National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Assessment of risks of groundwater contamination from abandoned on-farm storage sites in Ukraine

Project completion report

RIVM Letter Report 680272001/2012
J. Velstra et al.

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RIVM Letter report 680272001/2012

Acacia Water
Solutions in Groundwater

Colophon

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This investigation has been performed by order and for the account of NL Agency, within the framework of project G2G/09/UA/6/2

Abstract

Assessment of risks of groundwater contamination from abandoned on-farm storage sites in Ukraine. Project completion report.

Ukraine faces large challenges, as point sources of contamination endanger its highly productive, but vulnerable soils and drinking water wells. Risk assessment provides a methodology to prioritize and differentiate the vast amount of potentially contaminated sites in a first step towards remediation.

Increasing needs and decreasing budget
Centerderzhrodyuchist, the Ukrainian State Centre for Soil Fertility and Product Quality, is responsible for soil quality monitoring in Ukraine as well as soil fertility analysis and advises. The budget for both tasks is decreasing, while the need for detailed monitoring and information collection is increasing to assure sufficient and safe food production in the near future.

Safeguarding the agricultural area and food security
The risk of groundwater contamination by abandoned on-farm storage sites endangers the agricultural area and drinking water wells. This in turn endangers crop production and as a consequence food security.

Prioritizing and differentiate point sources of pollution
Decreasing budgets and high costs involved with remediation demand a methodology for risk assessment of point-source contamination. This involves an inventory of relevant point sources and/or contaminant mobilisation processes; secondly, an assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow and, thirdly, a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination. The Dutch and Ukrainian experts have elaborated this methodology and have laid it down in a guidance document.

Sponsor and teams
These findings are the result of a project, developed by NL Agency and financed by the Dutch Ministry of Economic Affairs, Agriculture and Innovation, to enable Ukrainian experts to carry out risk assessments for the abandoned on-farm storage sites in Ukraine. A Dutch team, with experts from the National Institute for Public Health and the Environment (RIVM), PBL Netherlands Environmental Assessment Agency and the consultancy firm Acacia Water BV, carried out this project together with experts of Centerderzhrodyuchist and with experts of two other Ukrainian institutes and organisations, both public and private, in 2011 and 2012.

Keywords:
groundwater, risk assessment, point sources, pollution, setting priorities

Rapport in het kort

Risicobeoordeling van grondwaterverontreiniging ten gevolge van verlaten opslagplaatsen op landbouwbedrijven in Oekraïne. Afsluitend projectrapport.

Oekraïne kampt met een groot aantal puntbronnen van pesticiden en meststoffen die de landbouwgronden en het drinkwater bedreigen. Risicobeoordeling biedt de mogelijkheid om het grote aantal verontreinigde locaties te identificeren en prioriteren als een eerste stap naar sanering van de locaties.

Toenemende behoeften en afnemende budgetten
Centerderzhrodyuchist, het Oekraïense Staatsinstituut voor Bodemvruchtbaarheid en Productkwaliteit, is verantwoordelijk voor zowel de monitoring van bodemkwaliteit als voor bodemvruchtbaarheidanalysen en bemestingsadvies. Het budget voor beide taken neemt af, terwijl de behoefte aan gedetailleerde monitoring en informatieverzameling toeneemt om een voldoende en een veilige voedselproductie voor de toekomst zeker te stellen.

Het veiligstellen van landbouwgrond en voedselveiligheid
De risico's van grondwaterverontreiniging zijn reëel door uitspoeling van pesticiden en meststoffen uit verlaten en onbeheerde opslagplaatsen voor deze producten in het landelijk gebied. De verontreiniging van het grondwater vormt een bedreiging voor zowel de landbouwproductie (gewasopbrengst en de voedselveiligheid) als voor de drinkwatervoorziening van kleine dorpen. Deze dorpen zijn voor hun drinkwater meestal afhankelijk van locale drinkwaterputten.

Prioriteren en differentiëren van puntbronnen
Teruglopende budgetten en de hoge kosten gerelateerd aan het saneren van al deze locaties vragen om een methodologie voor risicobeoordeling van puntbronnen. Hieronder wordt verstaan, ten eerste, het uitvoeren van een inventarisatie van relevante puntbronnen en/of processen die de mobiliteit van verontreinigingen beïnvloeden. Ten tweede betekent dit het bepalen in welke mate verontreinigingen in het freatische grondwater terechtkomen en op welke wijze deze worden getransporteerd via grondwaterstroming door de ondergrond. Ten derde houdt het in het uitvoeren van een risicobeoordeling met betrekking tot de land- en watergebruiksfuncties in de nabijheid van puntbronnen. Deze methodologie is uitgewerkt door de Nederlandse en Oekraïense deskundigen en vastgelegd in een leidraad.

Financiering en team
Bovenstaande bevindingen zijn het resultaat van een project, ontwikkeld door Agenschap NL en gefinancierd door het ministerie van Economische Zaken, om de opties te onderzoeken voor het gebruik van aardobservatie en GIS in de bodemkwaliteitsmonitoring in de Oekraïne. Een team van Nederlandse experts, afkomstig van het RIVM, het Planbureau voor de Leefomgeving (PBL), en het adviesbureau Acacia Water BV, heeft dit project in 2011 en 2012 uitgevoerd samen met experts van Centerderzhrodyuchist en experts van twee andere Oekraïense instituten en organisaties, zowel overheid als bedrijfsleven.

Trefwoorden:
grondwater, risicobeoordeling, puntbronnen, verontreiniging, prioritering

Contents

Appendix report (RIVM report number 680272001A)
The appendix report contains the power point presentations presented by Ukrainian and Dutch experts during the project missions.

Summary

Ukraine faces large challenges in order to protect and, if possible, to improve the quality of soil and water. The State Technological Centre of Soil Fertility and Products Quality (Centerderzhrodyuchist) is the institute in Ukraine responsible for monitoring of the quality of agricultural soils, both from the perspective of soil fertility as of environmental protection, including studying radioactive contamination status (Chernobyl).

To support the Ukrainian government, NL Agency developed a project to enable Centerderzhrodyuchist to assess the risk of point-source contamination (a/o pesticides, nitrate). The Ministry of Economic Affairs, Agriculture and Innovation financed project. A Dutch consortium, consisting of the National Institute for Public Health and the Environment (RIVM), PBL Netherlands Environmental Assessment Agency (PBL), and Acacia Water BV carried out the project in 2011-2012. Two other Ukrainian institutions and organisations, both public and private, were involved in at least one of the project missions to ascertain that all relevant parties in Ukraine could give input to the project and benefit from the outcomes. The project consisted of three missions, two in Ukraine (both in Kiev) and one in the Netherlands.

Centerderzhrodyuchist and the Dutch team conducted a need and gaps analysis, Ukrainian experts orientated themselves on Netherlands and EU best practices in dealing with point-source contamination (a/o pesticides, nitrate) in technical solutions and risk based assessments. In addition, the experts of Centerderzhrodyuchist were enabled to assess the risk of point-source contamination (a/o pesticides, nitrate). The cooperation between the Dutch team and the Ukrainian team has been very close and effective, despite the language problems.

The project has increased awareness of Ukrainian experts of the state of art of dealing with point-source contamination in the Netherlands and the EU, as well as approaches used in the Netherlands to prepare and implement new technologies in existing monitoring networks given political, scientific, and budgetary constraints. Given the wide range of organisations and large number of experts involved, it is presumed that the knowledge and skills acquired will be sustainable.

1 Introduction

Ukraine faces large challenges in order to protect and, if possible, to improve the quality of soil and water. The reasons are the increasing demands for agricultural products, large changes in land ownership and decreasing government budgets for soil quality monitoring.

In 2008-2009 Dutch and Ukrainian organisations carried out an evaluation of Ukraine soil monitoring efforts in relation to the EU Soil Framework Directive (Fraters and Grekov, 2009). The Dutch organisations were the National Institute for Public Health and the Environment (RIVM), PBL Netherlands Environmental Assessment Agency (PBL) and the consultancy firm Acacia Water BV. The Ukrainian partner was the State Technological Centre of Soil Fertility and Products Quality (Centerderzhrodyuchist). The evaluation showed that Ukraine monitoring systems for soils were – in terms of the extent and the quality of obtained data – in very good state. However, there was no systematic monitoring or data collection of soil erosion since the Institute for Soil Protection had been closed. Some threats for the monitoring system were specified, especially for the agrochemical passportisation monitoring network, due to decrease in funding for passportisation. Passportisation is the sampling and chemical analysis of soils of agricultural fields carried out for fertilization recommendations. Every agricultural field was until recently sampled once every five years. Soil quality monitoring was not integrated with other monitoring efforts in Ukraine, for example, with monitoring systems for other EU Environmental Directives. It was recommended to

- evaluate risks of information loss due to a decrease in monitoring for passportisation,
- to review necessity to monitor non-agricultural areas and need for structural collection of information on erosion and land slides,
- to study reporting by EU member states to the European Commission, and
- to consider integration of soil, groundwater and surface water monitoring systems that can be used for monitoring for several EU Environmental Directives.

Point of concern was that there was no (adequate) system for SFD monitoring of soil contamination (point source soil pollution), and the evaluation of risks for environment and human health in order to control and abate point source / local problems. It was recommended to set-up

- a system for making an inventory of (possibly) contaminated sites and
- a system for evaluating environmental and human health risks of contaminated sites.

The outcome of this evaluation of the soil quality monitoring efforts resulted in two requests from the Ukrainian government for support. One request regarded the support for a project to tackle the problem of increasing need for monitoring with declining budgets by looking at opportunities to use remote sensing data for monitoring purposes (Fraters et al., 2012). The second request regarded the support for a project to tackle the problem of point sources of pollutions especially with regard to risk assessment of abandoned sites for storage of agricultural chemicals (fertilisers and pesticides).

This report is the final or completion report on the project that looks at problem of point sources of pollutions especially with regard to risk assessment of abandoned sites for storage of agricultural chemicals (fertilisers and pesticides).

NL Agency of developed this project and the Dutch Ministry of Economic Affairs, Agriculture and Innovation financed it. The project code used by NL Agency is G2G09/UA/6/2. Hereafter the project name is abbreviated to "point sources of pollution project". The project has been carried out by Dutch consortium consisting RIVM, PBL and Acacia Water BV. The Ukrainian counterpart and beneficiary organization is the Ukrainian State Technological Centre of Soil Fertility and Products Quality (Centerderzhrodyuchist), formerly called in English State Technological Centre on Soil Fertility Protection, hereafter shortened to Centerderzhrodyuchist. Centerderzhrodyuchist falls under the Ministry of Agricultural Policy of Ukraine.

The purpose (programme objective) of this project is to enable the State Technological Centre on Soil Fertility Protection, 'Centerderzhrodyuchist' (part of the Ukrainian Ministry of Agrarian Policy), to assess the risk of point-source contamination (a/o pesticides, nitrate).

