Project Acronym and Title:

M4ShaleGas - Measuring, monitoring, mitigating and managing the environmental impact of shale gas

STAKEHOLDERS VIEWS ON MONITORING GROUNDWATER AND SOILS

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Public introduction

M4ShaleGas stands for *Measuring, monitoring, mitigating and managing the environmental impact of shale gas* and is funded by the *European Union's Horizon 2020 Research and Innovation Programme*.
The main goal of the M4ShaleGas project is to study and evaluate potential risks and impacts of shale gas exploration and exploitation. The focus lies on four main areas of potential impact: the subsurface, the surface, the atmosphere, and social impacts.
The European Commission's Energy Roadmap 2050 identifies gas as a critical fuel for the transformation of the energy system in the direction of lower CO_2 emissions and more renewable energy. Shale gas may contribute to this transformation.
Shale gas is – by definition – a natural gas found trapped in shale, a fine grained sedimentary rock composed of mud. There are several concerns related to shale gas exploration and production, many of them being associated with hydraulic fracturing operations that are performed to stimulate gas flow in the shales. Potential risks and concerns include for example the fate of chemical compounds in the used hydraulic fracturing and drilling fluids and their potential impact on shallow ground water. The fracturing process may also induce small magnitude earthquakes. There is also an ongoing debate on greenhouse gas emissions of shale gas (CO_2 and methane) and its energy efficiency compared to other energy sources
There is a strong need for a better European knowledge base on shale gas operations and their environmental impacts particularly, if shale gas shall play a role in Europe's energy mix in the coming decennia. M4ShaleGas' main goal is to build such a knowledge base, including an inventory of best practices that minimise risks and impacts of shale gas exploration and production in Europe, as well as best practices for public engagement.
The M4ShaleGas project is carried out by 18 European research institutions and is coordinated by TNO-Netherlands Organization for Applied Scientific Research.

Executive Report Summary

The natural environment in Europe is widely monitored. Environmental data and knowledge about the state of the environment are both commonly used for managing and taking informed decisions by many stakeholders, according to the sustainable development concept. At European level, basic principles for environmental monitoring are established by some European Directives such as the Water Framework Directive or Groundwater Directive. Moreover, there is a strong aspiration for standardization and unification of results, which is – in case of water monitoring - provided by a codified reporting system. However, goals, measures and results are diverse among countries. A reasonable assumption is that monitoring of changes in local environments in relation to a defined baseline is an essential tool to determine the environmental impact of shale gas activities. One of the main questions is whether the currently operating environmental monitoring systems are also applicable in shale gas development control? In previous report information about national monitoring systems were gathered. There is a huge number of institutions in EU member states responsible and engaged in both environmental status assessment and environmental monitoring with regard to surface water, groundwater and soils in Europe. Study objective for this report was to recognize their opinions about currently operating monitoring networks with special regard to their views on whether it is possible to use them effectively for monitoring of shale gas development impact. A specially prepared questionnaire was send to more than 200 recipients, representing 90 institutions of the kind mentioned above from 20 European countries. Questionnaire was divided into two parts - in the first the confirmation on so far gathered information on monitoring systems was sought (with updates possibility) and the following - was focused on awareness of shale gas issues and opinions on shale gas development monitoring approaches.
There was a small response among questioned institutions to the poll - only 12 out of 90 sent back the questionnaire. Updated description of water and soil monitoring networks, which is the supplement to Deliverable 7.1 (Fajfer at al., 2016) was obtained from Wallonia (Belgium); Estonia; Western Pomerania, Saxony-Anhalt, and Hessia (Germany);Hungary; Latvia; and Scotland (UK). The level of knowledge on shale gas issues varies between institutions and some of them do not find it relevant to their work. Summary of survey participants' opinions is prepared in a form of a table, enabling direct comparison between answers. Conclusions and further recommendations related to follow-up works are given.

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1 INTRODUCTION

1.1 Context of M4ShaleGas

Shale gas source rocks are widely distributed around the world and many countries have now started to investigate their shale gas potential. Some argue that shale gas has already proved to be a game changer in the U.S. energy market (EIA 2015[1]). The European Commission's Energy Roadmap 2050 identifies gas as a critical energy source for the transformation of the energy system to a system with lower CO_2 emissions that combines gas with increasing contributions of renewable energy and increasing energy efficiency. It may be argued that in Europe, natural gas replacing coal and oil will contribute to emissions reduction on the short and medium terms.

There are, however, several concerns related to shale gas exploration and production, many of them being associated with the process of hydraulic fracturing. There is also a debate on the greenhouse gas emissions of shale gas (CO_2 and methane) and its energy return on investment compared to other energy sources. Questions are raised about the specific environmental footprint of shale gas in Europe as a whole as well as in individual Member States. Shale gas basins are unevenly distributed among the European Member States and are not restricted within national borders, which make close cooperation between the involved Member States essential. There is relatively little knowledge on the footprint in regions with a variety of geological and geopolitical settings as are present in Europe. Concerns and risks are clustered in the following four areas: subsurface, surface, atmosphere and society. As the European continent is densely populated, it is most certainly of vital importance to understand public perceptions of shale gas and for European publics to be fully engaged in the debate about its potential development.

Accordingly, Europe has a strong need for a comprehensive knowledge base on potential environmental, societal and economic consequences of shale gas exploration and exploitation. Knowledge needs to be science-based, needs to be developed by research institutes with a strong track record in shale gas studies, and needs to cover the different attitudes and approaches to shale gas exploration and exploitation in Europe. The M4ShaleGas project is seeking to provide such a scientific knowledge base, integrating the scientific outcome of 18 research institutes across Europe. It addresses the issues raised in the Horizon 2020 call LCE 16 – 2014 on *Understanding, preventing and mitigating the potential environmental risks and impacts of shale gas exploration and exploitation.*

[1] EIA (2015). Annual Energy Outlook 2015 with projections to 2040. U.S. Energy Information Administration (*www.eia.gov*).

1.2 Study objectives for this report

Environmental monitoring system comprises testing, sampling, analysis and assessment of the state of the environment in order to register changes going on. This is an essential tool for evaluating environmental impact of shale gas activities. There are common basis for environmental monitoring in Europe, and within European Union there is a strong aspiration for standardization and unification of monitoring results. In previous reports information about monitoring systems committed to groundwater, surface water and soil observations was collected (Fajfer et al. 2016).

Study objective for this report is to recognize stakeholders opinions about currently operating monitoring networks with special regard to their views on whether it is possible to use them effectively for monitoring of shale gas development impact.

1.3 Aims of this report

This report is aiming at gathering opinions by conducting a poll among institutions involved in environmental monitoring of surface water, groundwater and soil. The inventory demonstrates existing stakeholders' assessment of sufficiency/insufficiency of monitoring networks of surface water, groundwater and soils in Europe in relation to shale gas activities and reveals their actual awareness and engagement in unconventional hydrocarbons exploration and production issues. Such knowledge will help to properly outline optimum approaches to environmental impact monitoring of shale gas operations.

2 METHODOLOGY OF THE SURVEY

2.1 Stakeholders and recipients

The general goals and rules for conducting of monitoring and status assessment of surface water and groundwater bodies in Europe are outlined in Water Framework Directive (DIRECTIVE 2000/60/EC) and, in case of groundwater, also in Groundwater Directive (DIRECTIVE 2006/118/EC). They both put the basis for water monitoring and assessment at the EU level, while legal basis and monitoring networks operational details are established at Member State or regional level. The monitoring networks are related to surface and groundwater bodies.

Despite much work that has been done, there is still no issue of any soil directive, which might specify objectives and principles of unified approach to soil status monitoring in terms of its natural properties and anthropogenic changes including both contamination and deterioration of natural properties due to different human activities on land surface.

A major information source about state of the environment in Europe is The European Environment Agency (EEA), an agency of the European Union, which coordinates the European environment information and observation network – Eionet[2]. However environmental monitoring in field is conducted by many different institutions at regional and local level. Responsible institutions in those European countries which may have interest in exploration and future production of hydrocarbons from unconventional resources were identified. A list of recipients is given in an appendix (APPENDIX 1). In total the questionnaire was send to more than 200 recipients, representing 90 institutions from 20 European countries.

