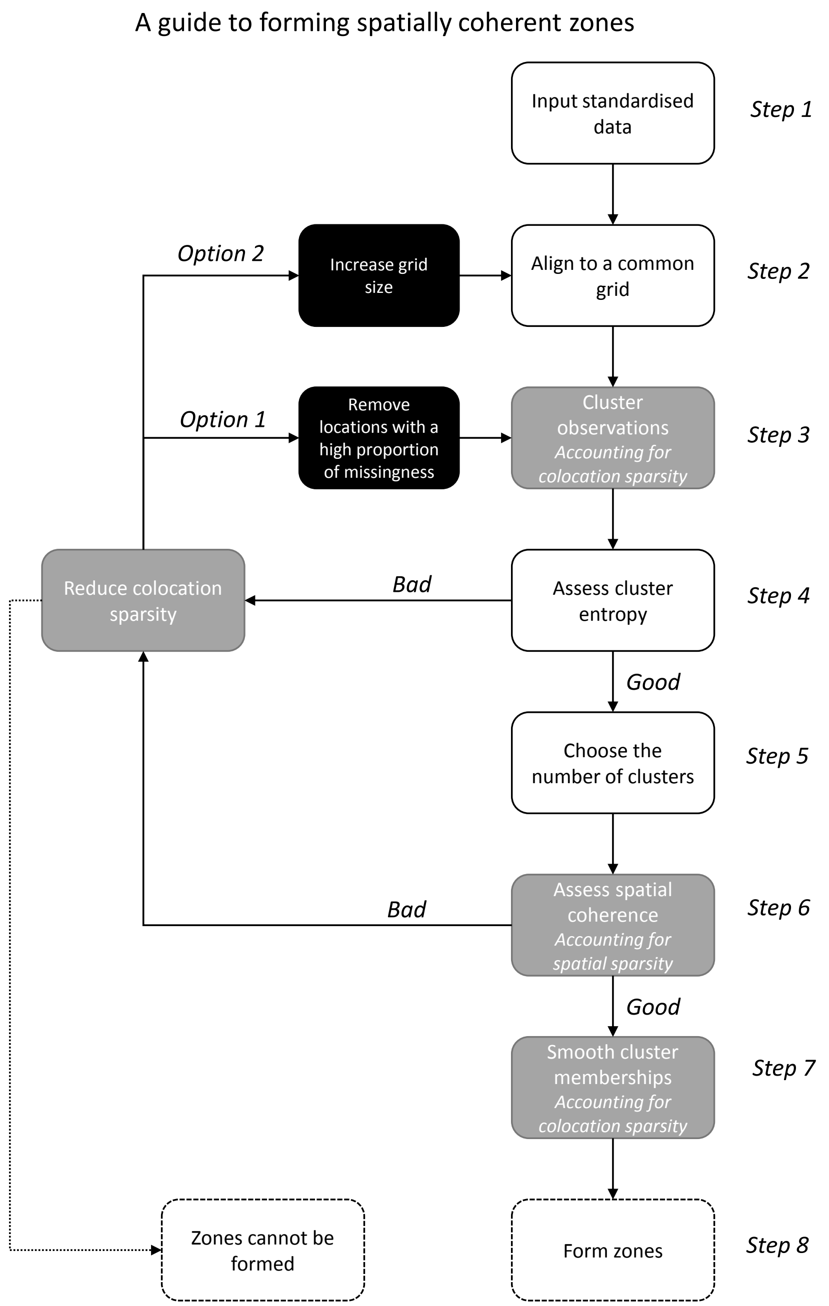

Figure 1: A flow diagram describing the process by which spatially coherent zones are calculated. Boxes highlighted in grey indicate the implementation of our methodological advancements specifically addressing the issues of data sparsity. Boxes highlighted in black indicate additional options one can iterate through to refine the formation of zones under high levels of sparsity.