The results and activities are presented and discussed in chapter 2 (results) and chapter 3 (activities). Chapter 4 discusses the cooperation between the Dutch organisations and Centerderzhrodyuchist and chapter 5 the programme objectives. The following chapters will deal with project effect and sustainability (chapter 6), Dutch economic interests (chapter 7), important developments (chapter 8) and follow up and recommendations (chapter 9). A text (Dutch and English version) for publication that summarises the project and its results is given in chapter 10.

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7 Project results

The project plan defines as project result a guidance document describing the methodology and stages of the risk assessment of point-source contamination (including data and methods). The document enables the experts from 'Centerderzhrodyuchist':

- to carry out a desk study, make an inventory of relevant point sources and/or contaminant mobilisation processes;
- to carry out an assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow;
- to carry out a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination.

The next three sections discuss the results. For details, we refer to the appendices included in the report and the appendices in the Appendix report.

Inventory of relevant point sources and/or contaminant mobilisation processes

Researchers presented essential aspects of the analysis during mission workshops. Aspects were discussed with the members of the Dutch team and colleagues from Centerderzhrodyuchist, regional centres and/or other Ukrainian organisations. Aspects discussed in more detail were:

- The current Ukrainian monitoring methodology and the results of monitoring of soil contamination with pesticides in different regions. It focussed on former storage sites in the Chernigov region, Zakarpatye region and north-western regions.
- The inventory of relevant point sources in the Netherlands and the way in which the Dutch authorities deal with prioritizing the need for remediation.
- Practical approaches and involvement of Dutch consultancy firms.

Several case studies from both the Ukrainian side and Dutch side were presented. The presentations were used as a basis for the discussions and during the course of the project the presentations (see appendix 4) developed into a clear and concise guidance document on which the Ukrainian experts can work with.

Assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow

Researchers presented essential aspects of the analysis during mission workshops. Aspects were discussed with the members of the Dutch team and colleagues from Centerderzhrodyuchist, regional centres and/or other Ukrainian organisations. Aspects discussed in more detail were:

- The interest and need for monitoring equipment of contaminants and more specifically pesticides and fertilisers.
- The interest in tools in modelling of transport of contaminants in the saturated and unsaturated zone.

Several case studies from both the Ukrainian side and Dutch side were presented. The presentations were used as a basis for the discussions and during the course of the project the presentations (see appendix 4) developed into a clear and concise guidance document on which the Ukrainian experts can work with.

Risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination

Researchers presented essential aspects of the analysis during mission workshops. Aspects were discussed with the members of the Dutch team and colleagues from Centerderzhrodyuchist, regional centres and/or other Ukrainian organisations. Aspects discussed in more detail were:

- The methodology for risk assessment used in the Netherlands and the way that it may be useful and combined with the assessment carried out in the Chernigov region to Ukraine, more specifically for the Zakarpaye region.
- The soil environmental policies in the Netherlands in the context of the European policy and the instruments and technologies.
- Risk assessment from several points of view, such as, point source related risk-based soil quality assessment and risk assessment methodology for leaching of plant protection products to groundwater were topics of discussion, both in a European context.

Several case studies from both the Ukrainian side and Dutch side were presented. The presentations were used as a basis for the discussions and during the course of the project the presentations (see appendix 4) developed into a clear and concise guidance document on which the Ukrainian experts can work with.

Orientation on Netherlands, EU best practices and involvement of Dutch consultancy firms

To provide a broad overview of Netherlands and EU best practices in the field of point-source contaminations the Dutch expert team included co-workers RIVM, PBL and Acacia Water (see Table 1). Several other co-workers of Dutch consultancy firms were involved in a study visit of a group of Ukrainian experts to the Netherlands (see Table 1).

From the Ukrainian site, three institutions and regional centres were involved in at least one of the project missions (see Table 2) to ascertain that all relevant parties in Ukraine could give input to the project and benefit from the outcome. Centerderzhrodyuchist was not only represented by experts from the national centre, but also by directors and/or experts from regional centres.

A general overview of Netherlands and EU best practices in the field of risk assessment of point-source contamination was presented both in Ukraine and in the Netherlands (Appendix report). More detailed and in depth information was presented at workshops during the study visit to the Netherlands (Appendix report).

Table 1 Team of Dutch experts and Dutch experts involved in study visit

Name	**Organisation and function**
Expert team responsible for project (surname, first name)	
Swartjes, Frank	RIVM, expert on risk assessment of contaminants
Kovar, Karel	PBL, vice team leader, policy researcher
Klijne, Arnoud de	RIVM, expert on Dutch and EU policies
Velstra, Jouke	Acacia Water, expert on groundwater flow (modelling) and contaminant transport (modelling)
Fraters, Dico	RIVM, team leader, soil scientist and expert in monitoring
Dutch experts involved in study visit *(mission 2 workshop)*	
Harmsma, Sible	Arcadis Nederland BV
Bouwknegt, Matthijs	Tauw BV
Bakker, Laurent	Tauw BV
Kools, Stefan	Grontmij Nederland BV
Boerboom, René	Haskoning Nederland BV
Honders, Ton	AgencyNL/ Bodem+
Versluijs, Kees	RIVM
Van der Linden, Ton	RIVM
Verbaan, John	MOURIK GROOT-AMMERS BV
Van Andel, Bas	MOURIK GROOT-AMMERS BV
Bockting, Gerald	formerly Development Corporation of the city of Amsterdam, now private company
Blom, Arie	municipal Development Corporation of the city of Amsterdam
Loogman, Cees	municipal Development Corporation of the city of Amsterdam

Table 2 List of Ukrainian experts involved in one or more of the project missions

Name	**Institute and function**
All missions (surname, first name)	
Grekov, Valeriy	Centerderzhrodyuchist, Director till March 2012 (deputy director State Scientific Centre Nature since March 2012)
Panasenko, Viktoriya (mrs)	Centerderzhrodyuchist, Soil scientist and scientific secretary
Tarariko, Olexander	Institute of Agro-ecology and Economics of Natural Resources, Professor and chief researcher
Penzenyk, Yuriy	director of a Regional Technological Centre of Soil Fertility and Products Quality
Zinchuk, Nikolai	director of a Regional Technological Centre of Soil Fertility and Products Quality
Melnik, Anatoliy	director of a Regional Technological Centre of Soil Fertility and Products Quality
Falchenko, Mykhaylo	Interpreter

Table is continued on next page

Missions 1 and/or 3 *(in Ukraine)*	
Centerderzhrodyuchist and/ or State Regional Centres (Oblderzhrodiuchist)	
Demydenko, Volodymyr (3)	Deputy Director
Kryvda, Yuriy (1,3)	Director Cherkasy centre
Maystrenko, Mykola (1,3)	Department head at Centerderzhrodyuchist
Pasichniak, Vasyl (1,3)	Director of the Vinnica centre
Sofiychenko, Vitaliy (3)	Director, since March 2012
Zhylkin, Volodymyr (1,3)	Deputy director
Institute of Hydraulic Engineering and Land Reclamation	
Kolomiyets, Sergiy (1,3)	Head of department, senior scientist

8 Project activities

The project plan defined the following project activities:
- An *inception mission* during which the project's activities will be specified and agreed upon by Ukrainian and Netherlands parties;
- A *study visit* of an Ukrainian delegation comprising at maximum 8 Ukrainian experts to the Netherlands visiting, including a network event comprising Dutch and Ukrainian stakeholders (a/o Dutch relevant business)
- *Workshops/training* on a Dutch and/or EU best practice for the Ukrainian situation regarding techniques of point source risk assessment of soil and water contamination;
- A *closing seminar* presenting the results of the project and informing Netherlands and Ukrainian stakeholders in Ukraine.

The complete program will be closely coordinated with the Netherlands Ministry of Infrastructure and Environment and the Agricultural Attaché of the Netherlands Embassy in Kiev.

The project consisted of three missions that included the above mentioned four project activities:
- Mission 1, the inception mission of the Dutch expert team to Ukraine from 23-26 May 2011 (Appendix 1).
- Mission 2, a study visit of the Ukrainian expert team to the Netherlands from 24-28 October 2011, during which workshops and training were organised (Appendix 2)
- Mission 3, final mission of the Dutch expert team to Ukraine from 16-19 April 2012 during which a closing seminar was held at the national centre in Kiev (Appendix 3).

The Dutch team cooperated with Mr Wout de Vogel as representative of the ministry of Infrastructure and Environment to coordinate the programme.

The Dutch team stayed in contact with the Netherlands Embassy in Kiev during the entire project. Mission reports were sent to the Embassy after each mission and a meeting was arranged in May 2011.

9 Cooperation between team and Centerderzhrodyuchist

The Dutch team responsible for the project consisted of five members from different institutions (see Table 1). The team leader and vice team leader were responsible for a previous project carried out in Ukraine in 2008-2009 (G2G07/UA/6/1) evaluating the Ukrainian soil quality monitoring efforts in view of the upcoming European Soil Framework Directive. That project lead to a (second) project (G2G09/UA/6/1) and the current third project (G2G09/UA/6/2) about risk evaluation of abandoned storage sites for agri-chemicals. That second project was carried out in the same period as the current (third) project with the same team leader and vice team leader.

The core of the Ukrainian team consisted of the director of Centerderzhrodyuchist, the scientific secretary, the directors of the regional centres in Cherkassy and Vinnitsa, a professor of the Institute of Agro-ecology and Environmental Economics of the National Academy of Agrarian Sciences and the head of a department at the Institute of Hydraulic Engineering and Land Reclamation (see Table 2). Most of these experts participated in the study visit and were involved in at least one of the other two missions. Most experts had also been involved in the previous project in 2008-2009 and, with the exception of the regional directors, were involved in the second project.

The cooperation between the Dutch team and the Ukrainian team has been very close and effective, even though the fact that most of the members of the Ukrainian team did not or did hardly speak or understand English. Only the scientific secretary has a command of English well enough for basic conversation. The understanding of English increased during the project(s) in 2011, especially the English of the director and the scientific secretary improved. Between the second and third mission some of the e-mail correspondence took place without intervention of the interpreter. The interpreter, who was involved in all three projects, played a valuable role, and certainly contributed to the success of the projects and the mutual understanding of Dutch and Ukrainian experts. To ensure full comprehension of the materials discussed all essential presentations and documentation have been made available in both English and Ukrainian.

The teams developed the mission programmes together. The experts of the Ukrainian team had a clear view of the objectives and were inclined to prepare missions carefully in advance. This made it possible to limit the number of missions within the project to three, the maximum number of missions possible due to decreased project budget compared with the first project with four missions in the 2008-2009 period.

10 Programme objective

Programme objective, as stated in the project plan is to enable the State Centre for Soil Fertility and Product Quality, 'Centerderzhrodyuchist', to assess the risk of point-source contamination (a/o pesticides, nitrate).

The experts of Centerderzhrodyuchist and others Ukrainian experts involved in the project have been made aware of discussions within the scientific and political arena in the Netherlands and the EU. Subjects included making an inventory of relevant point sources and/or contaminant mobilisation processes, assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow and risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination (see appendix 4).