Contact details were collected based on publicly available data.

2.2 Questions and scope of interest

General questionnaire is given in an appendix (APPENDIX 2). Questions were related to details about:

- surface water quantity and quality monitoring system
- groundwater quantity and quality monitoring system
- soil monitoring system

in particular country/ region. The goal was to confirm and verify information about number of monitoring points, scope of tests and frequency gathered at previous stage of this project (Fajfer et al., 2016). Therefore, relevant parts of a previous report were also attached and particular recipients were asked for verification.

In separate section of the questionnaire there were some questions about general opinions and attitudes to unconventional hydrocarbons impact and monitoring.

[2]EEA(http://www.eea.europa.eu/) sub-page ‘Who we are’(http://www.eea.europa.eu/about-us/who),visited in May 2016

Participants were asked for answers according to their personal approach and knowledge.

2.3 Feedback

Taking into consideration, that contact detail were collected mostly based on publicly available data and lots of them were general addresses (not to particular person) or online contact forms, accuracy rate of 57% is considered as quite high. This rate means that questionnaires were successfully delivered to more than half of recipients and some form of contact was set up with them.

Total number of returned fulfilled questionnaires is 12. A very valuable contribution was obtained from institutes representing 7 countries: Belgium (Wallonia), Estonia, Germany, Hungary, Latvia, Poland, and UK (Scotland), including opinions and attitudes outlook.

Based on survey's results, detailed description for contributed countries is given below as well as opinion outlook.

3 SURVEY'S RESULTS

3.1 Case study examples

In addition to previous report (Fajfer et al., 2016) detailed and updated description of water and soil monitoring networks is provided for countries and regions which participated in the survey and updated some data (Belgium – Wallonia, Estonia, Germany – Western Pomerania, Saxony-Anhalt, Hessia, Hungary, Latvia, and UK – Scotland. The scheme of description for water monitoring include: (1) institution involved, (2) legal basis, (3) tested parameters and frequency rules. Follow-up analysis of (4) network density is given to assess relevance of baseline environmental status for shale gas activities prepared based on general monitoring results. Next (5) soil monitoring system is briefly deliberated.

Belgium – Wallonia

(1) institution involved

Wallonia is a federal state of Belgium located in southern part of the country, with an area of 16,844 km², or 55% of the total area of Belgium (Britannica[3]). The water monitoring system covers the entire Wallonia's territory and is managed by Operational Directorate for Agriculture, Natural Resources and Environment (*Direction générale opérationnelle de l'Agriculture, des Ressources naturelles et de l'Environnement* DGARNE) of the Public Service of Wallonia (*Service Public de Wallonie* SPW), the Wallonia central administration (see Figure 1 for Institution's guide).

All the surface water physical and chemical monitoring data are managed by the Surface Water Directorate (*Direction des Eaux de surface*) of the Department of Environment and Water (*Département de l'Environnement et de l'Eau* DEE) while the surface water biological monitoring data are managed by the Department of the Natural and Agricultural Studies (*Département de l'Etude du Mileu Naturel et Agricole* DEMNA). All the acquisition, management and communication of groundwater monitoring data are the responsibility of the Groundwater Directorate (*Direction des Eaux souterraines*) of the Department of Environment and Water (*Département de l'Environnement et de l'Eau* DEE). Sampling and analysis are carried out by the Scientific Institute of Public Service (*L'Institut Scientifique de Service Public* ISSeP)

(2) legal basis

The legal basis for the water monitoring system can be found in the Wallonia's Water Code and more specifically in its annex IV for the monitoring technical methodology, which is the transposition of the water policy directive 2000/60/EC and its article 8 (SPW[4]). Details about the water management programs for Wallonia can be found (in

[3]Britannica http://www.britannica.com/place/Wallonia visited in May 2016

[4] SPW (http://environnement.wallonie.be/), sub-page "Legis - Code de l'Eau" http://environnement.wallonie.be/legis/Codeenvironnement/codeeaucoordonneR.html, visited in May 2016

French, German or Dutch) on the Public Service of Wallonia portal (SPW[5]). The Wallonia Region is divided into 4 river basins districts: Meuse, Seine, Scheldt, and Rhine District.

(3) tested parameters and frequency rules
Tested parameters are given in the Annex XI of the Walloon Water Code, entiteled: "Parameters to be measured for monitoring the quality of groundwater and surface drinking water (*Paramètres à mesurer pour la surveillance de la qualité des eaux souterraines et des eaux de surface potabilisables*) (SPW[4]).

The surveillance monitoring of surface water operates chemical and physical controls monthly while the operational monitoring operates controls 12 times during a 2 years period. For the groundwater surveillance monitoring the quantitative data acquisition is done at least monthly (more for automated acquisition) while the chemical data acquisition is done once or twice a year each three years. As for the surface water monitoring (same purpose), operational, additional and inquiry controls are developed. For operational controls a frequency of 2-4 monitoring a year is applied.

(4) network density
In terms of surface water, there is one operational monitoring point for every 53.5 km^2.In terms of groundwater, there is one chemical surveillance monitoring point for every 42.3 km^2.

The Public Service of Wallonia
Service Public de Wallonie SPW
http://www.wallonie.be/

- **Operational Directorate for Agriculture, Natural Resources and Environment**
  Direction générale opérationnelle de l'Agriculture, des Ressources naturelles et de l'Environnement
  DGARNE
  http://www.wallonie.be/fr/guide/guide-services/16088
  - **Departmnet of Environment and Water**
    Département de l'Environnement et de l'Eau DEE
    http://environnement.wallonie.be/administration/dee.htm
    - **Surface Water Directorate**
      Direction des Eaux de surface
    - **GroundwaterDirectorate**
      Direction des Eaux souterraines
  - **Department of Soil and Waste**
    Département du Sol et des Déchets DSD
    http://environnement.wallonie.be/administration/dgo3.htm

Figure 1: Authorities responsible for water and soil monitoring in the Wallonia Region – structure scheme.

[5] SPW(http://environnement.wallonie.be/), sub-page "Plans de gestion", http://eau.wallonie.be/spip.php?article140, visited in May 2016

(5) soil monitoring system
Unlike water surface monitoring and groundwater surface monitoring, there is no soil monitoring network in Wallonia. A compilation of data exists for analysis made on polluted sites or on sites where there is a suspicion of pollution. This database called *"Banque de Données de l'Etat des Sols Wallons"* is under construction as well as a public website application. The authority responsible for soil pollution characterization is the Department of Soil and Waste (*Département du Sol et des Déchets* DSD) of the Public Service of Wallonia.

Estonia

(1) institution involved
The water monitoring system covers the entire Estonian territory, which is 45,228 km² (Estonia.eu[6]). The monitoring system is a responsibility of Ministry of the Environment (*Keskkonnaministeeriumi*) and Environment Agency (*Keskkonnaagentuu*), who set up goals, scope, and methods as well as collects results and reports to EU Institutions.. Filed works are conducted by Estonian Environmental Research Centre (*Eesti Keskkonnauuringute Keskus*), Estonian University of Life Sciences (*Eesti Maaülikool*) in terms of surface water and Geological Survey of Estonia (*Eesti Geoloogiakeskus*) for groundwater monitoring.

(2) legal basis
Environmental Monitoring Act (Riigi Teataja[7]) and its regulations give general framework for carrying out monitoring activities on state level. General goals, parameters and sampling frequencies are set in ministerial regulations on implementation of national monitoring programme (Regulation No 71) and requirements on water monitoring programmes (Regulation No 25). Additionally, enterprises' monitoring obligations are regulated by their water permits or integrated permits.

(3) tested parameters and frequency rules
Physical-chemical parameters tested in surface water and groundwater are given in a table (TABLE 1)

Surface water chemical monitoring is sampled four times a year. Groundwater is sampled once a year for chemical parameters while groundwater level monitoring is continuous (automatic) in most wells.

