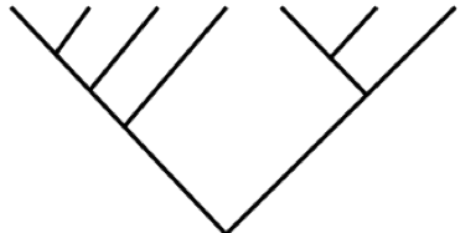
TODO: Add Powerpoint coverslide manually

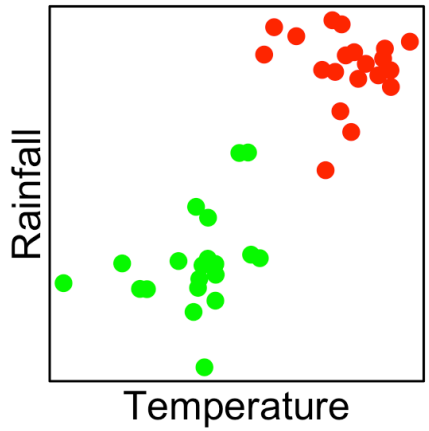
Species richness (S)

Species richness (S)

Speciation



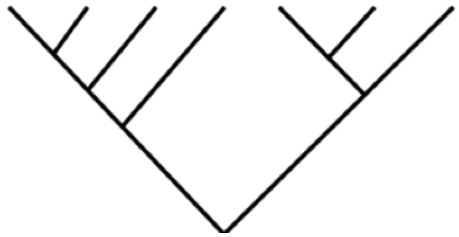
Co-existence



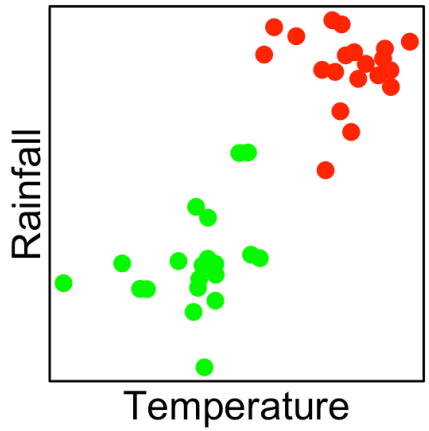
Species richness (S)

Extremely high S?

Speciation



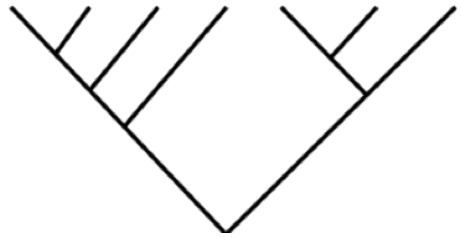
Co-existence



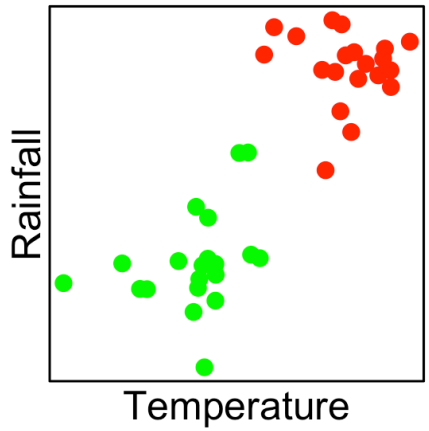
Species richness (S)

Environmental heterogeneity (EH)

Speciation



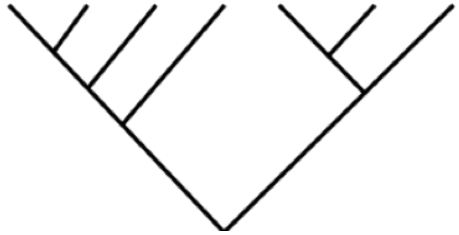
Co-existence



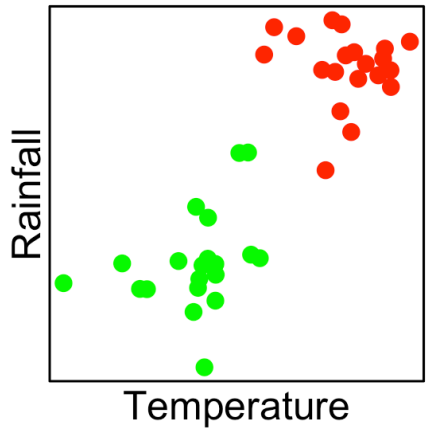
Species richness (S)

Environmental heterogeneity (EH)

Speciation *along ecological gradients*



Co-existence *within ecological space*



The Cape & SWA

TODO: maps of regions

Similar

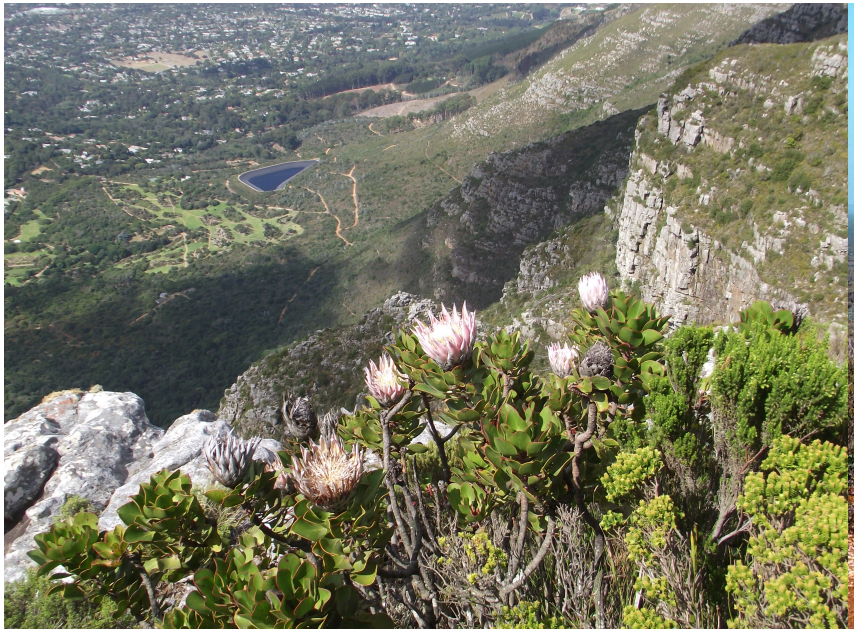
- Environments — *mediterranean, winter rainfall*
- Plant ecologies — *serotiny, sclerophylly*

But different

- S per unit area
- Topographies

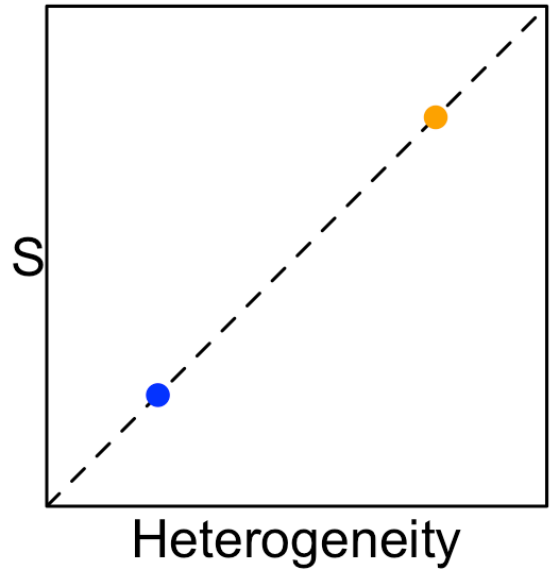
Cape > *SWA*

mountainous vs *flat*

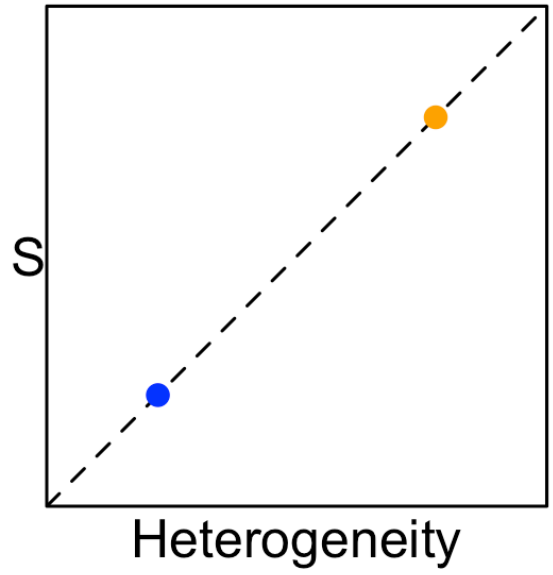


- Cape richness previously shown to depend on heterogeneity[1]
- Does this extend to SWA?

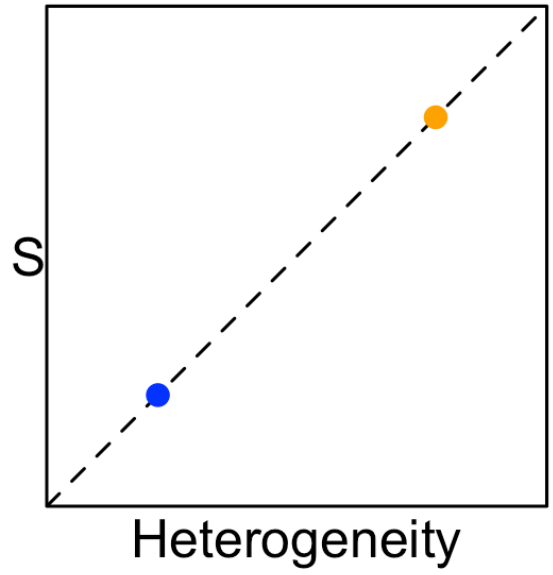
[1] Cramer & Verboom 2016. *J. Biogeography* 44(3)



