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**SHale gas**  
**Exploration and**  
**Exploitation induced**  
**Risks**

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# STATE OF THE PROJECT AFTER THE SECOND YEAR

Paolo Capuano (AMRA/UNISA)

## **Second Annual Meeting**

**Blackpool - June 5-7, 2017**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640896.

## ***IN MEMORY OF PAOLO GASPARINI***



Hi Paolo,

we are trying to keep on  
your way

# Mid- term report



# The mid-term review and the January meeting

- The mid-term report was delivered on time.
- The authorising officer let me know that

The project implementation is currently satisfactory

To improve the implementation INEA recommend:

- a) Milestones and deliverables should be submitted on time;
- b) The project should enhance cooperation with other 3 H2020 shale gas projects funded under the same topic (including exchange of data, most important deliverables and decision making models) through bilateral contacts and joint events;
- c) Beneficiaries must aim for a gender balance at all levels of personnel assigned to the action. The Agency will verify compliance with this obligation in the second project review.

# The mid-term review and the January meeting

- The mid term meeting can be summarized in the following bullets:
  - a) No extension is possible for the SHEER project. All the activities should be over by the end of the project.
  - b) Open Access should be granted for all publications. H2020 requirements for the open access are very strict.
  - c) Participation to conferences and meetings to disseminate the SHEER project is important if two conditions are met:
    1. Clear link to the project;
    2. Necessity to participate to meeting and/or conference. However, European conferences and meeting should be preferred.

# Milestones and Deliverables to be submitted in the last year



# List of milestones

Milestone number	Milestone title	WP number	Lead beneficiary	Due Date (in Months)
MS5	Established SHEER database repository services for data from onsite monitoring	WP2	IGF PAS	26
<b>MS7</b>	<b>Preliminary information on the seismicity, water conditions and air pollutants concentrations variability in the vicinity of shale gas well available within the SHEER database (WP2)</b>	<b>WP3</b>	<b>IGF PAS</b>	<b>26</b>
MS9	Multi-physical modelling setup, and the methods for the detection/ haracterization of low frequency	WP4	KeU	27
MS10	Methodologies for (Time-dependent) probabilistic seismic hazard analysis	WP4	AMRA	30
MS11	4D Detailed site hydrogeological models	WP5	RSK W Ltd	30
<b>MS14</b>	<b>Full quantitative multi-risk assessment has been performed in one test case</b>	<b>WP7</b>	<b>AMRA</b>	<b>30</b>

# List of deliverables

<b>Deliverable number</b>	<b>Deliverable title</b>	<b>WP number</b>	<b>Lead beneficiary</b>	<b>Due date (in month)</b>
D1.3	Second year meeting and advisory board	WP1	AMRA	26
D2.1	Test-bed of SHEER “smart” database	WP2	IGF PAS	30
D3.3	Methodology of integrated monitoring the environmental impact of shale gas exploration/ exploitation	WP3	IGF PAS	26
<b>D3.4</b>	<b>Report on monitoring of the seismic response to shale gas exploration / exploitation and impact on water and air conditions</b>	<b>WP3</b>	<b>GFZ</b>	<b>34</b>
D4.1	Report on efficient monitoring setup and analysis algorithms for shale gas operations	WP4	GFZ	30
D4.3	Report on the assessment of the response of induced seismic process to operational parameter	WP4	IGF PAS	30



# List of deliverables

<b>Deliverable number</b>	<b>Deliverable title</b>	<b>WP number</b>	<b>Lead beneficiary</b>	<b>Due date (in month)</b>
D4.4	Report on modelling of fracture processes and fluid migration	WP4	KeU	30
D4.5	Report on the estimation of seismic hazard related to shale gas operation	WP4	AMRA	30
D5.1	Hydrogeological models to assess the potential for groundwater impairment for a selected 'shale analog' site	WP5	RSK W Ltd	30

# List of deliverables

Deliverable number	Deliverable title	WP number	Lead beneficiary	Due date (in month)
D5.2	Impact of well construction and fracture stimulation on baseline hydrogeological conditions and on drinking water aquifers	WP5	RSK W Ltd	36
D6.3	Assessment of fulfilling the air quality criteria	WP6	IGF PAS	36
<b>D7.3</b>	<b>Multi-risk assessment in a test case</b>	<b>WP7</b>	<b>AMRA</b>	<b>30</b>
D7.4	Comparative analysis of the impacts of shale gas operations and the impacts of conventional gas and oil sources	WP7	AMRA	36
D8.2	Guidelines for the monitoring of shale gas exploration and exploitation induced environmental impacts	WP8	AMRA	36
D8.3	Guidelines for risk management of shale gas exploration and exploitation	WP8	RSK W Ltd	36
D8.5	Web services development and sustainability	WP8	KeU	36