(4) network density
In terms of surface water, there is one operational monitoring point for almost every 34 km^2.In terms of groundwater, there is one chemical monitoring point for every 188.45 km^2.

[6]Estonia.eu http://estonia.eu/ visited in May 2016
[7]RiigiTeataja (https://www.riigiteataja.ee/en/) , sub-page Environmental Monitoring Act (https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/527102015001/consolide), visited in May 2016

TABLE 1: Physio-chemical parameters tested in water monitoring in Estonia. Source: Environment Agency of Estonia.

Surface water – 1st level parameters	Surface water – 2nd level parameters	Groundwater
acidity	Ammonium (N-NH_4_90%)	As
alkalinity	biochemichal oxygen demand (BOD5), annual average	Ba
ammonia	electrical conductivity (in situ), annual average	benzene
ammoniacal nitrogen (N-NH_4)	Oxygen saturation (O2_10%)	bi-phenols
ammonium (NH4)	pH (in situ), annual average	Ca
biochemical oxygen demand	pH (pH_10%)	Cd
biochemical oxygen demand (BHT7)	pH EQR	Cl
calcium	total nitrogen (N_tot), annual average	CO2
chemical oxygen demand	total nitrogen EQR	COD_Mn
chemical oxygen demand (dichroic)	total phosphorus (P_tot), annual average	conductivity
chloride	total phosphorus EQR	dissolved oxygen (O2)
colour	water transparency EQR	Fe
degree of base saturation of oxygen		hardness
dissolved organic carbon		HCO3
dissolved oxygen (in-situ measurement)		Hg
electrical conductivity		K
electrical conductivity (in-situ measurement)		Mg
hydrocarbonate		mono-basic phenols
magnesium		Na
Manganese and its compounds		NH4
nitrate (NO3)		NO2
nitric nitrogen (NO3N)		NO3
nitrite (NO2)		oil products(C10- C40)
Nitrite nitrogen (NO2N)		PAH (total)
organic matter		Pb
phosphate (PO4)		pH
Phosphate phosphorus		PHT
pH-value		SO4
pH-value (in-situ measurement)		soil residue
potassium		temperature
redox potential		tetrachloroethylene
salinity		trichloroethylene
silicon		trichloromethane
sodium		
soluble silicates		
sulphate (SO4)		
suspended solids		
The amount of ions		
The amount of sodium and potassium		
total hardness		
total iron		
total nitrogen		
total organic carbon		
total phosphorus		
total soluble solids content		
transparency		
water temperature		
yellow matter		

(5) soil monitoring system

Soil monitoring programme covers arable lands and includes 30 monitoring points distributed all over Estonia covering different types of soil and land use. Also additional points are set up when needed. Monitoring data can be extrapolated to Estonian arable soils generally. The Ministry of the Environment and Environment Agency are responsible for policy, collecting results and reports, while The Agricultural Research Centre operates in field. In soil monitoring programme the rotation cycle is 5 years so every point is monitored once in 5-year period. It may vary if some points cannot be monitored on that year or must be replaced for some reason but in general the 5-year rotation is followed. Monitored parameters are: pH, KCl, P, K, Ca, Mg, Cu, Mn, B, humus % (Tjurin method), C-org (Dumas method), volume weight, porosity, grain size distribution, trampling load, heavy metals (Cd, Pb, Cr, Cu, Ni, Zn, Hg), glyphosate and other plant protection substances.

Moreover the forest soil monitoring programme ended in 2008 and Geological Survey of Estonia compiled The Geochemical Atlas of the Humus Horizon of Estonian Soil, based on surface soil and subsoil's monitoring, and published in1997.

Germany – Hessia, Saxony-Anhalt, Western Pomerania

(1) institution involved

The monitoring is based on the guidelines of the Water Framework Directive (respectively the German Water Management Act), Groundwater Directive (respectively the German Groundwater Ordinance) and yearly decree of the State Ministry of Environment and Agriculture. The annual decrees implemented into national law the monitoring assumptions developed by group of experts from federal states. Installation and operation of the monitoring system are described in the monitoring-programme of each federal state. The first programme covered the first WFD-management-cycle from 2010 to 2015. In 2016 the water management authorities have worked out a follow-up program for the next cycle but it is still unpublished.

In Hessia environmental monitoring is charged by Hessian Agency for Nature Conservation, Environment and Geology (*Hessisches Landesamt für Naturschutz, Umwelt und Geologie*).

In Saxony-Anhalt monitoring is run by the State Agency for Flood Protection and Water (*Landesbetrieb für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt – LHW*).

In Western Pommerania monitoring systems are managed by the State Agency for Environment, Nature protection and Geology Mecklenburg-Western Pomerania (*Das Landesamtfür Umwelt, Naturschutz und Geologie* – LUNG), in coordination with the Ministry of Agriculture, Environment and Consumer Protection and the Local State Agencies for Agriculture and Environment (StÄLU), who also operates in field. Sampling on groundwater monitoring sites is carried out by accredited companies on behalf of LUNG. Water analytics are partly realized by the federal environmental laboratory of LUNG. Determination of organic micropollutants is contracted by LUNG to external labs. Monitoring results are collected by LUNG and archived in databases. Delivery of data to EEA is prepared by LUNG and carried out by the German Federal Environment Agency (Umweltbundesamt), reporting under the WFD is prepared by

LUNG and uploaded to WISE by the German Federal Institute of Hydrology (Bundesanstalt für Gewässerkunde).

(2) legal basis
Legal basis is given by federal government with:

- Regulation on the protection of surface waters – Surface water regulation (*Verordnung zum Schutz der Oberflächengewässer – Oberflächengewässerverordnung*);
- Regulation on the protection of groundwater – Groundwater Ordinance (*Verordnung zum Schutz des Grundwassers –Grundwasserverordnung*);
- Regulation on the quality of water intended for human consumption – Drinking Water Ordinance (*Verordnung über die Qualität von Wasser für den menschlichen Gebrauch –Trinkwasserverordnung*),

where basis assumptions for the system are provided (e.g. goals, methods, frequency rules, general scope of analyses).

(3) tested parameters and frequency rules

In Hessia the sampling frequency for groundwater parameters is between once or twice a year and scope of parameters is given in a table (TABLE 2).

In Saxony-Anhalt and Western Pomerania scope and frequency are in accordance with federal law (no details given). In Western Pomerania, in terms of groundwater surveillance monitoring is carried out once per year and covers main anions and cations, metals and volatile hydrocarbons. In addition to this operational monitoring is carried out twice per year and also covers pesticides and their metabolites, pharmaceuticals, radio-opaque substances and artificial sweeteners.

(4) network density
There are around 4500 monitoring points for groundwater in Hessia. Approximately 400 are owned by the Federal State of Hessia, the others belong to water distribution companies. There is one groundwater monitoring well for each 5 km^2 in Hessia.

In Saxony-Anhalt surveillance system for surface water includes 10 monitoring sites on rivers and 2 on lakes, with monitoring points in different depths. Operational system consist of 463 monitoring points on rivers and 43 on lakes. Altogether there is 1153 monitoring points on rivers, and 48 on lakes, which gives one monitoring point for every 17 km^2. In terms of groundwater there is 430 monitoring points for water quality, which is about 2 wells for 100 km^2.

In Western Pomerania surface water quality network consist of 12 surveillance and 276 operational sites on rivers, which is 1 monitoring site for approx. 84 km^2; There are also monitoring points on lakes and a coastal ones (lakes: 15 surveillance and 130 operational; coastal: 5 surveillance and 38 operational). The groundwater monitoring network consists of 292 monitoring sites (surveillance monitoring network: 159 sites, operational monitoring network: 133 sites), which is 1 monitoring well for approx. 80 km^2.

TABLE 2: Physio-chemical parameters tested in groundwater monitoring in Hessia. Source: Hessian Agency for Nature Conservation, Environment and Geology.