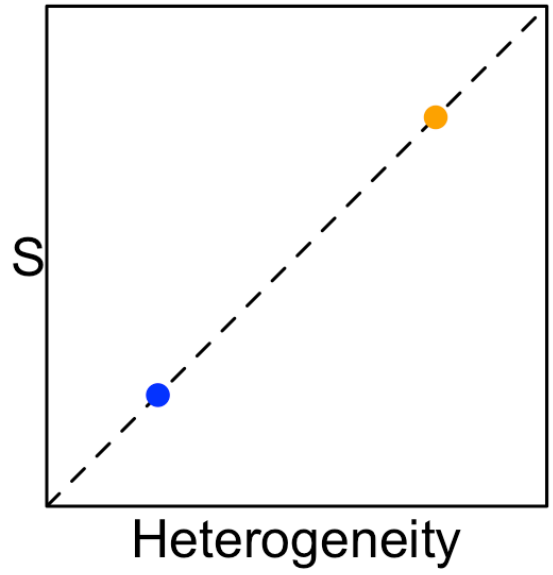
Hypothesis Cape vs SWA



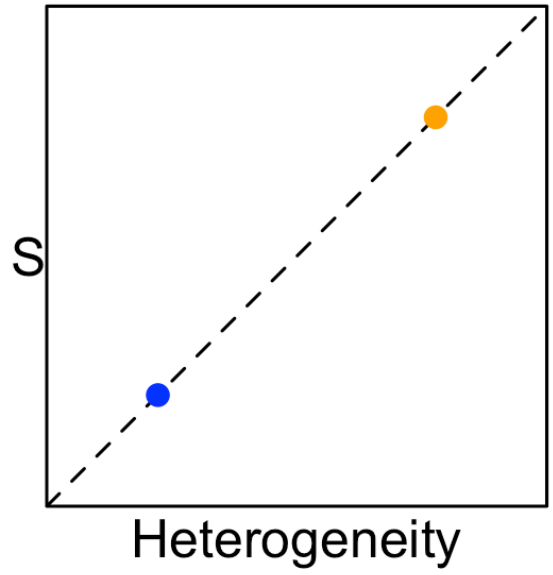
Hypothesis	Cape vs SWA
Degree of EH	
Scale EH	



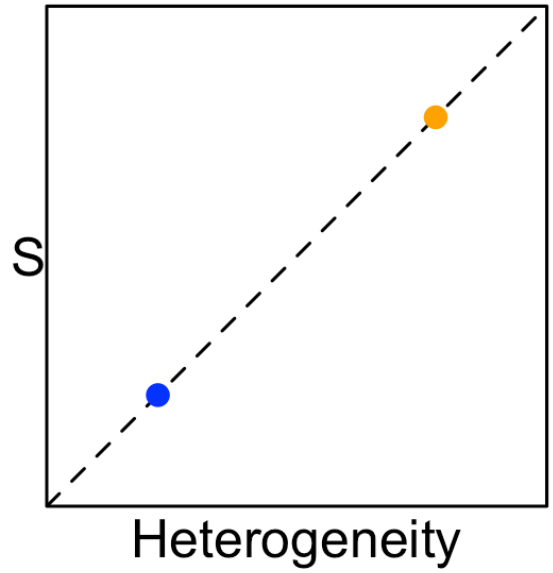
Hypothesis	Cape vs SWA
Degree of EH	>
Scale EH	<



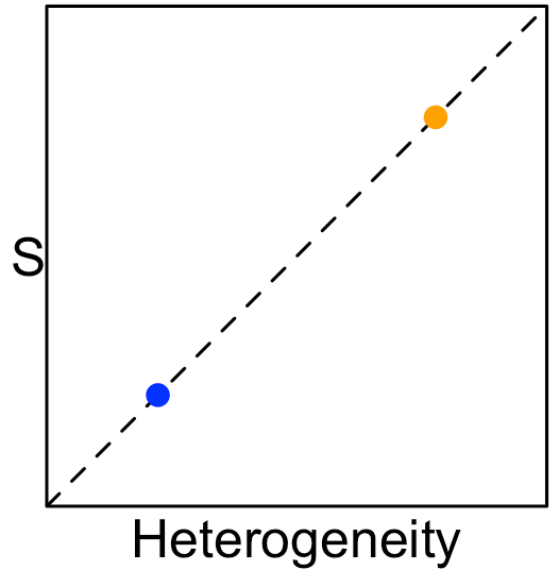
Hypothesis	Cape vs SWA
Degree of EH	>
Scale EH	<
Floristic turnover	>



Hypothesis	Cape vs SWA
Degree of EH	>
Scale EH	<
Floristic turnover	>
$S \sim$ EH	Both



Hypothesis	Cape vs SWA
Degree of EH	>
Scale EH	<
Floristic turnover	>
$S \sim$ EH	Both
Types of EH	



Hypothesis	Cape vs SWA
Degree of EH	>
Scale EH	<
Floristic turnover	>
$S \sim$ EH	Both
Types of EH	Soil?

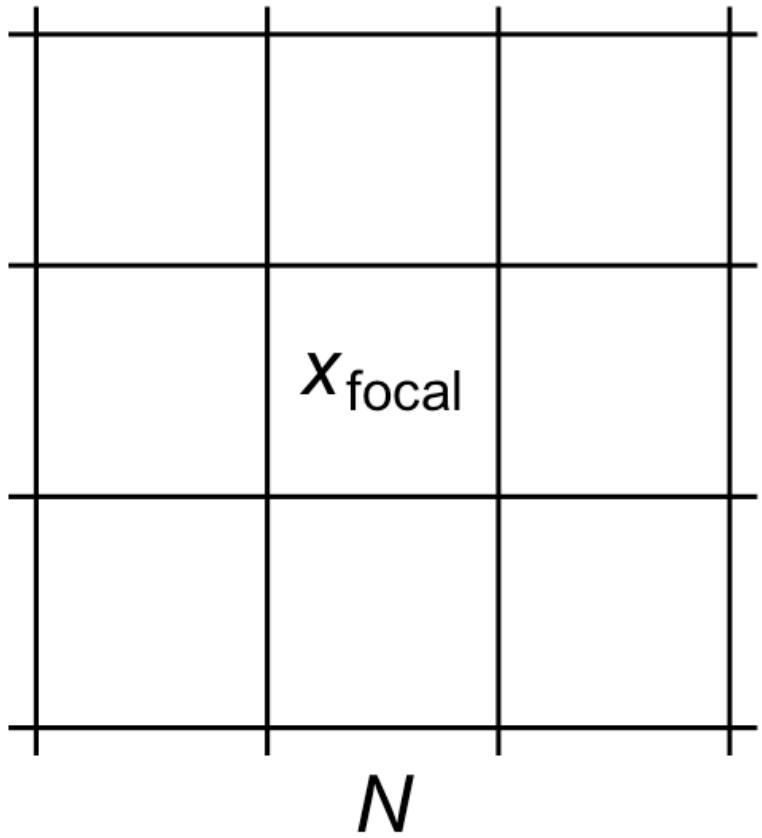
Data sources

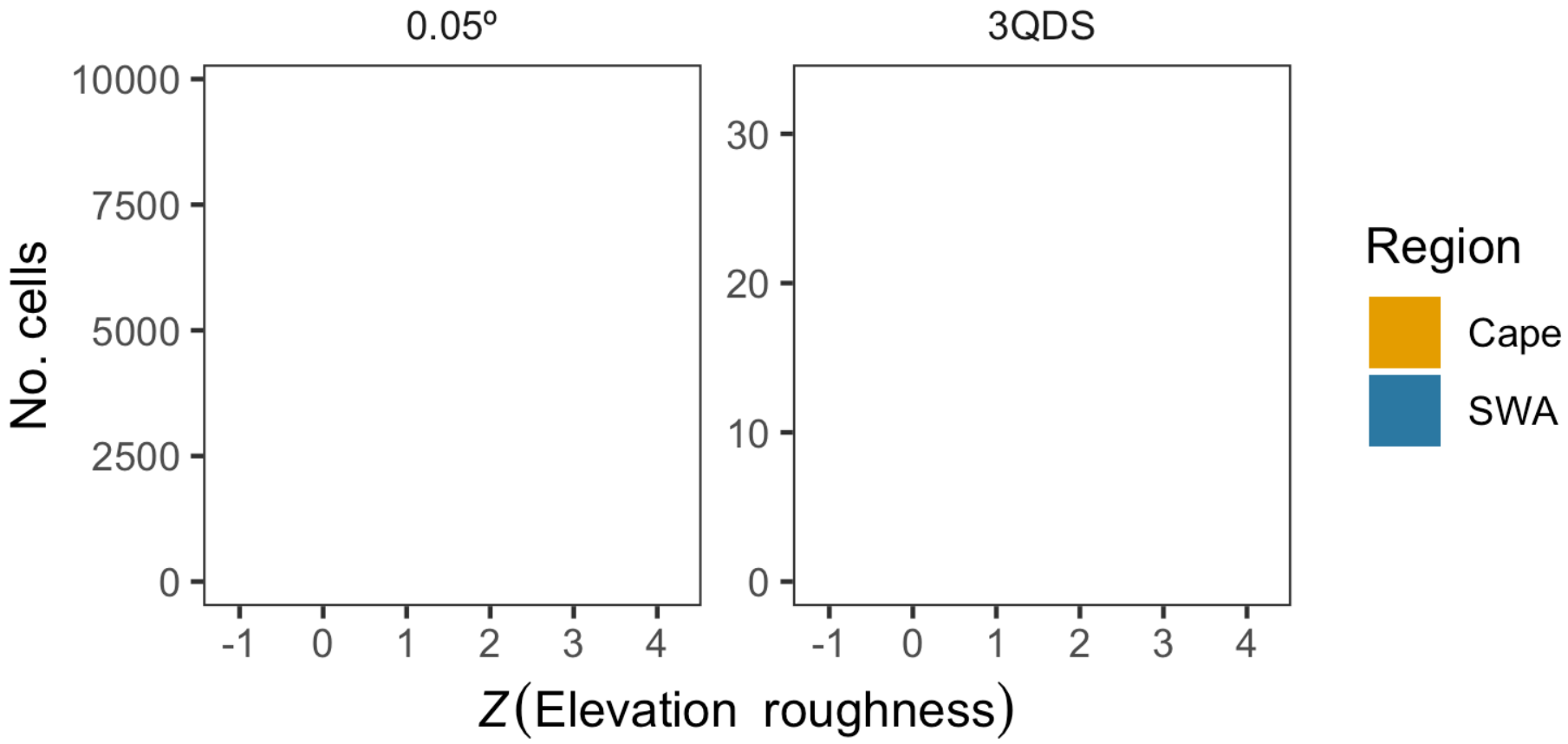
- Each region's boundaries
- Environmental data
  - NASA MODIS, CHIRPS, SoilsGrid250m
- Vascular plant occurrence records
  - GBIF

