).

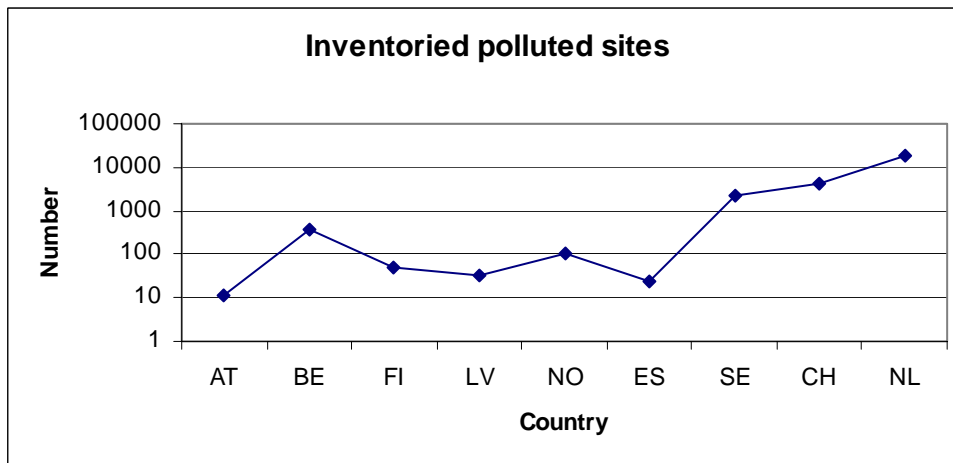


Figure 10: Number of inventoried polluted sites in 16 countries.

The total number of inventoried polluted railway sites in nine countries is about 25,500, with a mean of about 2,800.

4.4.2 Cause of pollution

As important causes of the pollution the storage or transfer of fuel and the storage of other materials were mentioned.

4.5 Research

4.5.1 Number of sites subject to research

In most of the countries sites with soil pollution in the railroad area were subject to research in the field and in the laboratory (see Figure 11).

The number of polluted railroad sites which were subject to research varies highly between the different countries: from 1 to about 4,500 (see Figure 12).

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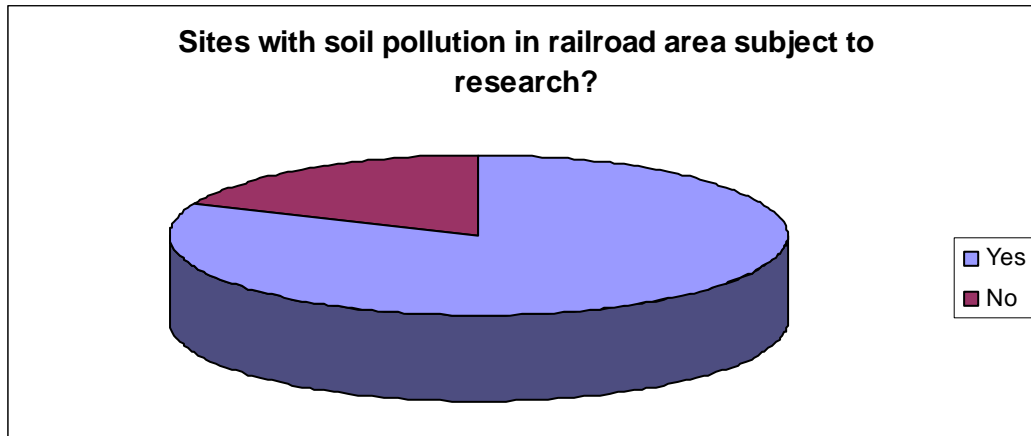


Figure 11: Number of countries with polluted railroad sites being researched.