Physio-chemical parameters tested in groundwater monitoring in Hessia		
Ammonium als NH4	Hydrogencarbonat	Perfluorbutansulfonat
Bromid	Säurekapazität (KS 4.3)	Perfluordecanoat
Chlorid	Tetrachlorethen	Perfluordodecanoat
Fluorid	Trichlorethen	Perfluorheptanoat
Phosphor (gesamt) als P	alpha-HCH	Perfluorhexanoat
Nitrat-als NO3	beta-HCH	Perfluorhexansulfonat
Nitrit als NO2	delta-HCH	Perfluornonanoat
o-Phosphat als P	epsilon-HCH	Perfluoroctanoat
Sulfat	gamma-HCH	Perfluoroctansulfonat
Aluminium	Bromacil	Perfluoroctansulfonsäureamid
Arsen	Mecoprop	Perfluortetradecanoat
Barium	MCPA	Perfluorundecanoat
Blei	Bentazon	Perfluorbutanoat
Bor	Clofibrinsäure	Perfluorpentanoat
Cadmium	Dichlorprop	Perfluordecansulfonat
Calcium	2,6-Dichlorbenzamid	Methyl-Desphenyl-Chloridazon
Chrom	Atrazin	Metazachlorsulfonsäure
Eisen	Chlortoluron	Metazachlorcarbonsäure
Kalium	Desethylatrazin	Metolachlorcarbonsäure
Kobalt	Desethylterbuthylazin	Metolachlorsulfonsäure
Kupfer	Desisopropylatrazin	Desphenyl-Chloridazon
Lithium	Dimefuron	N,N-Dimethylsulfamid
Magnesium	Diuron	EDTA Ethylendiamin-tetraessigsäure
Mangan	Ethidimuron	NTA Nitrilotriessigsäure
Molybdaen	Hexazinon	Acesulfam
Natrium	Isoproturon	Cyclamat(Natrium)
Nickel	Metazachlor	Saccharin
Selen	Metolachlor	Sucralose
Silicium	Monuron	Neotam
Strontium	Propazin	Neohesperidin, Dihydrochalcon (NHDC)
Thallium	Sebuthylazin	Arsen
Uran (gesamt)	Simazin	Chrom
Vanadium	Terbuthylazin	Selen
Zink	Amminomethanphosphonsäure	Aspartam
Zinn	Glyphosat	Chrom VI
Basenkapazität (KB 8.2)	Chloridazon	Chlortetracyclin
DOC	Carbamazepin	Doxycyclin
Gesamt-Härte	Diclofenac	Sulfamethoxazol
Carbonat-Härte	1H,1H,2H,2H-Perfluoroctansulfonat	Sulfamethazin

(5) soil monitoring system

The German soil monitoring system is compiled by Federal Environmental Agency of Germany (UBA) and is carried out within particular states, for example Hessian Agency for Nature Conservation, Environment and Geology (HLNUG), based on the national

conception for the organization and operation of soil monitoring plots derived plans and operates in fields. The soil monitoring programme for Hessia consists of 68 sites, where soil samples are collected every 5-10 years. Additionally there is one so called an intensive-measuring-site, where continuous measurements of water content and soil water tension are made, and deposition and leachate samples are collected every 4 weeks in 2 locations. Results are collected by Federal Environmental Agency (UBA).

Hungary

(1) institution involved

The General Directorate of Water Management (*Országos Vízügyi Főigazgatóság* – OVF) is responsible for the surface water monitoring of Hungary. In field operations the laboratories of Government Offices (7 altogether) are engaged as well as the Regional Water Directorates (12 altogether) who are responsible for groundwater field measurements. The Geological and Geophysical Institute of Hungary (*Magyar Földtaniés Geofizikai Intézet*– MFGI) also operates a monitoring system, which is part of the country wide groundwater monitoring.

(2) legal basis

Basic documentation for monitoring is Ministerial decree as well as River Basin Management Plan issued by government.

Groundwater monitoring has to be performed according to the provisions of the Governmental decree 221/2004. (VII. 21.) on certain rules of river basin management. KvVM / Ministerial Decree 30/2004 (XII.30.) on certain rules of examination of groundwaters applies to the rights and obligations established for the designation of groundwater bodies, characterization and assessment of their status, their monitoring, the review of the aforementioned tasks, as well as the collection, processing and reporting of data necessary for the execution of these tasks. KvVM / Ministerial decree 101/2007. (XII. 23.)on the rules of intervention to groundwater resources and guidelines to the drilling of wells contains the types and frequency of measurements to be performed which are scheduled in the operational water permits issued by the water authority. The decree on the rules of operates of drinking water supplies is also important, because significant part of the groundwater monitoring system is based on wells of drinking water supplies. This decree lays down what parameters are to be measured.

Every year OVF produce a guide for monitoring activity, which contains the monitoring points, methods, frequency etc.

(3) tested parameters and frequency rules

All the monitoring groundwater quality stations measure following parameters: water temperature, yield, dissolved oxygen, pH, specific electric conductivity, NO3, NH4, Na, K, Ca, Mg, Cl, SO4, chemical oxygen demand and alkalinity. There are other examined specific components according to the yearly established guide. It is determined on the basis of earlier results of the monitoring point or the status of the groundwater body. Sampling frequency of groundwater quality measurements are usually 4 times in a year in the operating wells and springs. There are 2 sampling in a year in the monitoring wells and in the wells out of operation.

(4) network density
In terms of surface water there are 145 surveillance and 1217 operational monitoring sites (in total 1279, one point for about 73km^2). In terms of groundwater quality there are 2001 surveillance and 425 operational wells, which is about one well for each 46,5km^2)

(5) soil monitoring system
no update

Latvia

(1) institution involved
Environmental monitoring is a responsibility of Latvian Environment, Geology and Meteorology Centre (*Latvijas Vides, ģeoloģijas un meteoroloģijascentrs* LEGMC), Latvian Institute of Aquatic Ecology (*Latvijas Hidroekoloģijas Institūts* LHEI), and Ministry of Environmental Protection and Regional Development (*Vides aizsardzības un reģionāl āsattīstības ministrijas*).

(2) legal basis
Following legal documents organize the system: Water Management Law (*Udens apsaimniekosanas likums*), and Cabinet Regulation No. 92 "Requirements for the Monitoring of Surface Water, Groundwater and Protected Areas and the Development of Monitoring Programmes". Details are derived within the Water monitoring programme 2015-2020 (*Udenu monitoringa programma 2015-2020*) issued by LEGMC and LHEI.

(3) tested parameters and frequency rules
The scope and frequency of analyses are established in the Water monitoring programme (in Latvian only, no details given).

(4) network density
The surface water quality network comprises 363 surveillance and 116 operational monitoring stations. Including investigative there is 488 surface water quality monitoring stations and this is total number to be observed till year 2020 at least during 1 year; only 19 intensive surveillance monitoring stations are measured every year. The groundwater quality monitoring network consist of 53 monitoring stations with 218 wells and 30.

(5) soil monitoring system
no update

United Kingdom – Scotland

(1) institution involved
Scottish Environment Protection Agency (SEPA) is in charge for environmental monitoring.

(2) legal basis
The UK report to EC as a single member state however environmental and planning regulations and their implementation e.g. Water Framework Directive, is devolved within the UK. In summary Scotland has a different regulatory framework to England, Northern Ireland and Wales. Since January 2015 Scotland also has a moratorium on all

onshore unconventional oil and gas activities, meaning no planning or environmental licenses under the Water Environment (Controlled Activity) (Scotland) regulations, known as CAR, can be granted for such activities. Scottish Government have commissioned further evidence gathering projects and will use the finding from these studies and the public consultation feedback to determine if and/or when the moratorium would be lifted.

No further update received.

