Extended Summary

of the Finnish report
"Management of arsenic risks in Pirkanmaa region

-Survey on available risk management instruments and tools"

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PREFACE

RAMAS (LIFE04 ENV/FI/000300) is a three-year project, which is jointly funded by the LIFE ENVIRONMENT – program, by the beneficiary, the Geological Survey of Finland (GTK), and by the partners: the Helsinki University of Technology (TKK), the Pirkanmaa Regional Environment Center (PREC), the Finnish Environment Institute (SYKE), the Agrifood Research Finland (MTT), Esko Rossi Oy (ER) and Kemira Kemwater (Kemira).

The acronym RAMAS arises from the project title "Risk Assessment and Risk Management Procedure for Arsenic in the Tampere Region". The project is targeting the whole Province of Pirkanmaa (also called the Tampere Region), which comprises 33 municipalities, and has 455 000 inhabitants within its area. The Finland's third largest city of Tampere is the economical and cultural centre of the region.

The project aims to identify the various sources of arsenic in the target area, to produce a health and environmental risk assessment for the region and to present recommendations for the preventive/remediation and water and soil treatment methods. This project is the first in Finland to create an overall, large-scale risk management strategy for a region that has both natural and anthropogenic contaminant sources.

The project's work is divided into logically proceeding tasks, which have responsible Task Leaders who coordinate the work within their tasks:

1. Natural arsenic sources (GTK), Birgitta Backman
2. Anthropogenic arsenic sources (PREC), Kati Vaajasaari until 30.4.2006; Ämer Bilaletdin since 1.5.2006
3. Risk assessment (SYKE), Eija Schultz
4. Risk Management (SYKE), Jaana Sorvari
5. Dissemination of results (TKK), Kirsti Loukola-Ruskeeniemi
6. Project management (GTK), Timo Ruskeeniemi

The project produces a number of Technical Reports, which are published as a special series by GTK. Each report will be an independent presentation of the topic in concern. The more comprehensive conclusions will be drawn in the Final Report of the RAMAS project, which summarizes the projects results. Most of the reports will be published in English with a Finnish summary.

The report at hand is the first one in the series. In future, a cumulative list of the reports published so far will be given in the back cover of each report. All documents can be also downloaded from the project's home page: www.gtk.fi/projects/ramas.

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1. Introduction

1.1. Arsenic in Pirkanmaa region

In Finland, the elevated concentrations of natural arsenic are derived from the arsenic bearing minerals which are locally enriched in the bedrock. Due to the action of geologic and geochemical processes, arsenic has migrated to groundwater and soils. In the Pirkanmaa region, elevated concentrations of arsenic have been detected in moraine and groundwater in drilled wells, in particular. Additionally, the study area includes anthropogenic sources of arsenic.

On the basis of geology and occurrence of arsenic in bedrock, the study area can be divided into three parts: 1) the Central Finland Granitoid Complex (CFGC), 2) the Tampere Schist Belt (TB) and 3) the Pirkanmaa Belt (PB). The high concentrations of natural arsenic are clearly focused on the areas 2) and 3) while most of the habitation is concentrated on the area 2) (TB). The Ylöjärvi mine studied in the RAMAS -project is situated in the TB. The most northern area, i.e. CFGC, differs from the TB and PB since the elevated environmental concentrations of arsenic rise from anthropogenic sources. Within all these three areas, the median arsenic levels in moraine are higher than the median value nationwide (2.6 mg/kg), i.e. 11.5 mg/kg in the PB area, 5.92 mg/kg in the TB area, and 3.72 mg/kg in the CFGC area. In 22.5 % of the wells studied, the quality standard for household water (10 µg/L) was also exceeded. The median value (5.5 µg/L) for drilled wells in the TB area was higher compared with the other two areas. (Backman et al., 2006[1])

The most important anthropogenic sources of arsenic in the Pirkanmaa region comprise the CCA[2]-based wood impregnation plants and soils and wood material contaminated by CCA. Potential risk areas include old waste treatment sites and mining areas (Parviainen et al., 2006[3]). The information on the risks on these is inadequate. Although the elevated natural concentrations of arsenic have been identified as a more important risk factor than the environmental pollution rising from anthropogenic sources, it is necessary to study particularly the risk management related to wastes and waste management in more detail.

1.2. Concepts of risk management

Term risk refers to probability of the appearance of harm or hazard. In the case of environmental contamination, the harm or hazards falling on the human beings, biota or other receptors to be protected, e.g. aquifers, are usually of the main interest. In addition to toxicological effects, these hazards can refer to adverse economic, psychological and socio-cultural effects. In a risk assessment process, the risks, i.e. the magnitude and probability of such adverse effects, are assessed.