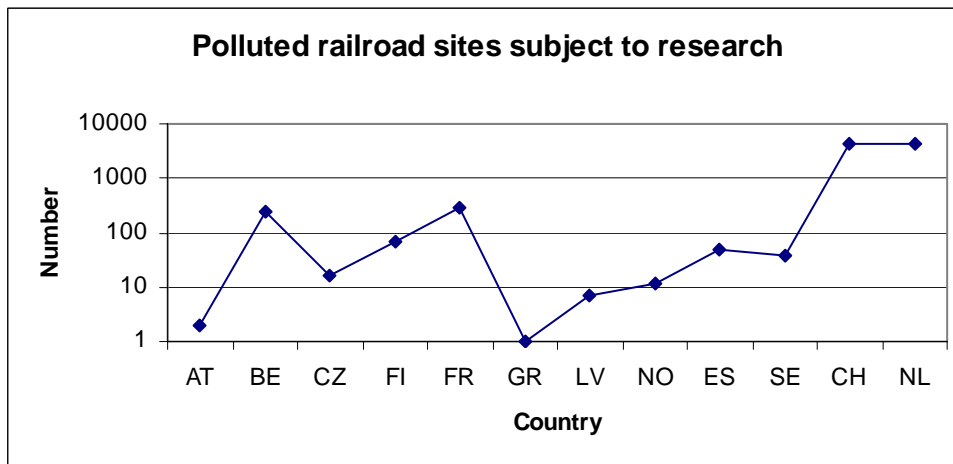


Figure 12: Number of polluted railroad sites being researched.

The total number of polluted railroad sites which were subject to research in twelve countries is about 9,400. The majority of sites where research did happen is situated in two countries.

4.5.2 Procedures

More than half of the companies mention that the research happened according to documented standard procedures (see Figure 13).

About two third of the companies documented the results centralized. Half of the companies documented the results digitally. A quarter of the companies documented the results only with hard copies. More than half of the companies documented the results systematically.

4.6 Remediation

4.6.1 Number of remediations

In the majority of the countries formerly polluted sites in railroad area have been remediated (see Figure 14).

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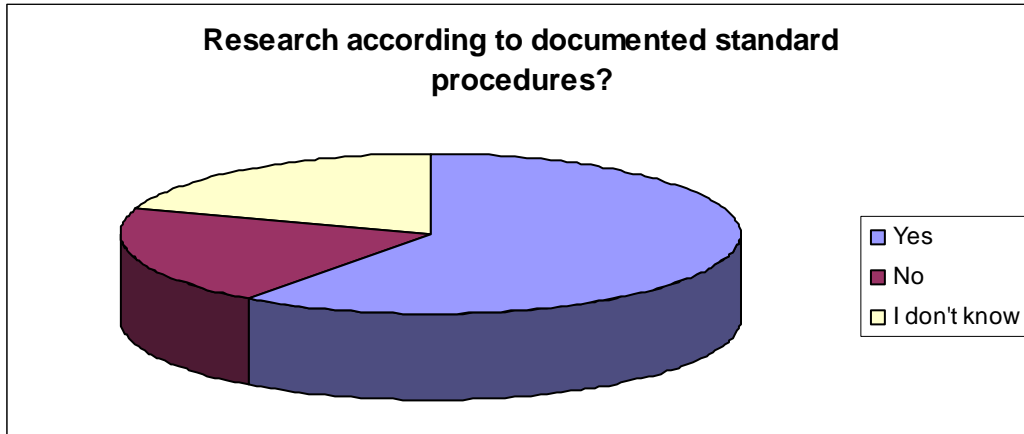


Figure 13: Number of countries that uses documented standard procedures for research.

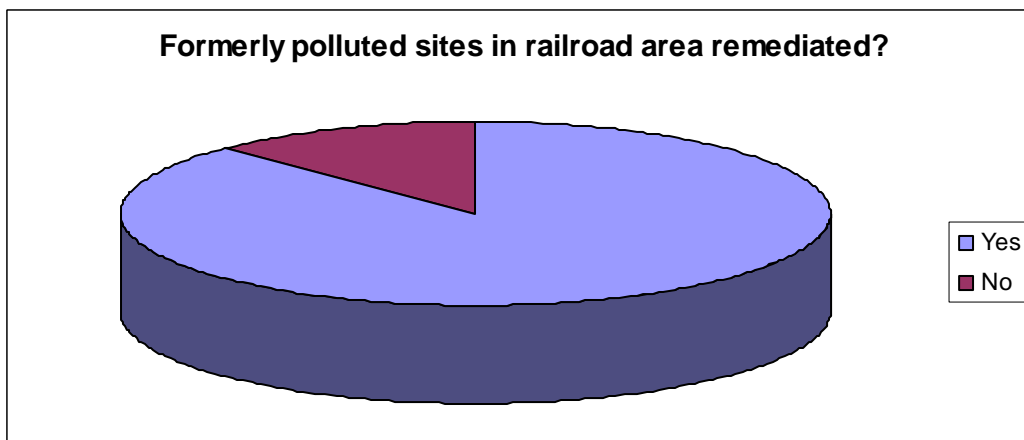


Figure 14: Number of countries where polluted railroad sites have been remediated.

