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Residential field studies for GCSE and A Level Geography and Geology in the UK, Andorra and Spain.

Statistical analysis using a Chi-Squared Test for Association.

Our null hypothesis H^O will be: There is no significant association between the shapes of boulders and their location in either Gabions or on the beach.

Our alternative hypothesis H^1 will be: There is a significant association between the shapes of boulders and their location in either Gabions or on the beach.

Number of sampled boulders in each powers index of roundness category

	Very angular	Angular	Sub-angular	Sub-rounded	Rounded	Very rounded
Gabions	2	5	6	4	3	0
Beach	0	2	6	7	4	1

This is our field data / also called our **Observed data**

Chi-Squared works by comparing your observed data with the expected data - ie what the data would be IF there were no association between the shape and the location. The greater the difference between what you have observed and the expected data, then the more likely that there is a significant association.

Observed data

	Angular	Rounded	Row total	
Gabions	13	7	20	
Beach	8	12	20	
Column total	21	19	40	**Grand total**

Expected data

	Angular	Rounded
Gabions	10.5	9.5
Beach	10.5	9.5

The expected data is calculated using the row, column and grand total values from the observed data table.

row total x column total / grand total

ie for Angular in the Gabions it is

20 x 21 / 40 = 10.5

for Rounded in the Gabions it is

20 x 19 / 40 = 9.5

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The next stage is the calculation that compares your OBSERVED data with the EXPECTED data.

The formula for Chi Squared is = ***the sum of (observed - expected)² / expected***

Chi Squared calculation

	Angular	Rounded	Total
Gabions	0.59	0.66	1.25
Beach	0.59	0.66	1.25
			2.50

for Angular in the Gabions it is

$(13 - 10.5)^2 / 10.5 = 0.59$

for Rounded in the Gabions it is

$(7 - 9.5)^2 / 9.5 = 0.66$

The calculated value of Chi Squared **2.50**

The final stage is to compare your calculated value with a CRITICAL VALUE.

The critical value is obtained from a table of values for Chi Squared. The critical value that you use depends on two things - the probability level / confidence level and the degrees of freedom. Degrees of freedom is a measure of the size of your data set.

Geographers usually work at a 0.05 probability / 95% confidence level when doing statistical tests.

The degrees of freedom are calculated as follows

(number of columns of observed data - 1) x (number of rows of observed data -1)

(2-1) x (2-1) = 1

The critical value for this test is 3.84.

Compare your result to the critical value.

If your result is EQUAL TO or GREATER than the critical value you can be 95% confident in REJECTING your null hypothesis.

If your result is LESS than the critical value you can be 95% confident in ACCEPTING your null hypothesis

Degrees of freedom	0.05 probability / 95% confidence	0.01 probability / 99% confidence
1	**3.84**	6.64
2	5.99	9.21
3	7.81	11.35
4	9.49	13.28

So in conclusion we have to accept the null hypothesis = that there is NO siginificant association between the shapes of boulders and their location in either Gabions or on the beach.

Further information and another worked example of a simpler version of the Chi Squared test can be found here

https://www.tutor2u.net/geography/reference/chi-squared-test

And this is a good website to get critical values for a variety of statistical tests.

https://www.socscistatistics.com/tests/criticalvalues/default.aspx