At the seminar, during the last mission, Ukraine experts presented their ideas for future use of risk assessment approaches for the point sources of contamination in Ukraine. They showed ways to implement these new ideas and methodologies and took into consideration factors that might form obstacles for implementation. Together with the Dutch experts, the outcome was discussed and final remarks were noted.

11 Project effect and sustainability

The current project on 'Assessment of risk of groundwater contamination by abandoned agriculture related on-farm storage sites (pesticides, fertilizers)', is one of the three projects carried out by in Dutch team in cooperation with Centerderzhrodyuchist. A first project, evaluating the Ukrainian soil monitoring effort in view of the upcoming EU Soil Framework Directive, was carried out in 2008-2009 and resulted in two new projects. These new projects have been carried out in 2011-2012, almost concurrently, and they aimed at improving the soil quality monitoring efforts and making them more efficient.

Centerderzhrodyuchist is a strong and leading institute in soil quality monitoring in Ukraine with qualified personnel and regional centres in each of the provinces (oblast). Directors of regional centres exchange information with Centerderzhrodyuchist and with each other. Centerderzhrodyuchist has good relations with other Ukrainian institutes operating in adjoining fields of action.

The project has increased awareness of Ukrainian experts of the state of art of risk assessment of point source contamination in the Netherlands and the EU, as well as approaches used in the Netherlands to prepare and implement new technology in existing monitoring networks given political, scientific, and budgetary constrains.

In addition to Centerderzhrodyuchist, two Ukrainian institutions were involved in at least two of the project missions (see Table 2). Directors and researchers from both the national centre (Centerderzhrodyuchist) as well as from the regional centre participated in project activities. It is difficult to assess the sustainability of the effects of the project, because a new government may replace institute directors after elections, like it is common in the USA. After the second mission of this project, the government replaced the director of Centerderzhrodyuchist. However, given the wide range of organisations and large number of experts involved, it is presumed that the knowledge and skills acquired will be sustainable. Contacts between the Dutch team and the old director as well as the current director and experts of Centerderzhrodyuchist still exist.

12 Dutch economic interests

The project facilitated Dutch companies to encounter people responsible for future developments in assessing (risk) of point sources of contamination and soil monitoring.

The project has been carried out by government agencies in cooperation with a consultancy firm, Acacia Water BV. During the study visit, seven representatives of companies used the opportunity to give a presentation. These were Arcadis (Appendix report, appendix 15), Tauw (Appendix report, appendix 16), Grontmij (Appendix report, appendix 17), Royal HaskoningDHV (Appendix report, appendix 18), MOURIK (Appendix report, appendix 19) and Acacia Water (Appendix report, a/o appendix 24).

The representative of MOURIK showed and explained the "Remediation Villa Industrial site", a combination of soil remediation and housing development carried out by the private company MOURIK. Ukraine experts were very interested in investigating the possibilities on the Dutch way of soil remediation. More specifically that not the authorities pay for the remediation but the private company. The private company will make a profit by combining the soil remediation with housing development. The interest lies in the opening for Ukraine government to cope with the expected immense costs for remediation.

The representative of the former Municipal Development Corporation of the city of Amsterdam, now a private company showed a "Landfill remediation site Volgermeerpolder". A combination of remediation and nature development. The showed a low cost remediation with the combined development of nature for the citizens of Amsterdam.

Contacts have been established between the director of Centerderzhrodyuchist and the representatives of the private companies. They see possibilities for cooperation to implement the Dutch state-of-the-art knowledge on soil remediation techniques and methodologies.

13 Important developments

Contacts have been intensified between experts form different Ukrainian institutes working in the field of agriculture related pollution and soil degradation, protection and remediation.

Possibilities for future activities have been discussed between the Ukrainian experts and experts from the Dutch institutes RIVM and PBL. Options include short courses on groundwater modelling and contaminant transport modelling. In addition, options on further elaborating the methodologies on risk assessment have been considered.

Ukraine experts and delegates of the private companies have discussed the possibilities to start risk assessment projects. Funding possibilities will be investigated.

Centerderzhrodyuchist has been made aware of an option to get funding for a young scientist to attend a conference in Vienna in May 2011. The scientific secretary has attended the conference. This was not at the expense of the G2G project.

14 Follow-up and recommendations

In Ukraine, four ministries are involved in preservation of public health and the environment, the Ministry of Ecology and Natural Resources (Міністерство екології та природних ресурсів), the ministry of Agrarian Policy and Food (Міністерство аграрної політики та продовольства), the Ministry of Public Health (Міністерство охорони здоров'я) and the Ministry of Emergency Situations (Міністерство надзвичайних справ) (Appendix report, Appendix 2). Agreements about responsibilities, tasks, and coordination between ministries as well as willingness to co-operate with other ministries are necessary for the development of a consistent and future proof inventory of contaminated sites and a risk assessment strategy in Ukraine.

There is interest in tools and training of staff of Centerderzhrodyuchist in modelling of transport of contaminants in the saturated and unsaturated zone. Such training will not be possible within the scope of the present project. Nevertheless, if such training might be possible in a follow-up project, the need for and the usefulness of such training can be assessed in the framework of the current project

In addition the topic of quantifying the effect of air pollution on soil quality and human health has been brought up by the director of Centerderzhrodyuchist as a theme for further future cooperation.

15 Publication text

15.1 Assessment of risk of groundwater contamination by abandoned on-farm storage sites in Ukraine

Ukraine faces large challenges, as point sources of contamination endanger its highly productive, but vulnerable soils and drinking water wells. Risk assessment provides a methodology to prioritize and differentiate the vast amount of potentially contaminated sites in a first step towards remediation.

Increasing needs and decreasing budget
Centerderzhrodyuchist, the Ukrainian State Centre for Soil Fertility and Product Quality, is responsible for soil quality monitoring in Ukraine as well as soil fertility analysis and advises. The budget for both tasks is decreasing, while the need for detailed monitoring and information collection is increasing to assure sufficient and safe food production in the near future.

Safeguarding the agricultural area and food security
The risk of groundwater contamination by abandoned on-farm storage sites endangers the agricultural area and drinking water wells. This in turn endangers crop production and as a consequence food security.

Prioritizing and differentiate point sources of pollution
Decreasing budgets and high costs involved with remediation demand a methodology for risk assessment of point-source contamination. This involves an inventory of relevant point sources and/or contaminant mobilisation processes; secondly, an assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow and, thirdly, a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination. The Dutch and Ukrainian experts have elaborated this methodology and have laid it down in a guidance document.

Sponsor and teams
These findings are the result of a project, developed by NL Agency and financed by the Dutch Ministry of Economic Affairs, Agriculture and Innovation, to enable Ukrainian experts to carry out risk assessments for the abandoned on-farm storage sites in Ukraine. A Dutch team, with experts from the National Institute for Public Health and the Environment (RIVM), PBL Netherlands Environmental Assessment Agency and the consultancy firm Acacia Water BV, carried out this project together with experts of Centerderzhrodyuchist and with experts of two other Ukrainian institutes and organisations, both public and private, in 2011 and 2012.

15.2 Risicobeoordeling van grondwaterverontreiniging onder verlaten opslagplaatsen op landbouwbedrijven in de Oekraïne

Oekraïne kampt met een groot aantal puntbronnen van pesticiden en meststoffen die de landbouwgronden en het drinkwater bedreigen. Risicobeoordeling biedt de mogelijkheid om het grote aantal verontreinigde locaties te identificeren en prioriteren als een eerste stap naar sanering van de locaties.

Toenemende behoeften en afnemende budgetten
Centerderzhrodyuchist, het Oekraïense Staatsinstituut voor Bodemvruchtbaarheid en Productkwaliteit, is verantwoordelijk voor zowel de monitoring van bodemkwaliteit als voor bodemvruchtbaarheidanalysen en bemestingsadvies. Het budget voor beide taken neemt af, terwijl de behoefte aan gedetailleerde monitoring en informatieverzameling toeneemt om een voldoende en een veilige voedselproductie voor de toekomst zeker te stellen.

Het veiligstellen van landbouwgrond en voedselveiligheid
De risico's van grondwaterverontreiniging zijn reëel door uitspoeling van pesticiden en meststoffen uit verlaten en onbeheerde opslagplaatsen voor deze producten in het landelijk gebied. De verontreiniging van het grondwater vormt een bedreiging voor zowel de landbouwproductie (gewasopbrengst en de voedselveiligheid) als voor de drinkwatervoorziening van kleine dorpen. Deze dorpen zijn voor hun drinkwater meestal afhankelijk van locale drinkwaterputten.

Prioriteren en differentiëren van puntbronnen
Teruglopende budgetten en de hoge kosten gerelateerd aan het saneren van al deze locaties vragen om een methodologie voor risicobeoordeling van puntbronnen. Hieronder wordt verstaan, ten eerste, het uitvoeren van een inventarisatie van relevante puntbronnen en/of processen die de mobiliteit van verontreinigingen beïnvloeden. Ten tweede betekent dit het bepalen in welke mate verontreinigingen in het freatische grondwater terechtkomen en op welke wijze deze worden getransporteerd via grondwaterstroming door de ondergrond. Ten derde houdt het in het uitvoeren van een risicobeoordeling met betrekking tot de land- en watergebruiksfuncties in de nabijheid van puntbronnen. Deze methodologie is uitgewerkt door de Nederlandse en Oekraïense deskundigen en vastgelegd in een leidraad.

Financiering en team
Bovenstaande bevindingen zijn het resultaat van een project, ontwikkeld door Agenschap NL en gefinancierd door het ministerie van Economische Zaken, om de opties te onderzoeken voor het gebruik van aardobservatie en GIS in de bodemkwaliteitsmonitoring in de Oekraïne. Een team van Nederlandse experts, afkomstig van het RIVM, het Planbureau voor de Leefomgeving (PBL), en het adviesbureau Acacia Water BV, heeft dit project in 2011 en 2012 uitgevoerd samen met experts van Centerderzhrodyuchist en experts van twee andere Oekraïense instituten en organisaties, zowel overheid als bedrijfsleven.

References

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Appendix 1 Report of inception mission

Short report on inception mission, Kiev, Ukraine, 23-26 May 2011
Version: Final (9 August 2011)

Introduction

The inception mission was carried out in the framework of the project G2G09/UA/6/2, formally titled "Assessment of risk of groundwater contamination by abandoned agriculture related on-farm storage sites (pesticides, fertilizers) - as required by the Groundwater Directive 2006/118/EC and the upcoming Soil Framework Directive". For this mission a team of four Dutch experts met with experts from several institutes in Kiev, Ukraine, from Monday 23 May till Thursday 26 May 2011.

The Dutch team consisted of Dico Fraters (RIVM, project leader), Karel Kovar (PBL), Jouke Velstra, (Acacia Water), Arnoud de Klijne (RIVM).

The inception mission was prepared in advance together with Mr Valeriy Grekov, director of the Ukrainian State Technological Centre on Soil Fertility Protection ("Centerderzhrodyuchist", and beneficiary institute) and Ms Viktoriya Panasenko, researcher and scientific secretary at the same institute.