The number of polluted railroad sites that were remediated varies highly between the different countries: from 1 to over 900 (see Figure 15).

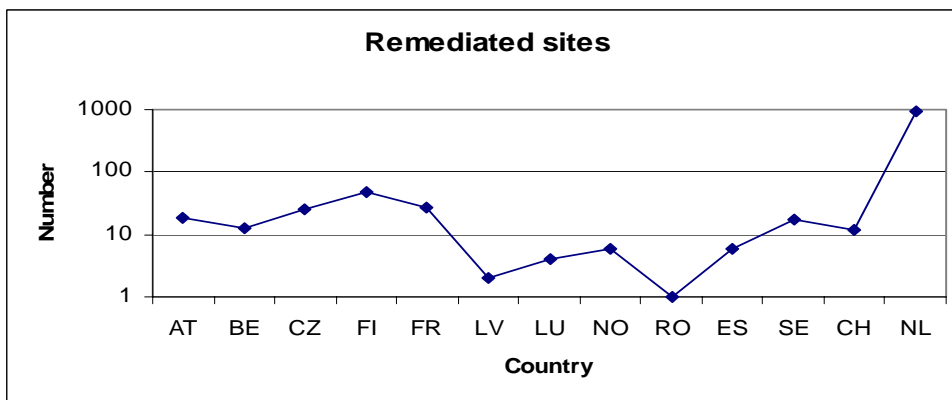


Figure 15: Number of remediated sites in 13 countries.

The total number of polluted railroad sites which were subject to remediation in thirteen countries is about 1,100. The majority of sites were remediation did happen is situated in one country.

4.6.2 Remediation program

Almost one third of the railway companies mentions that remediation took place as part of a remediation program (see Figure 16).

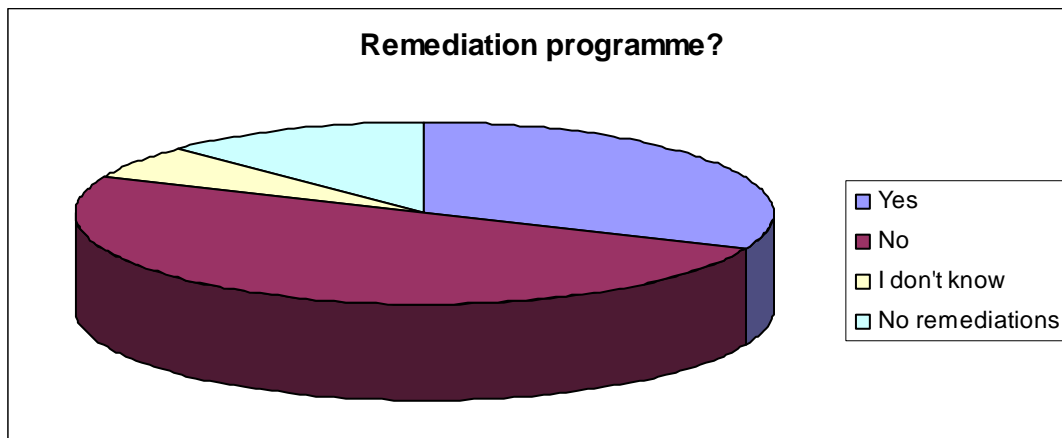


Figure 16: Number of companies with a remediation program.

4.6.3 Reasons for remediation

The next reasons were mentioned for the remediation:

- requirements from authorities (because of pollution, accidents, or the termination of activities with risk of soil pollution);
- real estate transactions, building or renovation.

4.6.4 Remediation techniques

As techniques for remediation 'classical' techniques, in-situ techniques and isolation techniques were mentioned:

'Classical' techniques:

- excavation and treatment of soil;
- pumping and treatment of groundwater and chemicals.

In-situ techniques:

- air sparging;
- air ventilation;
- bioremediation;
- bio venting;
- eluviations.

Isolation techniques:

- active wall;
- screening.

4.6.5 Costs of remediations

Most of the railway companies categorized the numbers of pollutions in different classes of cost (see Figure 17).

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The most pollutions have been categorized in the cost class < € 100,000, followed by the cost class € 100,000 – 1,000,000.