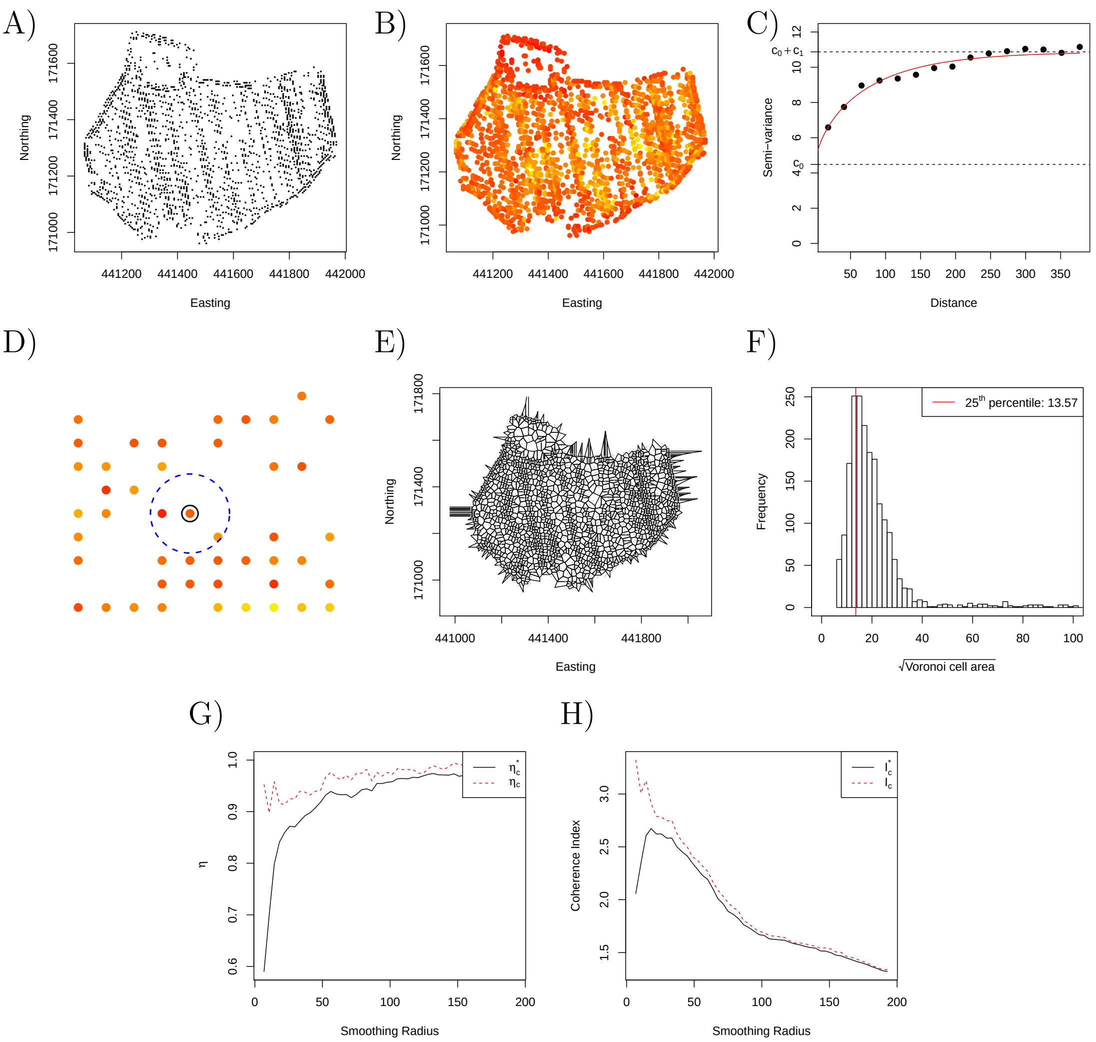

Figure 2: A) Locations of the set of complete observations for a single field on a grid size of 5m. B) Locations are coloured according to the transformed membership probabilities for the most commonly occurring class resulting from a fuzzy c-means clustering with 4 clusters and C) shows the associated variogram. D) An illustration of the neighbourhood under spatial sparsity. E) The Voronoi grid of observed spatial locations. F) Histogram of the length of Voronoi cell size, calculated as the square root of the Voronoi cell area. G) The numerator of the coherence index calculated based on a grid neighbourhood (red) and a Voronoi neighbourhood (black). H) The coherence index calculated based on a grid neighbourhood (red) and a Voronoi neighbourhood (black).