Ukrainian institutes involved in this mission, in addition to Centerderzhrodyuchist and the regional centres "Oblderzhroduchist" of Chernigov, Volynskiy and Zakarpatye were:
- the Institute of Hydraulic Engineering and Land Reclamation (NAAS), Institut gidrotehniky i melioracii;
- the Institute of Agro-ecology and Economics of Natural Resources, Institut agroekologii i ekonomiky pryrodokorystuvania.

Outline of inception mission programme

On 23rd of May 2011
- Flight of Dutch experts to Ukraine.
- Dinner of Dutch delegation with Mr Valeriy Grekov and discussion of the project and the programme for this mission.

On 24th of May 2011
- Workshop at Centerderzhrodyuchist with the aim to specify project results and project planning, to get acquainted with the nature of pollution in urban and industrial areas and rural/agricultural areas and the nature of threats (threatened objects), and to give an overview of methods used by Dutch institutes for the risk assessment of point source contamination and assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow. A list of presentations and participants is given in Appendix 1.

On 25th of May 2011
- Excursion in the Chernigov region to visit two sites with a abandoned warehouse contaminated with pesticides, in order to get a better understanding of the nature of pollution, the soil and groundwater characteristics and the possible threats. The first site was located in the village Bobryk (село Бобрик), in the Nizhyn district (Ніжинський район),

approximately 150 km from Kiev, on the northwest from Nezhin. The second contaminated site was located in the village Talalaivka (село Талалаївка), Nizhyn district (Ніжинський район), on the south from Nezhin, 10 km from village Bobryk. Wells with nitrate and possibly pesticide contaminated water were visited and sampled by Centerderzhrodyuchist, Chernigov center "Oblderzhroduchist".

On 26th of May 2011

- Meeting at the Dutch Embassy with Mr Meeuwes Brouwer and Mrs Irina Dudiak to discuss the project progress, results and possible spin-off. During this visit the other project, G2G09/UA/6/1, "Monitoring of the soils quality and vegetations using data of remote sounding of earth", was also discussed. The importance of involvement of private companies in the projects was stressed by Mr Brouwers.
- Flight of Dutch experts back to the Netherlands.

Outcome of inception mission

1. The goals of the project, project deliverables and planning were discussed in detail and finalised.
2. The presentations about risk assessment by the Dutch experts have given a first impression of the methodology for risk assessment used in the Netherlands and will enable the beneficiaries to decide upon the topics that would be of most interest for the Ukrainian experts to elaborate further during the upcoming second mission, from Ukraine to the Netherlands. Presentations will be translated from English to Ukrainian.
3. The presentations provided by the Ukrainian experts have given the Dutch experts insight into the available knowledge and monitoring data on pesticide contamination and transport in Ukraine. The Ukrainian knowledge and monitoring data will be used for providing a guidance document describing the methodology and stages of risk assessment of point source contamination in Ukraine. Presentations will be translated from Ukrainian to English.
4. Results of an INTERREG project carried out together with Poland and Belarus were presented. The old storage sites of agro-chemicals in the north-western region were characterised. Agro-chemical stored were removed and destroyed. Possibilities for phytoremediation of contaminated soil (treatment of environmental problems through the use of plants) were investigated. First results show that phytoremediation is a cost-effective method for remediation of pesticide contaminated soil. Results can be used for developing a risk assessment methodology for abandoned agriculture related on-farm storage sites in the Chernigov region.
5. Monitoring results of soil contamination with pesticides around former storage sites in the Chernigov regions were presented. A significant number of open wells in the Chernigov region is contaminated with nitrate. Soil around former storage sides is contaminated with pesticides. Limited data is available on pesticide contamination in groundwater. Results may help to better understand the nature and extent of the pesticide contamination in the Chernigov region.
6. Environmental problems of pollution of water sources and groundwater in the Zakarpatye region were presented. In the Zakarparye region abandoned pesticides storage sites are present. Results of pesticide contaminated water in the region were presented. Results of the methodology for risk assessment of former storage sites in the Chernigov regions can be useful for the Zakarpaye region.
7. Two abandoned warehouses contaminated with pesticides were visited in the Chernigov region during the mission. The site and local soil characteristics were investigated and photographed. Soil characteristics of parts of the Chernigov region appear to be similar to parts of the Netherlands. Residuals of pesticides are still present at some of the abandoned storage sites. Open

wells, used for drinking water, are present in the direct vicinity of the visited abandoned warehouses. Site information will be used in the further development of the risk assessment methodology.

8. The possibilities for providing Centerderzhrodyuchist with tools for modelling transport of contaminants were briefly explored. Tools are available on the internet for free.
9. There is interest in tools and training of staff of Centerderzhrodyuchist in modelling of transport of contaminants in the saturated and unsaturated zone. Such training will not be possible within the scope of the present project. Nevertheless, if such training might be possible in a follow-up project, the need for and the usefulness of such training can be assessed in the framework of the current project.
10. Planning and possible topics for the second mission were discussed. This second mission is a study visit of UA experts to the Netherlands. Topics that have been pointed out as important by the director and the scientific secretary of Centerderzhrodyuchist are (a) Landfill Risk Assessment and Landfill design and (b) Methods for point source remediation.
11. In addition the topic of quantifying the effect of air pollution on soil quality and human health has been brought up by the director of Centerderzhrodyuchist as a theme for further future cooperation.

Appendix 1.1 Workshop on 24th of May 2011

Chair: Valeriy Grekov, Centerderzhrodyuchist. Valeriy Grekov had to leave the meeting for a short period during which Oleksandr Tarariko (Institute of Agro-ecology and Environmental Economics of the National Academy of Agrarian Sciences) was chairing the meeting.
Number of participants: 1 3(9 from UA and 4 from NL)

Presentations

- Dutch team project leader (Dico Fraters) presents the background, goals and deliverables of project and the programme of inception mission.
- Centerderzhrodyuchist (Viktoriya Panasenko) gives an introduction about the ecological condition of natural environment of Ukraine.
- Centerderzhrodyuchist, Chernigov center "Oblderzhroduchist (Anatoliy Melnik) presents the results of the report name: "Inspection of soils round warehouses of pesticides in territory of the Chernigov region".
- Institute of Hydraulic Engineering and Land Reclamation (Sergey Kolomiyets) presents the results of the report name: "Nitrate pollution of a surface water and groundwater".
- Dutch expert (Karel Kovar) gives an Outline of Risk-based assessment of impact of contamination at abandoned agriculture related storage sites (pesticides, etc.), the effect of contamination on human health, soil ecosystem, groundwater, and food safety.
- Centerderzhrodyuchist, Volynskiy center "Oblderzhroduchist (Nikolai Zinchuk) presents the results and experience of realisation of the international (INTERREG) project of environment improvement in a river basin the Western Bug".
- Centerderzhrodyuchist, Zakarpatye center "Oblderzhroduchist" (Yuriy Penzenyk) presents the environmental problems of pollution of water sources, soil waters and soils in the Zakarpatye region.
- Dutch expert (Jouke Velstra) presents the conceptual aspects of transport of contaminants through the unsaturated soil into phreatic groundwater and transport in aquifers due to groundwater and gives an example of risk-based assessment for remediation of contamination, by modelling transport of contaminants in aquifers due to groundwater flow.

List of participants from Ukraine

Participants from "Tsenterderzhrodyuchist":

Mr Valeriy Grekov (prof., director)
Ms Viktoriya Panasenko (prof., scientist secretary)
Mr Volodymyr Zhylkin (Deputy Director)
Mr Nikolay Maystrenko (prof. head department)
Mr Anatoliy Melnik (prof. director of the Chernigov center "Oblderzhroduchist")
Mr Nikolai Zinchuk (prof. director of the Volynskiy center "Oblderzhroduchist")
Mr Yuriy Penzenyk (director of the Zakarpatye center "Oblderzhroduchist")

Dutch project team:	Mr Dico Fraters (RIVM), Mr Karel Kovar (PBL), Mr Jouke Velstra (Acacia Water), Mr Arnoud de Klijne (RIVM)
Other participants:	Oleksandr Tarariko (prof. research of the Institute of Agro-ecology and Environmental Economics of the National Academy of Agrarian Sciences) Sergiy Kolomiyets (researcher at the Institute of Hydraulic Engineering and Land Reclamation)
Interpreter:	Mr Mykhaylo Falchenko

Appendix 2 Report of study visit and training mission

Short report on mission 2, held in the Netherlands, 24-28 October 2011
Version: Final (24 January 2012)

Introduction
This report regards Mission 2 of the project G2G09/UA/6/2, formally titled "Assessment of risk of groundwater contamination by abandoned agriculture related on-farm storage sites (pesticides, fertilizers) - as required by the Groundwater Directive 2006/118/EC and the upcoming Soil Framework Directive". For this mission a team of Dutch experts met with experts from several institutes from Ukraine, from Tuesday 25 October till Thursday 27 October 2011.

The main focus in this mission is on the following subjects presenting the Dutch approach:
- to carry out a desk study, make an inventory of relevant point sources and/or contaminant mobilization processes
- to carry out an assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow
- to carry out a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination

The Dutch team consisted of Dico Fraters (RIVM, project leader), Frank Swartjes (RIVM), Karel Kovar (PBL), Jouke Velstra, (Acacia Water BV), and Arnoud de Klijne (RIVM).

The mission was prepared together with Mr Valeriy Grekov, director of the Ukrainian State Technological Centre of Soil Fertility and Products Quality ("Tsenterderzhrodyuchist", beneficiary institute of the project) and Ms Viktoriya Panasenko, researcher and scientific secretary at the same institute.

Ukrainian institutes involved in this mission are:
- ' Centerderzhrodyuchist ' = the Ukrainian State Technological Centre of Soil Fertility and Products Quality;
- three Regional Technological Centres of Soil Fertility and Products Quality ('Oblderzhroduchist'), namely from the regions Chernigov, Volynskiy and Zakarpatye; and
- the Institute of Agroecology and Economics of Natural Resources (Institut agroekologii i ekonomiky pryrodokorystuvania).

Outline of programme of Mission 2

On 24 October 2011
- Flight of Ukrainian experts to the Netherlands.

On 25 October 2011
- Workshop at RIVM in Bilthoven with the theme "Methodology for risk assessment of point-source contamination (incl. data and methods): Theoretical background of the Dutch approach"
- These presentations focus on the methodology on a national scale and the theoretical background of the Dutch approach.
- A list of presentations and participants is given in Appendix 1.

On 26 October 2011
- Workshop at RIVM in Bilthoven with the theme "Case studies for risk assessment of (point-source) contamination (incl. data and methods) and remediation in the Netherlands"
- The focus on this day is on case studies involving commercial consultancy firms.
- A list of presentations and participants is given in Appendix 2.

On 27 October 2011
- Excursion and field visits at two remediation sites: in Hilversum and Volgermeerpolder
- First visit was to the "Remediation Villa Industria site", a combination of soil remediation and housing development carried out by the private company MOURIK GROOT-AMMERS BV.
- Second visit was to the "Landfill remediation site Volgermeerpolder", a combination of remediation and nature development supervised by the Municipal Development Corporation of the city of Amsterdam
- Dinner with Ukrainian delegation and discussion of the project results.
- A list of presentations and participants is given in Appendix 3.