[1] Backman, B., Luoma, S., Ruskeeniemi, T., Karttunen, V., Talikka, M. and Kaija, J., 2006. Natural Occurrence of Arsenic in the Pirkanmaa region of Finland. Geological Survey of Finland, RAMAS-project serial publication. 88p.
[2] CCA refers to the impregnant comprising chromium, copper and arsenic.
[3] Parviainen, A., Vaajasaari, K., Loukola-Ruskeeniemi, K., Kauppila, T, Bilaletdin, Ä., Kaipainen, H., Tammenmaa, J. and Hokkanen, T., 2006. Anthropogenic Arsenic Sources in the Pirkanmaa Region in Finland. Geological Survey of Finland, RAMAS-project serial publication.

Toxicological risk assessment can be based on chemical studies, modelling, and biological and ecological studies. Risk management refers to all actions and control mechanisms which aim at reducing the risks. These include

- policy instruments, e.g. regulations, guidelines, strategic programs
- economic policy instruments, e.g. funds, taxes, fines, incentives
- informational instruments, e.g. registers, education, research
- land use planning
- technical means to eliminate exposure or contaminant transport, e.g. remediation and removal techniques for different contaminated environmental media.

Risk management can also cover actions to limit risks in the case when exposure has already taken place. For example, medical treatment in the case of arsenic poisoning is such an action (e.g., Tchounwou et al., 2004[4]). In this RAMAS study, however, such risk management actions were not considered. The focus of the study was in the public control mechanisms covering different policy and informational instruments. Economic policy instruments were not studied in detail since these are generally not restricted to the risk management of specific, individual harmful substances.

1.3. Levels and targets of risk management actions

The present policy instruments in Finland are mainly based on the regulations issued in the European Union. In Finland, there are no separate regional laws or regulations hence, the national legislation is adopted similarly all around the country. Moreover, the management of environmental risks has seldom been studied in a regional scale.

Risk management of arsenic can be targeted to sources of emissions in different environmental media or to maintaining the quality of the living environment (Fig. 1). Sources of arsenic comprise products and raw materials containing arsenic, different human activities which might lead to environmental pollution by arsenic and the existing contaminated sites and wastes in which arsenic is present. In Fig. 1., the ”Living environment/ human” refers mainly to the neighbourhoods and local areas used for food production.

Spatially, all levels of risk management (Fig. 1.) were included in this study, but the focus was at the national level. The role of the regional authorities is covered shortly. In this report, occupational exposure and labour protection are considered only as an additional risk factor hence they were not studied in detail.

In most cases, arsenic is not the only contaminant to be managed, i.e. other contaminants, heavy metals in particular, can be found simultaneously. In such cases, risk management actions are not planned solely on the basis of risks associated with arsenic (see Fig. 1, the arrows from the box "Arsenic compounds"). Since the focus of the RAMAS –project is on arsenic only, this perspective is not considered in detail in this study.

[4] Tchounwou, P.B., Centeno, J.A. and Patlolla, A.K., 2004. Arsenic toxicity, mutagenesis, and carcinogenesis – a health risk assessment and management approach. Molecular and Cellular Biochemistry 255: 47-55. Kluwer Academic Publishers, the Netherlands. 10p.

