**Shale gas Exploration and Exploitation induced Risks**

<table>
<thead>
<tr>
<th>Type of funding scheme:</th>
<th>Research and Innovation Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work programme topics addressed:</td>
<td>LCE-16-2014: Understanding, preventing and mitigating the potential environmental impacts and risks of Shale Gas Exploration and Exploitation</td>
</tr>
<tr>
<td>Name of the coordinating person:</td>
<td><strong>PAOLO GASPARINI, AMRA Scarl, Napoli, Italy</strong></td>
</tr>
</tbody>
</table>
The SHEER main objective is to develop best practices for assessing and mitigating the environmental footprint of shale gas exploration and exploitation. It will develop a probabilistic procedure for assessing short and long-term risks associated with:

- **Groundwater contamination**
  By chemicals contained in the flow back, formation, produced and waste waters

- **Air pollution**
  By migration of fugitive methane through induced and natural fractures and mobilization of radioactive particles and gases from the underground

- **Induced seismicity**
  By fracking and injection of waste water

SHEER uses both data from the monitoring of the Wysin site in Pomerania (Poland) and from past cases. The latter are relative to the exploitation of shale gas, traditional hydrocarbons and geothermal energy production.
<table>
<thead>
<tr>
<th>1. AMRA</th>
<th>5. KNMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analisi e Monitoraggio del Rischio Ambientale, <strong>Italy</strong>&lt;br&gt;P. Gasparini</td>
<td>Royal Netherlands Meteorological Institute, <strong>Netherlands</strong>&lt;br&gt;B. Doost</td>
</tr>
<tr>
<td>2. IGF PAS</td>
<td>6. RSK</td>
</tr>
<tr>
<td>Institute of Geophysics, Polish Academy of Sciences, <strong>Poland</strong>&lt;br&gt;S. Lasocki</td>
<td>RSK W Ltd, <strong>United Kingdom</strong>&lt;br&gt;A. Gunning</td>
</tr>
<tr>
<td>3. KeU</td>
<td>7. UGL</td>
</tr>
<tr>
<td>Keele University, <strong>United Kingdom</strong>&lt;br&gt;N. Cassidy</td>
<td>University of Glasgow, <strong>United Kingdom</strong>&lt;br&gt;P. Younger</td>
</tr>
<tr>
<td>4. GFZ</td>
<td>8. UW</td>
</tr>
<tr>
<td>Helmholtz-Zentrum Potsdam Deutsches Geoforschungszentrum, <strong>Germany</strong>&lt;br&gt;T. Dahm</td>
<td>University of Wyoming, <strong>United States</strong>&lt;br&gt;M. Cheadle</td>
</tr>
</tbody>
</table>
which may develop as an unwanted by-product of the fracking processes and may become pathway for gas and fluid migration towards underground water reservoirs or the surface.

DESCRIPTION

The severity of each hazard depends strongly on the unexpected enhanced permeability pattern which may develop as an unwanted by-product of the fracking processes and may become pathway for gas and fluid migration towards underground water reservoirs or the surface.
SHEER DISTINCTIVE FEATURES

DATA GATHERING

Wysin site monitoring and data collection from the site preparation phase to the production phase

Polish shale gas site
Municipality: Gmina Liniewo
Village: Wysin
### POMERANIA SITE

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Orbit</th>
<th>Track</th>
<th>Frame</th>
<th>N. images</th>
<th>Time interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVISAT</td>
<td>DESCENDING</td>
<td>36</td>
<td>2502</td>
<td>19</td>
<td>2002-2008</td>
</tr>
<tr>
<td>ERS</td>
<td>DESCENDING</td>
<td>308</td>
<td>2504</td>
<td>33</td>
<td>1992-2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Total 52</strong></td>
<td></td>
</tr>
<tr>
<td>ERS</td>
<td>ASCENDING</td>
<td>372</td>
<td>1093</td>
<td>24</td>
<td>1992-2010</td>
</tr>
</tbody>
</table>

Starting from 2015 the SENTINEL 1-A sensor will be used
DATA GATHERED FROM THE SHEER PROJECT (1/2)

Data availability from conventional oil and gas production sites

<table>
<thead>
<tr>
<th>Project Partner responsible</th>
<th>Site</th>
<th>Country</th>
<th>Seismic data</th>
<th>Ground subsidence</th>
<th>Water quality data</th>
<th>Air quality data</th>
<th>Production data</th>
</tr>
</thead>
<tbody>
<tr>
<td>KeU</td>
<td>Beckingham</td>
<td>UK</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KNMI</td>
<td>Groeningen</td>
<td>Olanda</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data availability from geothermal energy production

<table>
<thead>
<tr>
<th>Project Partner responsible</th>
<th>Site</th>
<th>Country</th>
<th>Seismic data</th>
<th>Ground subsidence</th>
<th>Water quality data</th>
<th>Air quality data</th>
<th>Production data</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGF-GFZ</td>
<td>Gross Schoenebeck</td>
<td>Germania</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>AMRA-GFZ</td>
<td>The Geiser</td>
<td>California</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
## DATA GATHERED FROM THE SHEER PROJECT (2/2)

