# Results

## Comparing regions’ environmental heterogeneity

We compared both the various forms of EH’s values and PC1 of EH between the GCFR and SWAFR using common language effect sizes (*CLES*; ref) [Move this to methods? NOTE: *CLES* = the proportion of pairwise comparisons where the value from one category is greater than that of the other.]. The *CLES* of GCFR vs SWAFR heterogeneity values was regressed against the spatial scale at which it was calculated using OLS linear regression (Figure 1) [Move this to methods too?]. PDQ, NDVI, pH and, arguably, elevation (Figure 1a,c,e,i) are all consistently more heterogeneous in the GCFR than in the SWAFR, regardless of spatial scale. The GCFR is more heterogeneous at finer scales in terms of MAP, surface temperature, CEC and soil carbon (Figure 2b,d,f,h). Notably, the GCFR is more pronouncedly heterogeneous at broad scales in terms of clay (Figure 2g) [NOTE: perhaps something to do with the Succulent Karoo vs CFR? TODO: expand in discussion. TODO: add maps to go with this idea]. In general (see PC1; Figure 2j), the GCFR is more environmentally heterogeneous than the SWAFR, and particularly so at fine spatial scales. The GCFR is more finely scaled in its heterogeneity, though some variables show no scale-dependence, and heterogeneity in clay is greatest in the GCFR at broad scales.

## Comparing and decomposing regions’ species richness

Using Whittaker’s definition of additive turnover (ref), we partitioned *S*HDS into it’s - and -components (QDS and *T*QDS respectively). Using this method, we can see that almost all HDS in both the GCFR and SWAFR are composed of QDS that only account for no more than ca. 50% of *S*HDS (Figure 2a). After accounting for the generally greater *S*HDS in the GCFR (Figure 2b), *S*HDS is more attributable to floristic turnover in in the GCFR than it is in the SWAFR (Figure 2c).

## Environmental heterogeneity as an explanation of species richness

We regressed vascular plant species richness (*S*) against each axis of EH separately (Table 2, Figure 3) and in multivariate models (Figure 4) at both HDS- (Table 2a, Figure 4a) and QDS-scales (Table 2b, Figure 4b). Heterogeneity in elevation and mean annual surface temperature were consistently positively “main effect only” across scales when considered in univariate models (Table 2). This pattern is mirrored by the major axis of EH: PC1 (Figure 3), though there is scale-dependence in the slope of that relationship. In a univariate context, all other EH-variables showed varying degrees of covariance with *S* (Table 2).

Considering the multivariate models of *S*HDS (Figure 4a) and *S*QDS (Figure 4b), the importance of different axes of EH varies between the HDS- and QDS-scales (Table 3). At the HDS-scale, the GCFR and SWAFR share no “common effects” of EH on *S*, while at the QDS-scale the relationships between *S* and heterogeneity in elevation, MAP and CEC are common to the two regions.

## Tables

Table 2: Results of univariate regressions of vascular plant species richness against various axes of EH and overall EH (PC1) across the GCFR and SWAFR, at both (a) HDS- and (b) QDS-scale. For each axis of EH, we fit three univariate models: *S* as a function of EH, *S* as a function of EH with an additive term describing region and *S* as a of EH with an interaction term for region. We used Akaike’s information criterion (*AIC*; ref) to select which of these three model types fit best for each EH predictor variable. In each case, the best-fitting model (those presented) was selected as the simplest model with *∆AIC* < 2. Abbreviations are as follows: MAP, mean annual precipitation; PDQ, precipitation in the driest quarter; CEC, cation exchange capacity; T, temperature.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Model term | | | | | |
| Response | Model type | EH predictor | Slope |  | SWAFR effect |  | Slope:SWAFR |  |
| (a) *S*HDS | Main effect × region | MAP | + | \*\*\* | + |  | – | \*\* |
|  | Main effect + region | Clay | + | \* | – | \*\* |  |  |
|  |  | NDVI | + | \*\*\* | – | \* |  |  |
|  | Main effect only | Elevation | + | \*\*\* |  |  |  |  |
|  |  | PDQ | + | \*\*\* |  |  |  |  |
|  |  | Soil C | + | \*\*\* |  |  |  |  |
|  |  | Surface T | + | \*\*\* |  |  |  |  |
|  |  | PC1 | + | \*\*\* |  |  |  |  |
|  | Region only | CEC | – |  | – | \*\* |  |  |
|  |  | pH | + |  | – | \*\* |  |  |
| (b) *S*QDS | Main effect × region | NDVI | + | \*\*\* | – | \*\* | – | \*\*\* |
|  |  | PDQ | + | \*\*\* | + |  | + | \*\*\* |
|  |  | Soil C | + | \*\*\* | – |  | – | \*\* |
|  | Main effect only | Elevation | + | \*\*\* |  |  |  |  |
|  |  | MAP | + | \*\*\* |  |  |  |  |
|  |  | Surface T | + | \*\*\* |  |  |  |  |
|  |  | PC1 | + | \*\*\* |  |  |  |  |
|  | Region only | CEC | – |  | – | \*\*\* |  |  |
|  |  | Clay | + |  | – | \*\*\* |  |  |
|  |  | pH | – |  | – | \*\*\* |  |  |

Table 3: Interpretation of region-specific scale-dependencies in Figure 4. Positive scale-dependence (+) means a greater magnitude of effect on *S* at broader spatial scales; negative scale-dependence (–) means a greater magnitude of effect on *S* at smaller spatial scales.