Summary

Although the data set is small, it can be clearly notice, that networks' density is highly diverse (TABLE 3) and strongly related to local condition. For example in Hessia (German federal state) there is impressive number of groundwater monitoring points as network include wells operated by private enterprises. In Estonia there is significant difference between surface water network's density (a site per 24 km^2) and groundwater network's density (a site per 188 km^2) which probably results from geological conditions. Generally density and resolution of network seems to be inadequate for establishing baseline and definitely insufficient for shale gas monitoring, if dedicated to every single well pad.

TABLE 3: Density of water monitoring networks in states participated in the survey. *rate shows number of square kilometres per one monitoring point

	Area	Surface water network		Groundwater network	
	[km^2]	number of points	rate*	number of points	rate*
Wallonia	16844	315	53,47	398	42,32
Estonia	45228	1863	24,27	240	188,45
Hungary	93060	1379	72,75	2001	46,5
Hessia	21115	no data	-	4500	4,69
Saxony-Anhalt	20406	1153	17,69	430	47,45
Western Pomerania	23200	276	84,05	292	79,45
Latvia	64589	488	132,35	218	296,27

3.2 Opinion outlook

As the conducted poll shows, this split of responsibility on environmental monitoring in some cases creates a situation in which it is uncertain who actually is supposed to address new forthcoming challenges like unconventional hydrocarbons exploration and production environmental impact assessment and control. That is why sent questionnaires were in many cases redirected several times and the final response was so little. Only in 6 out of 12 returned questionnaires the actual knowledge on shale gas issues was declared, with less awareness of technology and potential hazards and in 2 out of these 5 cases - with very little applicability of this issues to work responsibilities. The most often mentioned source of knowledge was the internet, only in Poland responders declared that they had had the opportunity to take part in workshops or seminaries organized on unconventional hydrocarbons related topics.

Except for Polish (additional monitoring needed) and Hungarian (existing monitoring sufficient with regard to present shale gas development stage) cases, most of responding

institutions were not sure about sufficiency of ongoing data collecting systems for baseline environmental status for shale gas development establishing, they tended to propose improvements and additional dedicated measurements in order to assess the benchmark level for shale gas activities. Only 3 institutions tried to indicate which parameters should be taken into account in baseline state assessment, though in most cases they did not propose indicators specific for oil and gas activities impact, but general parameters.

Only 4 out of 12 responding institutions assessed the possibility of environmental impact assessment based on ongoing monitoring systems. They were skeptical about the sufficiency of these and recommended some modifications and supplements, except for Hungary, where operational monitoring of oil and gas production places was conducted and this was considered as sufficient for detection of potential adverse changes in environmental status.

Summary of survey participants' opinions is given in a table (TABLE 3).

Based on few comments done in the questionnaire one can conclude that even these institutions which decided to respond to the poll have no prepared scenario or even opinion on requirements or approaches to surface and groundwater and soil status monitoring with regard to potential hazards posed by unconventional oil and gas exploration and production activities.

The final question is why there was so little response to the poll? The total number of 90 institutions from 20 countries were asked to fulfill the questionnaire, and there was a feedback from 13% of them. A list of contacts was prepared based on publicly available data and it may be expected that public institutions responsible for monitoring should be more eager to respond for an inquiry. However participation in the survey was voluntary and questionnaire was quite wide in scope. Moreover shale gas issue seems to be a little controversial, so some institutions refused to participate due to a lack of competence in shale gas issue, although almost all questions were related to general environmental monitoring and not to shale gas directly.

The reason for such poor response may lie in little unconventional hydrocarbons activities being conducted at the moment in most of EU countries, so the potentially involved institutions cannot see any incentive to face the problem which may not come into being soon. This may be the case especially in countries with bans or moratoria.

Little response to opinion seeking poll may point out that without special requirements on the EU or particular governments' level the bodies responsible for environmental impact control are not willing to prepare the strategy for such new challenges as unconventional hydrocarbons activities' impact control.

TABLE 3: Summary of survey participants' opinions.

administrative agent *on behalf of* **Public Service of Wallonia – Department of Environment and Water** Belgium	chief specialist *on behalf of* **Environment Agency of Estonia** Estonia	senior policy officer *on behalf of* **Scottish Environment Protection Agency** Scotland	head of division *on behalf of* **Latvian Environment, Geology and Meteorology Centre** Latvia	unknown *on behalf of* **Geological and Geophysical Institute of Hungary** Hungary	water management referents *on behalf of* **General Directorate of Water Management** Hungary	geologist *on behalf of* **Hessisches Landesamt für Naturschutz, Umwelt und Geologie** Germany	head of division *on behalf of* **State Agency for Environment, Nature protection and Geology Mecklenburg-Western Pomerania** Germany	head of division *on behalf of* **The Landesamt für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt** Germany	geologist *on behalf of* **Polish Geological Institute – National Research Institute** Poland	unknown *on behalf of* **Chief Inspectorate Of Environmental Protection** Poland	chief specialist *on behalf of* **Regional Inspectorate Of Environmental Protection in Warsaw** Poland
Are you familiar with shale gas issues?											
knowledge3/5	knowledge 3/5	knowledge 5/5	knowledge 2/5	knowledge 5/5	no answer	knowledge 3-4/5	no answer	no answer	knowledge 5/5	knowledge 3/5	knowledge 3/5
interest 4/5	interest 3/5	interest 5/5	interest 4/5	interest 5/5	no answer	interest 5/5	no answer	no answer	interest 5/5	interest 1/5	interest 3/5
need 3/5	need 1/5	need 5/5	need 4/5	need 4/5	no answer	need 4/5	no answer	no answer	need 5/5	need 1/5	need 5/5
Are you familiar with exploration/extraction technology in case of unconventional hydrocarbons?											
knowledge 2/5	knowledge 1/5	knowledge 4/5	knowledge 1/5	knowledge 4/5	no answer	knowledge 4/5	no answer	no answer	knowledge 5/5	knowledge 2/5	knowledge 5/5
interest 4/5	interest 2/5	interest 5/5	interest 4/5	interest 5/5	no answer	interest 4/5	no answer	no answer	interest 5/5	interest 1/5	interest 3/5
need 1/5	need 1/5	need 5/5	need 1/5	need 4/5	no answer	need 4/5	no answer	no answer	need 5/5	need 1/5	need 5/5
Are you aware of potential environmental hazards caused by exploration/extraction of unconventional hydrocarbons?											
YES	NO	YES	YES	YES	no answer	YES	no answer	no answer	YES	YES	YES
interest 4/5	interest 2/5	interest 5/5	interest 4/5	interest 4/5	no answer	interest 5/5	no answer	no answer	interest 5/5	interest 3/5	interest 3/5
need 4/5	need 1/5	need 5/5	need 1/5	need 4/5	no answer	need 4/5	no answer	no answer	need 5/5	need 1/5	need 5/5
Do you know where in your vicinity potentially shale gas prone areas are located?											
NO	NO	YES	YES	YES	no answer	YES	no answer	no answer	YES	YES	YES
Have you ever searched for information about shale gas?											
no answer	YES	YES	YES	YES	no answer	YES	no answer	no answer	YES	YES	YES
Did you find it?											
no answer	YES	YES	YES	YES	no answer	YES	no answer	no answer	YES	YES	YES
Where did you find it?											
no answer	internet browsers, articles, research studies	governments, regulators, academics	The State Geology Fund, LEGMC data base, as well as information that LEGMC have from other projects(about territory of Latvia)	on internet sites and in relevant books, publications and reports of hydrocarbon exploration and production companies	no answer	library catalogues, periodicals, the Internet	no answer	no answer	scientific papers, government announcements, newspaper's article, local authorities actions, industry data and direct contacts; workshops and seminaries, internet	internet sites (Polish Geological survey and Ministry of Environment)	trainings, internet sites, publications
Do you think it is possible to establish baseline environmental status based on ongoing monitoring of surface water bodies, groundwater and soils?											
no answer	Do not know	no answer	It may be possible to establish baseline environmental status by improvement of ongoing monitoring.	Based on the current situation of Hungarian shale gas/tight gas exploration, I think that it is possible	no answer	No, additional special monitoring systems have to be established for deep underground	no answer	no answer	NO This data may be helpful and should be used, however additional site-specific tests should be conducted as well	NO	It is not possible, because currently ongoing monitoring gives overall view of environment's state and is not specific enough for particular site assessment
Which parameters would you consider to take into account while describing baseline status of surface water bodies, groundwater and soils before a launch of shale gas exploration and production?											
no answer	no answer	no answer	In Latvia shale gas exploration have never been carried out. However, there may be possibility to	Air quality, soil and groundwater quality, ensuring the protection of groundwater, impacts	no answer	Parameters of the EU-WFD and of our groundwater monitoring (see chapter groundwater)	no answer	no answer	In surface water and groundwater: pH, specific electrical conductivity, total alkalinity, barium,	Parameters related to technological processes of extraction	Heavy metals and hydrocarbons

