# DELIVERABLE D3.3. REPORT ON DEVELOPED NUMERICAL MODELS RELATING TO MINE GAS EMISSIONS – SUMMARY

## WORKFLOW

Input data for numerical simulations were taken from literature studies and consideration of WP1. Climate Review & Projections (D1.3 Regional climate change projections), then in situ measurements were carried out in the frameworks of WP2. Climate Impact Identification. $CO_2$ and $O_2$ were detected in unnormal concentrations, CO and $CH_4$ were not detected.

Next, we did the numerical modelling which was based on the studies and on the results of previous measurements. Modelling was divided into two parts.

- Part 1. Ansys Fluent - the process was simulated in general. More intense pressure drops than measured, but still expected as real were tested. Different sealings at the shaft bottom were also checked (considering further mitigation methods for WP4. Risks and Impact Mitigation & Adaptation). Having the results from this part, from the studies and from the measurements we put this into Part 2.
- Part 2. FDS/Pyrosim software - to check gas distribution near the shaft under hypothetical but possible extreme weather event. The results show the areas of gas hazard around the shaft and safe distance from the point of emissions. This part was extended with methane which was not detected during measurements. Wind influence was also checked. Having the results, we can set the save distance in WP4. Risks and Impact Mitigation & Adaptation, when we analyse gas hazard.

## SUMMARY OF THE RESULTS

When considering gas emissions from an abandoned shaft it was pointed out that there are no doubts that pressure drop is a major force causing the emissions. Simulations carried out in Ansys Fluent program confirmed that statement.

It was clearly shown that outlet velocity is rising when pressure drops. Higher pressure drop makes higher outlet velocity (exceeding 3.0 m/s). Concentration of gases emitted (carbon dioxide and methane) rise continuously (carbon dioxide up to 9.0% vol. and methane up to 5.0% vol.), except oxygen which concentration decreases when pressure is falling. The results taken from the first part of the task 3.3 were set as initial values for FDS/Pyrosim modelling.

The simulations of gas distribution around an abandoned shaft were conducted using FDS/Pyrosim software.

Five scenarios (variants) were computed. The results lead to following conclusions:

- Lack of wind contributes to the maintenance of an increased concentration of emitted gases in the vicinity of the liquidated shaft, the range of the zone with increased concentration of emitted gases, which may pose a threat to people, is about 25m.
- The wind significantly dilutes the pollutants emitted from the abandoned shaft, but causes hat the range of the emitted stream of gases to exceed 50m in the direction of the wind.
- High gas emission velocity, exceeding 13.0 m/s, the gases should be transported further away from the emission source, and their dilution in the atmospheric air is also expected, however, it was only a hypothetical and unreal case.
- In the case of expected extreme weather events - doubled emissions velocity and maximal/minimal gas concentration values were assumed. Maximum $CO_2$ concentration near the shaft was 4.0% by volume at ground level and 2.0% vol. at the level of 1m. At the level of 0m, the area with the ascertained elevated concentration exceeded the range of 15m from the emission point. In the case of $CH_4$, the maximum concentration near the shaft was 1.5 vol.%. at ground level and 0.65 vol.% at the level of 1m. At the level of 1m, the area with the stated concentration of 0.85% vol. it reached beyond the boundaries of the measuring area, i.e. exceeded the range of 15 m from the point of emission. In the case of $O_2$, the concentration dropped to about 9.0 vol.%. at ground level, the range of the zone with reduced oxygen concentration exceeded 18m.