On 28 October 2011
- Flight of Ukrainian experts back to Ukraine.

Outcome of the second mission
1. The goals of the project, project deliverables and planning were discussed in detail and adapted.
2. The presentations about risk assessment by the Dutch experts have given insight in the methodology for risk assessment used in the Netherlands. Presentations will be translated from English to Ukrainian.
3. The soil environmental policies in the Netherlands in the context of the European policy and the instruments and technologies involved were presented.
4. Risk assessment from several points of view was discussed. Point source related risk-based soil quality assessment and risk assessment methodology for leaching of plant protection products to groundwater were topics of discussion, both in a European context.
5. The inventory of over 430,000 contaminated site was explained together with the Dutch approach of prioritizing and the de current status. Currently 75,000 sites are remediated. One important aspect is that remediation was formally financed by the Dutch authorities. However, currently, a substantial and growing part of the costs of remediation is paid for by private companies and is combined with commercially developing each site.

6. The presentations about case studies by the Dutch commercial consultancy firms have given insight of the practical approaches for risk assessment and subsequent remediations used in the Netherlands.
7. Developed remediation approaches and risk assessment were presented by Dutch companies. Particularly of interest was the application of the TRIADE method, developed by RIVM and presented by the Grontmij company, to determine site-specific ecological risks of soil contamination. Royal Haskoning focussed on the natural attenuation (NA) approach which is much more cost-efficient than traditional remediation techniques.
8. Dutch companies are involved in Ukraine. TAUW elaborated on the risk assessment of obsolete pesticide stocks & former storage sites, a study that was carried in Ukraine.
9. Two remediation sites were visited. The first is located in Hilversum, "Remediation Villa Industria site". The visit, hosted by the private company MOURIK GROOT-AMMERS BV, involved the introduction to the approach of combined remediation and housing development, remediation techniques developed by MOURIK GROOT-AMMERS BV and a tour around the active site. The second visit was to the Volgermeerpolder, located in Amsterdam. A site that was used for several decades for waste dump for the city of Amsterdam. The remediation approach used is innovative and could be carried out at much lower costs than the traditional remediation approach. Finally the site is now developed as a nature reserve with possibilities for extensive recreation.

Planning and possible topics for the third mission were discussed. This third mission is a visit of Dutch experts to Ukraine.

Appendix 2.1 Workshop on 25th of October 2011

Chair: Frank Swartjes (RIVM), Opening by Dico Fraters (RIVM).
Number of participants: 13 (5 from UA and 8 from NL)

Presentations

- Soil environmental policies in the Netherlands – sharing experiences –
  Ton Honders (AgencyNL/ Bodem+)
- Point source related risk-based soil quality assessment in the Netherlands and Europe
  Frank Swartjes (RIVM)
- Contaminated sites: inventory, priority setting and monitoring of site management
  Kees Versluijs (RIVM)
- Risk assessment methodology for leaching of plant protection products to groundwater. European and national scale.
  Ton van der Linden (RIVM)
- Groundwater flow (direction, velocity) and transport of contaminants in aquifers due to flow of saturated groundwater
  Jouke Velstra (Acacia Water BV)

Participants from Ukraine:

1. Valeriy Grekov, director of ' Centerderzhrodyuchist ' = the Ukrainian State Technological Centre of Soil Fertility and Products Quality **(not attending)**
2. Oleksandr Tarariko, professor at the Institute of Agroecology and Economics of Natural Resources
3. Yuriy Penzenyk, director of a Regional Technological Centre of Soil Fertility and Products Quality
4. Nikolai Zinchuk, director of a Regional Technological Centre of Soil Fertility and Products Quality
5. Anatoliy Melnik, director of a Regional Technological Centre of Soil Fertility and Products Quality
6. Mykhaylo Falchenko (interpreter)

Dutch project team:

Dico Fraters (RIVM)
Karel Kovar (PBL)
Jouke Velstra (Acacia Water BV)
Arnoud de Klijne (RIVM)
Frank Swartjes (RIVM)

Other participants:

Ton Honders (AgencyNL/ Bodem+)
Kees Versluijs (RIVM)
Ton van der Linden (RIVM)

Interpreter:

Mr Mykhaylo Falchenko

Appendix 2.2 Workshop on 26th of October 2011

Chair: Dico Fraters (RIVM).
Number of participants: 14 (5 from UA and 9 from NL)

- [Enhancing Soil Fertility, *Gert-Jan van der Maas (presenter) and Matthijs Bokhorst.*

This presentation is related to the project "G2G09UA61, remote sensing", by the Dutch company Soil Advisory Holland.]

Presentations related to project "G2G09UA61, risk assessment":

- Risk management of soil contamination in the Netherlands.
  Sible Harmsma, Arcadis Nederland BV
- Risk assessment of obsolete pesticide stocks & former storage sites – case study Ukraine.
  Matthijs Bouwknegt and Laurent Bakker, Tauw BV
- Location specific ecotoxicological risk assessment, defining ecological risks of contamination by application of the TRIADE method (*final title be given later*)
  Stefan Kools, Grontmij Nederland BV
- Landfills, risk assessment method and natural attenuation (NA).
  René Boerboom, Haskoning Nederland BV

Participants from Ukraine:

1. Valeriy Grekov, director of ' Centerderzhrodyuchist ' = the Ukrainian State Technological Centre of Soil Fertility and Products Quality **(not attending)**
2. Oleksandr Tarariko, professor at the Institute of Agroecology and Economics of Natural Resources
3. Yuriy Penzenyk, director of a Regional Technological Centre of Soil Fertility and Products Quality
4. Nikolai Zinchuk, director of a Regional Technological Centre of Soil Fertility and Products Quality
5. Anatoliy Melnik, director of a Regional Technological Centre of Soil Fertility and Products Quality
6. Mykhaylo Falchenko (interpreter)

Dutch project team:
Dico Fraters (RIVM)
Karel Kovar (PBL)
Jouke Velstra (Acacia Water BV) **(not attending)**
Arnoud de Klijne (RIVM)
Frank Swartjes (RIVM)

Other participants:
Gert-Jan van der Maas, Soil Advisory Holland, for project G2G09UA61
Sible Harmsma, Arcadis Nederland BV
Matthijs Bouwknegt and Laurent Bakker, Tauw BV
Stefan Kools, Grontmij Nederland BV
René Boerboom, Haskoning Nederland BV

Interpreter:
Mr Mykhaylo Falchenko

Appendix 2.3 Excursion and field visits on 27th of October 2011

Excursion and fieldtrip.
Number of participants: 9 (5 from UA and 4 from NL)

Soil remediation site Villa Industria in Hilversum
Our host is the MOURIK GROOT-AMMERS BV company, specialized in construction, road-building, soil remediation and project development. The presentations and visit to the site were done by John Verbaan (milieutechnoloog, eco-technologist) and Bas van Andel (site remediation manager):

- Presentation: General explanation about the remediation approach of MOURIK
- Presentation: Remedation approach of oil, PAH and BTEX at the soil remediation site Villa Industria
- Presentation: Remedation approach of pesticides at Luxan Elst site
- Tour on the site Villa Industria

Remediation site Volgermeerpolder
Our host is Ontwikkelingsbedrijf Gemeente Amsterdam (http://www.oga.amsterdam.nl/). This is the municipal Development Corporation of the city of Amsterdam. The main tasks of the Development Corporation are leasing of ground surfaces and preparation of building sites. The division "Bodemcoördinatie en Grondbank" (Ground surface coördination and Soilbank) is engaged with reuse of soil and aftercare of remediation projects.

- Presentation by Gerald Bockting: Historic development of the site from peat tot landfill
- Presentation by Gerald Bockting: Remediation approach of the landfill and development to nature
- Tour on the site, by Gerald Bockting, Arie Blom and Cees Loogman

Participants from Ukraine:

1. Valeriy Grekov, director of ' Centerderzhrodyuchist ' = the Ukrainian State Technological Centre of Soil Fertility and Products Quality **(not attending)**
2. Oleksandr Tarariko, professor at the Institute of Agroecology and Economics of Natural Resources
3. Yuriy Penzenyk, director of a Regional Technological Centre of Soil Fertility and Products Quality
4. Nikolai Zinchuk, director of a Regional Technological Centre of Soil Fertility and Products Quality
5. Anatoliy Melnik, director of a Regional Technological Centre of Soil Fertility and Products Quality
6. Mykhaylo Falchenko (interpreter)

Dutch project team:
Arnoud de Klijne, RIVM
Frank Swartjes, RIVM
Jouke Velstra, Acacia Water BV
Karel Kovar, PBL

Other participants:
John Verbaan (milieutechnoloog, eco-technologist), MOURIK GROOT-AMMERS BV
Bas van Andel (site remediation manager), MOURIK GROOT-AMMERS BV
Gerald Bockting, formerly municipal Development Corporation of the city of Amsterdam, now private company

Arie Blom, municipal Development Corporation of the city of Amsterdam
Cees Loogman, municipal Development Corporation of the city of Amsterdam

Interpreter:
Mr Mykhaylo Falchenko

Appendix 3 Report of final mission

Short report on final mission, Kiev, Ukraine, 16-19 April 2012
Version: final (10 May 2012)

Introduction
This mission was carried out in the framework of the project G2G09/UA/6/2, formally titled "Assessment of risk of groundwater contamination by abandoned agriculture related on-farm storage sites (pesticides, fertilizers) - as required by the Groundwater Directive 2006/118/EC and the upcoming Soil Framework Directive". For this mission a team of four Dutch experts met with experts from several institutes in Kiev, Ukraine, from Monday 23 May till Thursday 26 May 2011.

The Dutch team consisted of Dico Fraters (RIVM, project leader), Karel Kovar (PBL), Jouke Velstra, (Acacia Water), Frank Swartjes (RIVM).

The final mission was prepared in advance together with Mr Valeriy Grekov, AgroBonus, former director of the Ukrainian State Technological Centre on Soil Fertility Protection ("Centerderzhrodyuchist", and beneficiary institute) and Ms Viktoriya Panasenko, researcher and scientific secretary of the Ukrainian State Technological Centre on Soil Fertility Protection ("Centerderzhrodyuchist", and beneficiary institute).

Ukrainian institutes involved in this mission, in addition to Centerderzhrodyuchist and the regional centres "Oblderzhroduchist" of Chernigov, Volynskiy and Zakarpatye were:
- three Regional Technological Centres of Soil Fertility and Products Quality ('Oblderzhroduchist'), namely from the regions Chernigov, Volynskiy and Zakarpatye; and
- the Institute of Agroecology and Economics of Natural Resources (Institut agroekologii i ekonomiky pryrodokorystuvania).
- the Institute of Hydraulic Engineering and Land Reclamation.

Outline of mission programme
On 16 April 2012
- Flight of Dutch experts to Ukraine.
- Dinner of Dutch delegation with Mr Valeriy Grekov and discussion of the project and the programme for this mission.