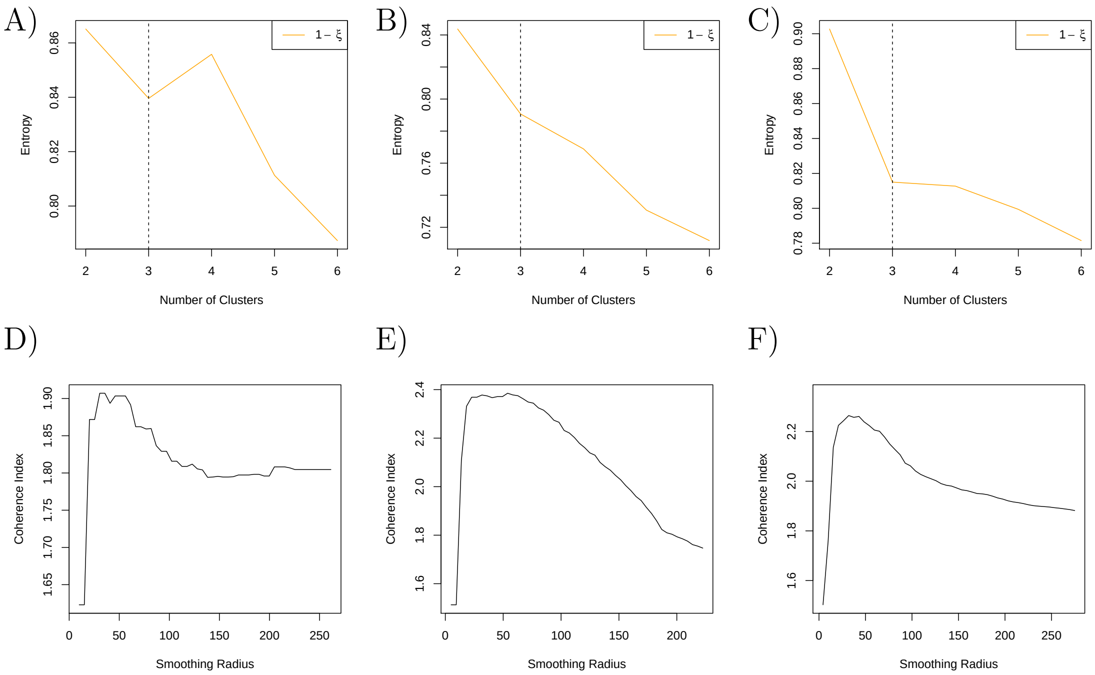

Figure 3: A) - C) The relationship between the cluster entropy, ξ, and number of clusters. These are illustrative examples of a "bad" (no distinct change point in the gradient of entropy can be identified), "moderate" and "good" (a distinctive change in gradient can be identified) cluster assessment, respectively. D) - E) The coherence index plotted as a function of the smoothing radius. These are illustrative examples of a "bad" (jagged, ill-behaved curve), "moderate" and "good" (smooth, with clear maximum identifiable) smoothing assessments, respectively.

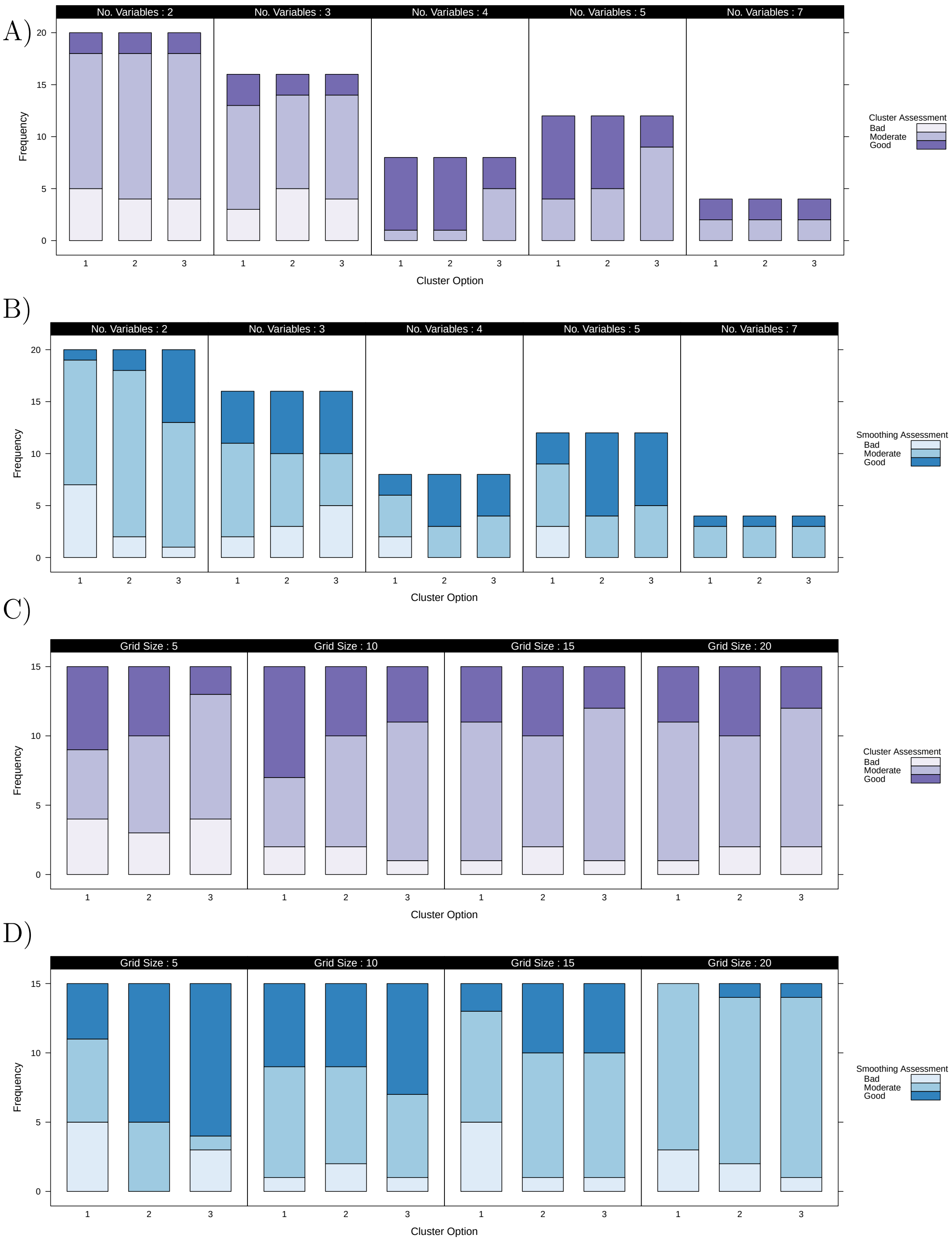

Figure 4: Results from an empirical study of three fields through an assessment of clustering (A and C) and smoothing (B and D). A)-B) The frequency of data scenarios that were considered to have "bad", "moderate" or "good" assessment for differing numbers of variables (years of data) under each of the three clustering options. C)-D) The frequency of data scenarios that were considered to have "bad", "moderate" or "good" assessment for data aligned to different grid sizes under each of the three clustering options. Frequency, refers to the number of data scenarios of each type see Table 1). Cluster option 1, refers to the original fuzzy c-means, option 2 includes the post-hoc allocation of partially observed locations and option 3 refers to the fuzzy c-means with optimal completion strategy.