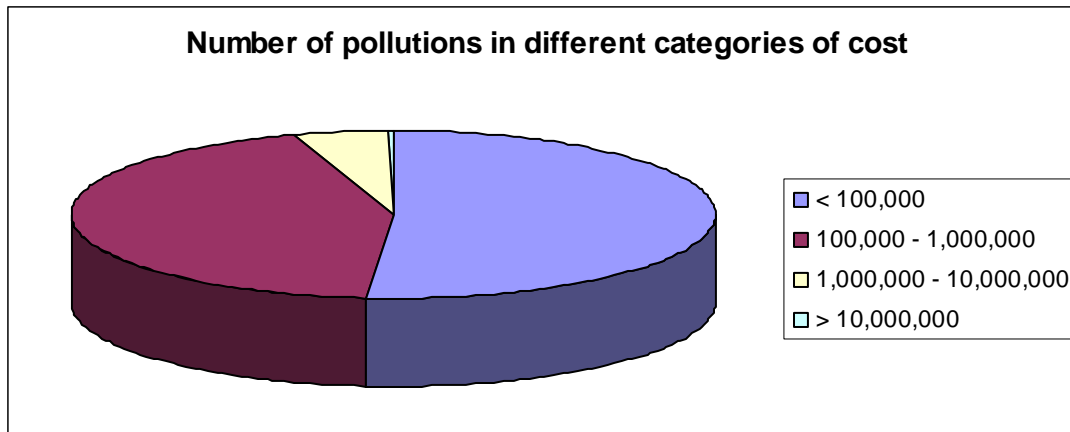


Figure 17: Number of pollutions in different categories of cost.

From these figures the total costs for the remediation in the past and in the future have been calculated (see Figure 18). The calculations have been based on remediations, investigations and inventories. Some numbers are so low compared to others, that the results are not visible.

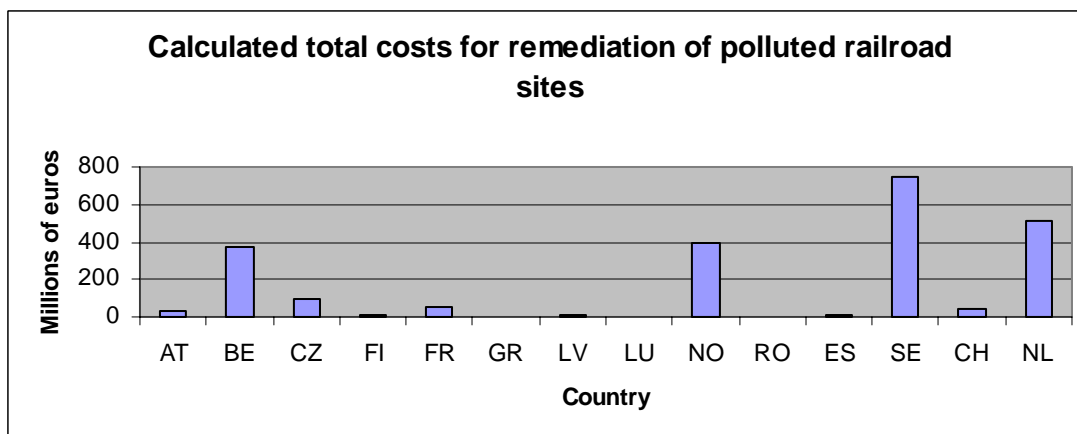


Figure 18: Calculation of total costs of remediation of polluted railroad sites.

The calculation of the total costs varies highly between the different railway companies: from € 0.1 million to about € 750 million. The average for 14 railway companies is about € 165 million.

4.6.6 Annual budgets

Half of the companies have an annual budget for both investigation and remediation; two companies have an annual budget only for remediation (see Figure 19).

The annual budget varies highly between nine companies: from € 154,000 to € 20 million. The sum of the annual budgets in these countries is € 38.2 million, with a mean of € 4.2 million.