On 17 April 2012
- Workshop at Centerderzhrodyuchist with the aim of Ukrainian Experts to inform Dutch project team about agriculture related pollution in Ukraine, and Dutch experts outline various aspects of the methodology for dealing with contaminated sites. A list of presentations and participants is given in Appendix 3.1.

On 18 April 2012
- Excursion in the Cherkasy region to visit two contaminated sites. 1-st pollution place: village Les'ky (село Леськи), Cherkasy district (Черкаський район), approximately 200 km from Kiev. And the 2-nd pollution place: village Medvedivka (село Медведівка), Chygyryn district (Чигиринський район), on the south from Les'ky.

On 19 April 2012
- Flight of Dutch experts back to the Netherlands.

Outcome of mission
1. The project goals were discussed with the Ukrainian delegation.
2. The guidance document consists of all presentations given over de course of the project. It describes the methodology and stages of the risk assessment of point-source contamination.
3. The Ukrainian experts will be able:
    a. to carry out a desk study, make an inventory of relevant point sources and/or contaminant mobilisation processes;
    b. to carry out an assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow;
    c. to carry out a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination.
4. Project evaluation by the beneficiary (Ukrainian State Technological Centre on Soil Fertility Protection, "Centerderzhrodyuchist").

Appendix 3.1 Details of mission programme 16-19 April 2012

Tuesday 17 April 2012

MORNING
(9:30) Meeting with Mr Vitaliy Sofiychenko, Valeriy Grekov and Viktoriya Panasenko

Opening of meetings
(9:30 – 9:40) Acquaintance and introduction

(9:40 – 10:00) Session 1: Introduction
- (9:40 – 9:45) Vitaliy Sofiychenko (Director of "Centerderzhrodyuchist") – welcome to the participants
- (9:45 – 9:50) Valeriy Grekov (Deputy Director the State Scientific Production Center "Nature", now at Agrobonus) inform about previous missions
- (9:50 – 10:00) NL team (Karel Kovar) informs UA-experts:
    - refresher about project goals
    - looking back at Missions 1 and 2, assessment of meeting the project goals

(10:00 – 12:10) Session 2: Ukrainian Experts inform Dutch project team about agriculture related pollution in Ukraine, and Dutch experts outline various aspects of the methodology for dealing with contaminated sites
- (10:00 – 10:20) Yuriy Penzenyk, report: "Dutch soil and water contamination models adaptation possibility in Zakarpatska Oblast"
- (10:20 – 10:50) Mykola Zinchuk, report: "Phytoremediation efficiency within unfit pesticides storage areas"
- (10:55 – 11:40) NL team, Frank Swartjes, report: "Dutch approach for setting priority for remediation of contaminated sites (soil and groundwater)"
- (11:40 – 12:10) Sergiy Kolomietc, report: "Migration of nutrients in the agricultural landscape of small rivers pools"

AFTERNOON

(13:30 – 14:50) Session 3: Continuation of presentations by the Netherlands and Ukraine

- (13:30 – 14:10) NL team, Jouke Velstra, report: "Assessment of groundwater flow direction and velocity at contaminated sites: Examples from Dutch engineering practice"
- (14:10 – 14:40) NL team, Frank Swartjes, report: "Dealing with contaminated sites: State of the art in 16 'old' EU countries, developments in 'new' EU countries, and possibilities for Ukraine"

(14:40 – 15:00) Session 4: Discussion and closure

Wednesday 18 April 2012

(08:00 – about 21:00) Field trip to contaminated sites
1-st pollution place: village Les'ky (село Леськи),
Cherkasy district (Черкаський район), approximately 200 km from Kiev,
It is 20 km from Cherkasy.
2-nd pollution place: village Medvedivka (село Медведівка),
Chygyryn district (Чигиринський район), on the south from Les'ky.
It is 25 km from village Les'ky.

List of Ukrainian participants taking part in the field trip:
The persons from Kiev:
Valeriy Grekov
Viktoriya Panasenko
Iurii Penzenyk
Mykola Zinchuk
Anatolii Melnyk

From Cherkasy there will be two persons taking part in the field trip (they will go by own car): Iurii Kryvda (Director Cherkasy center) and Volodymyr Demydenko (Deputy Director).
Iurii Kryvda will show us all in the field and lead us around the contaminated sites.
Director of the Vinnica center (Vasyl Pasichniak) to join us in Cherkasy.

Thursday 19 April 2012
- Departure to the Netherlands

Appendix 4 Guidance document

Guidance document on methodologies and stages of risk assessment of point-source contamination

RIVM National Institute for Public Health and the Environment
PBL Environmental Assessment Agency
Acacia Water BV
Centerderzhrodyuchist

24 September 2012

Content

1. Introduction

Ukraine faces large challenges in order to protect and, if possible, to improve the quality of soil and water. The reasons are the increasing demands for agricultural products, large changes in land ownership and decreasing government budgets for soil quality monitoring.

In 2008-2009 Dutch and Ukrainian organisations carried out an evaluation of Ukraine soil monitoring efforts in relation to the EU Soil Framework Directive (SFD). Point of concern was that there was no (adequate) system for SFD monitoring of soil contamination (point source soil pollution), and the evaluation of risks for human health and the environment, in order to control and abate point source / local problems. It was recommended to set-up

- a system for making an inventory of (possibly) contaminated sites and
- a system for evaluating human health and environmental risks of contaminated sites.

The outcome of this evaluation of the soil quality monitoring efforts resulted in a request from the Ukrainian government for support. The request regarded a project to tackle the problem of point sources of pollutions, especially with regard to risk assessment of abandoned sites for storage of agricultural chemicals (fertilisers and pesticides). These sites may provide a risk for human health, food safety, resource depletion (contaminated drinking water resources and agricultural land), and ecological damage.

To support the Ukrainian government, NL Agency developed a project to enable Centerderzhrodyuchist to assess the risks of point-source contamination (a/o pesticides, nitrate). The Dutch Ministry of Economic Affairs, Agriculture and Innovation financed this project. A Dutch consortium, consisting of the National Institute for Public Health and the Environment (RIVM), PBL Netherlands Environmental Assessment Agency (PBL), and Acacia Water BV carried out the project in 2011-2012. Two other Ukrainian institutions, the Institute of Agroecology and Economics of Natural Resources (Institut agroekologii i ekonomiky pryrodokorystuvania) and the Institute of Hydraulic Engineering and Land Reclamation), were involved in at least one of the project missions to ascertain that all relevant parties in Ukraine could give input to the project and benefit from the outcome. Several co-workers of other Dutch consultancies were involved in a study visit of a group of Ukrainian experts to the Netherlands.

The project plan defines as project result a guidance document describing the methodology and stages of the risk assessment of point-source contamination (including data and methods). The document enables the experts from 'Centerderzhrodyuchist':

- to carry out a desk study, make an inventory of relevant point sources and/or contaminant mobilisation processes;
- to carry out an assessment of the leaching of contaminants into groundwater and transport in aquifers due to groundwater flow;
- to carry out a risk assessment as regard to land and water use functions in the vicinity of a point-source of contamination.

The next chapters will discuss these topics in detail. The chapters summarise the information provided during the project and laid down in presentations. All presentations are included in the Appendix report (RIVM report 680272001A).

2. Inventory of relevant point sources and/or contaminant mobilisation processes

This chapter is mainly based on the papers in Appendix 2, 3, 7, 10, 12, 15, and 20 in the Appendix report.

The first step in the process of the evaluation of risks of point source pollution for human health and the environment, in order to control and abate point source and/or local problems, is to make an inventory of potentially contaminated sites (potential point sources)). This inventory regards questions like:
- Which type of sites are suspect?
- Which type of activities have taken place?
- Which type of chemicals were involved?
- How many sites are there for each type?
- Where are they located?
- Which risk level do they have?
- How have they been tackled so far?
- What is the total budget needed for risk reduction?

The next steps are priority setting (which are the sites to be tackled first?) and monitoring the state of site management (how is the available annual budget spent?). Priority setting includes the assessment of the site development needs and potentials, the costs and available budget, the type of risk (human, groundwater dispersion, ecology), the risk level, i.e. the pollution level and type of land use. Monitoring is needed to answer question like: 'How many contaminated sites dealt with, in terms of surveys, investigations, safety measures, cleaning, management– to start, ongoing, completed' and 'Who is responsible, what are the costs actually made and who paid ?'.

A potentially contaminated sited is not always a contaminated site and a contaminated site is not always a point source or does not always provide an immediate risk for human health or the environment. In Chapter 3 and 4 this topics are discussed in more detail.

Listing (potentially) contaminated sites
There are in general three branches of inventory to designated potentially contaminated sites:
- research of historical polluting activities, using archives and aerial photos;
- research of reports about calamities and/or illegal activities;
- surveys of areas currently in use for activities that may cause pollution. This is actually an inventory of polluting activities. In the Netherlands, the selection of categories of polluting activities has been based on experience gained 1985-1996 (see Figure 1).

The list of located (potentially) contaminated sites is the results of the above mentioned inventory of polluting activities and a list of located sites with known pollution.

The inventory is an ongoing process and the list with (potentially) polluted sites will be updated regularly as new insight is gained (see Table 1). It is important that the site information is comparable, in order to be able to prioritise sites for further action. Therefore, there it will be necessary to:
- make a protocol that describes the general process of making an inventory and lists the information that should be provided.

– create a (simple) database to collect all information, that can easily be adapted if new understanding is gained about information needed for further action and to be stored in the database.

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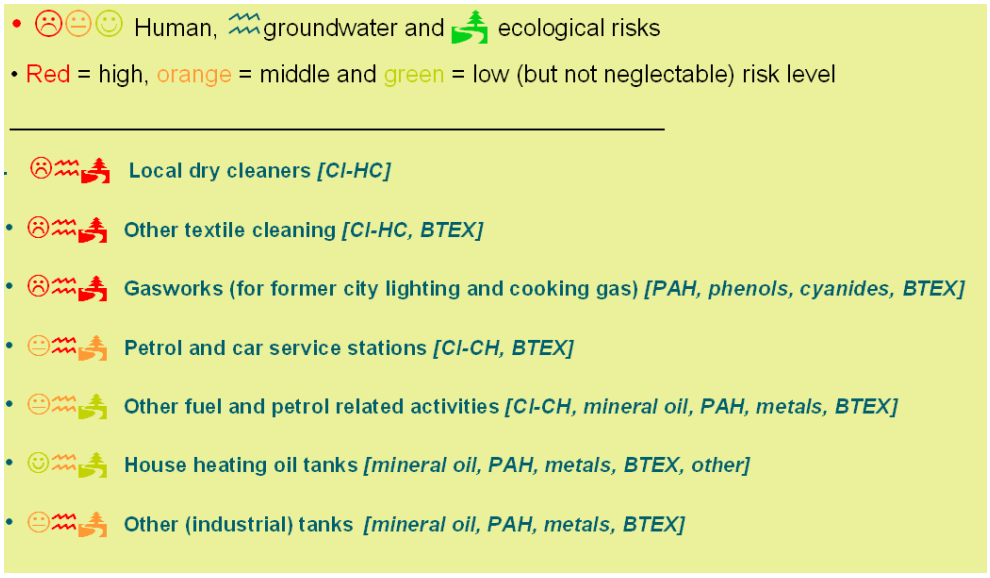

Figure 1 Categories of polluting activities, with associated protection targets, risk categories and main pollutants (see Appendix report, appendix 12 for more information)

Table 1 Number of identified potentially contaminated sites in the Netherlands between 1982 and 2005. Source: Appendix report, appendix 12.