# List of deliverables: summary

2			26
7			30
1			34
6			36
N.			Month

# **SHEER progresses in the last 12 months**



# SHEER – objectives

- Design, definition and creation of the SHEER database
- Development of a monitoring execution plan agreed with the PGNiG operator and arrangement of the Polish test site for the collection of a complete suite of data
- Development and application of methodologies to assess environmental impacts and risks across the different operational phases using data gathered from past case studies and monitoring activities
- Identification of plausible scenarios of events or chains of events related with shale gas development that may have an impact on the environment and/or the society
- Development of best practices for assessing and mitigating the environmental footprint of shale gas exploration and exploitation
- Guidelines for monitoring environmental impacts and for the management of natural risks induced by shale gas exploration and exploitation

# Last 12 months of WP2

- **Task 2.1. Compilation of the SHEER database (Beata Orlecka-Sikora, Monika Staszek – IG PAS, AMRA, KeU, GFZ, KNMI, RSK, UW):**
  - One Complete Data Storage with an access for Consortium members: SHEERWER
  - Integration of Oklahoma, Cooper Basin and The Geysers datasets
  - Integration of satellite data (Groningen, Lubocino, Wysin)
  - Start of collecting SHEER Publications and thematic-oriented Literature (currently Risk Assessment available)
- **Task 2.2. Harmonizing SHEER database components (Stanisław Lasocki, Staszek Monika – IG PAS, AMRA, KeU, GFZ, KNMI, RSK, UW)**
  - Continuation of data formats homogenization, metadata preparation and data integration on TCS AH platform: Data from WYSIN, LUBOCINO, PREESE HALL and GROSS SCHOENEBECK episodes is already homogenized and integrated on TCS AH platform. Integration of data from GRONINGEN, THE GEYSERS and OKLAHOMA episodes in progress.
- **Task 2.3. Integration of data from on-site monitoring with SHEER database (Stanisław Lasocki, Monika Staszek – IG PAS, GFZ, RSK, AMRA)**
  - Updates of Wysin data on SHEERWER and TCS AH platform

# Last 12 months of WP3

- **Task 3.1 Preparatory operations (IG PAS, All):** Stimulation of Wysin-2H and Wysin-3H took place in days 08-18/06/2016 and 19-29/07/2016, respectively. **All shale gas activities in Poland were suspended/ (terminated) in Autumn 2016.**
- **Task 3.2 Monitoring of induced seismicity (GFZ, IG PAS, AMRA, KNMI):**

**Till the 17<sup>th</sup> of January 2017**

- 17 <sup>th</sup> January 2017		Płachty	Głodowo	Chrósty Wysięskie	GW	Other	Overall
Surface stations	Short-period	8	9	8	3		28
	Broadband	1	1	1		7	10
Borehole stations						3	3
Groundwater monitoring wells						4	4
Air pollution station						1	1

**In days 17-19<sup>th</sup> of January 2017 most of the stations were uninstalled. Actual state of monitoring equipment**

19 <sup>th</sup> January 2017- now		Płachty	Głodowo	Chrósty Wysięskie	GW	Other	Overall
Surface stations	Short-period	0	0	0	3		3
	Broadband	1	1	1			3
Borehole stations						3	3
Groundwater monitoring wells						4	4
Air pollution station						1	1

**Additionally, most of the land lease contracts (32 of 39) have been terminated.**

- **Task 3.3 Monitoring of groundwater conditions (RSK, UGL, IG PAS):** Continuation of field monitoring of groundwater conditions (continuous and site-visit).
- **Task 3.4 Monitoring of air pollution (IG PAS):** Continuation of field monitoring of air pollution (continuous measurements). Visited at least once-twice a month for the routine maintenance and quality checks. Up to now over 30 on-site visits.

# Last 12 months of WP4

## **Task 4.1. Advanced processing of induced seismicity data (GFZ, AMRA, KNMI):**

- Assessment of the detection performance at the Wysin fracking site (Lopez Comino et al. 2017 GJI)
- Development/application of waveform-based detector to real data at the Wysin site (May-September 2016)
- Detection, location, and characterization of acoustic emissions induced by hydraulic fracturing in a mine (Lopez Comino et al. Submitted).
- Development of methods to estimate borehole sensor orientations (Hofman et al. Submitted) and invert for enhanced seismograms at borehole location, improving detection/characterization of weak events.
- Accurate estimation of dynamic stress drop (through the apparent stress), static stress drop, radiation efficiency and rupture velocity for induced microearthquakes at The Geysers.

## **Task 4.2. Statistical description of the induced seismic processes and assessment of relationship with technological/operational parameters (IGF-PAS, AMRA, KNMI):**

- Analysis of statistical significance of temporal changes in the static stress drop of induced seismic events and its distribution in relation to injection rates (The Geysers)..
- Investigation and quantification of the correlation between spatio-temporal seismicity evolution and variation of the injection data from The Geysers.
- Multi-dimensional cluster analysis for The Geysers geothermal field data.
- Analysis of probability distributions of magnitude and interevent times (Oklahoma and the Geysers datasets).
- Seismic interferometry applied for monitoring the changes in geological medium due to hydrofracturing at Wysin.