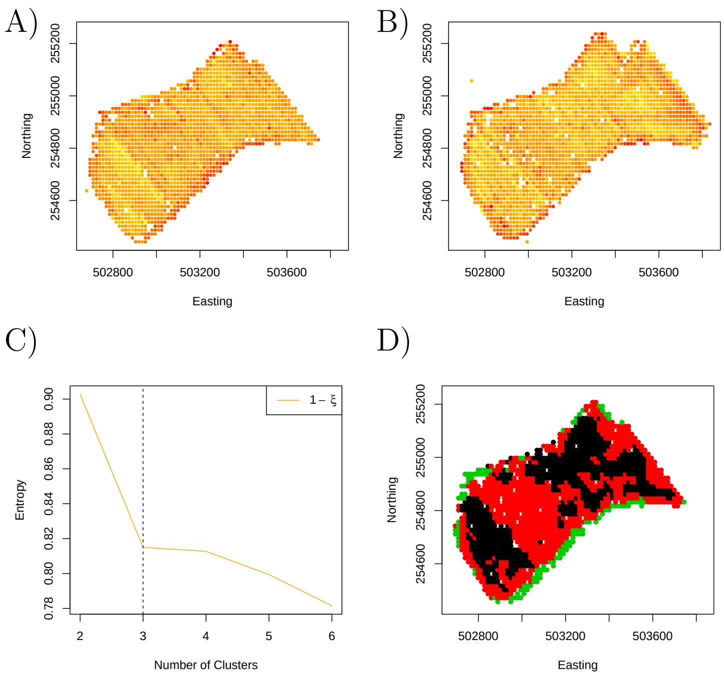

Figure 5: A)-B) Standardised yield measurements over two years, aligned to a 10m grid. C) The normalized classification entropy of the fuzzy c-means, indicating a choice of 3 clusters is appropriate. D) The resulting spatially coherent zones (smoothed via the weights of equation (4))

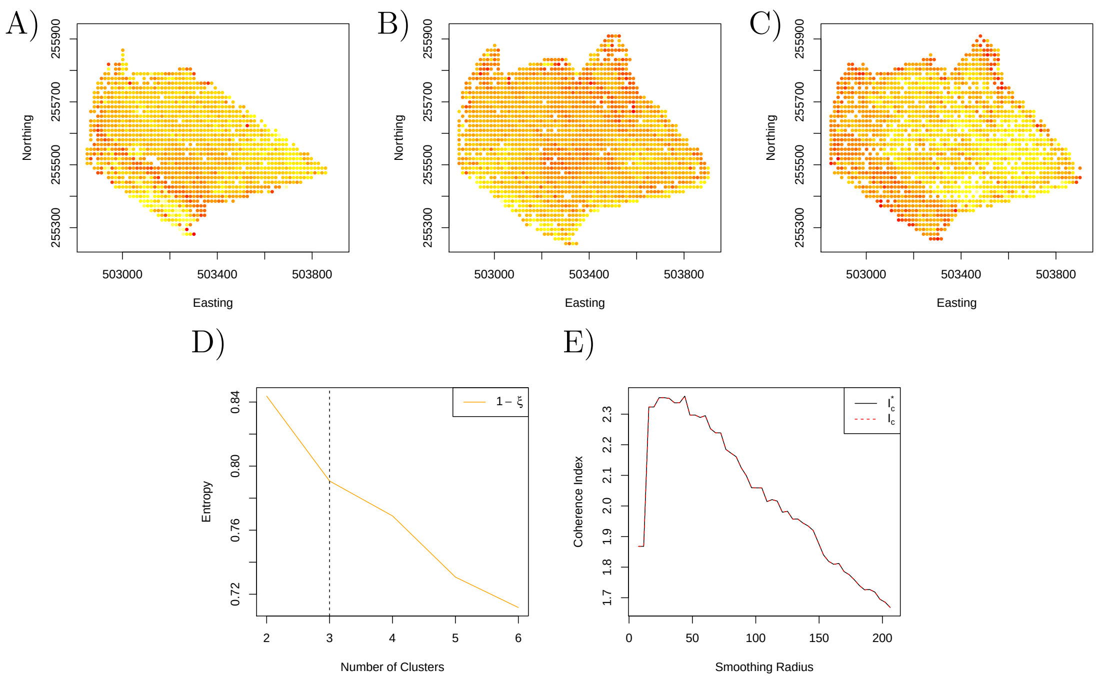

Figure 6: A)-C) Standardised yield measurements over three years, aligned to a 10m grid. D) The normalized classification entropy of the fuzzy c-means with a nominal selection of 3 clusters. E) The associated coherence index.