|  |  |  |
| --- | --- | --- |
| Scale-dependence | GCFR | SWAFR |
| + | Clay, pH |  |
| None |  | CEC |
| – | NDVI, soil C | PDQ |

## Figures

Figure 1: Simple linear regressions of the common language effect size (CLES; ref) of (a–i) various forms of EH and (j) the first principal component of EH (PC1), where the CLES is treated as the effect of GCFR relative to SWAFR values. Only significant (P ≤ 0.05) fits are plotted, with the exception of the fit for CEC, which was plotted in light of its marginal significance (P = 0.06). Grey bands denote 95% confidence intervals about the fitted lines. Across the five spatial scales, all CLES-values differed significantly from zero following two-sided t-tests (P < 0.001). PC1 accounted for between 43.64 and 46.40% of the variation in EH values across the five spatial scales at which it was calculated.

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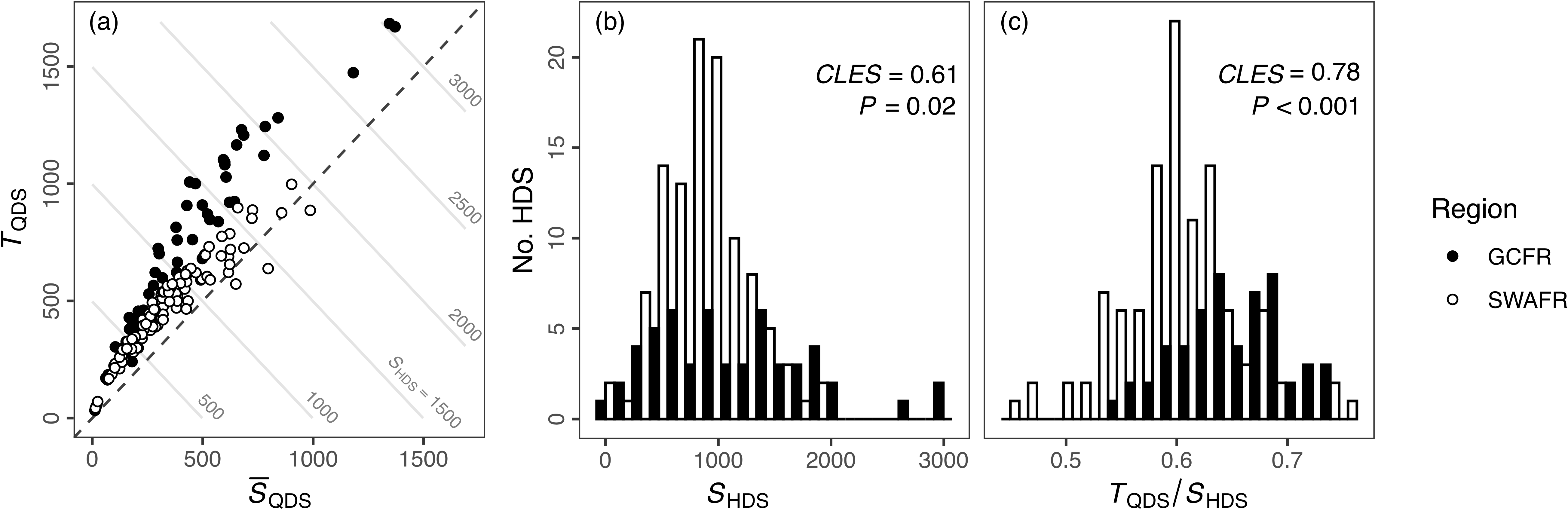


Figure 2: (a) Scatter plot of mean QDS-scale richness (QDS) and turnover (*T*QDS) with contour lines denoting the *S*HDS that would arise as their sum (i.e. increasing from lower-left to upper-right). Distributions of (a) HDS-scale species richness (*S*HDS) and (b) the turnover partition of that richness expressed as a proportion (*T*QDS / *S*HDS). *CLES*-values inset are for comparisons where GCFR EH-values are greater than SWAFR EH-values; *P*-values inset are from Mann-Whitney *U*-tests. Not shown here, when comparing raw QDS-scale species richness values (*S*QDS), the results are as follows: *CLES* = 0.60, *P* < 0.001.

Figure 3: Fits of simple linear regressions of (a) SHDS (R2 = 0.23) and (b) SQDS (R2 = 0.15) against each respective scale’s PC1-values. Grey bands denote 95% confidence intervals. When calculated at the QDS-scale, PC1 explained 39.86% of the variation in EH, while at the HDS-scale PC1 explained 41.55% of the variation in EH

Figure 3: Fits of simple linear regressions of (a) *S*HDS (*R*2 = 0.23) and (b) *S*QDS (*R*2 = 0.15) against each respective scale’s PC1-values. Grey bands denote 95% confidence intervals. When calculated at the QDS-scale, PC1 explained 39.86% of the variation in EH, while at the HDS-scale PC1 explained 41.55% of the variation in EH.

Figure 4: Slope estimates of the multiple linear regressions of (a) SHDS (R2adj = 0.49) and (b) SQDS (R2adj = 0.33) againt the various forms of EH. Each model was simplified, from a starting model with all predictors and their interactions with region, using reverse stepwise regression model selection based on AIC-scores in R. Points with error bars denote slope estimates and their 95% confidence intervals. Estimates illustrated in black were significant (P < 0.05), while those in grey were not.

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