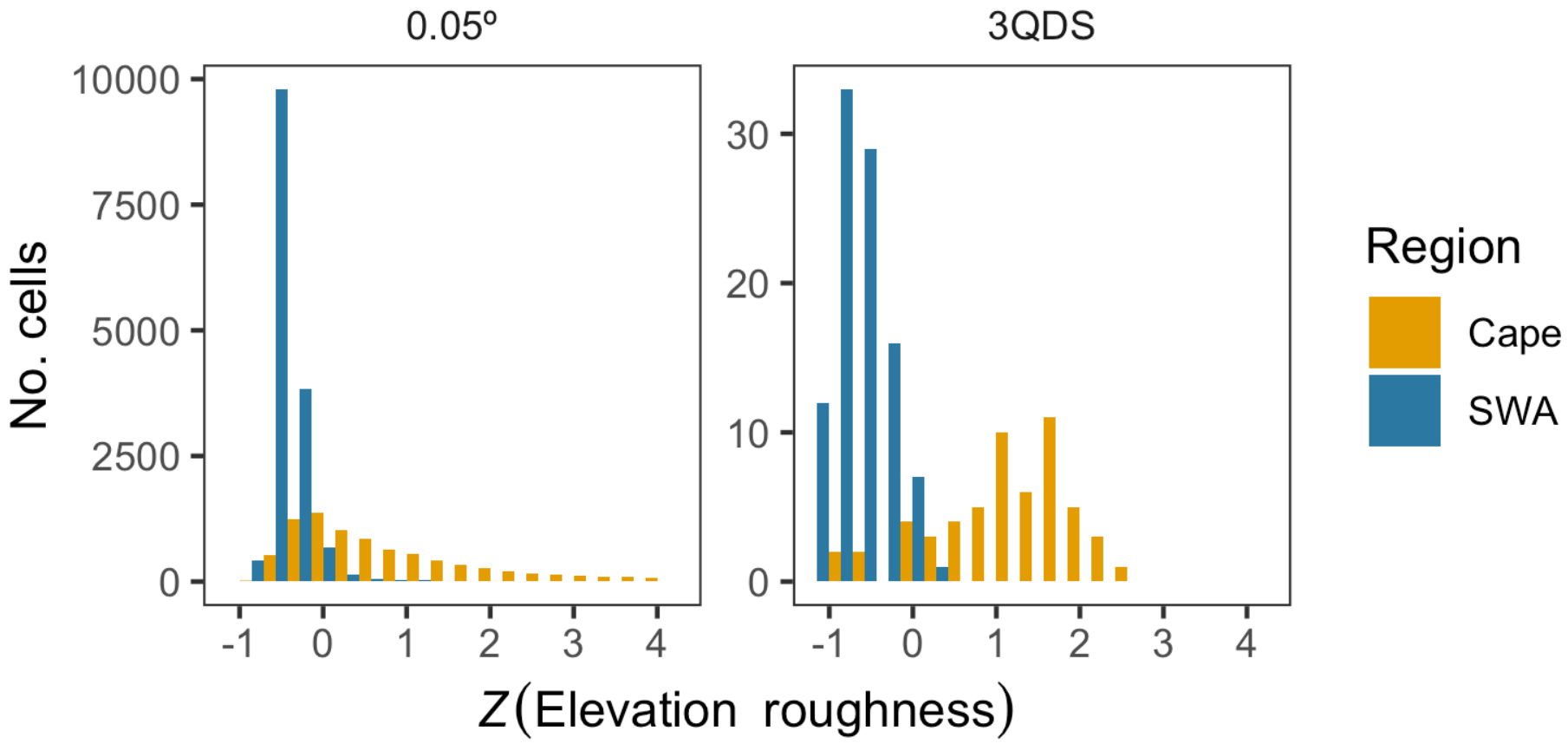
Environmental heterogeneity (EH)

Local neighbourhood N about cell x_{focal}

Roughness $R(N) = SD_{focal}(N)$




0.05º
3QDS
10000
7500
5000
2500
0
30
20
10
0
No. cells
-1
0
1
2
3
4
Z(Elevation roughness)
Region
Cape
SWA