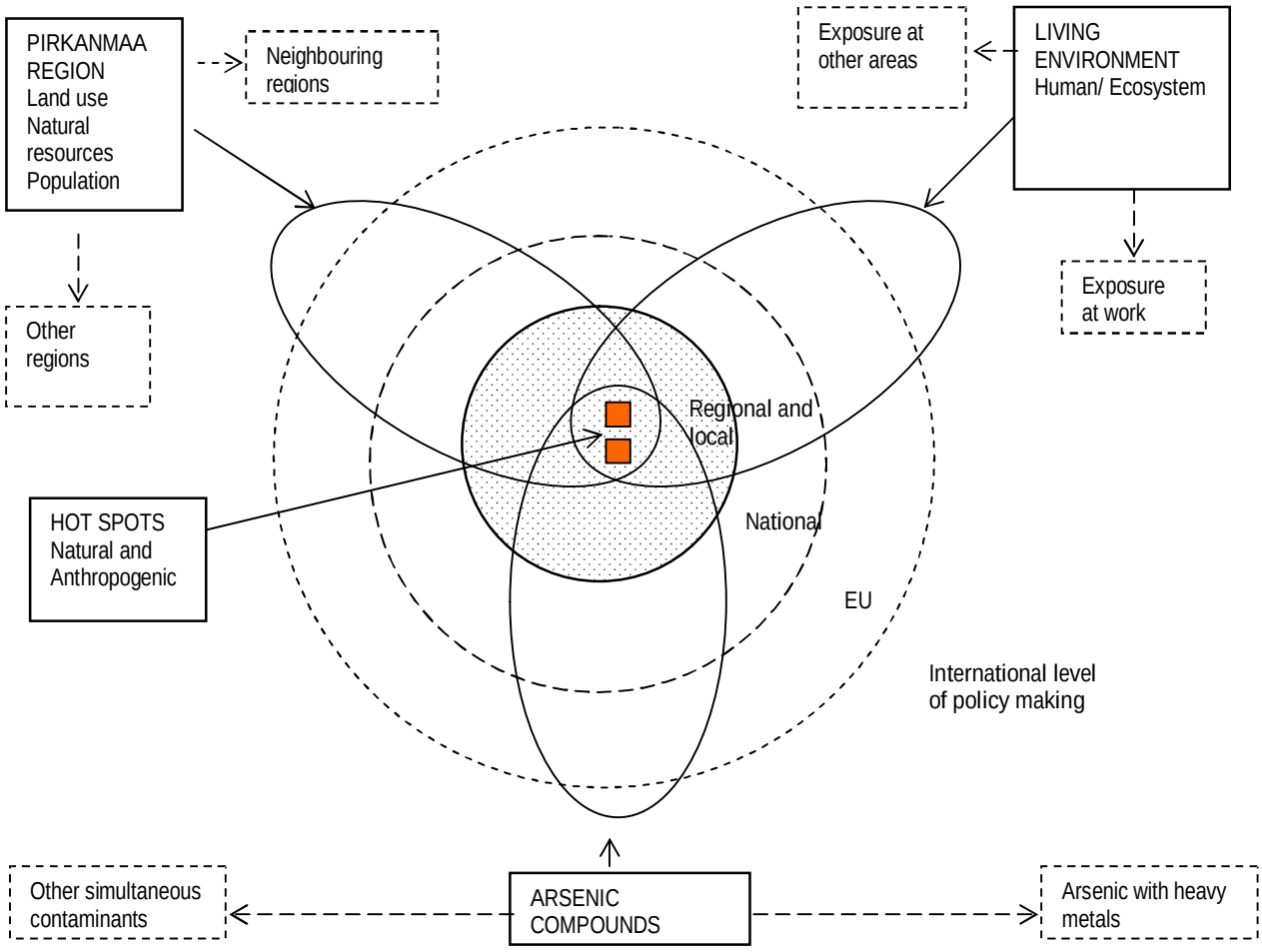

Figure 1. Different levels of the risk management of arsenic: control of the sources of emissions (Arsenic compounds), ensuring the quality of the living environment (Living environment), risk management of contaminated sites (Hot spots); and the characteristics at the Pirkanmaa study area (Pirkanmaa region). (The idea for the figure adapted from Assmuth and Jalonen, 2005[5]).

Although the starting point of the RAMAS –project is the risk management of environmental arsenic, it was necessary to cover also the risk management of arsenic sources in this study. This wider perspective was urged in order to manage the arsenic flows in a wide regional scale. Additionally, in the planning of risk management actions diffuse sources, e.g. foods and air, can have a significant impact on the total exposure. Therefore, in this study, alongside with the risk management associated with maintaining the quality of the living environment, the instruments for the management of anthropogenic sources and emissions of arsenic are also covered.

[5] Assmuth, T. and Jalonen, P., 2005. Risks and management of dioxin-like compounds in Baltic Sea fish. TemaNord 2005:568. 376p. (Fig. 26, p. 297).

2. The most significant policy instruments identified

All policy instruments covered in this survey have been presented in Tables 1, 2 and 3 in Appendix I. The policy instruments have been divided in three categories, namely

- Acceptance practices and quality control of products and raw materials
- Management of industrial and other large scale operations which might cause environmental pollution
- Monitoring of environmental quality.

The adverse environmental effects of the chemicals and products, e.g. pesticides, biocides, additives in animal feed, animal drugs, containing arsenic have been proven as significant compared with their benefits. For this reason, most of such products have already been recalled in the European Union and also in Finland. For example, based on the Arsenic Directive the use of CCA in wood treatment has banned with some exceptions. However, the management of wood waste including CCA is still partly unresolved. The main goal is to enhance recycling of the waste but while the decisions on the waste management are pending, the material has been stored in centralized repositories. The recycling options of arsenic have also been studied. The EU Council Decision on acceptance of wastes on landfills (2003/33/EY), implemented in Finland in March 23rd, 2006 and to be adopted after September 1st, 2006 certainly affects the management of CCA-waste. The pending renewal of the Arsenic Directive may also affect the final decisions on the management of CCA-containing waste wood. Additional important regulations which may affect the future waste management practices include the regulations for classification of wastes (see Table I).

Table I. The policy instruments identified as the most important in the management of environmental arsenic.

