Guide for CLUZ v2022.11.26

CLUZ for Marxan with Zones

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CLUZ (Conservation Land-Use Zoning software) is a QGIS 3 plugin that lets users design conservation area networks and other conservation landscapes and seascapes (Smith, 2019). It can be used for on-screen planning and also acts as a link for the Marxan and Marxan with Zones conservation planning software packages. It was developed by Bob Smith, from the Durrell Institute of Conservation and Ecology (DICE), and funded by the UK Government's Darwin Initiative.

This guide is for using CLUZ with Marxan with Zones. Another guide is available for using CLUZ with Marxan. The CLUZ plugin consists of the CLUZ menu, containing 18 functions, and 8 buttons that appear on the QGIS toolbar. Each of the functions and buttons are described below, together with details of the file formats used in CLUZ.

Marxan with Zones is a spatial prioritisation package designed to identify sets of planning units for each specified management zone that meet targets whilst minimising planning unit costs and maintaining connectivity. An analysis involves running Marxan with Zones a number of times, with each run identifying a near-optimal portfolio of planning units for each management zone, so that the "best" output is then identified as the one with the lowest cost (Ball et al., 2009). Marxan with Zones also produces a selection frequency output based on counting the number of times each planning unit appears in each of the management zones in each of the runs.

Most of the CLUZ functions work on any computer that can run QGIS 3. One known issue is running Marxan with Zones through CLUZ on Mac OS X computers or on computers with very restrictive security settings. In such cases users should set up the Marxan with Zones files in CLUZ, run Marxan with Zones independently and then import the results into CLUZ.

CLUZ functions

CLUZ menu items

 *View and edit CLUZ setup file*

The CLUZ setup file contains information on the location of the Marxan with Zones program, the folders that contain the Marxan with Zones data and where the Marxan with Zones output files will be stored. It also lists the location of the planning unit layer, the target table and the zones table. All of the CLUZ functions use information from the CLUZ setup file, so the user has to load a suitable file or create a new one before carrying out any analysis. This function lets the user create or load an existing file and to edit its details.