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			consider some parameters (for example porosity (in some wells), temperature data, well logging data, lithological description, chemical analysis, TOC and others) which could be measured for better knowledge of shale gas distribution and quality.	of noise and vibration, state of surface technological systems, natural radioactivity, water use and water balance, quantitative and qualitative parameters of drilling mud and flow-back fluids, state of undersurface technological systems, quality and quantity of fluids coming back to surface, possible surface movements, fluid levels in the well, quality and quantity of generated waste.					boron, chlorides, lithium, potassium, sodium, strontium, calcium, volatile aromatic hydrocarbons, phenol index, aggressive carbon dioxide, methane; in soils: soil gas survey (methane, C_2-C_5 alkanes, C_2-C_5 alkenes, carbon dioxide in soil gas, soil compaction, the contents of humus, K+, Na+, Ca++, Mg++ ions, humic acids, and nutritional components, pH, the contents of hydrocarbons (total, aliphatic, aromatic), gasoline, mineral oil		
Do you think it is possible to assess environmental impact of shale gas activities relying only on currently ongoing monitoring?											
no answer	NO	no answer	Partly. There can be used some data from currently ongoing monitoring system that can already give some information about current situation. However, in general this information is insufficient and data which could give some information about shale gas are rare and describe only some small part. It is also important to admit that at the moment in Latvia the main target of ongoing water monitoring system is active water exchange zone (about 300 m	Yes, the active producing wells (2-3) are working on the base of allowed Technical Operation Plan. The detailed specification of environmental monitoring is a part of the TOP allowed by the mining and environmental authorities.	no answer	no answer	no answer	no answer	NO, resolution is not sufficient	NO	NO

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			depth) and there is only some rare data that covers deeper part (groundwater monitoring that is carried out by operators).								
Would you recommend any adjustments/modifications to the currently operate monitoring system to adapt it to shale gas development environmental impact monitoring and control?											
no answer	no answer	no answer	Partly. Maybe there can be made some modifications to adapt current system to shale gas development, however only in terms of legislation of Latvia. At the moment it is hard to tell some specific modifications (these could be measured parameters) but in future it is possible to consider them.	NO	no answer	Special monitoring systems have to be established for deep underground in each groundwater storey depending on the geological, hydrogeological and tectonic situation.	no answer	no answer	Not yet; First more data should be collected and analyzed.	NO	Implementation of investigative monitoring at planning exploratory sites, before, during and after exploratory or extraction works
Would you recommend additional, independent system for shale gas development environmental impact monitoring and control?											
no answer	Not yet in Estonia	no answer	Just in case if usage of ongoing monitoring would be successful enough for establishment of shale gas recourses (or in case of exploration).	Yes, for example passive seismic monitoring, airborne remote sensing monitoring of impacts on the surface	no answer	no answer	no answer	no answer	YES Based on local conditions and technology employed, covering baseline status, operations' control and long term monitoring along production stage and after well abandonment	YES	Implementation of investigative monitoring at planning exploratory sites, before, during and after exploratory or extraction works
Would you like to share any comments?											
No shale gas initiative currently exists in the Walloon Region		Since Jan 2015 Scotland has had a moratorium on all onshore unconventional oil and gas activities, meaning no planning or environmental licenses can be granted for such activities. Scottish Government have	NO	During the monitoring activity the operator must insure the resulting data storage and the availability for the necessary evaluation to the stakeholders and authorities. Based on the information system it is necessary	the General Directorate of Water Management does not officially engage in shale gas issue						

administrative agent *on behalf of* **Public Service of Wallonia – Department of Environment and Water** Belgium	chief specialist *on behalf of* **Environment Agency of Estonia** Estonia	senior policy officer *on behalf of* **Scottish Environment Protection Agency** Scotland	head of division *on behalf of* **Latvian Environment, Geology and Meteorology Centre** Latvia	unknown *on behalf of* **Geological and Geophysical Institute of Hungary** Hungary	water management referents *on behalf of* **General Directorate of Water Management** Hungary	geologist *on behalf of* **Hessisches Landesamt für Naturschutz, Umwelt und Geologie** Germany	head of division *on behalf of* **State Agency for Environment, Nature protection and Geology Mecklenburg-Western Pomerania** Germany	head of division *on behalf of* **The Landesamt für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt** Germany	geologist *on behalf of* **Polish Geological Institute – National Research Institute** Poland	unknown *on behalf of* **Chief Inspectorate Of Environmental Protection** Poland	chief specialist *on behalf of* **Regional Inspectorate Of Environmental Protection in Warsaw** Poland
		commissioned further evidence gathering projects and will use the finding from these studies and the public consultation feedback to determine if and/or when the moratorium would be lifted. If it is lifted the Scottish Government will determine what, if any, further regulations and monitoring requirements will be needed		to analyze the measured/noticed environmental changes, the interconnections of different parameters, the cause and effect relationships.							

4 CONCLUSIONS

The general goals and rules for conducting of monitoring and status assessment of surface water and groundwater bodies in Europe are outlined in Water Framework Directive and, in case of groundwater, also in Groundwater Directive. They both put the basis for water monitoring and assessment at the EU level, while legal basis and monitoring networks operational details are established at Member State or regional level.

Despite much work that has been done, there is still no issue of any soil directive on European level, which might specify objectives and principles of unified approach to soil status monitoring in terms of its natural properties and anthropogenic changes including both contamination and deterioration of natural properties due to different human activities on land surface.

The data on water and soil status observations gathered at member states and regional levels is reported, collected and stored by the European Environment Agency, though information on results is also available through different dissemination systems in particular countries or regional institutions (use of local languages may a serious obstacle while one looks for information). There is huge number of institutions in EU member states responsible and engaged in both environmental status assessment and environmental monitoring with regard to surface water, groundwater and soils in Europe.

The environmental monitoring systems operating in European countries and regions are well defined, stable and comprehensive. Systems do not respond immediately to any changes in policy or industry, like shale gas development. This is actually their strong advantage. Main goal, which is to monitor environmental status, is achieved constantly with firm and consistent approach, so it is not expected to change or adjust instantly. Based on few comments done in the questionnaire one can conclude that institutions are aware of shale gas issue and its potential hazards. However, it seems that there is no prepared scenario or opinion on requirements or approaches to surface and groundwater and soil status monitoring with regard to potential hazards posed by unconventional oil and gas exploration and production activities.

The final question is why there was so little response to the poll? The total number of 90 institutions from 20 countries were asked to fulfill the questionnaire, and there was a feedback from 13 % of them. Maybe the reason lies in little unconventional hydrocarbons activities being conducted at the moment in most of EU countries, so the potentially involved institutions cannot see any incentive to face the problem which may not come into being soon. This may be the case especially in countries with bans or moratoria. But in fact the scope of possible explanation for such a situation is very wide and may include both intentional lack of reaction and renunciation because of no duty on response. Maybe a poll as a tool for collecting stakeholders opinion on specific topics is not a good one and in the future some other forms of communication must be used.

Little response to opinion seeking poll may indicate the need for special requirements on the EU or particular governments' level the bodies responsible for environmental impact control are not willing to prepare the strategy for such new challenges as unconventional hydrocarbons activities' impact control.