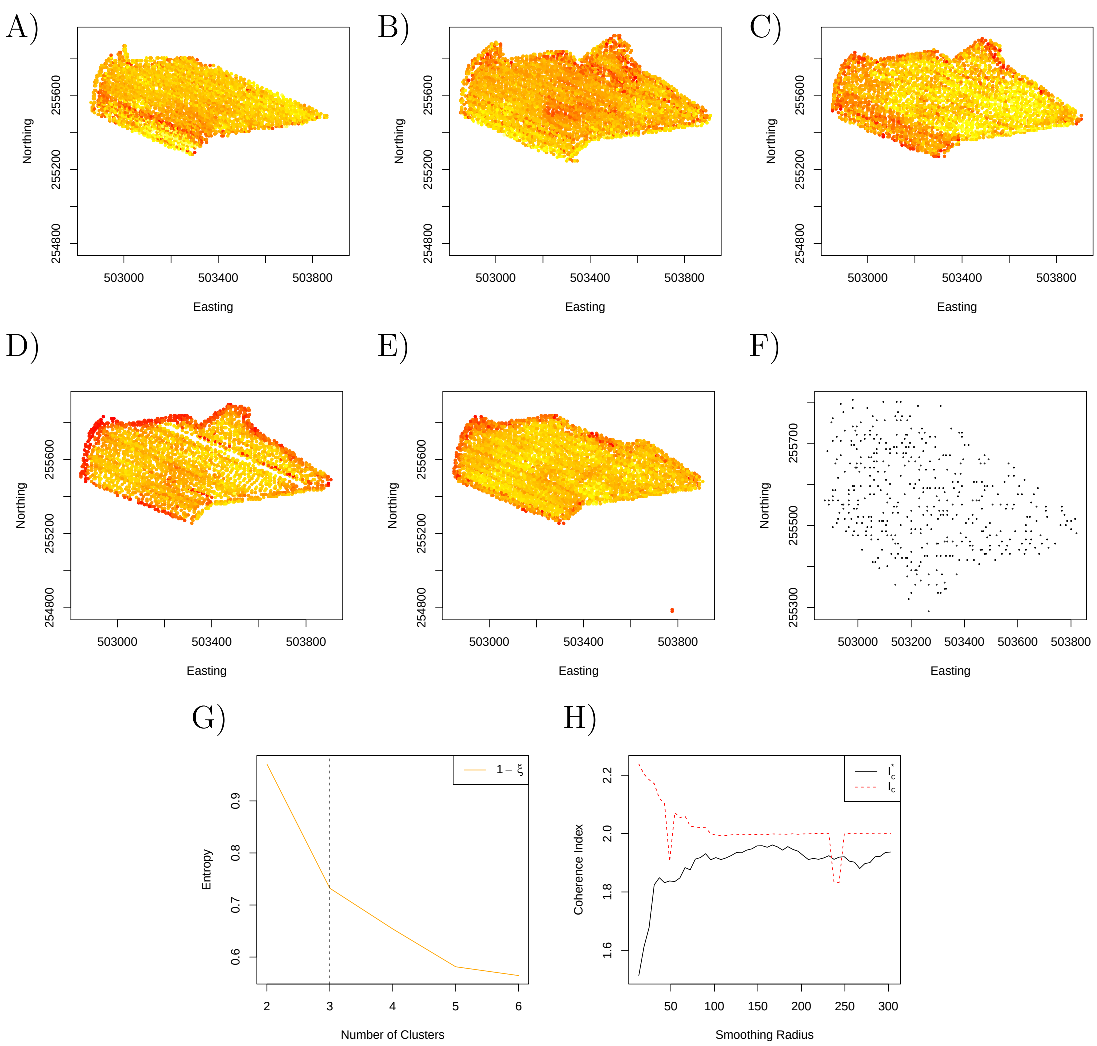

Figure 7: A)-E) Standardised yield measurements over five years, aligned to a 5m grid. F) The spatial locations of complete observations on a grid of 5m. G) The normalized classification entropy of the fuzzy c-means. H) The associated coherence index based on the underlying grid of 5m (red) and Voronoi cell length (black).