0.05º
3QDS
No. cells
10000
7500
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2500
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30
20
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0
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2
3
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Z(Elevation roughness)
Region
Cape
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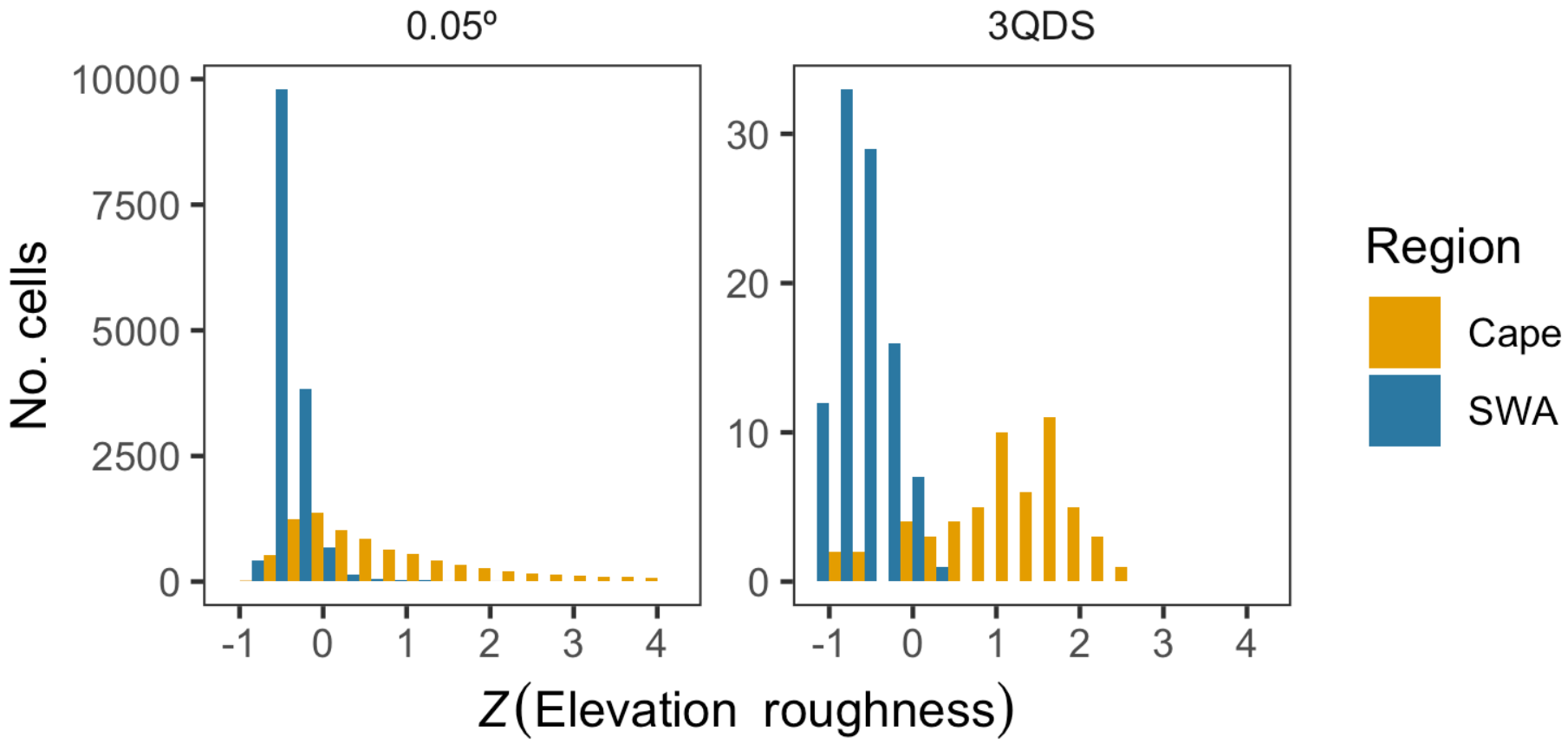
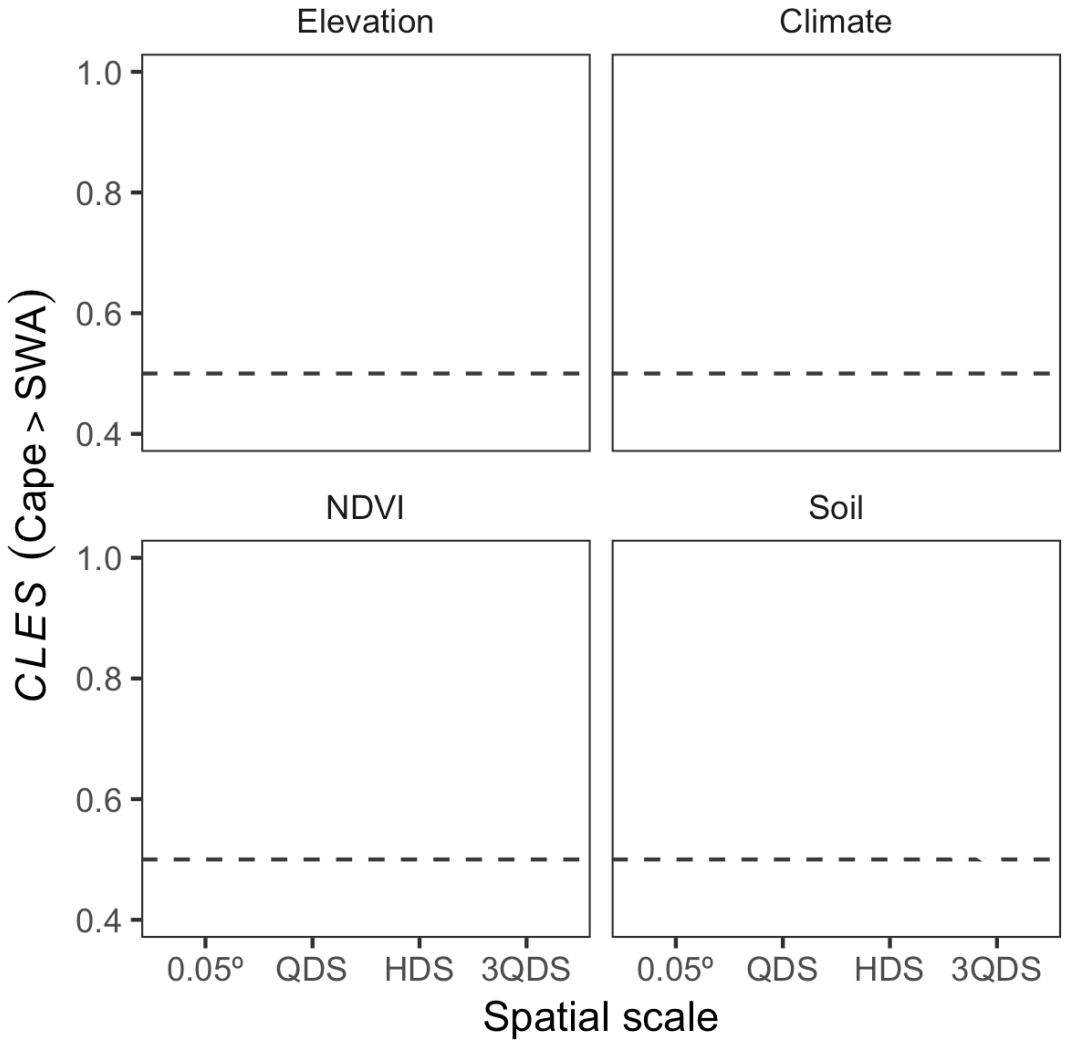
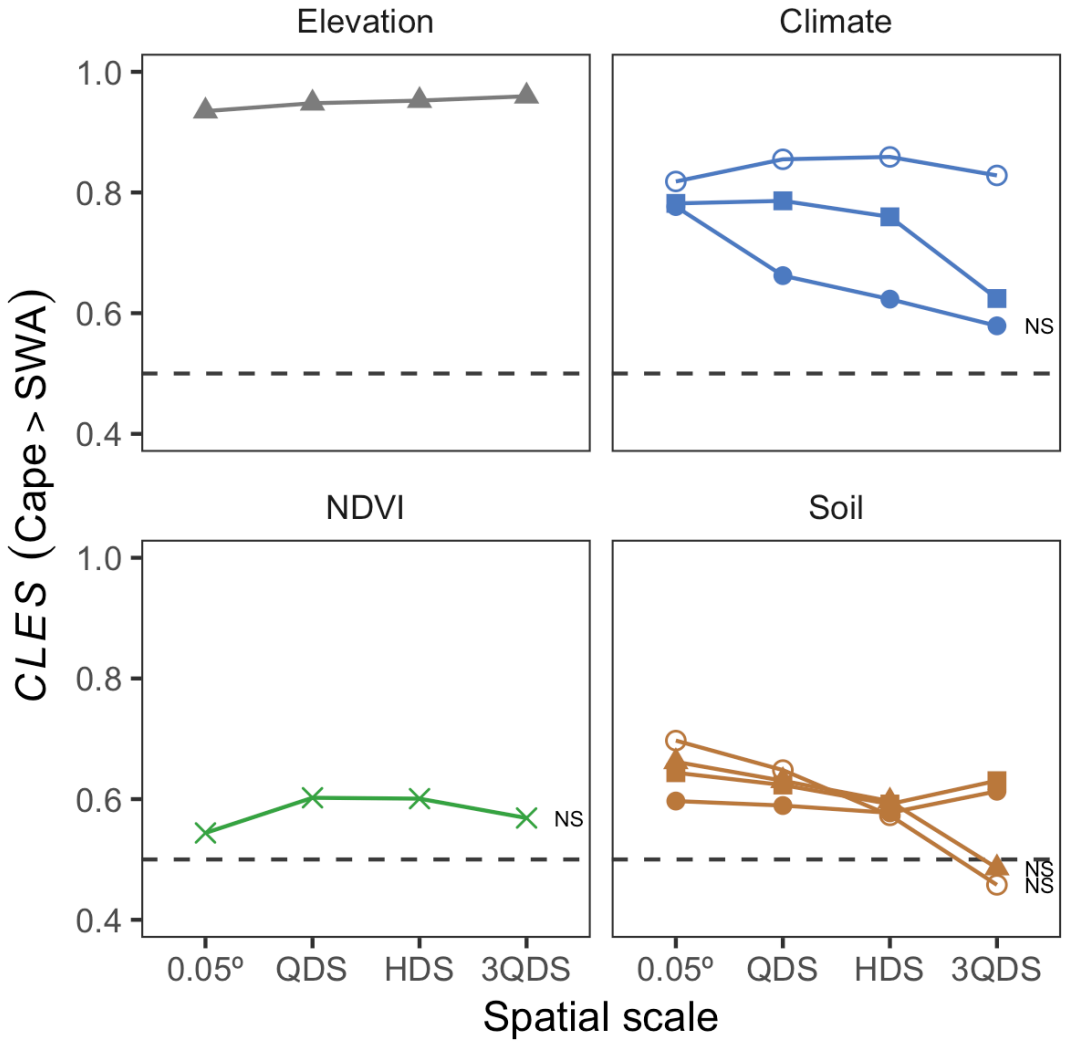
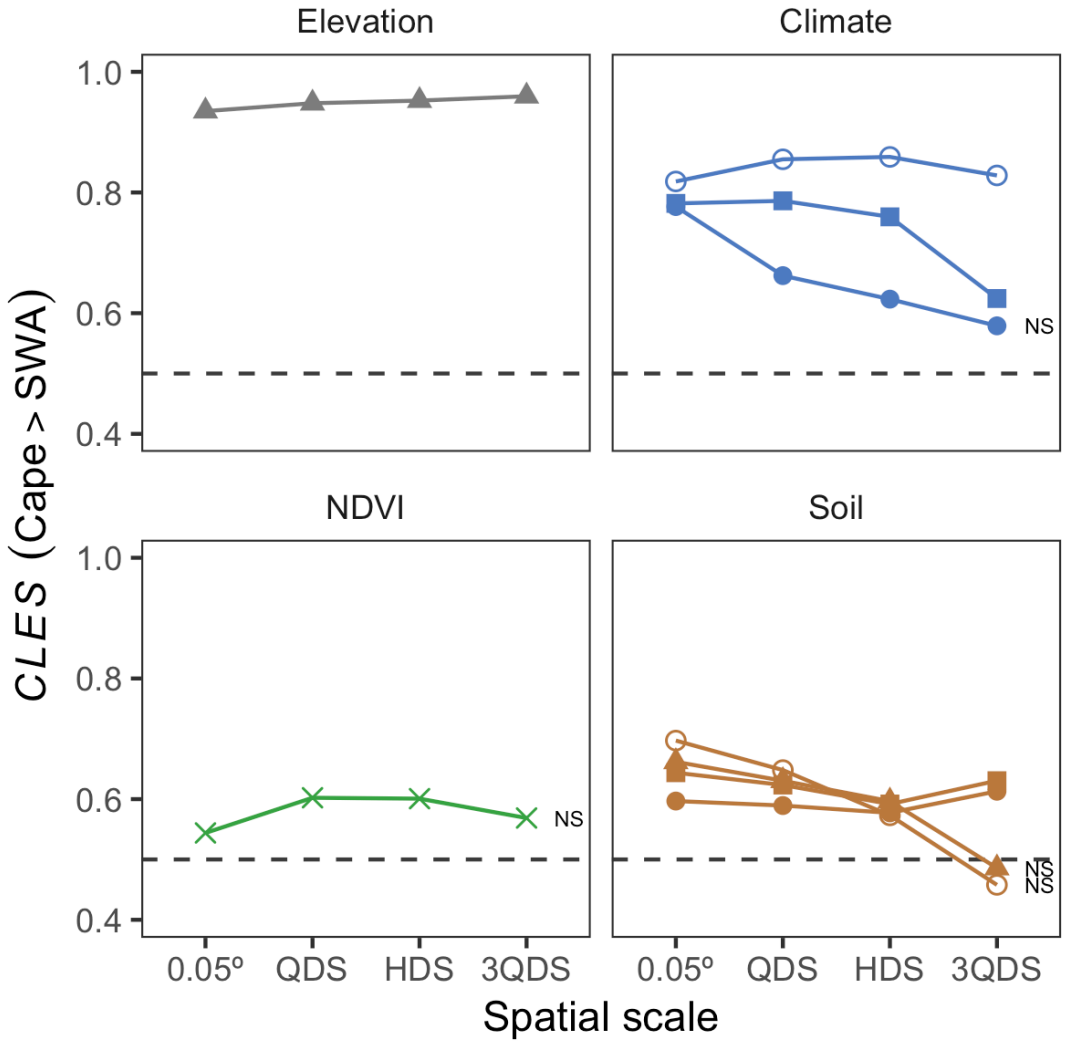


- Roughness varies with scale
- And differently so for the Cape and SWA


Elevation
Climate
NDVI
Soil
1.0
0.8
0.6
0.4
CLES (Cape > SWA)
0.05º
QDS
HDS
3QDS
Spatial scale


Elevation
Climate
NDVI
Soil
CLES (Cape > SWA)
1.0
0.8
0.6
0.4
NS
NS
NS
NS
0.05º
QDS
HDS
3QDS
Spatial scale