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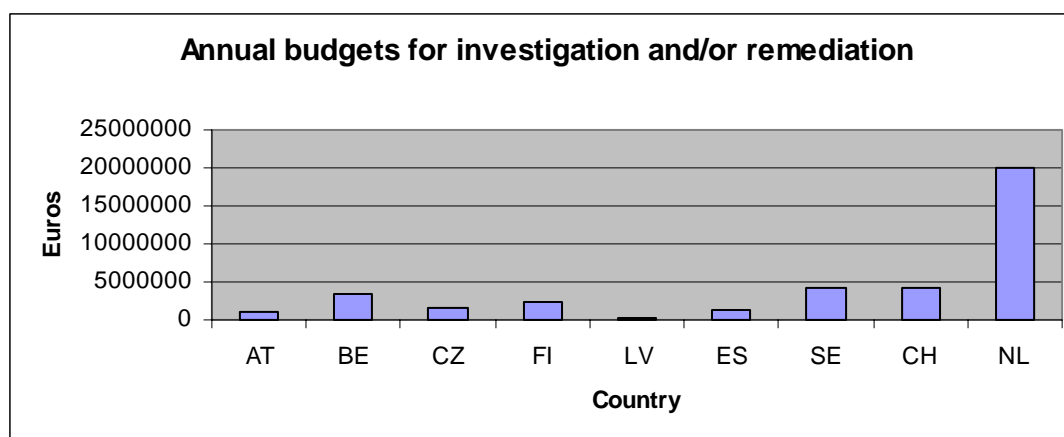


Figure 19: Annual budgets for investigation and/or remediation.

4.7 Organization

4.7.1 Number of special organizations

More than two third of the companies has a special organization for dealing with polluted sites (see Figure 20).

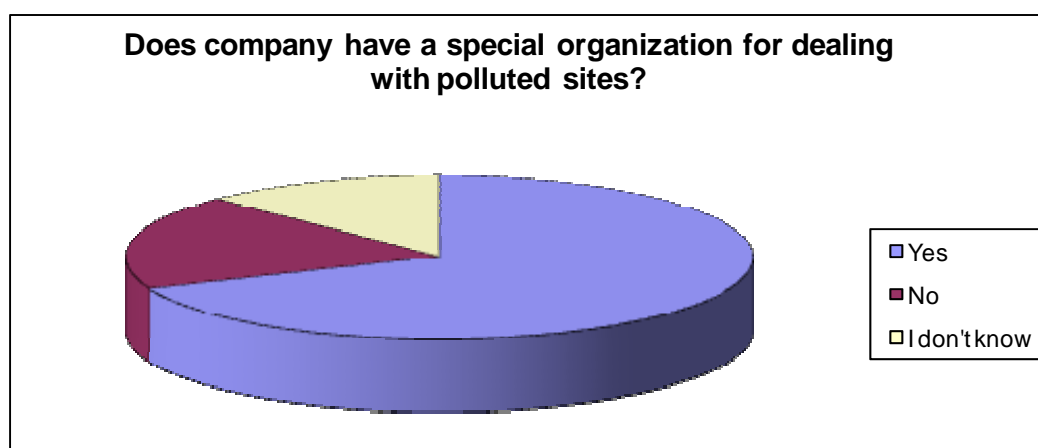


Figure 20: Number of companies with a special organization for dealing with polluted sites.

4.7.2 Number of persons

The number of persons involved in the organizations varies highly between the companies: from 0.5 to 27 (see Figure 21).

The total number of persons in eight countries is 43.2. If The Netherlands are not taken into account, the mean number of persons is 2.3.

4.8 Knowledge base

To the opinion of the majority of companies a knowledge base in the field of railway related soil pollution is very useful or useful (see Figure 22).