Instrument	Basis
Arsenic Directive	CCA- treated wood waste
Act on the use of fertilizers	Ashes (basis not clearly stated)
Act on the use of secondary aggregates in earth construction	Ashes (mainly protection of groundwater quality)
Regulations concerning landfill disposal and acceptance of wastes on landfills	Ashes, contaminated sites (mainly protection of groundwater quality)
Environmental permit and notification procedures	Mining areas and waste treatments sites, contaminated sites (all environmental risks covered)
Soil guideline values for the assessment of contamination level and treatment of contaminated soil	Contaminated sites (ecological and health risks)
Water Framework Directive and the pending directive on the protection of groundwater resources	Quality of surface waters and ground waters (ecological and health risks)
Drinking water directive and the national acts on concerning drinking water quality and quality control	Quality of household water (health risks)

The most important policy and regulatory instruments comprise the environmental permit and notification process and the practices for the management of water quality. In the management of ground water quality, the most important provisions include the prohibition of polluting ground water (Environmental Protection Act). Protection plans for aquifers also serve as an important risk management tool. The quality of household water is strongly regulated by the drinking water directive and the act on water quality and quality control issued by the Ministry of Social Affairs and Health.

Several changes in the regulations and guidelines relevant in the risk management of arsenic are ongoing. It is difficult to predict the significance and effects of these changes. For example, in the future the arsenic levels in the environment and in wastes will be compared with the recent and pending composition and solubility standards issued for contaminated soil and wastes. The environmental standards issued for wastes to be disposed on landfills will be adapted also in the case of assessment of risks associated with recycling of wastes in fertilizers and earth construction. Guidance for the interpretation and application of the new regulations is also under preparation.

At national level, arsenic has not been identified as a priority substance in the management of water resources. Moreover, in the Pirkanmaa region, arsenic has not been considered as a significant contaminant in the protection of surface water resources. The future ground water directive assumes that chemical quality criteria are issued at national level. It is most probable that the significance of arsenic will be evaluated in this context equivalent to the procedure used in the assigning of priority substances in surface water protection.

3. Focus of the present risk management actions

Overall, the risk management of arsenic has more or less focused on health risks while ecological aspects have been seldom considered. This is mainly due to the fact that arsenic is a known carcinogen. For the risk management, several criteria, i.e. guidelines and standards, have been issued (Table 2). The starting point, methods of definition and objectives of these criteria vary.

In the context of health risks, the assuring of drinking water quality has been the main goal. For this purpose different strategic plans, policy and administrative instruments and technical methods have been developed around the world. In Finland, too, the main focus in risk management has been on the elimination of health risks associated with drinking water intake. For this purpose, the drinking water standard 10µg/L of As issued by WHO and the European Union Water Framework Directive (WFD) has been implemented.

In the regulations and guidelines concerning recycling of wastes (fertilizers, residues to be used in earth construction), the environmental standards are originally based on criteria issued for wastes disposed on landfills (implemented by the Council of State Decree, VNA 202/2006). These regulations include composition and solubility standards for arsenic. The main starting point of these standards has been the protection of groundwater from harmful leachates.

Ecological risks form the main basis of the soil guideline values of arsenic which are included in the pending Council of State Decree on the assessment of contamination level and remediation need of a contaminated site. Here, the guideline values are based on the internationally reported toxicity benchmarks on soil and terrestrial biota (plants, earthworm). Although it is known that arsenic does not accumulate in living organisms in a significant extent, the data on long term terrestrial toxicity

in particular, is very limited. Moreover, the ecological effects caused by the non-anthropogenic arsenic concentrations are unknown. In the derivation of the soil guideline values, it was assumed that the organisms adapt to such high naturally occurring concentrations and consequently, no significant adverse effects on terrestrial ecosystems are expected. When considering the remediation need, high natural arsenic concentrations alone should not lead to remediation liabilities. The liability may, however, come true in the case of human actions which affect the realization of risks by, e.g. changing the toxicity or transport potential of arsenic.

In Finland, no quality standards for the concentration of arsenic in surface water and ground water exist at national level. Furthermore, the EY directive on air quality has not yet been implemented. Guidelines for the dredged sediments based on ecological risks have been issued but since these cover sea ecosystems only, they are not applicable in the inland waters of the Pirkanmaa region.

Table 2. Summary of the most important Finnish guidelines, standards and other benchmarks used in the risk management of arsenic. GLV = guideline value; LV = limit value; SS = solubility standard; L/S = liquid/solid –ratio; CS = composition standard.