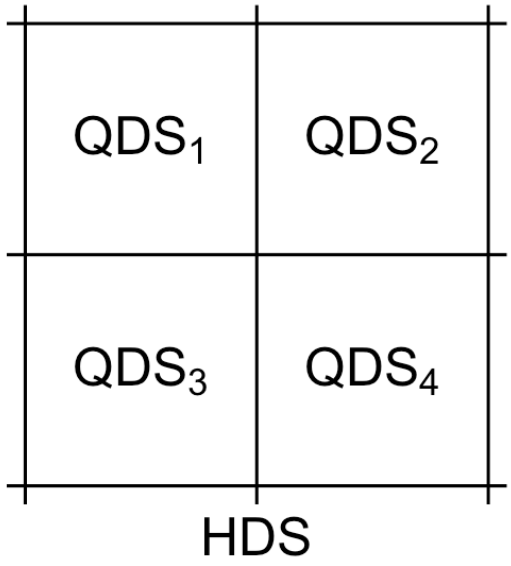


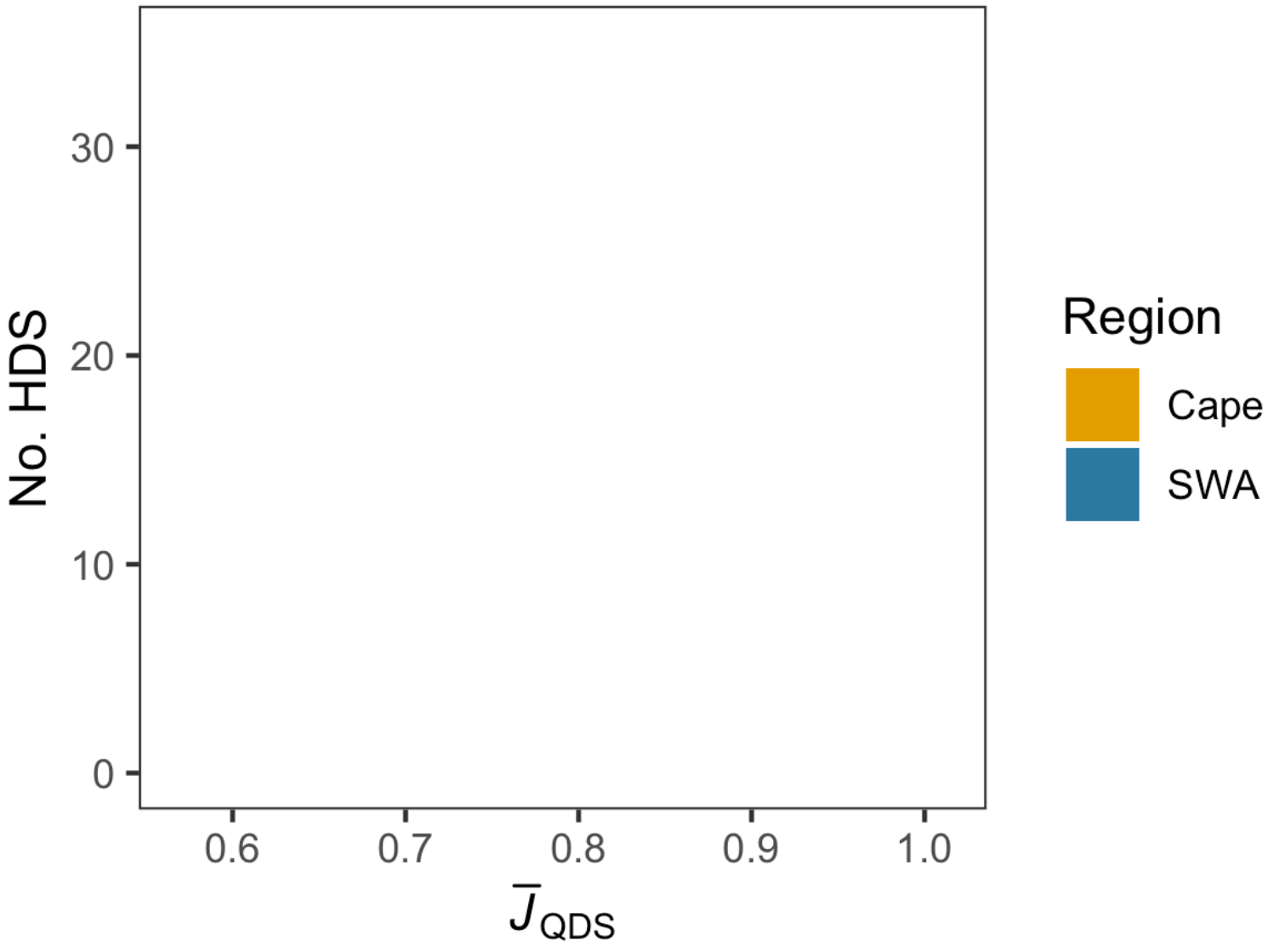
- Different forms of roughness scale differently
- And differently so for the Cape & SWA

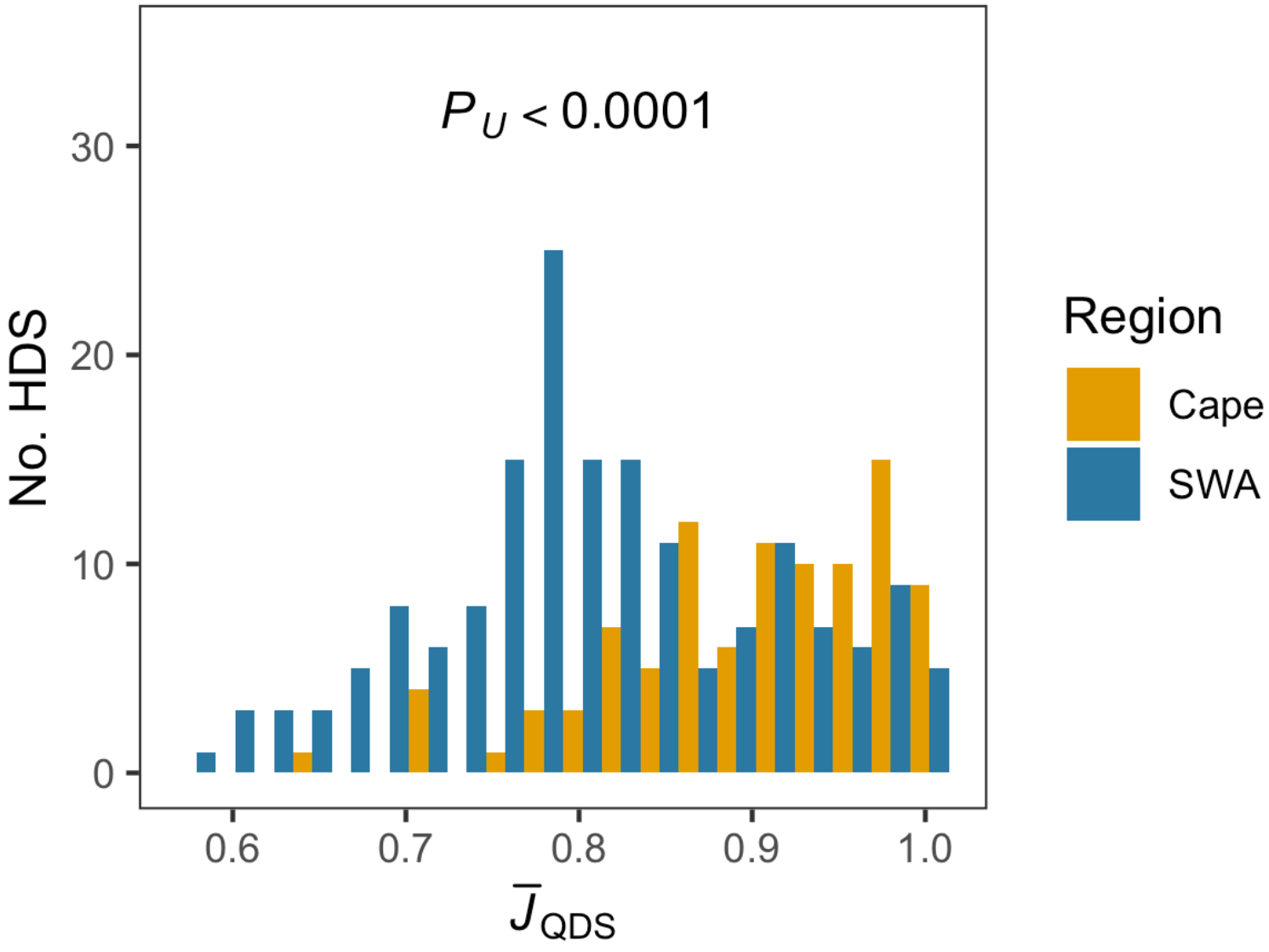
Species turnover

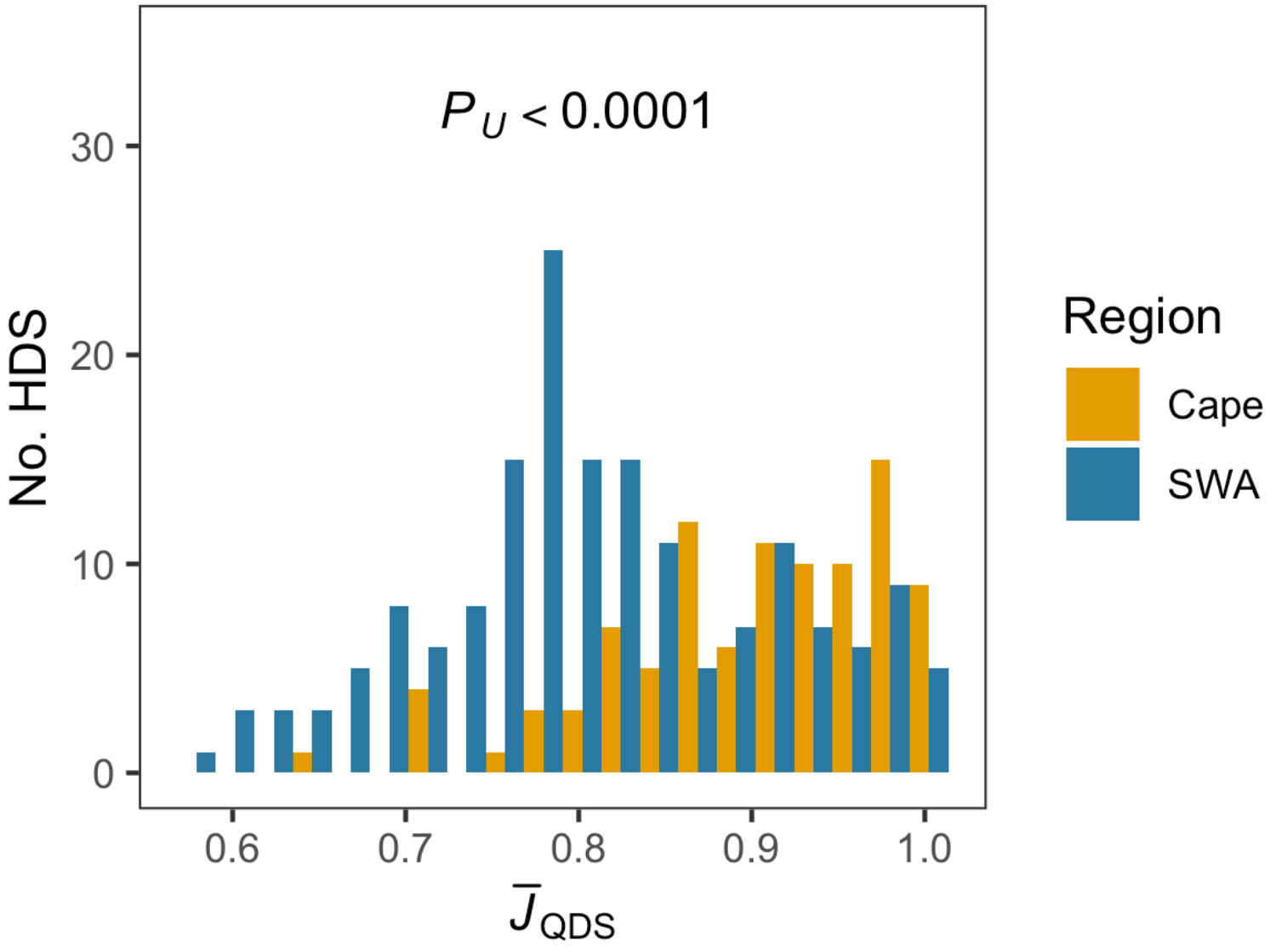
Each HDS is composed of 2–4 QDS

$\overline{J}_{QDS}$ = average Jaccard distance between QDS




30
20
10
0
No. HDS
0.6
0.7
0.8
0.9
1.0
$\bar{J}_{QDS}$
Region
Cape
SWA


$P_U < 0.0001$
No. HDS
30
20
10
0
0.6
0.7
0.8
0.9
1.0
$\bar{J}_{QDS}$
Region
Cape
SWA



