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# An optical image time series inversion method and application to long term sand dune movements in the Sinai Peninsula

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The migration of sand dunes poses a large threat to the desert infrastructure (e.g. highways, culverts, pipelines, and railways). Monitoring the migration of sand dunes over time enables drawing a complete picture of the areas exposed to large migration rates, the windiness conditions, and the probable desertification problems. In this study, we introduce an optical imagery time series inversion method (OPTSI) to calculate the long term movement of sand dunes based on a series of Landsat-8 images that cover the Northern Saini Peninsula. Our method includes two main steps: 1) Selection of pairs, 2) Inversion of time series. The "pairing scheme" is to select pairs less affected by the decorrelation mismatches based on three baselines: Temporal, radiometric and spatial baselines. The temporal baseline is set to be maximum of 4.5 years to avoid large variation in the surface of dunes. The radiometric baseline mainly results from the variations of both sun elevation and sun azimuth, the pairs less affected by these variations are considered to reduce the shadowing artifact. The spatial baseline is limited to mitigate the stripe artifacts. The inversion of time series is to estimate the incremental displacement between each adjacent epoch. The inversion step is performed by applying a first-order Tikhonov solution. This would favor a constant rate solution, as the solution of singular value decomposition is more prone to local oscillation in case of the lack of measurements. The method is applied to study the dune migration of the North Saini sand sea, which extends from the Suez Canal in the west to the Nizzana dune filed in Negev desert in the east. The retrieved displacements time series show the stability of Nizzana dune in comparison to Saini dune filed, which agrees with the previous findings. This activity of Saini dunes is mainly attributed to trampling, sheep grazing, and anthropogenic activities. The average velocity of dune migration at different locations in North Saini sand sea east to the bitter lake is about 11 m/yr between 2013 and 2018. In addition, the direction of sand dune movement shows a high degree of variability due to the complex wind regime. The results are validated by estimating the residual of displacement over the Saini Peninsulas' Mountains. The mean value of residuals is less than 0.4 m/yr. The developed method has the advantage to be less affected by correlation mismatches and would be useful for large scale monitoring of active dunes to assess the desertification problems.