Medium	Benchmark	Notice
Domestic water	10 µg/L	Effective from January 1st, 1995.
Wash waters (food production)	20 µg/L	No contact with food nor use as drinking water allowed.
Soil	GLV 10 mg/kg LV 50 mg/kg Lower GLV 50 mg/kg / upper GLV 100 mg/kg	Recommendation, benchmarks dating from 1994 Updated benchmarks, issued in the Council of State Decree (draft on February 2nd, 2006)
Sediment	Level 1 15 mg/kg / Level 2 60 mg/kg	For the disposal of dredged sediments in sea (guideline, the Finnish Ministry of the Environment, 2004).
Waste disposed on a landfill - **inert waste** - **non-hazardous waste** - **hazardous waste**	 SS 0.5 mg/kg (L/S = 10) SS 2 mg/kg (L/S = 10) SS 25 mg/kg (L/S = 10)	
Waste recycled in earth construction	CS 50 mg/kg, SS 0.5 mg/kg or 1.5 mg/kg CS 60 mg/kg, SS 0.14 mg/kg or 0.85 mg/kg	Benchmarks for waste concrete and ashes (Council of State Decree, VNA 591/2006). Recommendation for all wastes (Finnish Environment Institute, 2000) Higher SSs refer to paved structures.
Animal feed	2 mg/kg or 4 mg/kg, in some cases 40 mg/kg	For some feeds the higher concentration shown is allowed.
Fertilizers, soil amendments, compost products	10 mg/kg or 50 mg/kg	Depends on the application. Renewal of the regulations is ongoing.
Air, workplace	0,01 mg/m^3	Issued by the Decree of the Ministry of Social Affairs and Health, 2005.

4. Arsenic removal and treatment techniques

In general, the treatment of arsenic containing wastes, soil, water, and other media is difficult and challenging since arsenic tends to alter its chemical speciation when environmental conditions are changed. When the speciation is changed, the toxicity and mobility also change. Arsenic tends to form rather stable chemical compounds with some iron species. Therefore, iron has been used extensively in the treatment of different media contaminated with arsenic. The availability and low costs of ferric compounds have also affected the prevalence of removal and treatment techniques based on iron. The activated aluminium formerly used in the filters for the purification of tap water in single households has also been partly replaced with ferric compounds. In Finland, membrane filters are also available for the same purpose. Since arsenic is normally not a problem in waterworks, there has been no need for its removal from raw water in a large scale. At contaminated sites, oxidation and chemical precipitation have been used for the treatment of water containing arsenic. Different filters and equipment based on electric ion exchange and reverse osmosis are also available for the treatment of leachates from landfills.

In soil remediation, landfill disposal has been the most common method. In the landfills, soil is either disposed as waste or used in the different structures or daily cover. Occasionally, soil has been pre-treated by stabilization. In some cases, isolation *in situ* has been used at contaminated sites. Other possible *in situ* techniques have not been applied yet.

At contaminated sites generated by human activities, arsenic is never the only relevant contaminant to manage. Arsenic is found simultaneously with other contaminants and often it is not the most critical element to be considered in the selection of remediation methods. In fact in Finland, arsenic has not been an insuperable problem in the remediation of contaminated sites. It seems that the terms set in environmental permits for the treatment of soil contaminated by arsenic have been fulfilled in previous remediation projects. On the other hand, in Finland the history of soil treatment is rather short, e.g. the oldest stabilizations date back to 10 to 15 years. Our interviews targeted to the representatives of some Finnish companies offering planning and realization of remediation projects showed that there is interest on studying the feasibility of *in situ* stabilization in Finnish conditions. An overview of the remediation methods available in Finland is presented in Table 3.

At mining sites, the acidic waste waters and sediments containing arsenic make a challenge when remediation is to be carried out. Since there are no references available in Finland, the projects carried out in other countries need to be studied. So far, arsenic has been only monitored at the range of Finnish mines and some plants processing metals.

The development of methods for the extraction of valuable elements from different residues is ongoing. The purpose of these studies is to find means to recover those substances which might have a market and could be reused as a raw material. In the case of arsenic, it is doubtful that such techniques could provide a solution since its use in chemicals and products is very restricted. Due to the Arsenic Directive, the market and e.g., the use in preservatives will be concentrated in other than EU countries.

Table 3. Remediation of contaminated sites: summary of the remediation methods suitable for arsenic and studied and used in Finland.