– The Cape has ↑ species turnover

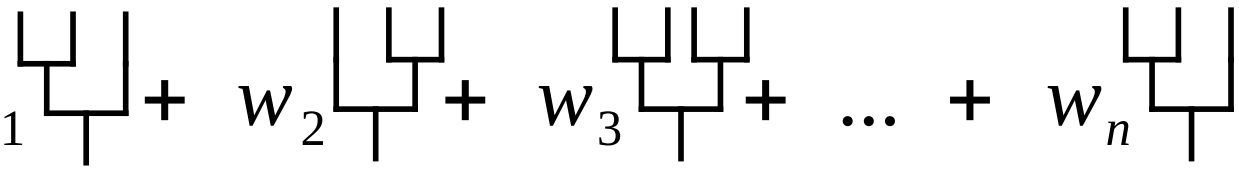
BRT-modelling

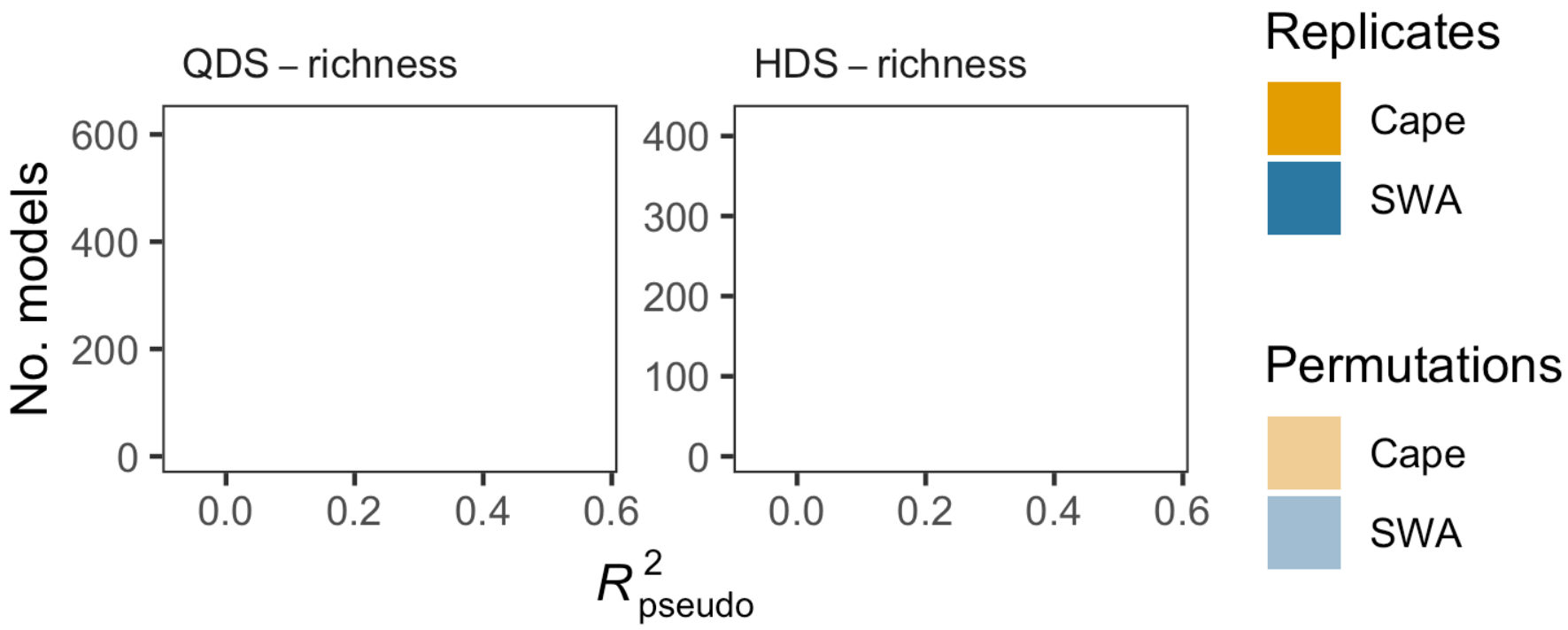
- Machine-learning
- Non-linear, complex & multivariate datasets

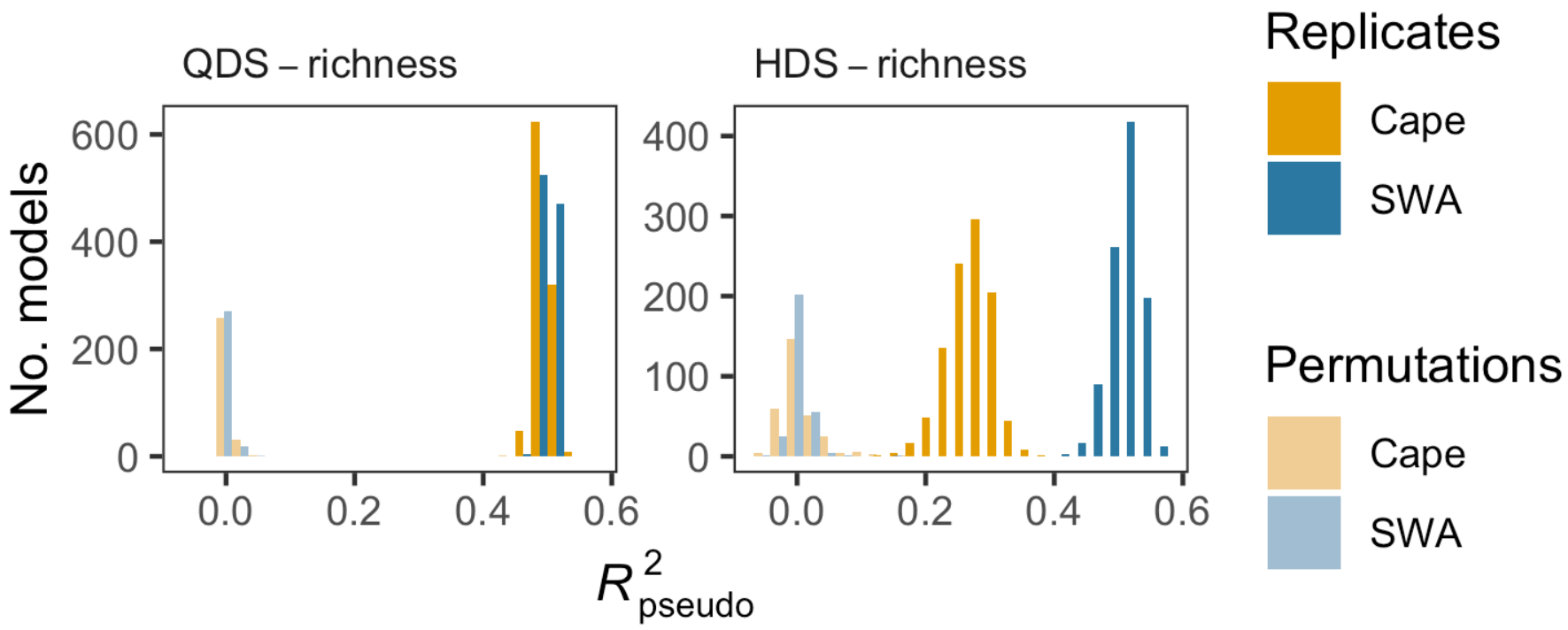
BRT-modelling

- Machine-learning
- Non-linear, complex & multivariate datasets

$$\hat{S} = w_1 + w_2 + w_3 + \ldots + w_n$$




QDS – richness
HDS – richness
No. models
600
400
200
0
400
300
200
100
0
0.0
0.2
0.4
0.6
R^2_{pseudo}
Replicates
Cape
SWA
Permutations
Cape
SWA