Based only on data gathered so far within this project, the responsible bodies either do not work or do not want to share their findings on a common set of parameters observed within monitoring systems which would be useful for defining environmental baseline status for shale gas operation, as well as no special approaches to dedicated monitoring system tracking possible impact are being worked out. This goal will be reviewed for further studies.

4.1 Knowledge gaps

Currently institutions responsible for environmental status assessment and operating monitoring systems are aware of shale gas possible hazards but no official work on either benchmark level assessment for future changes control or on dedicated monitoring strategy are conducted. It seems that more scientific data and recommendation, particularly in terms of trace markers and parameters may help to adjust goals and manuals if needed in the future to meet new challenges related to unconventional hydrocarbons' possible impact.

4.2 Follow-up steps

Further research will focus on scientific studies related to shale gas environmental impacts, which is a crucial issue when it comes to deriving a set of monitoring parameters and recommending best practices for monitoring of the actual impact of shale gas activities on surface water, groundwater and soils .

A particular emphasis shall be given to soil, as there is virtually no baseline data with a resolution relevant to singular well pad. Second issue of paramount importance is the use of methane measurement in soil and groundwater as a monitoring tool for impact of shale gas activities.

Although stakeholders engagement seems to be very little in environmental hazards related to shale gas development issues, their opinion will have to be taken into consideration once the recommendations of best practices for control of the impact using environmental monitoring are prepared.

5 REFERENCES

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Konieczyńska M., Lipińska O., (2015) List of stakeholders in monitoring surface, groundwater and soils, Polish Geological Institute - National Research Institute, M4ShaleGas project.

DIRECTIVE 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, L327/1, 1-72.

DIRECTIVE 2006/118/EC of the European Parliament and the Council of 12 December 2006on the protection of groundwater against pollution and deterioration. Official Journal of the European Union L 372/19.

12 responded General questionnaires:

- Public Service of Wallonia – Department of Environment and Water
- Environment Agency of Estonia
- Scottish Environment Protection Agency
- Latvian Environment, Geology and Meteorology Centre
- Geological and Geophysical Institute of Hungary
- Hungarian General Directorate of Water Management
- Hessisches Landesamt für Naturschutz, Umwelt und Geologie
- State Agency for Environment, Nature protection and Geology Mecklenburg-Western Pomerania
- The Landesamt für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt
- Polish Geological Institute – National Research Institute
- Polish Chief Inspectorate Of Environmental Protection
- Regional Inspectorate Of Environmental Protection in Warsaw, Poland

6 APPENDIX 1: SURVEY'S RECIPIENTS.

COUNTRY	INSTITUTION	CONTACT DETAILS
Belgium	Soil Survey Centre	not found
Belgium	The Faculties of Agriculture of Gembloux, Gent and Leuven	gembloux@ulg.ac.be
Belgium - Flemmish	VMM The Flemmish Environmental Agency	info@vmm.be
Belgium - Wallonia	The Department of Environment and Water (Direction Generale Operationnelle Agriculture, Ressources Naturelles et Environment DGARNE)	
	Branch Surface water	desu.dee.dgarne@spw.wallonie.be
	Groundwater Directorate	deso.dee.dgarne@spw.wallonie.be
	Development of management plans, economic analysis, reporting WISE	http://spw.wallonie.be/dce/spip.php?article69 N. Fermin
	Development of Management Plans	http://spw.wallonie.be/dce/spip.php?article69 C. Bosly
	Hydromorphology - state of water bodies surface, register of protected areas	http://spw.wallonie.be/dce/spip.php?article69 P.N. Libert
	Environmental permits	http://spw.wallonie.be/dce/spip.php?article69 K. Cheboub-Benchaba
	Network monitoring physico-chemical quality of surface waters	http://spw.wallonie.be/dce/spip.php?article69 J. Delvaux
	Chemical and physicochemical general	http://spw.wallonie.be/dce/spip.php?article69 B. Bastin eau@spw.wallonie.be
	general organization of the Directorate	http://spw.wallonie.be/dce/spip.php?article69 F.Paulus
	director	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf F.Lambot
	cell Studies	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf D. deThysebaert
	Integrated Cell	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf P. Orban
	Gauging (Water levels)	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf S. Gailliez
	Atlas non-navigable water courses	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf S. Gaspar
	Atlas non-navigable water courses district: Cork	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf X. Legall http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf

		L. Pirard
	district: Market	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf D.Genin
	district: Mons	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf J. Lecomte
	district: Namur	http://environnement.wallonie.be/de/dcenn/dcenn_contact.pdf L.M. Petiau
	Risk Management of Geological and Mining industry	J. Beaujean S. Roquet
Belgium	Bruxelles environnement brussels	online contact form
Belgium	Société Bruxelloise de Gestion de l'Eau	info@bmwb.be info@sbge.be
Bulgaria	ExEA Executive Environment Agency	iaos@eea.government.bg
Czech Republic	Masaryk University	http://www.muni.cz/research/publications/777414 J. Ráček T. Ludík,
Czech Republic	Ministry of the Environment of the Czech Republic	info@mzp.cz
	Section of Policy of the Environment and International Relations	http://www.mzp.cz/en/organisational_structure V. Smrž
	Department of EIA and Integrated Preventio	http://www.mzp.cz/en/organisational_structure E. Doležal
	Department of Water Protection	http://www.mzp.cz/en/organisational_structure J. Nistler
Czech Republic	Czech Geological Survey	secretar@geology.cz http://www.geology.cz/rebilance/english/contacts P. Mixa R. Kadlecová J. Zusková
Czech Republic	Czech Environmental Inspectorate (CEI)	http://www.cizp.cz/Media R. Burketová J. Jandová
Denmark	The Danish Nature Agency, Nykøbing	nyk@nst.dk
Denmark	The Danish Nature Agency, Vandplaneroghavmiljø	tbr@nst.dk
Denmark	Aarhus University, DCE - Danish Centre for Environment and Energy	dce@au.dk
Denmark	Aarhus University, DCE - Danish Centre for Food and Agriculture	dca@au.dk
Denmark	Geological Survey of Denmark and Greenland GEUS	flar@geus.dk tl@geus.dk
Denmark	Technical University of	http://www.dtu.dk/english

	Denmark	
Estonia	The Estonian Environment agency *Senior Specialist (Management Monitoring)* *Senior Specialist (water)* *Senior Specialist (water)* *Senior Specialist (Management Monitoring)* *Senior Specialist (water)* *Specialist (water)* *Hydrology department - head* *Analysis Department of the Environment - head* *general*	http://www.keskkonnaagentuur.ee/et/kontaktid A. Martin K. Altoja P. Ennet A. Põder N. Sinikas K Olesk T. Pedusaar A Sims kaur@envir.ee
Estonia	The EstonianEnvironment Information Centre	not found
Estonia	Geological Survey of Estonia *Geochemistry and Environmental* *Hydrogeology*	http://www.egk.ee/about-gse/structure/geochemistry-and-environmental-geology/?lang=en M.Karimov V. Petersell K. Täht-Kok H. Milvek S.Nirgi http://www.egk.ee/about-gse/structure/hydrogeology/?lang=en M. Truu
France	IFP Energies nouvelles (IFPEN)	the project partner
France	The French Geological Survey	online contact form
France	INERIS	neris@ineris.fr
France	The Gis Sol (Group of Scientific Interest on Soil)	not found
Germany	The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety - Bundesumweltministerium	online contact form
Germany	German Research Centre for Geosciences GFZ	the project partner
Germany	Federal Institute for Geosciences and Natural Resources (BGR)	http://www.bgr.bund.de/EN/Themen/Wasser/Monitoring/monitoring_node_en.html S. Altfelder F. Wagner http://www.bgr.bund.de/EN/Themen/Wasser/Informationsgrundlagen/informationsgrundlagen_node_en.html