Railway related Soil Pollution in Europe

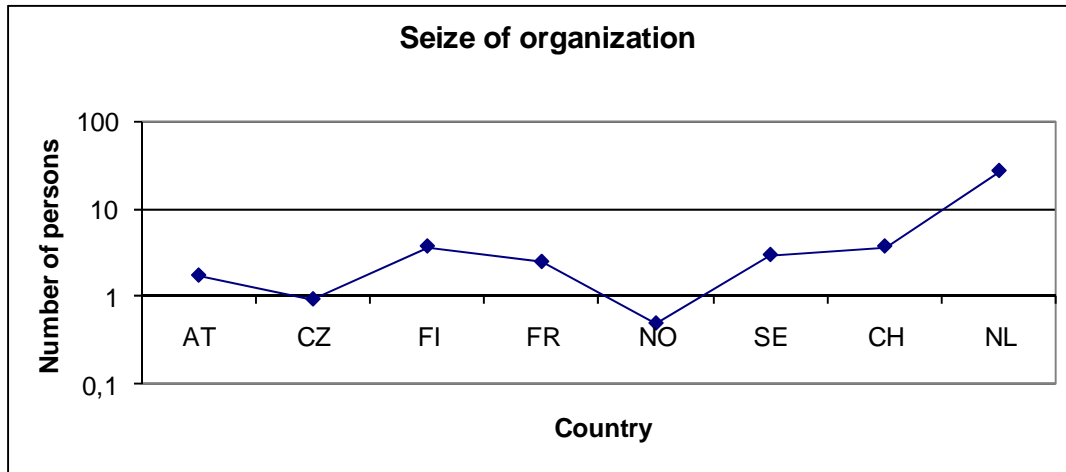


Figure 21: Seize of organizations for dealing with polluted sites.

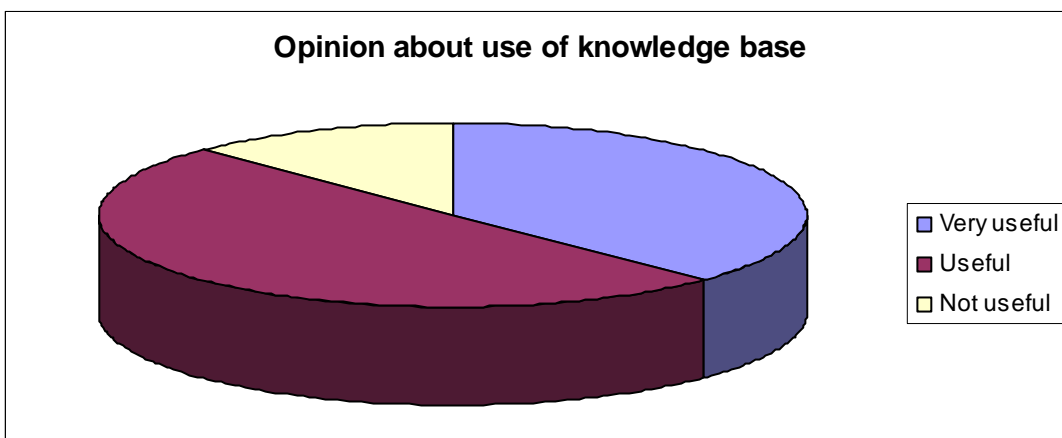


Figure 22: Opinion about the use of a knowledge base in the field of railway related soil pollution on a European scale.

More than two third of the companies would like to gather information from such a knowledge base, the remainder would consider to do so (see Figure 23).

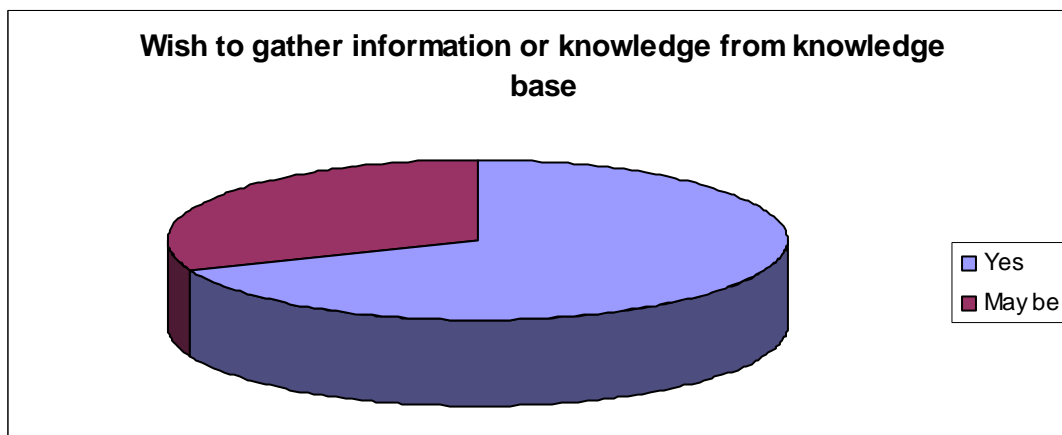


Figure 23: Opinion about the gathering of information or knowledge from a knowledge base.

More than half of the companies would like to share information with such a knowledge base, the remainder would consider to do so (see Figure 24).