Data availability from shale gas operation sites

<table>
<thead>
<tr>
<th>Project Partner responsible</th>
<th>Site</th>
<th>Country</th>
<th>Seismic data</th>
<th>Ground subsidence</th>
<th>Water quality data</th>
<th>Air quality data</th>
<th>Production data</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGF</td>
<td>Pomerania</td>
<td>Poland</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>?</td>
</tr>
<tr>
<td>IGF</td>
<td>Lubocino 2H well, Pomerania</td>
<td>Poland</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KeU</td>
<td>Preese Hall 1</td>
<td>UK</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Probabilistic methodology for assessing short and long-term risks

To implement an effective mechanism to identify and structure scenarios of risk interactions and cascading effects, taking into account the phase of development of the project:

- Drilling, Hydraulic stimulation, Production, Abandonment

To develop and implement physically-based, probabilistic tools for the assessment of the likelihood of occurrence of interrelated risk scenarios considering:

- Induced seismicity
- Ground water pollution
- Air pollution
- NaTech-like accidents
To develop a procedure to assess time dependent vulnerability of infrastructures, of life-lines, and of socio-economics assets to different possible hazards, in order to perform a real multi-risk analysis.

V. Ivan and P. Gasparini (AMRA) published a work on the identification of the level of knowledge in relation to the impact of environmental risks attached to shale gas exploitation in the academic and scientific community. The article found out that developing a comprehensive approach based on scientific data and an appropriate regulatory framework will provide a path forward for the future development of contested policies like shale gas  


To implement the developed framework in one of the study case.

To perform a comparative analysis between the impacts of shale gas operations and the impacts related to exploitation of alternative energy sources.
POSSIBLE HAZARDS PRODUCED BY SHALE GAS OPERATIONS

- Water availability
- Industrial accidents
- Visual impacts
- Noise pollution
- Traffic
- Induced seismicity
- Seismic risk (ST/LT)
- Groundwater contamination
- Surface water contamination
- Air pollution
- Crack formation/migration
EXPECTED RESULTS OF THE PROJECT

Assessment of the environmental impacts of shale gas extraction and exploration and to develop best practices aiming at reducing its environmental footprint through:

- The compilation of a database consisting of seismicity, data on the state of water and air and operational data collected from a shale gas site during the project and data gathered from past case studies, including data from conventional hydrocarbon exploration and enhanced geothermal fields involving fluid injection used as a proxy;

- The development of a methodology to assess environmental impacts and risks across the different operational phases of shale gas exploitation;

- The application of the developed methodology to the data gathered from past case studies and monitoring activities;

- Proposal of best practices for the monitoring and assessment of environmental impacts associated with shale gas exploration and exploitation;

- Elaboration of guidelines for risk management of shale gas exploitation induced environmental impacts addressed to emergency planners, policy-makers and responding organizations for the management of environmental impacts.
STATE OF THE PROJECT

• Information on site operations

• SHEER Database

• Dissemination

http://www.sheerproject.eu
STATE OF THE PROJECT

INFORMATION ON SITE OPERATIONS

• Installation of surface seismic monitoring network. The network consists of 3 BB stations (GFZ) and 3 miniarrays: 1 BB and 8-9 SP each (GFZ & IGF PAS);
• Seismic data gathered since June. On-line data transmission from 16 SP seismic stations (IGF PAS);
• Signals from GFZ stations are not transmitted on-line. The first datasets were recently downloaded from GFZ stations;
• Air quality monitoring since June. On-line data transmission (IGF PAS);
• Drilling for four borehole water quality monitoring and three shallow borehole seismic observations. The seismic instrumentation (AMRA) and the water monitoring equipment (RSK) will be installed in the next days.
STATE OF THE PROJECT

SHEER DATABASE

• SHEER database designed;
• Data availability checked;
• Gross Schonebeck episode integrated;
• Integration of all episodes will start in November.
STATE OF THE PROJECT

DISSEMINATION

The objective is to inform stakeholders, public bodies and the about the aims, progress and outcomes of the SHEER project in a timely, informative and effective manner.

To increase public awareness a picnic close to the Wysin site was organized in September by IGF-PAS.

A dissemination plan has been prepared by the Keele University

The dissemination channels already available are:
• The website (http://www.sheerproject.eu)
• The facebook page
• The twitter page
In September P. Gasparini and Simona Esposito (AMRA) published on the Italian journal “Le Science” an article on the shale gas dilemma

http://www.lescienze.it/archivio/articoli/2015/09/01/news/il_dilemma_dello_shale_gas-2727870
THE SHEER WEBSITE

http://www.sheerproject.eu

Introduction
The SHEER project addresses the topic LCE-16:2014: Understanding, preventing and mitigating the potential environmental impacts and risks of Shale Gas Exploration and Exploitation.

SHEER will set up a probabilistic methodology to assess and mitigate the short and the long term environmental risks connected to the exploration and exploitation of shale gas.

SHEER will utilize monitoring data available in literature integrated by monitoring data acquired during the project in one European shale gas exploitation site.
WHERE SHEER DEVELOPMENTS MEET EPOS OBJECTIVES?

INFRADERV: EPOS IP Project
Wp14 TCS AH

LCE-16-2014
SHEER Project

Task 1 Strategic activities & governance
Task 2 Coordination and Interaction with the community
Task 3 Interoperability with EPOS ICS and testing
Task 4 Integration of Anthropogenic Hazards Episodes
Task 5 Assessment of the relations between technical operations and induced seismic/deformation processes
Task 6 Time- and technology-dependent probabilistic seismic hazard analysis
Task 7 Holistic framework for multi-hazard and multi-risk assessment
Integration of AH Episodes:
SHEER database components that will be integrated