		S. Broda http://www.bgr.bund.de/EN/Themen/Wasser/Beschaffenheit/beschaffenheit_node_en.html G. Houben A. Larm http://www.bgr.bund.de/EN/Themen/Wasser/Management/management_node_en.html S.I. Vassolo http://www.bgr.bund.de/EN/Themen/Boden/boden_node_en.html E. Eberhardt E. Fries http://www.bgr.bund.de/EN/Themen/Boden/Informationsgrundlagen/informationsgrundlagen_node_en.html U. Stegger http://www.bgr.bund.de/EN/Themen/Zusammenarbeit/int-zusammenarb_node_en.html B. Stribrny F. Schwarz
	GeologischeLandesämter (Sate Geological Surveys)	abteilung9@rpf.bwl.de poststelle@lfu.bayern.de A. Limberg lbgr@lbgr.brandenburg.de info@gdfb.de R. Taugs webmaster@hlug.de poststelle@lung.mv-regierung.de info@lbeg.niedersachsen.de poststelle@gd.nrw.de office@gla-rlp.de lua@lua.saarland.de lfulg@smul.sachsen.de poststelle@lagb.mw.sachsen-anhalt.de poststelle@tlug.thueringen.de
Germany	The Helmholtz Centre for Environmental Research (UFZ)	http://www.ufz.de/index.php?de=39119 D.Borchardt http://www.ufz.de/index.php?de=38459 I. Bärlund
Germany	German Environment Agency UBA	info@umweltbundesamt.de
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		info@vallei-veluwe.nl info@wrij.nl info@wsrl.nl info@wshd.nl post@hdsr.nl info@hhsk.nl info@hhdelfland.nl info@overmaas.nl info@wpm.nl info@dommel.nl info@aaenmaas.nl info@brabantsedelta.nl info@scheldestromen.nl
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Netherlands	Deltares	https://www.deltares.nl/en/
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Slovakia	Slovak Hydrological Institute	http://www.uh.sav.sk/en-gb/About-Institute/Contact-us P. Pekárová Y. Velísková P. Šurda
Slovakia	Water Research Institute *General Director of the Water Research Institute* *Department of policies, programs and water planning* *Department programs and concepts* *Department of Water Quality* *Department of surface water and groundwater* *Department of physico-chemical, radiochemical and inorganic analysis* *Department of Water Management Information Systems*	http://www.vuvh.sk/default.aspx?frmName=Contacts L. Kopčová J. Gajdová A. Vranovská P. Belica A. Patschová J. Tkáčová M. Reháček
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Ukraine	the State Geological Survey	not found
Ukraine	The State Hydrometeorological Service	not found
Ukraine	The Ministry of Health	not found
Ukraine	The Ministry of Agricultural Policy	not found
Ukraine	Ministry of Ecology and Natural Resources of Ukraine	gr_priem@menr.gov.ua http://eng.menr.gov.ua/index.php/contacts A. V. Storchous S. M. Salata V. H. Vasylenko N. S. Trofymenko O. F. Kulyk
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7 APPENDIX 2: GENERAL QUESTIONNAIRE.

I. Details of person(s) who work on questionnaire:

Name: Click here to write.
Institution: Click here to write.
Position, responsibilities: Click here to write.
Contact details: e-mail address

II. Give details about surface water quantity and quality monitoring system in your country / region:

Territorial range: what area is covered by the system?
Click here to write : administrative, geographical region /approximate surface in km^2

Legal basis: is there any national legal document for the monitoring establishment (e.g. regulation, act)? Attach if possible
Click here to write : title, issuing body, editorial details

Basic documentation: where details about the system are given (e.g. goals, methods, frequency, scope of analyses)? Attach if possible
Click here to write : title, issuing body, editorial details

Institutions involved:
Who is responsible for the monitoring system - set up goals, scope, methods: Click here to write.
Who operates in field: Click here to write.
Who collects results and reports to EU Institutions: Click here to write.

How many monitoring points does the monitoring network consist of? Attach a map if possible.
Click here to write : Number of points in surveillance system.
Click here to write : Number of points in operational system.
Click here to write : Total number of points.
Click here to write : up to date (year)
Which parameters are tested? List or attach document, table, picture etc.
Click here to write.

Describe sampling frequency. List or attach document, table, picture etc.
Click here to write.

III. Give details about groundwater quantity and quality monitoring system in your country / region:

Territorial range: what area is covered by the system?
Click here to write : administrative, geographical region /approximate surface in km^2

Legal basis: is there any national legal document for the monitoring establishment (e.g. regulation, act)? Attach if possible
Click here to write.

Basic documentation: where details about the system are given (e.g. goals, methods, frequency, scope of analyses)? Attach if possible
Click here to write.

Institutions involved:
Who is responsible for the monitoring system – set up goals, scope, methods: Click here to write.
Who operates in field:
Click here to write.
Who collects results and reports to EU Institutions: Click here to write.

How many monitoring points does the monitoring network consist of? Attach a map if possible.
Click here to write.

Which parameters are tested? List or attach document, table, picture etc.
Click here to write.

Describe sampling frequency. List or attach document, table, picture etc.
Click here to write.

IV. Give details about soil monitoring system in your country / region:

Territorial range: what area is covered by the system?
Click here to write : administrative, geographical region /approximate surface in km^2

Structure: give details about system's structure, e.g. how many water bodies etc., which level do you represent?
Click here to write.

Legal basis: is there any legal document (e.g. regulation, act)? Attach if possible
Click here to write.

Basic documentation: where details about the system are given (e.g. goals, methods, frequency, scope of analyses)? Attach if possible
Click here to write.

Institutions involved:
Who makes policy and set up goals, scope, methods: Click here to write.
Who operates in field: Click here to write.
Who collects results and reports to EU Institutions: Click here to write.

How many monitoring points does the monitoring network consist of? Attach a map if possible.
Click here to write.

What parameters are tested? List or attach document, table, picture etc.
Click here to write.

Describe frequency. List or attach document, table, picture etc.
Click here to write.

Benchmark data. Are there any country / regional wide geochemical survey / maps to be considered as a baseline of surface soils and/or subsoils?

Click here to write : title, issuing body, editorial details / database metadata details

V. In this section there is a direct reference to unconventional hydrocarbons. Answer the questions according to your knowledge, based on your monitoring system management and results.

Are you familiar with shale gas issues? Do you know what unconventional hydrocarbons are?
Yes / No rank your knowledge: from 0 – '*minimum*' to 5 – '*maximum*'
rank your interest: from 0 – '*I'm not interested'* to 5 – '*I'm highly interested*'
rank necessity: from 0 – *'I don't need this in my work'* to 5 – *'I need this in my work'*.
Are you familiar with exploration/extraction technology in case of unconventional hydrocarbons?
Yes / No rank your knowledge: from 0 – *'minimum'* to 5 – *'maximum'*
rank your interest: from 0 – '*I'm not interested'* to 5 – '*I'm highly interested*'
rank necessity: from 0 – *'I don't need this in my work'* to 5 – *'I need this in my work'*.
Are you aware of potential environmental hazards caused by exploration/extraction of unconventional hydrocarbons?
Yes / No Yes / No
rank your interest: from 0 – '*I'm not interested'* to 5 – '*I'm highly interested*'
rank necessity: from 0 – *'I don't need this in my work'* to 5 – *'I need this in my work'*.
Do you know where in your vicinity potentially shale gas prone areas are located?
Yes / No
Have you ever searched for information about shale gas? Did you found it and where?
Click here to write.
If you needed such information where would you search for it?
Click here to write.
Do you think it is possible to establish baseline environmental status based on ongoing monitoring of surface water bodies, groundwater and soils?
Click here to write.
Which parameters would you consider to take into account while describing baseline status of surface water bodies, groundwater and soils before a launch of shale gas exploration and production?
Click here to write.
Do you think it is possible to assess environmental impact of shale gas activities relying only on currently ongoing monitoring?
Click here to write..
Would you recommend any adjustments/modifications to the currently operate monitoring system to adapt it to shale gas development environmental impact monitoring and control?
Click here to write.
Would you recommend additional, independent system for shale gas development environmental impact monitoring and control?
Click here to write.
Would you like to share any comments?
Click here to write