Year	Number of sites	Estimated remediation cost (million euros)	Type of sites
1982	2 000	2 000	Dump sites
1987	10 000	10 000	+ existing industrial sites
1995[1]	200 000	40 000	+ historical industrial sites
2005	425 000	20 000	'final' survey

[1] 1995 was more an alarming estimate than an inventory, but gave way for a complete inventory (1996-2005), followed by priority setting in view of cost estimates.

Situation in Ukraine

The main sources of air pollution are transport, industry and power plants. For water, the main polluters are housing, steel plans, coal mining industry, power plants and agriculture. For soils, the main polluters are dumps, agricultural storages sites of pesticides and fertilisers, industry and transport (Appendix report, Appendix 2).

There is some insight in the number of potentially contaminated sites. According to the State Register, there are about 24.000 potentially hazardous enterprises. This register includes industrial enterprises, mines, quarries, main gas pipelines, oil pipelines and product pipelines, hydraulic engineering constructions, hub railway stations, bridges, tunnels, storage sites and industrial waste grounds, dangerous substances storage sites and others. For surface waters and groundwater maps have been drawn with indications of pollutions levels. Fifty percent of the municipal drinking water supply does not meet the standards for drinking water. In some regions (oblast) an inventory was made for (former) storage sites of agro-chemicals (Appendix report, Appendix 2).

With respect to agro-chemical storage sites, there is only limited information available on the national scale. In the Chernihiv region 351 sites have been investigated, 51% were contaminated. At 11% of the sites the maximum permissible concentration was exceeded (DDT, y-HCH, Simazine, Atrazine, Promerin). In the same region about 1800 drinking water wells have been sampled for nitrate. In 69% of the wells the nitrate concentration exceeded the drinking water standard (Appendix report, Appendix 3). One of the causes probably is the lack of sewages systems in rural villages. Also in villages in the Kiev region high nitrate concentrations in wells were detected (Appendix report, Appendix 4). In the Volyn region, 371,853 tonnes of unfit and prohibited for use agrochemicals have been disposed, which allowed to free the territory of Western Bug river from these chemicals completely. A phytoremediation system has been put in place on these former storage sites. This process will probably last around 15-20 years (Appendix report, Appendix 6, 21). In the Zakarpatye region there are more than 30 former agro-chemical storage sites that require urgent disposal of pesticide residuals (Appendix report, Appendix 20).

Priority setting

An important aspect of the process of making an inventory is setting priorities regards further investigations. The reasons for this priority setting are multitude, as the numbers of potentially contaminated sites tends to increase almost exponentially in the beginning (see Table 1). Therefore, governments will soon conclude that there is a lack of money and capacity to tackle all locations, there are juridical obligations, and there will be increasing damage if no action is taken at all.

To be able to set priorities a minimum of information is needed about each potentially contaminated site to estimate which sites are potentially most hazardous for human health and/or the environment. What are the expected pollution levels, what is the exposure level, what are the expected health effects? From a financial point of view, question to be answered are: 'what are the estimated costs for remediation?' and 'who will pay for the remediation of the site (government, polluter)?'.

Contaminant mobilisation processes and land use

Some sites are contaminated, however, there is no immediate risk for human health or the environment. For examples, a site with pollutants which are strongly adsorbed to the soil, while the site is still in use as an industrial site. These pollutants may form no (additional) risk for the workers on that site. If leaching and/or erosion of soil is further prevented by soil sealing, there will be hardly any immediate (additional) risk for the environment, as the site itself is already an industrial area and not a nature reserve.

Changes in land use may change the risks for human health and the environment. This may be because the site becomes accessible to people, for example, when the industrial plant is removed and houses are built on the site, with gardens and/or vegetable gardens. In addition, changes in land use may produce mobilisation possesses, for example, when the site is turned into forest and the acidity of the soil increases (lowering of pH). At lower pH, most heavy metals become increasingly mobile and may cause damage to the ecosystem and or may leach to ground and/or surface waters.

In the next chapters, leaching of contaminants and risk assessment as regards to land and water use functions will be dealt with in more detail.

3. Assessment of the leaching of contaminants into phreatic groundwater and transport in aquifers due to groundwater flow

This chapter is mainly based on the papers in Appendix 4, 5, 8, 9, 13, 14, 23 and 24 in the Appendix report.

The assessment of the leaching of contaminants into phreatic groundwater (see Figure 2) and transport in aquifers due to groundwater flow (see Figure 3) is based on conceptual models.

Leaching of contaminants
Flow of soil moisture and concomitant, though often retarded, transport of contaminants in the unsaturated zone (vadose zone) are predominantly in vertical direction (Figure 1) and modelled as one-dimensional flow. Although, diffusion and (sub)surface flow in undulating, hilly or mountainous areas may cause horizontal flow and transport. The installation of drainage systems (mole drains, tile drains, open drains) and or the presence of (semi-) impermeable soil layers may, of course, cause significant horizontal flow. Important factors that influence the travel time of pollutants through the unsaturated zone are amount of annual groundwater recharge (precipitation excess), thickness of the unsaturated zone, chemical and biological properties of the pollutant and chemical and hydrological characteristics of the soil.

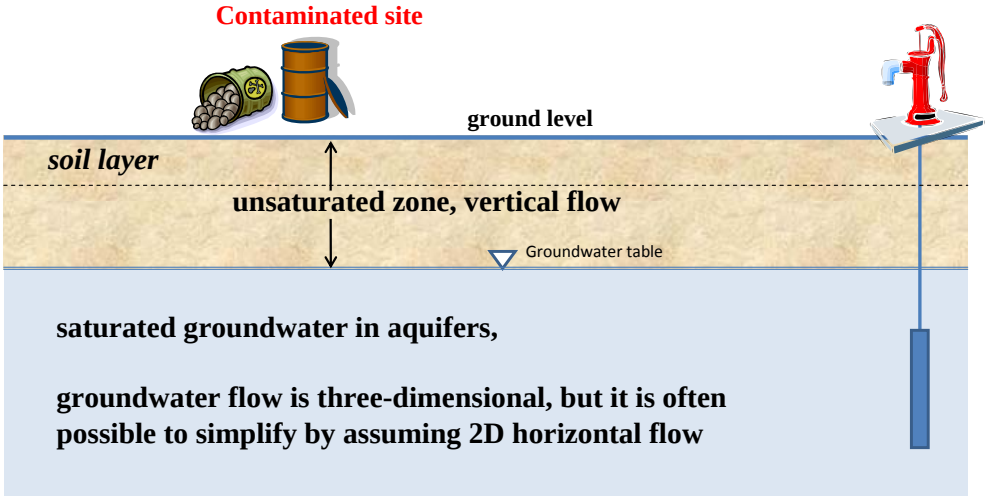

Figure 2. Simplified conceptual model for leaching of contaminant to phreatic groundwater.

Transport of contaminants
Transport of contaminants in the saturated zone (aquifer) is three-dimensional, however, it is often possible to simplify by assuming two-dimensional groundwater flow and contaminant transport (Figure 3).

The main parameters that determine contaminant transport of non-degradable contaminants in an aquifer are groundwater flow (v) and retardation of the contaminant by the aquifer matrix (R). The advancement of the concentration front (p) can be calculated by dividing groundwater flow by the retardation factor:

[1] $p = v / R$

where:

- p = forward movement of concentration front at, for example, the intervention value (mm / year)
- v = groundwater flow velocity (m/ year), v is the specific groundwater discharge (also known as Darcy flux or seepage flux) divided by the effective porosity of the aquifer
- R = retardation factor (dimensionless), assuming linear equilibrium sorption. If no sorption, R takes the value of 1, otherwise R>1

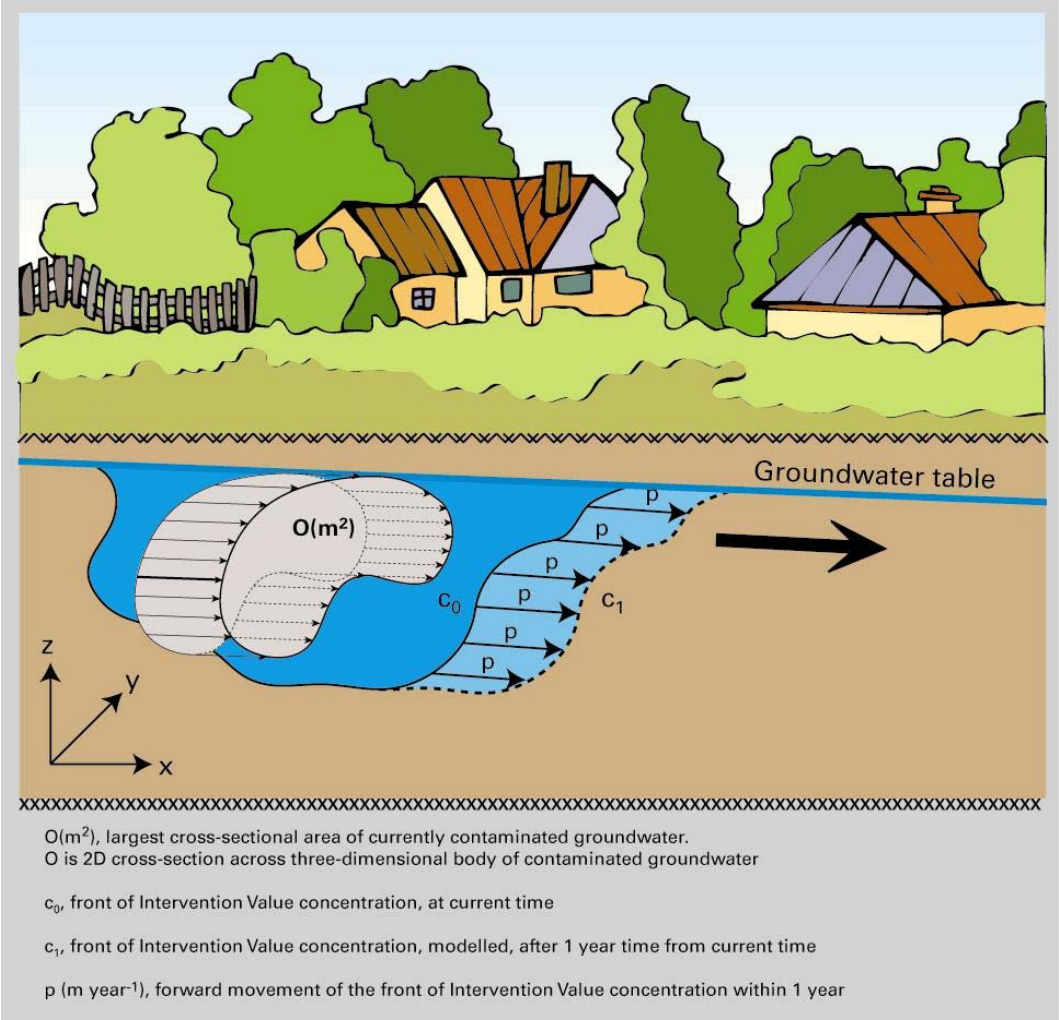

Figure 3. Simplified conceptual model for contaminant transport through (phreatic) groundwater.