## **Task 4.3. Multi-physical modelling of the fracturing process (KeU, AMRA):**

- Extension of the sensitivity analysis modelling to include the effects of pore pressure and injection fluid properties have on the fluid migration and local stress (ongoing work)

## **Task 4.4. Time-Dependent Seismic Hazard Assessment (AMRA, IGF-PAS, KNMI):**

- Analysis of the time-distribution of induced seismic events taking into account industrial information as fluid injection rates and volumes. development of tools for non-stationary hazard assessment.



# Last 12 months of WP5



- **Ongoing groundwater monitoring:**
  - Baseline monitoring continued until June 2016
  - Post-frac monitoring has been underway since July 2016
  - Seven post-frac visits have been undertaken to date
  - Visits planned for June & August 2017
- **Geological model:**
  - Revised model produced
  - Updated hydrogeological model is underway
- **Interpretation of data:**
  - Baseline water level report is essentially complete
  - Post-frac water level report is in progress
  - Baseline groundwater chemistry report is complete in draft
  - Post-frac groundwater chemistry report is in progress

## Last 12 months of WP6

- Development of the method of identification of air pollution episodes in the area of monitoring and their origin with support of modeling tools and statistical analysis.
- Continuous analysis of data collected at Stary Wiec station within the frame of Task 3.4 of WP3 activities. Data cover the period of 23 months, from August 2015 to May 2017.
- Analysis of data from the closest stations belonging to the monitoring network of Pomeranian Voivodship as well as other available data (in the case of methane and radon).
- No significant episodes of air pollutants related to the shell gas exploitation activity have been detected so far except two significant episodes of elevated concentrations of methane in July and September 2016, undoubtedly related to the well exploration procedures.

# Last 12 months of WP7

- **Task 7.1. Identification and structuring multi-risk scenarios (AMRA, KeU, KNMI):**
  - A full set of risk pathway scenarios have been identified considering different phases of a project development (Site development; Drilling activities; Hydraulic fracturing; Production; abandonment)
  - The main outcome of the activities under this task have been presented in deliverable D7.1: “Framework for holistic multi-risk assessment of shale gas operations: (1) Methods for identifying and structuring scenarios”.
  - Causal diagram representation of the scenarios is being used to build logic structures following a bow-tie approach.
- **Task 7.2. Development of a probabilistic framework for the assessment of impacts associated with shale gas operations adopting a multi-risk perspective (AMRA, KNMI)**
  - The activities in this task have been focused on the implementation of the probabilistic model for quantitative multi-hazard risk assessment .
  - A bow-tie approach has been identified as the tool that better adapt for this problem. Different modeling tools have been implemented for performing quantitative analyses.
  - The main outcome of the activities under this task have been presented in deliverable D7.2: “Framework for holistic multi-risk assessment of shale gas operations: (2) Probabilistic framework”.
  - Implementation of a virtual site started to be developed.
- **Task 7.3. Comparative analysis of the impacts of shale gas operations with the impacts associated to conventional gas and oil sources (KNMI, AMRA, KeU)**
  - Activities in this task just started by analyzing the scenarios produced by T7.1 and the probabilistic tools implemented by T7.2.
  - The first step is oriented towards highlighting pathways that are common to conventional and unconventional developments

# Last 12 months of WP8

- Ongoing dissemination, collation and encouragement of all SHEER related research at conferences/events and via publication (with emphasis on open access).
- SHEER Social Media and Online Sites Expanded (Research Gate and LinkedIn Groups created)
- Three SHEER Newsletters Collated and Distributed (Issues, 3, 4 and 5)
- Presentations of SHEER work at EGU 2017
- Organisation and advertisement of SHEER's first Stakeholder/ Delegate Conference
- Completion of the cost-benefit analysis considering the establishment and ongoing operation of the shale gas test site (Task 8.2 MS16)



Welcome to the fifth SHEER newsletter. The aim of this Horizon 2020 project is to develop best practices aimed at accessing the impacts and mitigating the environmental footprint of shale gas extraction and exploration.

**First SHEER Conference set for a full house**

This year the Second SHEER Annual Meeting taking place in Blackpool will be followed by a one day free conference for delegates and stakeholders. Interest in the conference has been extremely high and all tickets have been allocated. We are therefore anticipating a full house with 120 attendees including consultants, academics, regulators and approximately 30 members of the SHEER Consortia. We look forward to seeing you there!

**In this Issue...**

- SHEER Conference Update
- Monitoring performance of hydraulic fracturing using a synthetic microseismic catalogue at the Wypisn site (Poland)
- Monitoring at Wypisn
- EPOS Anthropogenic Hazards
- EGU 2017
- New Publications
- SHEER participation in meetings and events

**Latest Project Developments**

- Environmental monitoring at Wypisn has continued since the fracturing.
- Three new peer-reviewed publications
- Work from the project has been presented at several conferences

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