QDS – richness
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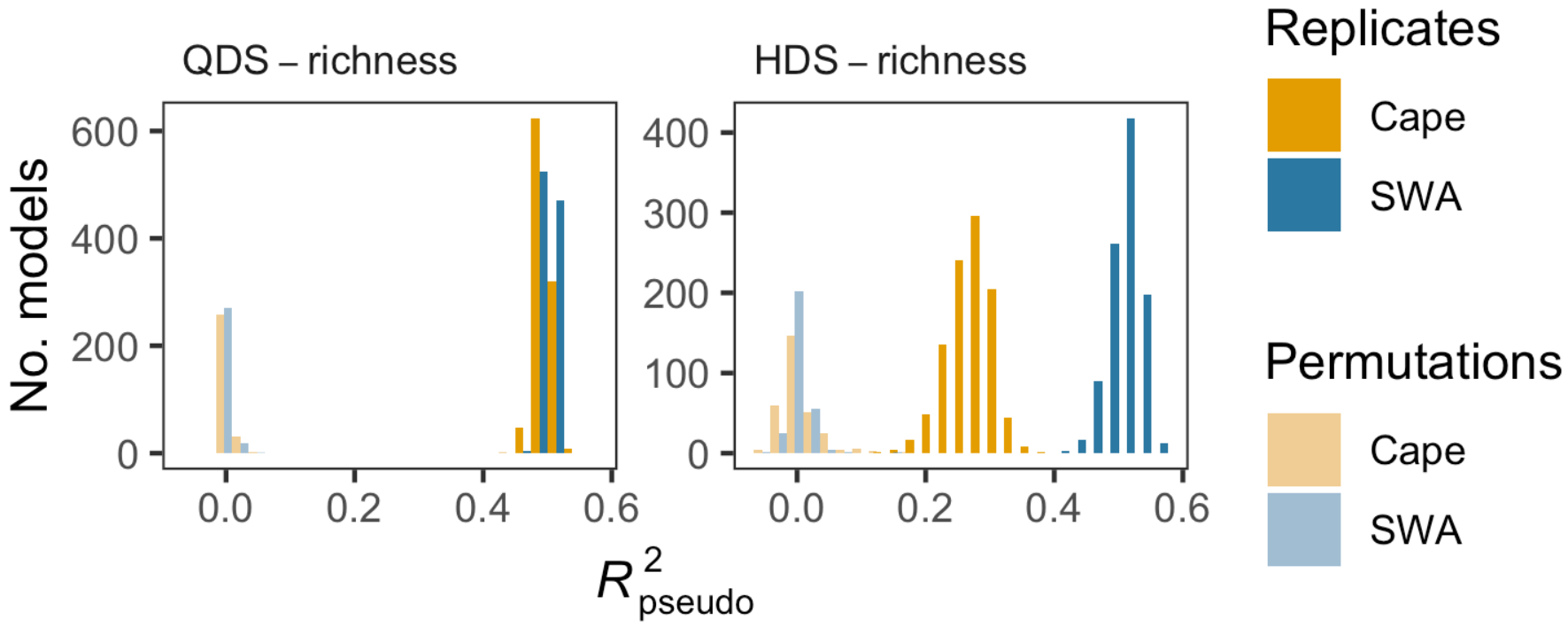
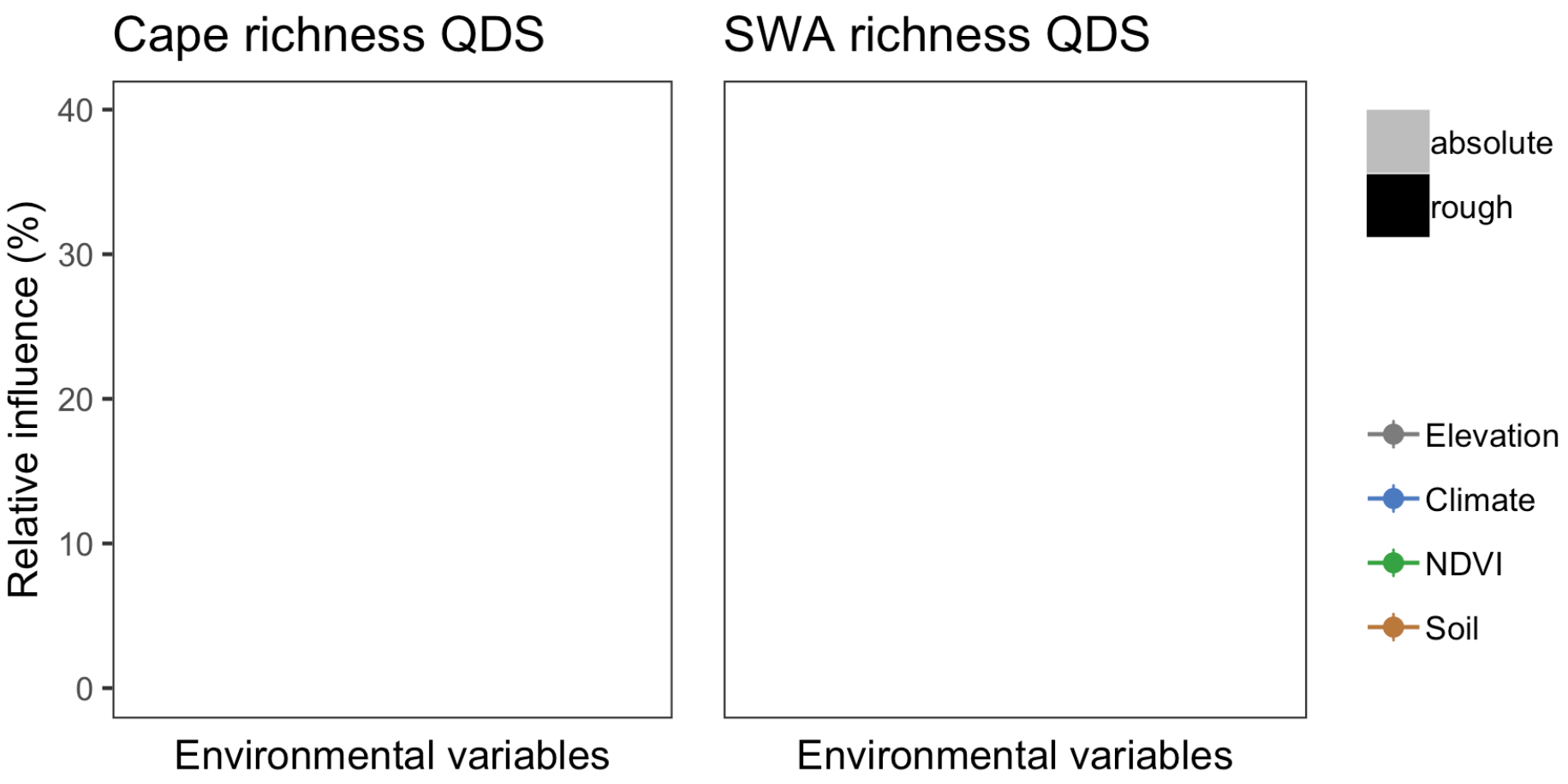
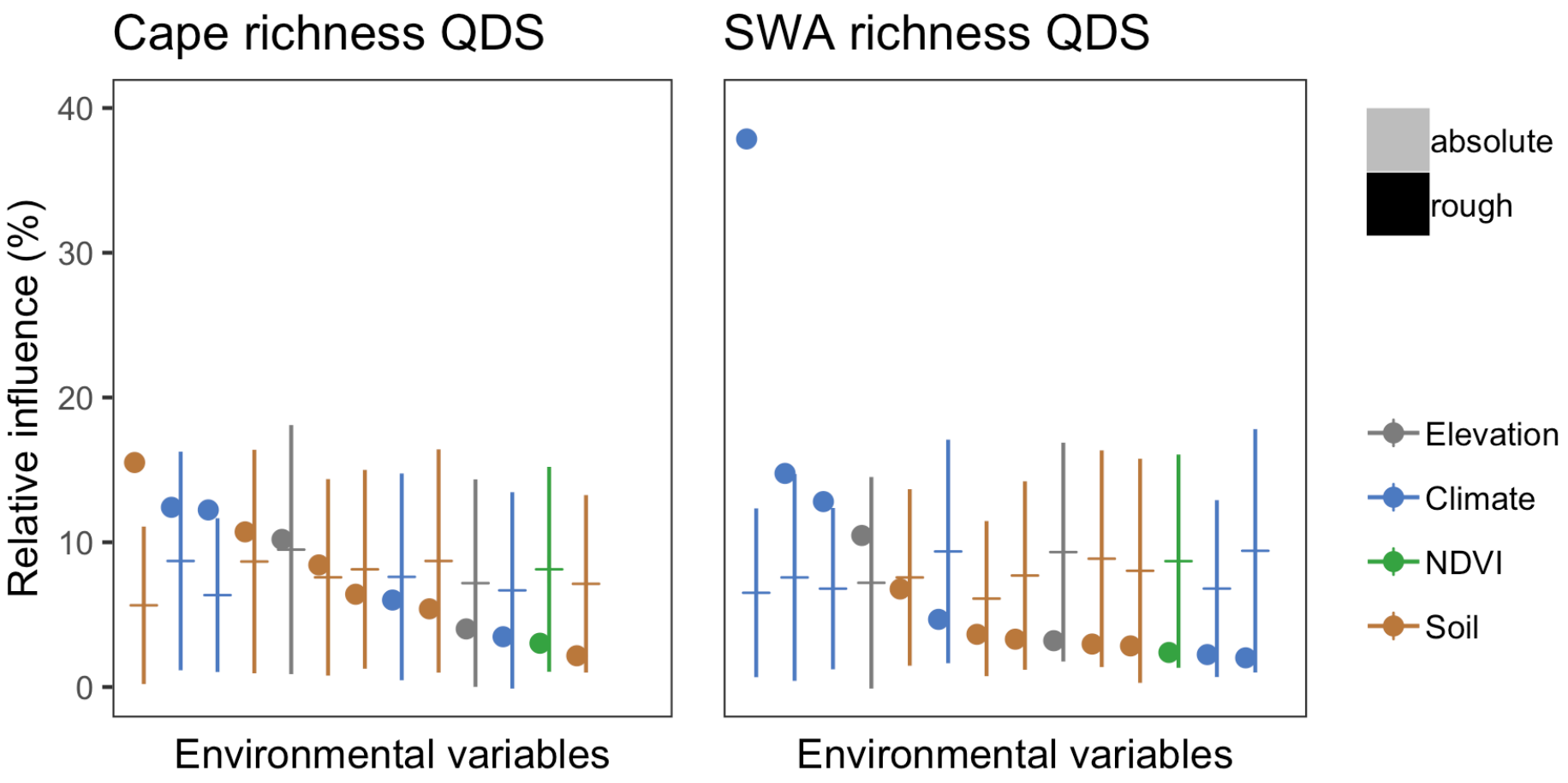
No. models
600
400
200
0
400
300
200
100
0
0.0
0.2
0.4
0.6
R^2_{pseudo}
Replicates
Cape
SWA
Permutations
Cape
SWA



- Patterns different from chance (permuted null) ✓
- Cape patterns breakdown at coarser scales ✓
- SWA patterns do not ✓


Cape richness QDS
SWA richness QDS
Relative influence (%)
40
30
20
10
0
Environmental variables
Environmental variables
absolute
rough
Elevation
Climate
NDVI
Soil