A linear retardation factor (R) is a function of the adsorption coefficient (K_d), the soil bulk density (ρ) and the pore volume (ε):

$$[2] \qquad R = 1 + K_d * \frac{\rho}{\varepsilon}$$

where:
- R = retardation factor (dimensionless), assuming linear equilibrium sorption. If no sorption, R takes the value of 1, otherwise R>1
- Kd = adsorption coefficient (dm^3 / kg)
- ρ = soil bulk density (kg / dm^3)
- ε = pore volume (dimensionless)

The increase in volume of contaminated water-saturated soil volume (d) can be estimated by multiplying the advancement (forward movement) of Intervention Value (IV) concentration front within one year (p) by the cross-sectional area of contaminated groundwater body, delineated by the IV-concentration for groundwater (O):

[2] $d = p * O$

where:
- d = increase in volume of contaminated water-saturated soil volume (m3 / year)
- p = forward movement of concentration front at, for example, the intervention value (mm / year)
- O = largest cross-sectional area (m2) of contaminated groundwater body, delineated by IV-concentration for groundwater

In low-flow systems, diffusion may play an important role in contaminant transport. For degradable contaminants decay may influence forward movement and the change in volume of the contaminated water-saturated soil volume significantly (Figure 4).

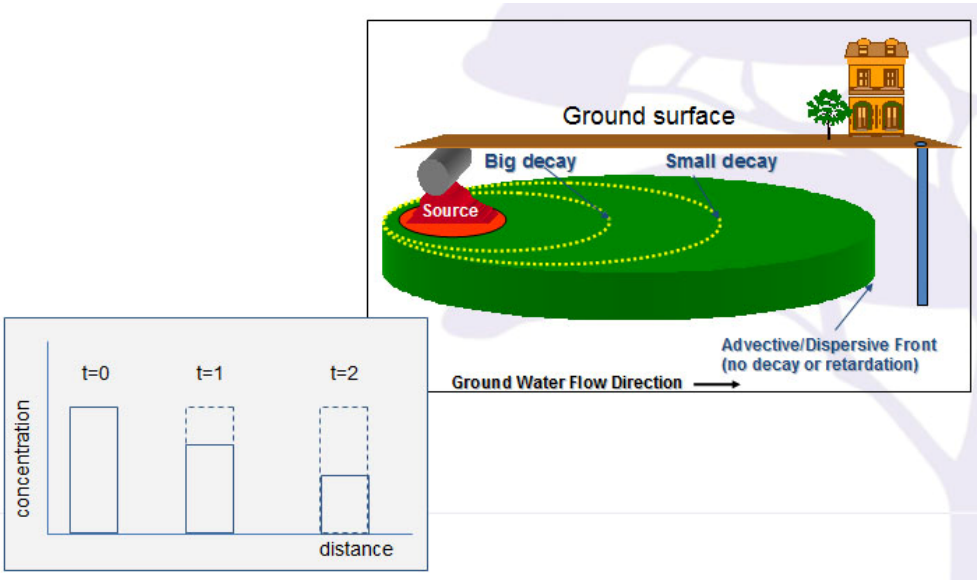

Figure 5. Influence of decay on advancement of contaminant front in saturated groundwater (no retardation).

Modelling of groundwater flow and contaminant transport

Modelling of groundwater flow and contaminant transport can be done to predict where contaminants will flow in the course of time and how long it takes before contamination will reach a certain point in the soil-water system.

The three basic steps in modelling are:
- solving the groundwater flow problem (groundwater heads)
- generating path lines and travel times
- modelling of solutes transport

There are two approaches to simulate concentrations, firstly, a simple path line approach, and, secondly, a complex fully three dimensional approach. The complex model is not always the best model. In general, start simple, keep a model as simple as possible, and increase complexity only if you can account for this by observations. Without observations of real world (heads and fluxes) it is not possible to build a model. The more observations available, the better the model will function (Appendix report, Appendix 8 and 9).

4. Risk assessment as regard to land and water use functions near a point-source of contamination

This chapter is mainly based on the papers in Appendix 5, 6, 11, and 16 up to and including 19, 21, 22 and 25 in the Appendix report.

Contaminants may spread through the environment by many different ways and may pass one or more compartments (soil, water, air). Contaminants may affect humans directly or indirectly via drinking water, crops and/or livestock, and they may affect ecosystems (Figure 5).

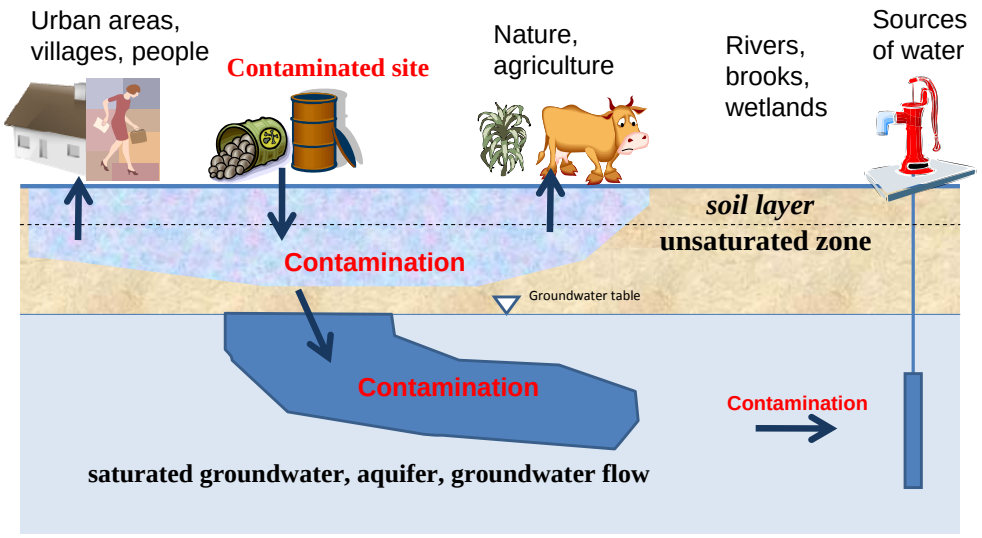

Figure 5. Simplified conceptual model for spreading of contaminants in the environment.

In the Netherlands, contaminants and risks are considered part of human existence. The current day risk assessment philosophy includes terms as cost efficiency, fitness-for-use, green remediation technologies, natural attenuation, and risk communication.

A tiered approach helps to keep risk assessment simple when possible and to make it more complex when necessary. In each tier the approach is more site specific, less conservative and more realistic, i.e. the approach becomes more

complex. Such an approach improves efficiency, without compromising scientific integrity.

The Dutch framework for soil quality management considers three levels of contamination, each requesting a different management:
1. Clean, contaminant concentration is below background (upper soil) or Target Value (groundwater); no further action is required.
2. (Slightly) contaminated, the contaminant concentration is higher than the background or Target Value, but below the Intervention Value; sustainable soil management is required.
3. Seriously contaminated, the contaminant concentration is higher than the Intervention Value; the urgency of the remediation has to be determined.

The Intervention Value includes the assessment of risk to human health and for the ecosystem. The value is derived using the exposure model CSOIL (human health protection) and Species Sensitivity Distributions (ecological protection). The lowest value of the one derived for human health and the one derived for the ecosystem protection is used as Intervention Value, so that human health and the ecosystem both are protected at the level of the Intervention Value. However, the height Intervention Value for soil also depends on sites specific soil properties such as the organic matter and clay contents to account for bioavailability. The presence of similar contaminants it taken into consideration (linear addition) when deciding on the level of contamination of a site. The Intervention Value for groundwater considers three criteria:
- direct consumption of groundwater,
- ecological effects in groundwater,
- concentration equilibrium with the Intervention Value for soil.

Pesticides
A tiered approach, as it is cost-effective, is also used at the level of the European Union to assess leaching of pesticides for the authorisation assessment of pesticides. In the Netherlands, the first tier is considered too simple and, therefore, the tier 2 approach is used as standard. The leaching assessment is carried out with a freely available tool (PEARL). The tier 3 assessment includes estimation of pesticide transformation in the saturated zone and pesticide monitoring in shallow groundwater at 10 m below the surface level (Appendix report, Appendix 13).

Priority setting for remediation
The procedure for remediation priority setting is a (smart) combination of calculations (modelling) and measurements (monitoring). Its aim is to be efficient and pragmatic and to select those locations that are commonly considered having the highest risks for human health and/or the environment. Selection is necessary, as there is neither budget nor capacity to tackle all contaminated sites at once. Moreover, remediation of all these sites is from a risk assessment perspective unnecessary. Again, a tiered approach is used for priority setting.

The protection targets are human health, ecosystems and the groundwater. To estimate the site-specific risks for human health a combination of modelling and measuring is used. Modelling is done with the same model used to derive the Intervention Values, i.e., CSOIL, but site-specific input parameters are used in calculations. Contaminant concentrations in contact media (vegetables, indoor air, and dust) could be measured and biomonitoring (hair, nails, urine, blood) could be carried out. The site-specific risk for the ecosystem is calculated using the TRIAD approach. This approach takes into account soil chemistry, toxicity of the

contaminant and ecology (multiple weight of evidence). The calculation of the groundwater-related risks has two tiers. The first tier makes an inventory of risk factors, such as the presence of LNAPL/DNAPL, nearby susceptible object (e.g. water wells, groundwater dependent ecosystems), and the volume of the plume with a concentration exceeding the Intervention Value. The second tier gives three options: simple calculations, more complex calculations, and monitoring. (Appendix report, Appendix 22).

5. Discussion and conclusions

Ukraine government has an incomplete picture of the number of potentially contaminated sites and the risks involved for human health and the environment. Available information show that the number of potentially contaminated sites may be high and that the risks for people living around these sites are not only hypothetical. Contaminated sites occur in built up areas as well as in rural areas.

To decrease the number of people affected directly or indirectly by contaminated sites and to protect ecosystems a consistent and well-balanced and cost-efficient policy is necessary. This policy needs to include an inventory of potentially contaminated site, the selection of actually contaminated sites and the setting of priorities for remediation of the contaminated sites.

The main conclusions with respect to making an inventory of potentially contaminated sites, the assessment of risk for human health and the environment, and setting of priorities for remediation of contaminated sites are:

- Simple when possible and only complex when necessary, use by preference a tiered approach.
- Make a selection of ‘tested and tried’ legal, financial and technological instruments and make them suitable for the Ukrainian situation.

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