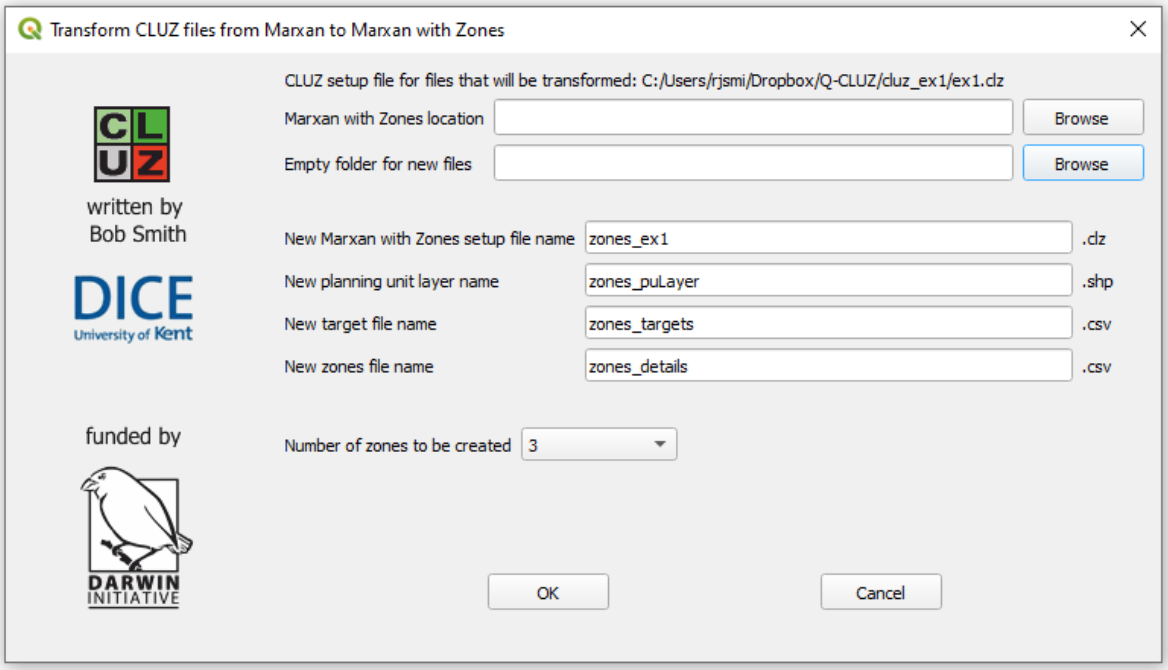
 *Create initial CLUZ files*

This function produces the three core files that CLUZ needs to run Marxan, so the details for using it are in the 'CLUZ for Marxan' guide. You should use this function to create the CLUZ for Marxan files, add your abundance data and then use the 'Transform CLUZ files from Marxan to Marxan with Zones format' function to produce the files you need for Marxan with Zones.

Transform CLUZ files from Marxan to Marxan with Zones format

This function transforms files from Marxan to Marxan with Zones format. This means that to create Marxan with Zones files, the user first needs to create the files in Marxan format with the 'Create initial CLUZ files' function and add their distribution data using the 'Convert polyline or polygon themes to Marxan abundance data', 'Convert raster layer to Marxan abundance data' and 'Import fields from table into Marxan abundance file' functions.

Once the user has set up their files in Marxan format, this function will copy their data into a new folder, change it into Marxan with Zones format and create a new CLUZ setup file linking to all the new data. As part of this, the user has to specify the location of the Marxan with Zones software, the folder where the new files will be stored and the name of the new Marxan with Zones setup file (which will be saved into the specified empty folder). They can also edit the names of the output files from the default options and specify the number of zones to be created.



Convert polyline or polygon themes to Marxan abundance data

This function is not available when using the Marxan with Zones functionality in CLUZ. Instead, you should add your abundance data to your CLUZ files formatted for Marxan and then transform these CLUZ files from Marxan to Marxan with Zones format using the relevant function.

Convert raster layer to Marxan abundance data

This function is not available when using the Marxan with Zones functionality in CLUZ. Instead, you should add your abundance data to your CLUZ files formatted for Marxan and then transform these CLUZ files from Marxan to Marxan with Zones format using the relevant function.

Import fields from table into Marxan abundance file

This function is not available when using the Marxan with Zones functionality in CLUZ. Instead, you should add your abundance data to your CLUZ files formatted for Marxan and then transform these CLUZ files from Marxan to Marxan with Zones format using the relevant function.

Remove features from CLUZ target table and Marxan abundance file

This function lets the user delete records on unwanted conservation features from the CLUZ system by removing the relevant data from the target table and the Marxan abundance file.

Recalculate target table data

This function calculates the total amount of each feature in the planning region and the amount that is included in each zone (ie in *Earmarked* or *Locked* units) based on the Marxan abundance file (puvspr2.dat file) and planning unit layer attribute table. It should be used whenever changes have been made to the conservation portfolio without using CLUZ.

Troubleshoot all CLUZ files

This function inspects all of the CLUZ files to check they are in the correct format.

Display distributions of conservation features

This lets the user show the distribution of any of the features listed in the target table based on the data stored in the Marxan abundance file (puvspr2.dat file).

Identify features in selected units

This provides information on the features found within the planning units that have been pre-selected by the user (using QGIS's Select Features functions). For each zone, CLUZ lists the amount of each feature in the Unassigned and Earmarked + Locked planning units, as well as listing the target for each feature in each zone and the overall target and target shortfall.

Calculate richness scores

This calculates two types of richness metrics:

- Feature count – the number of features in each planning unit.
- Restricted Range Score – the sum of the restricted range value for each feature found in the planning unit. The restricted range value = area of feature in planning unit / total area of feature in planning region.

If the target table contains a field named Type then this function can be used to calculate values for a subset of features, where each subset is defined by the number code in the Type field. For example, if the Type field codes vegetation types as 1 and species as 2, then this function can be used to count only the number of species found in each planning unit.

Calculate portfolio characteristics

This function is not available when using the Marxan with Zones functionality in CLUZ.