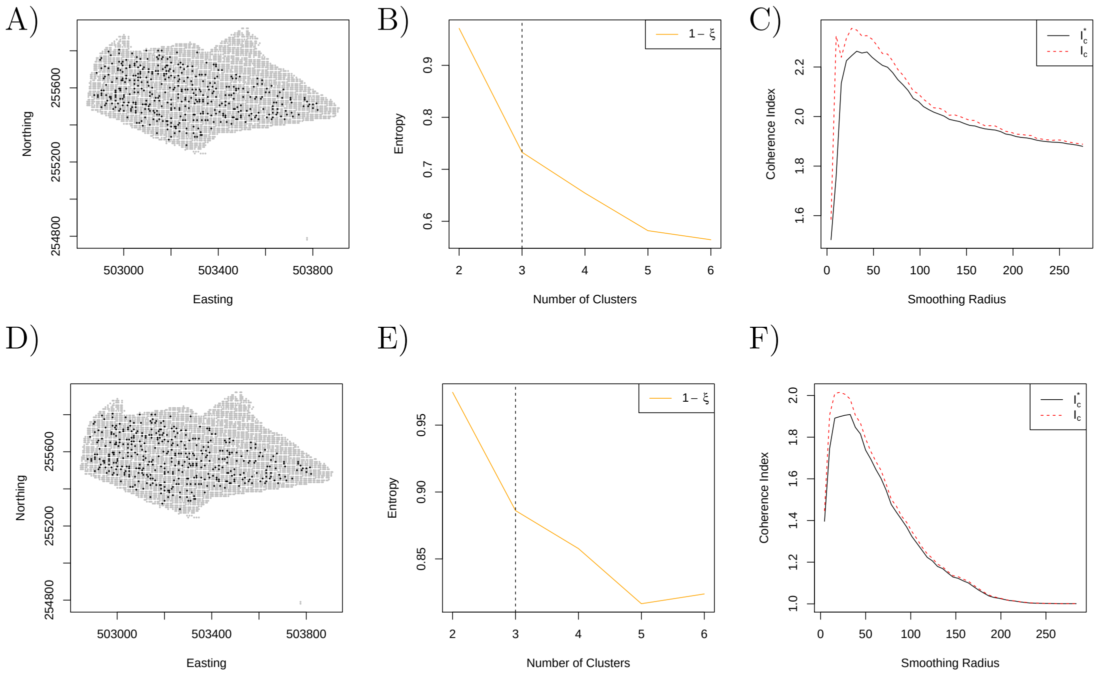

Figure 8: A) The spatial locations of both complete (black) and partial (grey) observations on a grid of 5m. B) The normalized classification entropy of the fuzzy c-means. C) The associated coherence index based on the underlying grid of 5m (red) and Voronoi cell length (black) using all locations through a post-hoc allocation of to the nearest cluster. D) The spatial locations of both complete (black) and partial (grey) observations on a grid of 5m. E) The normalized classification entropy of the OCS fuzzy c-means. F) The associated coherence index based on the underlying grid of 5m (red) and Voronoi cell length (black).