Method	Experience	Notice
Stabilization	Several reference projects based on the use of mobile treatment units or soil excavation and treatment off site. No experiences on *in situ* stabilization.	Although arsenic compound are difficult to stabilize the conditions set in environmental permits have been fulfilled.
Isolation / encapsulation	A couple of reference projects including arsenic.	
Landfill disposal	Normally, soil has not treated when disposed on a landfill (if acceptable).	Used extensively in structures on landfills which have to be closed since they do not fulfill the EU criteria set for different landfills.
Soil washing or wet separation	A few equipment and reference projects exist, not used at sites contaminated by CCA.	Technical restrictions exist, most suitable for sandy soil or gravel which can be recycled. The residues often require treatment.
Incineration	An experimental project for CCA wood has been run in a plant for treatment of hazardous waste. One company offers a mobile unit for the treatment of contaminated soil.	Arsenic is partly volatilized. Consequently, the flue gases must be treated.
Treatment of landfill leachates	Different filters, equipment based on electric ion exchange and reverse osmosis are available. A few reference projects exist.	
Pump-and-treat (groundwater)	A few reference projects exist. E.g., oxidation and chemical precipitation have been used as treatment techniques.	
Reactive walls	No references for arsenic exist. Two experimental projects for the remediation of sites contaminated by solvents exist.	Method is based on adsorption of contaminants to a suitable adsorbing material.
Microbiological methods: e.g., sulfidization or reduction of iron	One environmental permit (in 2005) exists for the sulfidization of sediment containing As.	Microbiological methods are normally used alongside with other methods e.g., oxidation As(III) => As(V).
Electrochemical methods e.g., electrokinetics, electric coagulation, electrolytic ion exchange	Methods have been studied in the treatment of various metals, arsenic not included yet. Electronic migration of arsenic has been reported to be rather slow.	Electrochemical methods are normally used alongside with other techniques. Could be suitable for the treatment of heavily contaminated waste waters, e.g., the volume of sludge generated could be reduced.
Fytoremediation	Some preliminary studies have been carried out. The results are not very promising. No full-scale remediation projects exist.	Environmental conditions (e.g., climate, soil) has to be suitable for the hyperaccumulator. The Finnish conditions are unsuitable for the known arsenic hyperaccumulator, brake fern

5. Other risk management tools

Since in the Pirkanmaa region, the elevated concentrations of arsenic are focused on drilled wells, arsenic is not a problem for the public water supply. In the monitoring studies at waterworks, the concentration has been below the quality standards for domestic water. Therefore, entry into the public water supply would be an efficient way to secure clean drinking water supply. Regionally, these actions could be financially supported. In Pirkanmaa, a target has been set to develop the water system in such way that till 2020 92 % of all households will be joined in the public water supply.

In addition to the financial support targeted to water supply systems, it is possible to channel funds to remediation of contaminated sites prioritized on the basis of risks to the environment. These sites could include the former CCA-treatment plants and old mining areas which have been closed prior to the legislative obligation to present plans on the landscaping of the area. Funds could be directed through branch-specific trusts.

Except in the case of drinking water supply, the management of arsenic risks by informational instruments, e.g. registries, education, guidance etc., is still scattered in Finland. The municipal health officers follow the orders and instructions on the quality control of domestic water issued by the Ministry of Social Affairs and Health. However, the information on the concentration and spatial distribution of arsenic in well waters have systematically compiled only in some municipalities. The information on the technical and other solutions suitable for the removal of arsenic for obtaining arsenic-free domestic water are available, e.g. in the internet pages of the Finnish environmental administration, among others.

It would be useful to put together the available data on the sources, emissions, risks and effects of arsenic in the Finnish environment and present these as a freely available internet-based portal. The environmental authorities also need information on the suitability of the technical means to diminish and eliminate the risks. At least at the Pirkanmaa study area, this data was quite dispersed and not readily available. The national VAHTI register, in which data is collected on the environmental load of industrial activities, contained very little information on the wastes containing arsenic. On the contrary, the data on the emissions to air and water systems has been collected more systematically in this register. In the case of old mining areas, the data available was overall very limited.

6. Conclusions and future prospects

Several instruments and tools are available for the management of risks associated with environmental arsenic. In the overall management of the arsenic flows, in addition to environmental standards, different quality standards for products and raw materials are also important.

At the next stage of the project, the risk management actions and the alternative risk management strategies feasible and suitable for the Pirkanmaa region will be determined. Hence, the future study will be more focused on the risk management at regional and local level. This risk management might mean focusing on the contaminated sites of a specific type, water systems, domestic water or food items. The planning of risk management strategies presumes data on the most significant risk factors, e.g. sources, receptors, as well as the magnitude and spatial and time distribution of the

risks on the Pirkanmaa study area. This data is produced within another task of the RAMAS – project.

In practice, in the management of environmental risks associated with arsenic the regional environmental centres have an important role since they are responsible for, e.g.

- the realization of the Water Framework Directive,
- authorizing and supervising the industrial and other activities causing emissions to the environment,
- organizing environmental monitoring and maintaining registers,
- increasing the awareness of environmental issues (e.g., education of municipal authorities),
- the consideration of risk management in land use planning (e.g., providing data for the provincial land use plan and master plan).

In the future, the role of different actors in the risk management has to be defined in detail in cooperation with the regional and municipal authorities. Therefore, some experts and authorities involved in the management of the water supply system, in the management of contaminated sites, and in waste management in Pirkanmaa will be interviewed. It is important to have a clear understanding of the responsibilities and tasks of different actors involved since it is possible that the actual risk management actions to be realized in Pirkanmaa extend to cover the spheres of authority of several actors.