Cape richness QDS
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Relative influence (%)
40
30
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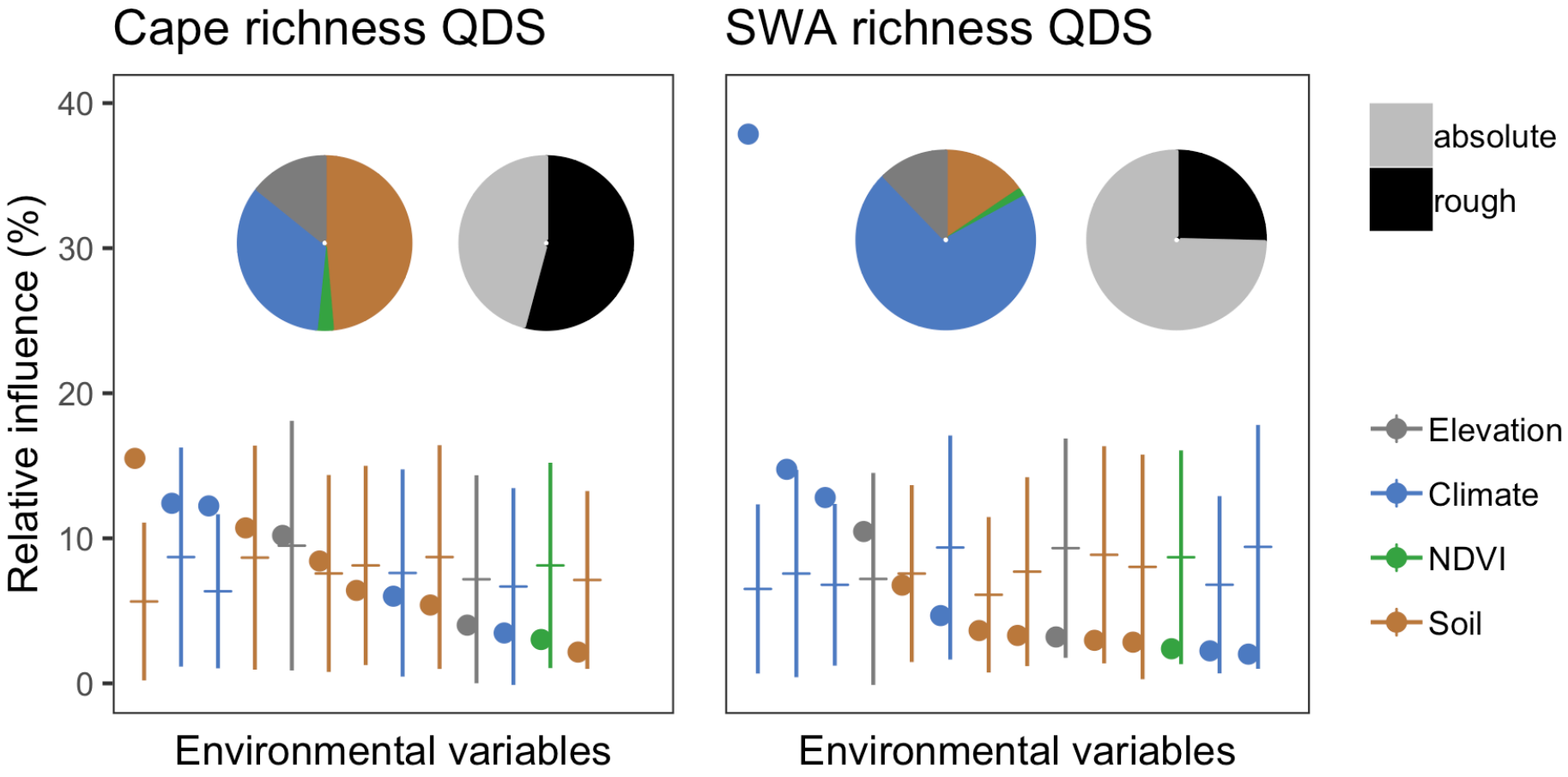
Environmental variables
Environmental variables
absolute
rough
Elevation
Climate
NDVI
Soil


Cape richness QDS
SWA richness QDS
Relative influence (%)
40
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0
Environmental variables
Environmental variables
absolute
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Elevation
Climate
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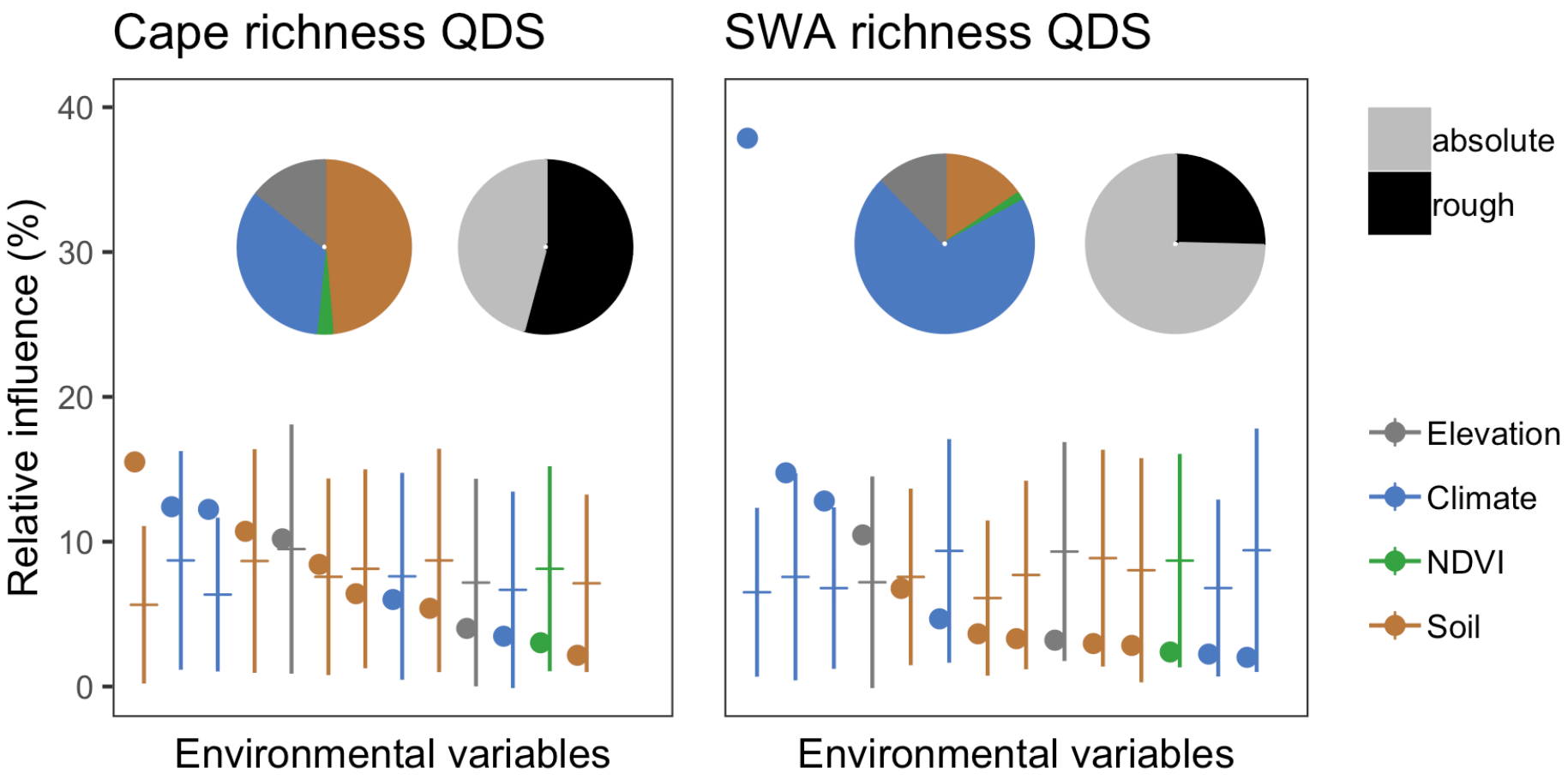
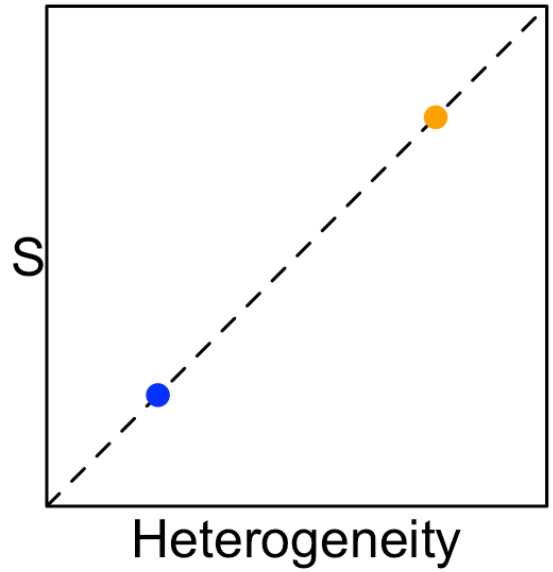
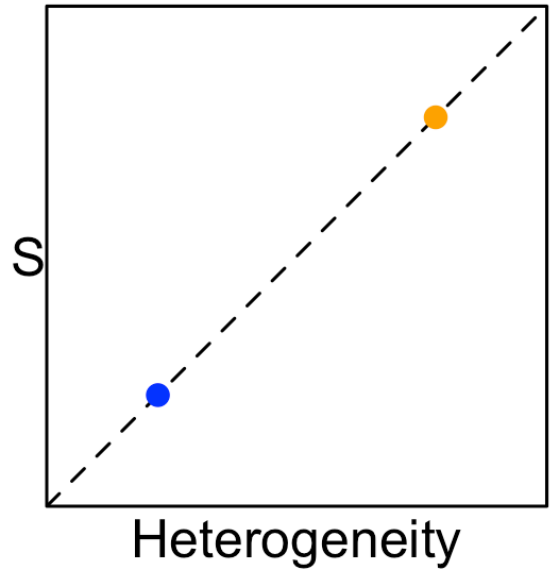
Soil

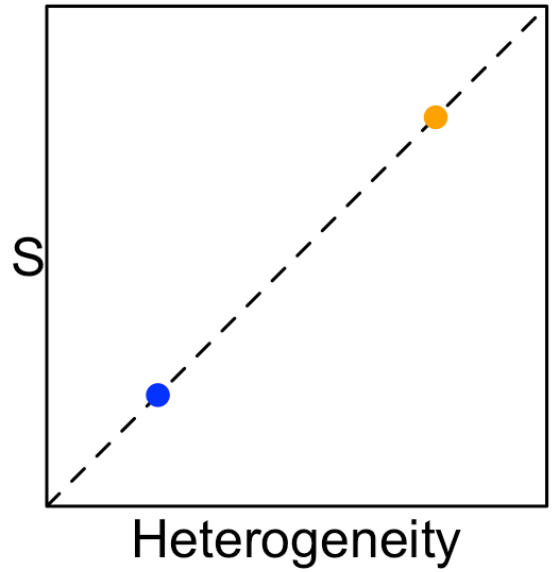


Cape	SWA
Broad suite of variables	MAP
Roughness, soil	Absolute, climate


S
Heterogeneity



Hypothesis	Cape vs SWA	✓?
Degree of EH	>	
Scale EH	<	
Floristic turnover	>	
$S \sim$ EH	Both	
Types of EH	Soil?	



Hypothesis	Cape vs SWA	✓?
Degree of EH	>	✓
Scale EH	<	✓
Floristic turnover	>	✓
$S \sim$ EH	Both	✓
Types of EH	Soil?	$\frac{1}{2}$

Conclusions

- The Cape is more environmentally heterogeneous than SWA

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  - Consequently more species rich
  - Greater floristic turnover supports this.

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  - Consequently more species rich
  - Greater floristic turnover supports this.
- Different axes of EH are biologically important in the Cape and SWA.

Soil?

Thank you[1]!

TODO: Add Hons thesis cover photos here

[1] And an extra thank you to my supervisors, Mike & Tony