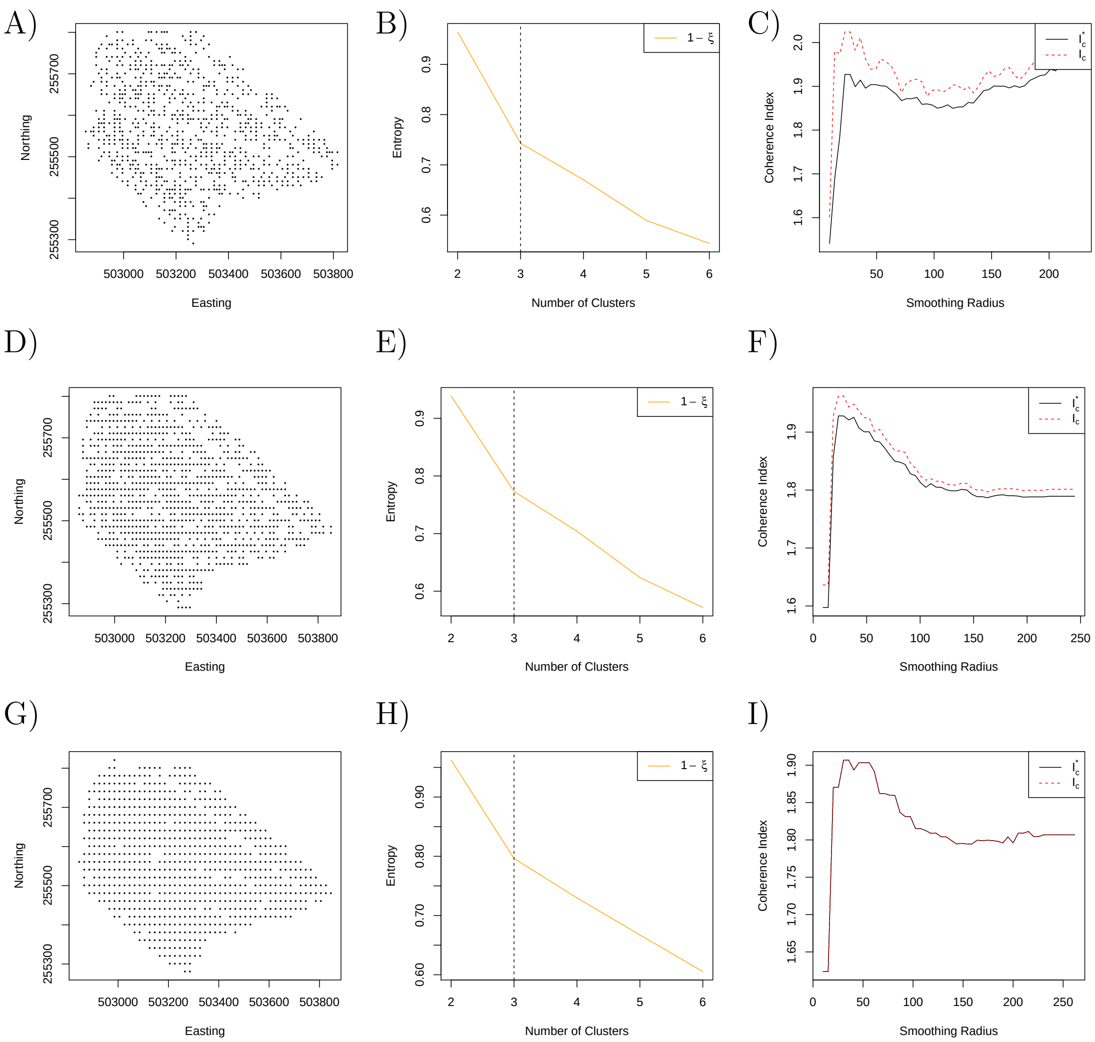

Figure 9: A) The spatial locations of complete observations on a grid of 10m. B) The normalized classification entropy of the fuzzy c-means. C) The associated coherence index based on the underlying grid of 10m (red) and Voronoi cell length (black). D) The spatial locations of complete observations on a grid of 15m. E) The normalized classification entropy of the fuzzy c-means. F) The associated coherence index based on the underlying grid of 15m (red) and Voronoi cell length (black). G) The spatial locations of complete observations on a grid of 20m. H) The normalized classification entropy of the fuzzy c-means. I) The associated coherence index based on the underlying grid of 20m (red) and Voronoi cell length (black).

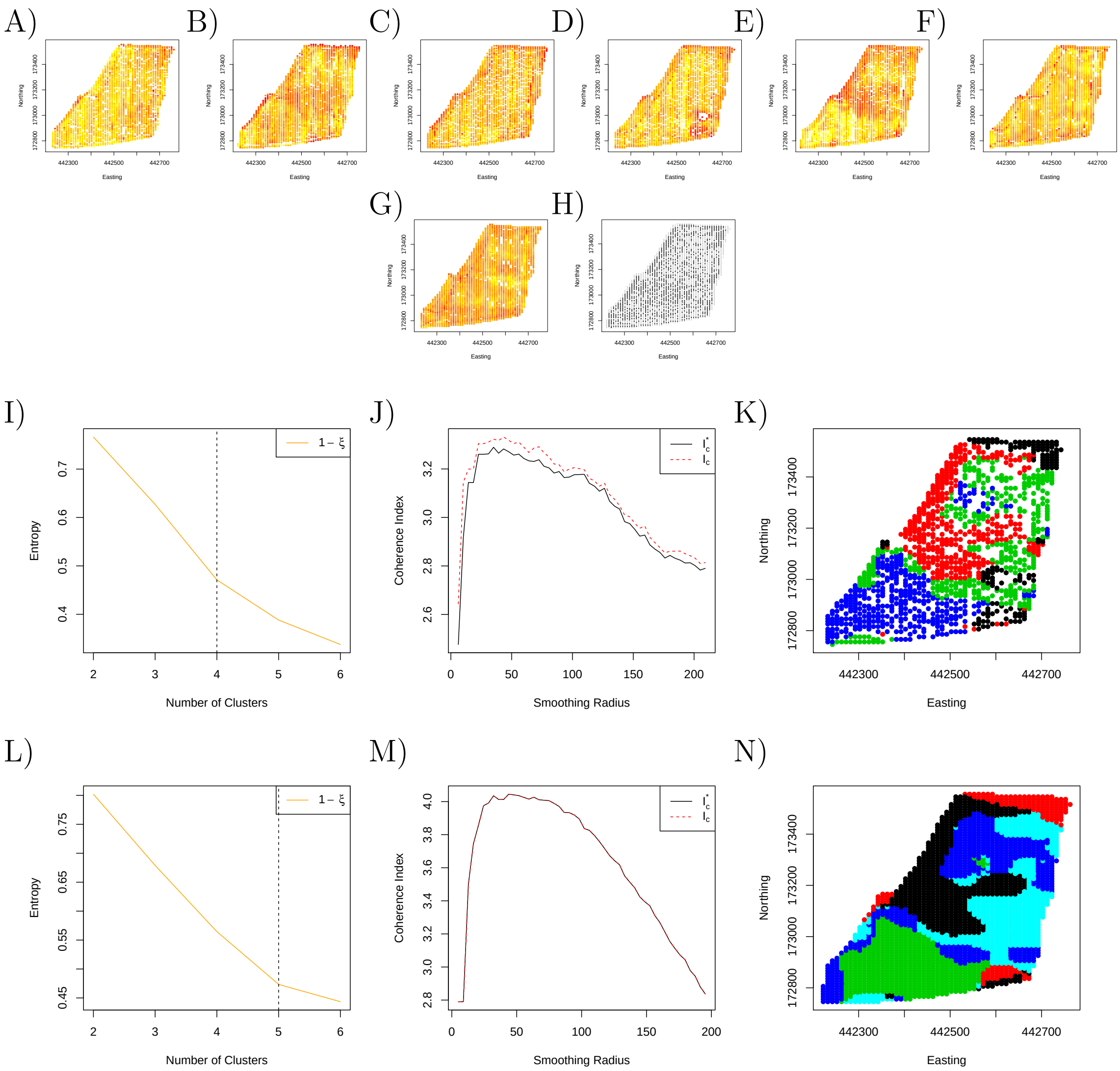

Figure 10: A)-G) Standardised yield measurements over 7 years, aligned to a 10m grid. H) The spatial locations of both complete (black) and partial (grey) observations on a grid of 10m. I) The normalized classification entropy of the fuzzy c-means. J) The associated coherence index based on the underlying grid of 10m (red) and Voronoi cell length (black) and K) the associated smoothed clusters. L) The normalized classification entropy of the OCS fuzzy c-means. M) The associated coherence index based on the underlying grid of 10m (red) and Voronoi cell length (black) and N) the associated smoothed clusters.