Railway related Soil Pollution in Europe

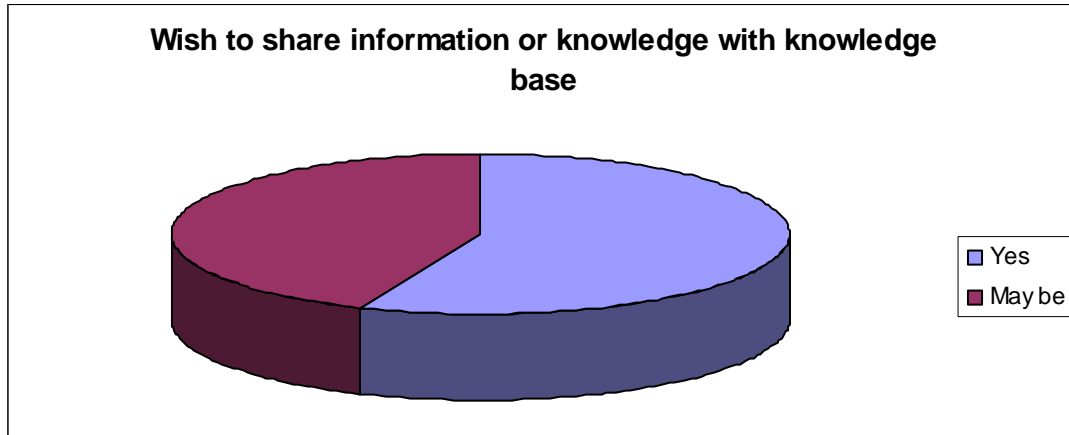


Figure 24: Opinion about the sharing of information or knowledge with a knowledge base.

5 Discussion

5.1 Quality of answers

We can't offer an overview of the quality of the data given by the sixteen companies. By cross checking some of the answers, we discovered some inconsistencies which gave rise to additional communication.

We think that answers were given from different perspectives sometimes, because a common terminology is lacking yet. This holds for infra managers and operators especially.

This should be kept in mind at reading this report, which should be seen as a first step to a common European approach of railway related soil pollution.

5.2 Significance

Soil pollution on railroad area in European countries is not exceptional:

- The total number of polluted sites in nine countries has been calculated on about 25,500.
- About 9,400 sites in twelve countries were subject to research in the field and in the laboratory.
- About 1,100 sites in thirteen countries were subject to remediation.

The total costs of remediations in the past and in the future were calculated on € 2.3 billion.

About one third of the companies reported railroad operations being restricted or cancelled because of soil pollution.

Although the large variation in the estimates between the different railroad companies, it should be concluded from these figures that soil pollution on railroad area is a significant problem in terms of money and time. This subject deserves appropriate attention from the direction and the management of the railway companies.

5.3 Legislation

Almost all railroad companies are state-owned enterprises and there are no initiatives for privatization on the short term. From state-owned enterprises a model attitude toward sustainable soil use should be expected.

The legal status of soil pollution varies between the different countries in Europe. This variation refers to requirements for soil protection as a regular part of the license of railroad activities and to the legislation on soil remediation for railroad and railroad activities.

The proposals of the European Union will certainly lead to more harmonization of the legislation on this area between the different Member States, which will certainly lead to efforts on this area within all Member States. Cooperation between railway companies from different Member States will lead to more efficiency. Moreover, it will be more effective, within the own country and within the European Union.

5.4 Progress

5.4.1 Inventory

Most railroad companies made an inventory of polluted sites. This can be seen as a first useful step to manage problems with soil quality. The resulting numbers of potentially polluted railway sites are highly incomparable however. There is no relation between the number of potentially polluted railway sites and the length of the railroad net or the part that has been electrified.

The only explanation for the different results is a difference in the methods used to make the inventories. Harmonization of the methods used to make an inventory of polluted railroad sites will be necessary to obtain a comparable first impression of this phenomenon.

The storage or transfer of fuel and the storage of other material were main causes for the pollution. Almost 60 percent of the causes were specified as 'Other causes' however. This means that the specification of causes used in the questionnaire certainly needs extension, as a base for a good inventory.

5.4.2 Research

Most railroad companies mention that sites with soil pollution in the railroad area were subject to research in the field and in the laboratory.

In view of the total number of potentially polluted sites it is usefully to review the methods used for the research. In most cases the research happened according to documented standard procedures. This probably refers to national standards. A comparison between the methods used will be useful as a base for harmonization.

The same holds for the documentation, in such a way that the results are easily accessible for colleagues in other countries and comparisons between railroad companies can easily be made.