Create Marxan input files

This produces the additional files needed to run Marxan with Zones from the planning unit layer, target table and zone table. The target and feature files are created from the CLUZ target table, the planning unit files are created from the CLUZ planning unit shapefile, the zone files are created from the CLUZ zone table and the boundary file is created from the planning unit shapefile. This means you should create all the files before running Marxan with Zones for the first time, but only need to update these files if you have changed the underlying CLUZ files.

The user can specify if the bound.dat file should include data on the planning region boundary, i.e. edges that are not shared between planning units. Including these boundaries makes it less likely that Marxan with Zones will select planning units at the edge of the planning region.

Marxan uses these files every time it runs, so this function should be used whenever the data has been updated in CLUZ if Marxan is to reflect these changes.

Launch Marxan with Zones

This function opens the Launch Marxan with Zones dialogue window, which lets the user specify different parameters before running the program. Parameters are the number of iterations per run, the number of runs, the output file name, whether boundary cost values should be included and whether Marxan should save extra outputs.

The Advanced options lets the user specify what proportion of planning units should be selected at the beginning of each run and the definition of whether a species target has been met. It also lets the user specify whether the Boundary Length Modifier value should differ between the different zones, based on multiplying them by user-specified zone costs (the default is a value of 1 between every combination of zones, i.e., the boundary cost between two planning units in different zones is the same as the boundary cost between two planning units in the same zone).

Load previous Marxan with Zones results

This lets the user add results from previous Marxan with Zones analyses to new fields in the planning unit layer table and display them in the View.

Calibrate Marxan with Zones parameters

This lets users undertake sensitivity analyses to measure how changing either the BLM (Boundary Length Modifier), Number of iterations, Number of runs or SPF (Species Penalty Factor) influences the Marxan with Zones results. The user has to specify the number of analyses, the minimum value of the parameter to be tested, the maximum value of the parameter to be tested and whether there should be exponential steps between the minimum and maximum steps. Selecting exponential steps means the calibration process tests a wide variety of values, e.g.

Parameter to Calibrate = Number of iterations, Number of analyses = 4; Min = 100000; Max = 100000000

☐ Use exponential steps	Values =	100000,	33400000,	66700000,	100000000
☒ Use exponential steps	Values =	100000,	1000000,	10000000,	100000000

The user also has to specify the Marxan output files base name, i.e. if the number of analyses is 4 and the base name is “blm_test” then the names of the Marxan output files will be blm_test1, blm_test2, blm_test3 and blm_test4. Finally, the user has to specify the name of the output file.

CLUZ will then save the following information from each of the Marxan analyses in the specified output file: Analysis (identifier number), Name (Marxan output files name), Iterations (number of iterations), Runs (number of runs), BLM (Boundary Length Modifier value used), SPF (SPF value used), Med Portfolio Cost (median cost of all the portfolios produced in the analysis = combined planning unit cost + boundary cost + penalty factor cost), Med Planning Unit cost (median portfolio planning unit cost), Med Boundary length (median portfolio boundary length), Med Feature Penalty cost (median portfolio feature penalty cost), Med MPM (median portfolio minimum proportion met) and Med PU Count (this is for consistency with the equivalent function for Marxan, as in Marxan with Zones every planning unit is assigned to a zone).

MP *Launch MinPatch*

This function is not available when using the Marxan with Zones functionality in CLUZ.

CLUZ buttons

Open Target Table

Clicking on this button will open the target table, allowing the user to view details of each feature, their targets and how much is currently conserved in the planning region. The values in the **PC_target** field are automatically updated each time the table is opened and are colour coded depending on whether the target has been met.

Ab *Display Marxan Abundance File Data*

Clicking on this button lets the user select and display the amount of each of the specified conservation features in the Marxan abundance file (puvspr2.dat file).

Z *Open Zones Table*

Clicking on this button shows the user specified number of zones and their names.

Change Status of Earmarked Units to Available

Clicking on this button will change the status of all Earmarked planning units to Available and will update the target table to reflect these changes. This is useful when undertaking onscreen conservation planning, as it lets the user remove any changes and start afresh.

