# Abstract in Manuscript:

During the 2024 B-Cubed Hackathon, we extended the R package "`rasterdiv`" by incorporating Time-Weighted Dynamic Time Warping (TWDTW) to the package’s pre-existing `paRao()` function for the calculation of parametric Rao’s Quadratic Diversity (Rao’s Q) index. The implementation within "`rasterdiv`" uses the "`twtwd`" function from the `TWDTW` R package. This enhances the user’s ability to accurately assess biodiversity when using contemporary remote sensing tools like satellite images. As some biodiversity indices (e.g. Shannon’s H) do not account for spatio-temporal dynamics at all, and others (e.g. Rao’s Q) only include the spatial dimension, significant variations in phenology are often overlooked.

Through integrating TWDTW into the `paRao()` function, users can better assess an ecosystem’s biodiversity by accounting for phenological differences among its constituent flora. This is particularly valuable for distinguishing between natural habitats and artificial land cover types, which can lack phenological changes. Previous studies have also found that the time weighting ability of TWDTW enables the discernment of different floral community types which could otherwise be misclassified as the same by traditional Dynamic Time Warping (DTW) approaches.

To evaluate the efficacy of TWDTW within the `paRao()` function, we compared the ability of TWDTW Rao’s Q index with other biodiversity indices at classifying the different floral communities in a disturbed grassland in Calabria, Italy. Our study used a time series of Planet Phenological Index (PPI) data from the Sentinel-2 satellite network. The results indicated that accounting for phenological cycles can filter out artefacts and better classify floral communities. This improves the ability to assess ecosystem health and resilience, providing a more comprehensive understanding of biodiversity dynamics.

We conclude that the inclusion of phenology in biodiversity assessment is necessary, and that our modifications of `paRao()` will be valuable to facilitate the accurate detection and description of ecosystem trends in response to our changing environment.

# ChatGPT’s Draft Abstract:

In this study, we extend the R package "rasterdiv" by incorporating Time-Weighted Dynamic Time Warping (TWDTW) to enhance biodiversity assessment through remote sensing. Biodiversity indices traditionally focus on spatial components, often neglecting temporal dynamics crucial for ecosystem analysis. By integrating TWDTW, we enable the calculation of Rao’s Quadratic Diversity index (Rao’s Q) over time-series data, thus capturing phenological variations.

Our method leverages the TWDTW algorithm to account for temporal shifts in vegetation phenology, improving the resolution of biodiversity indices from satellite imagery. This is particularly valuable in distinguishing between natural habitats and artificial land cover types, which lack temporal phenological changes. The implementation within "rasterdiv" uses the "twtwd" function from the TWDTW R package, enabling robust phenological analysis across multiple temporal snapshots.

We applied our extended Rao’s Q index to multiband remote sensing data from a disturbed grassland, demonstrating its efficacy in reflecting ecosystem diversity. Our findings indicate that accounting for phenological cycles can filter out artifacts and better classify floral communities. This approach enhances the ability to monitor ecosystem health and resilience, providing a more comprehensive understanding of biodiversity dynamics.

The study underscores the importance of incorporating temporal dimensions in biodiversity indices, offering a significant improvement over static spatial analyses. Our contributions provide a valuable tool for environmental informatics, aiding in the accurate detection and description of ecosystem trends in response to environmental changes.