INJECTING WASTEWATER SINCE ‘94

The Raton Basin, a coal-bed methane field, has had large volumes of fluid pumped from and injected into the subsurface as well as increased earthquake occurrences. Prior to 2001 there was one M≥4 earthquake and after major injection began in 1999 there have been over two dozen.

Problem?

Induced earthquakes pose a HAZARD to local residents and infrastructure as well as create CHALLENGES for energy production.

RESULTS

Time series analysis uses images from the European Space Agency Sentinel-1 C-band instrument. Differential InSAR time series analysis quantifies line-of-sight (LOS) ground deformation at a centimeter spatial resolution. The results provide high resolution images of ground motions in the basin and measure LOS deformation over ~ 55 months from May 2017 to July 2020.

FIGURE 2 (above) - Time series of vertical ground deformation rate (m/yr) with plotted Glasgow et al., 2021 seismic 2017-2020 catalog for earthquakes Mc≥1.3 within the basin and 3/29 injection wells in the basin.

DISCUSSION & CONCLUSION

• ANALYSIS 01: Time series reveals positive vertical displacement (uplift) in regions where there is induced seismicity this can be seen in figure 2.
• ANALYSIS 02: Time series reveals negative vertical displacement (subsidence) in regions where there are injectioni wells this can be seen in figure 2.
• CONCLUSION: The uplift signals were found to correlate spatially to wastewater injection wells where injection volumes were the highest.

INJECTION VOLUME

EARTHQUAKE DENSITY

METHODS

I. PREPARE

Reference SLC (date A)

Select Image Pairs from SLC Scene list

Create Interferograms

Unwrap Phase interferometric phase

Select interferograms ISCE software

Calculate Coherence using DEM reference or reflector between image pair

Apply orbital correction and align images

Create Time Series

Multidimensional Small Baseline Subset (MSBAS)

II. POST-PROCESS

Downsample Atmospheric Correction using GACOS (90m) weather model

Apply Atmospheric Correction to the range/azimuth to lat and lon

Create Time Series

Multidimensional Small Baseline Subset (MSBAS)

III. POST-PROCESS

DISPLACEMENT (METERS)

VOLUME (BBLS)

TIME SERIES OF INJECTION VOLUME

TIME SERIES OF EARTHQUAKE FREQUENCY

TIME SERIES OF DEFORMATION

TIME

CONCLUSION:

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FUTURE WORK & REFERENCES

• Increase time span for time series using Sentinel-1 and Japanese Space Agency ALOS-1 L-band instrument (2006-2011)
• Incorporate mining data into analysis
• Test different time series parameters
• Extend processing to northern region