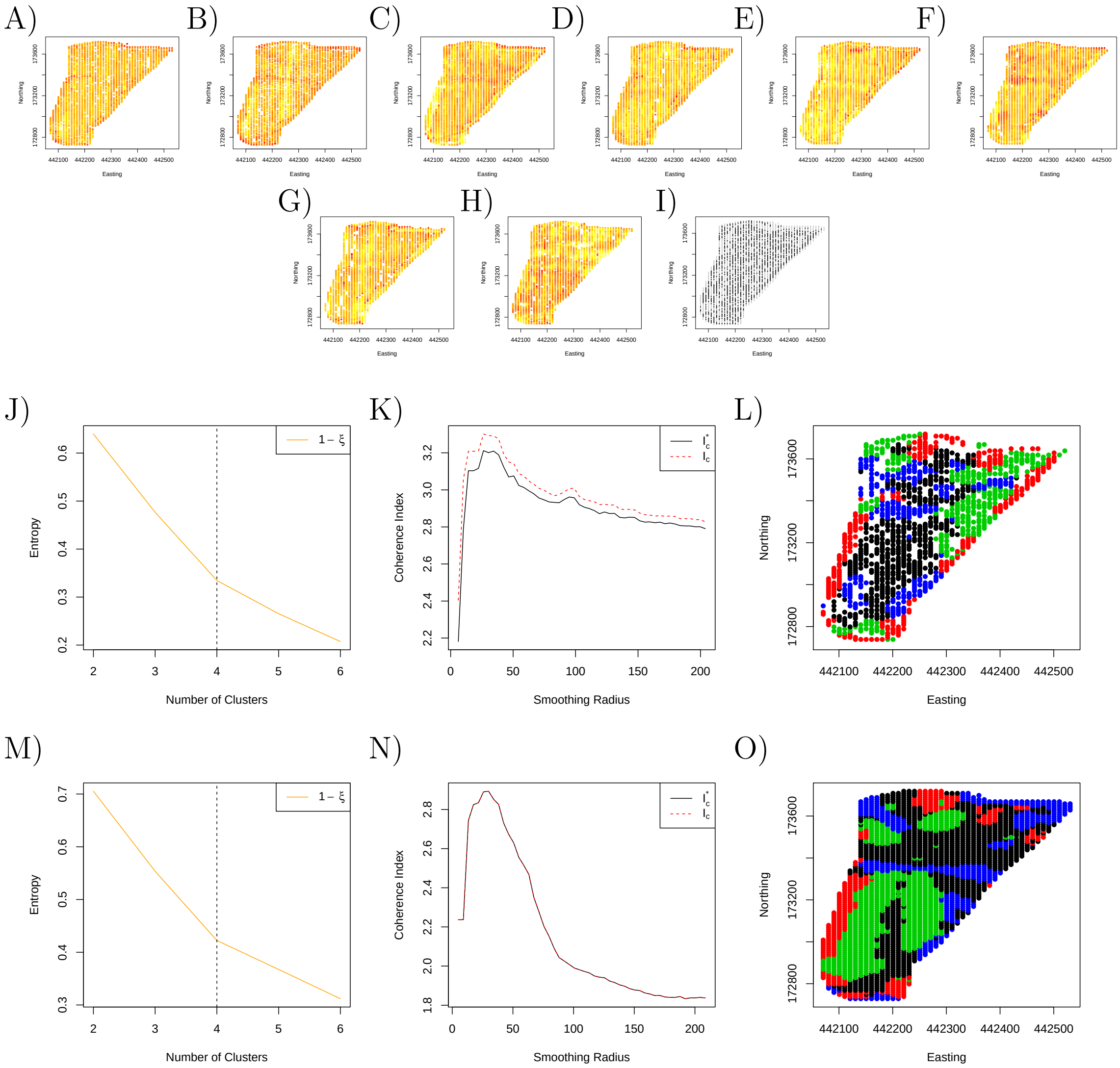

Figure 11: A)-H) Standardised yield measurements over 8 years, aligned to a 10m grid. I) The spatial locations of both complete (black) and partial (grey) observations on a grid of 10m. J) The normalized classification entropy of the fuzzy c-means. K) The associated coherence index based on the underlying grid of 10m (red) and Voronoi cell length (black) and L) the associated smoothed clusters. M) The normalized classification entropy of the OCS fuzzy c-means. N) The associated coherence index based on the underlying grid of 10m (red) and Voronoi cell length (black) and O) the associated smoothed clusters.