5.4.3 Remediation

Most railroad companies mention that there are formerly polluted sites in railroad area that have been remediated. In a minority of the cases the remediation took place as part of a remediation program.

This can be understood very easily, because five companies reported less than 10 remediations, four companies between 10 and 20, three companies between 20 and 50 and only one over 900.

This also means that the experience with soil remediation between different railroad companies differs greatly.

Both classical methods (excavation of soil, pump and treat of groundwater) and modern methods (biological, in-situ) were mentioned for the remediations. It should be interesting to investigate if modern (and cheaper) methods could have been used in cases where classical (more expensive) methods were used.

Railway related Soil Pollution in Europe

Four countries estimate the costs on < € 10 million, six countries from € 10 million to € 100 million and four countries from € 100 million to more than € 500 million. The calculations of the different companies depend to a high degree on the number of polluted sites in the different inventories. A harmonization of the calculations will be very usefully before publishing these figures.

5.5 Organization

A major part of the railroad companies has a special organization for dealing with polluted sites. In total about 50 persons work within these organizations.

From the answers in the questionnaires we have learned that differences occur in the use of definitions and nomenclature within the different companies in Europe.

This means there is a good reason and a good base for cooperation and harmonization.

5.6 Knowledge base

The majority of the railroad companies thinks a knowledge base in the field of railway related soil pollution on a European scale would be (very) useful for the transfer of knowledge.

The extent of the problem of soil pollution on railroad area, indicated by the number of potentially polluted sites and the calculated costs for remediation, and the difference in progress with the soil remediation within the different companies, are strong arguments for such a knowledge base.

An easy way to transfer knowledge is to make existing knowledge accessible.

6 Conclusions

6.1 Significance

Soil pollution on railroad land in European countries is a significant problem in terms of:

- Recurrence of polluted sites.
- (Future) legal obligations.
- Efforts to inventory, to do research and to remediate polluted sites.
- The huge costs.
- The interference with desired developments (e.g. real estate).

6.2 Legislation

European legislation in the field of soil pollution is in development. This will certainly lead to the introduction or the adjustment of national laws.

Within the Member States of the European Union big differences occur in status quo of the legislation in the field of soil pollution. These differences apply to:

- Requirements for soil protection as a regular part of the license of railroad related activities.
- Soil remediation on railroad area and for railroad related activities.
- Warning procedures for soil pollution.
- Prescriptions for an investigation of soil pollution or a soil remediation before a railroad operation.

6.3 Progress

Within the Member States of the European Union big differences occur in the progress of soil remediation. These differences apply to:

- The making of an adequate inventory of polluted sites.
- The research of polluted sites.
- The remediation of polluted sites.
- The availability of annual budgets.
- The presence of a special organization for dealing with polluted sites.

6.4 Organization

Within the Member States of the European Union big differences occur in working methods. These differences apply to:

- Methods to make an inventory of polluted sites.
- Methods to do research on polluted sites.
- Methods to remediate polluted sites.
- Terminology.

6.5 Knowledge base

The support for a common knowledge base is high.

7 Recommendations

We recommend the UIC:

- 1 To ask the direction and the management of all railway companies in the European Union to pay systematically attention to prevention and remediation of polluted soil based on this description of the Status Quo of railway related soil pollution in Europe. The message should be that soil pollution on railway properties is rather common, and that the costs and the time can be reduced by an early start with inventory and research.
- 2 To extend the existing cooperation in the field of soil pollution between some railway companies to all railroad companies in the European Union.
- 3 To develop a common knowledge base about soil remediation for railroad companies in the European Union. A start could be made by placing this report, often used terminology and FAQ's on the website of the UIC.
- 4⁵ To start a project to raise the general awareness of soil pollution on railway properties in Europe, as a follow up of this description of the state of the art of this subject. This could be done by describing railroad operations which suffered of delay because of soil pollution. More awareness is helpful for the decision to make an inventory of polluted sites on railway properties, especially on sites where railroad operations are expected. Such an inventory can be regarded as a no regret first step for proper soil management.
- 5 To start another project to compare working methods for the making of an inventory and for doing research in the field and in the laboratory. A comparison of these methods will result in a better understanding of differences in those methods and could be the base for a harmonization of these methods. The last point is of special interest for those countries that just start with the making of policy for the approach of soil pollution.

⁵ This recommendation needs to be discussed within the Soil Network and with the UIC.