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Monitoring mining-induced ground deformation in Karagandy mining basin using InSAR

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Strata deformation associated with underground longwall coal mining can induce large magnitudes of ground surface subsidence. The Karagandy basin, one of the largest coal mining regions in Kazakhstan, is located in close proximity to urban areas and critical infrastructure, necessitating detailed investigation into the spatial distribution and temporal dynamics of subsidence. Synthetic aperture radar interferometry (InSAR) is recognised as a powerful tool to detect, map and quantify ground deformation. In this research, C-band Sentinel-1 products were used to implement interferometric and time-series analysis using the Small BAseline Subset (SBAS) algorithm. Subsidence bowls were detected over eight mining sites. The maximum annual velocity along line-of-sight, some ≈ 82 mm/year, was detected at the Kostenko mine, whilst cumulative subsidence reached a maximum of 350 mm in five years. Wavelet transform analysis was used to inspect the non-linear nature of the signal and confirmed the annual periodicity of ground deformation. Spatio-temporal analysis of subsidence patterns revealed the different drivers of deformation, with sites clustered accordingly. Results from the research offer considerable insight for facilitating decision-making in forward sustainable mining operations, both in Kazakhstan and further afield.