APPENDIX 1

Table I. The most important environmental regulations concerning the acceptance and quality control of the products and raw materials containing arsenic

Regulation	Implementation in Finland	Notice
Animal feed: Commission Directive **2003/57/EC** of 17 June 2003 amending Directive 2002/ 32/EC of the European Parliament and of the Council on undesirable substances in animal feed, Commission Directive **2003/100/EC** of 31 October 2003 amending Annex I to Directive 2002/32/EC of the European Parliament and of the Council on undesirable substances in animal feed **Additives in feed:** 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	Decree of the Ministry of Agriculture and Forestry on organizing the control of feed (**3/2006**) and Decree on harmful substances, products and organisms in animal feed (**2/2006**). Decree of the Ministry of Agriculture and Forestry (**42/2002**) on the environmental impact of animal feed.	The highest arsenic content in feed is given, the concentration is monitored. Some additives containing arsenic compounds accepted in other countries have not been accepted in Finland.
Fertilizers: Regulation **2003/2003/EC** of the European Parliament and of the Council of 13 October 2003 relating to fertilizers	Finnish Act on fertilizers (**232/1993**), Governmental proposition for the Parliament of a new act on fertilizer products (HE/2005 vp) Decision of the Ministry of Agriculture and Forestry on some fertilizer products 1994: appendix 2 quality criteria (a new decree is pending)	Maximum concentration of arsenic in materials used for soil improvement and compost products and fertilized breeding beds. Has not been applied for wood and peat ash, and materials used for public greeneries and landscaping. Changes to maximum concentration of arsenic and applications are pending.
Sewage sludge: Council Directive **86/278/EEC** of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture	Council of State Decision on the use of sewage sludge in agriculture (**282/1994**)	Directive (86/278) does not assume monitoring of arsenic. Changes to Finnish legislation are pending (maximum concentration of arsenic and applications).
Arsenic Directive: Commission Directive **2003/2/EC** of 6 January 2003 relating to restrictions on the marketing and use of arsenic (tenth adaptation to technical progress to Council Directive 76/769/EEC)	Council of State Decree on wood treated with arsenic compound and products containing arsenic, mercury compound and dibuthyltinhydrogenborate and marketing and restricting the use of products containing these (**440/2003**), entered into force 30th June, 2004. A guidebook is in preparation.	These regulations further restrict and ban the use of chemicals containing arsenic as well as restrict the use of wood containing arsenic to specific applications and to professional use. E.g., the use in residential areas and other areas where repeated dermal contact is possible is prohibited.

Other legislation on chemicals: Council Directive **67/548/EEC** of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the **classification, packaging and labelling** of dangerous substances. Council Regulation **793/93/EEC** of 23 March 1993 on the **evaluation and control of the risks** of existing substances. Council Directive **91/414/EEC** of 15 July 1991 concerning the placing of **plant protection products** on the market. Directive **98/8/EC** of the European Parliament and of the Council of 16 February 1998 concerning the placing of **biocidal products** on the market. Proposed EU regulatory framework for the Registration, Evaluation and Authorisation of Chemicals (**REACH**) on 29 October 2003 (**COM(03) 644**).	Chemicals Act (**744/1989**) and Chemicals Decree (**675/1993**) Decree of the Ministry of Social Affairs and Health on the list of hazardous substances (**509/2005**) Act on pesticides (**327/1969**) Decree on pesticides (**792/1995**) REACH will be implemented in Finland as such.	Arsenic containing chemicals used in agriculture and preservatives have been removed efficiently from the market already in 1960s'. Arsenic and arsenic compounds have been classified on the basis of harmful properties.

Table II. The most important environmental regulations concerning the risk management of polluting activities.

Regulation	Implementation in Finland	Notice
Council Directive **96/61/EC** of 24 September 1996 concerning integrated pollution prevention and control (**IPPC**). Commission Decision on the implementation of a European pollutant emission register (**2000/479/EC**, **EPER**) according to Article 15 of Council Directive 96/61/EC.	Environmental Protection Act (**YSL 86/2000**) and Environmental Protection Decree (**YSA169/2000,** changes are pending, considering among other things, the list of substances under permission procedure).	Arsenic and its compounds are mentioned in the appendix III of the IPPC directive (in some cases emissions to air and water need to be restricted and monitored). Finland reports the data concerning plants regulated by IPPC-directive in the coming E-PRTR register on the basis of benchmarks. The decision is included in the Kiova memo in Århus convention. The data are collected from the Finnish VAHTI register.
Waste water treatment and waste management:	Waste Act (**1072/1993**) and Waste Decree (**1390/1993** and change **1128/2001** on interpreta-	For monitoring the ground water quality, arsenic has been recommended as one of the variables

Council Directive **91/271/EEC** of 21 May 1991 concerning **urban waste water** treatment. Council Directive **1999/31/EC** of 26 April 1999 on the **landfill** of waste **2003/33/EC**: Council Decision of 19 December 2002 establishing criteria and procedures for the **acceptance of waste at landfills** pursuant to Article 16 of and Annex II to Directive 1999/31/EC Directive **2000/76/EC** of the European Parliament and of the Council of 4 December 2000 on the **incineration** of waste.	tion concerning hazardous waste, appendix 4 A). Decree of the Ministry of the Environment on the **list of the most common wastes and hazardous wastes** (**1129/2001**). Council of State Decree on **landfills** (**202/2006**). Council of State Decree on the use of some **wastes in earth construction (591/2006)**. Council of State Decree on the **incineration** of waste (**362/2003)**.	e.g., in the monitoring programmes in landfills. 2003/33/EC and Finnish Decree 202/2006 include solubility standards for accepting wastes to different landfills. The Finnish standards issued for some wastes used in earth construction or as fertilizers are based on these solubility standards. Combustion of wood treated with the CCA impregnant is regulated by 2000/76/EC and in Finland, Decree 362/2003.
	A council of state Decree on the assessment of **pollution level and remediation need of soil** is pending. Instructions of the Ministry of the Environment concerning **dredged sediments** (19th May, 2004).	The Decree will include guideline values for arsenic. The instructions include quality standards for arsenic.

Table III. The most important environmental regulations concerning the controlling of the quality of the environment (water, air).

Regulation	Implementation in Finland	Notice
Directive **2000/60/EC** of the European Parliament and of the Council of 23 October 2000 establishing a **framework for** Community action in the field of **water policy** repeals the following directives: • (2007) Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States • (2013) Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	Act on the organization of River Basin Management (**1299/2004**) and Decree on River Basin Districts (**1303/2004**). Guidebook on groundwater issues and Water Framework Directive (Ministry of the Environment, 29th October, 2004). Legislation on the list of national priority substances is under preparation.	Arsenic is included in the directive on hazardous substances (76/464/EEC). Arsenic is mentioned as a significant contaminant in appendix VIII of the Water Framework Directive (2000/60/EC). Arsenic does not belong to the first list of priority substances defined by EC (**2455/2001/EC**), neither does it belong to the national list of proposed priority substances.

• (2013) Council Directive 86/280/EEC of 12 June 1986 on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC • (2013) Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances Decision No **2455/2001/EC** of the European Parliament and of the Council of 20 November 2001 establishing the **list of priority substances** in the field of water policy and amending Directive 2000/60/EC (Text with EEA relevance)		
Proposal for a Directive of the European Parliament and of the Council on the **protection of groundwater** against pollution /* **COM/2003/0550 final - COD 2003/0210 */**		Arsenic is included in the list of substances which should be considered when issuing national limit values on the basis of artiсla 3.
Council Directive **98/83/EC** of 3 November 1998 on the **quality of water intended for human consumption.**	Decrees of the Ministry of the Social Affairs and Health Relating to the Quality and Monitoring of Water Intended for Human consumption (**461/2000** and **401/2001**). Decree of the Ministry of Agriculture and Forestry for the food production on the assurance of food quality (**16th February**, **2006**).	Quality standards include maximum concentration of arsenic according to recommendations issued by WHO, includes requirements for monitoring and reporting. In the Decree of the Ministry of Agriculture and Forestry, the maximum concentration of arsenic in wash waters have been issued.
Council Directive **76/160/EEC** of 8 December 1975 concerning the **quality of bathing water.** Proposal for a Directive of the European Parliament and of the Council concerning the quality of bathing water **/* COM/2002/0581 final - COD 2002/0254 */**	Decisions given by the Ministry of the Social Affairs and Health.	The old directive presumes determination of arsenic concentration, if its existence is doubtful. This requirement will be removed from the future regulations.
Council Directive **96/62/EC** of 27 September 1996 on **ambient air quality assessment and management.**	Council of State Decree on the quality of ambient air (**711/2001**). Implementation of the Ambient Air Quality directives partly ongoing.	A target concentration for arsenic in ambient (outdoor) air has been issued (2004/107/EC, Appendix I).

Directive **2004/107/EC** of the European Parliament and of the Council of 15 December 2004 **relating to arsenic**, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air **Proposal** for a Directive of the European Parliament and of the Council on **ambient air quality and cleaner air** for Europe (presented by the Commission) (**COM/2005/447**) Council Directive **98/24/EC** of 7 April 1998 on the protection of the health and safety of workers from the **risks related to chemical agents at work** (Individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC, "the Working Environment Framework Directive")	The Decree of the Ministry of the Social Affairs and Health on Concentrations Known to be Hazardous (**109/2005**)	Maximum allowable concentrations in workplace air is given.