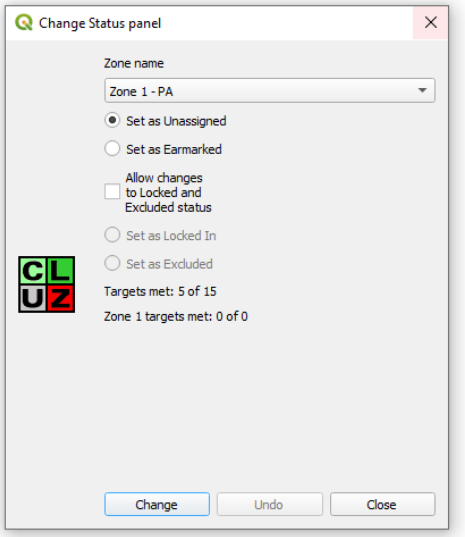
Open Marxan with Zones Target Results Table

As part of each Marxan with Zones analysis, the software produces an output file that lists how many of the targets were met by the best portfolio. Clicking on this button opens a table containing this information for the most recent analysis. CLUZ will only display a target results table if Marxan has been run since opening QGIS and using CLUZ. NB Marxan sometimes fails to include the conservation feature names in its output files, and in this case, it will be added by CLUZ.

Change Status of Best Units to Earmarked

Clicking on this button will give Earmarked status to any planning unit that was identified by Marxan with Zones as being part of the best portfolio for each zone. To do this, CLUZ uses information from the Best field, which is added to the planning unit layer table whenever Marxan with Zones is run.

Change Planning Unit Status



Clicking on this will open the **Change Status panel**, which lets the user change the status of any selected planning unit in any zone. As a first step, the user must specify which zone they want to edit.

The user can then specify which of the four status types they want to change. *Locked In* units are those that are already assigned to that management zone. *Earmarked* units are those that have been suggested for inclusion in that management zone. *Unassigned* units are those that have not been selected by the user to be part of the management zone. *Excluded* units are those that will definitely not belong to the specified zone for ecological, economic or political reasons.

The Change Status panel lets the user change the status value of selected planning units by choosing the relevant button . If the status of a planning unit is changed in one zone, then its status will be updated in the other zones, e.g. if the user specifies that a planning unit should be Locked In to Zone 2, then its status in Zone 1 and Zone 3 will be updated to Unassigned.

Turning off the **Allow changes to Locked and Excluded status** check box means that only the status of *Earmarked* and *Unassigned* units can be changed. Turning on the check box lets the user change units to *Locked In* or *Excluded* status, and lets the status of *Locked In* or *Excluded* units be modified. This is generally only done at the beginning of the planning process.

At its simplest level, conservation planning in CLUZ involves identifying and setting the *Locked In* and *Excluded* units at the beginning of the process and then deciding whether the remaining units should have *Earmarked* or *Unassigned* status for each zone.

Identify Features in Planning Unit

Choosing this tool and clicking on a planning unit will produce a window showing the conservation features that are found in the unit, together with the amount of each feature, its target and the percentage of that target that has been met.

CLUZ file format description and checklist

CLUZ uses three different files as the source of all the information it needs to display and analyse the conservation planning data. This section provides a checklist of the correct format for these files, which can be used when creating new CLUZ files or to identify possible problems with existing files.

Abundance file (puvspr2.dat file)

This is a comma delimited text file that is stored in the specified input folder. The first line of the file consists of the headings, which are **species**, **pu** and **amount**. The subsequent lines list the conservation feature's unique ID value, the planning unit unique ID value and the feature amount.

This text file must be ordered by the planning unit id, it cannot contain any other information and each value must be separated with a comma. The best way to avoid formatting errors is to import all of the data into the puvspr2.dat using CLUZ.

Planning unit layer attribute table

The planning unit layer is the shapefile that shows the boundary of each of the planning units in the study region. The planning unit layer attribute table is the associated database that describes the features of each of these units. This table must include the following fields with the following format:

Field Name	Field Type	Field Width	Decimal places	Notes
Unit_ID	Integer	-	0	The id code of each planning unit must be a unique integer.
Area	Number	-	-	This field should contain data on the area of each planning unit.

The planning unit attribute table should also include two fields for each specified zone. The field name will begin with a 'Z' and then the user specified id value for that zone, e.g. if the user specified three zones with id values of 1, 2 and 3 then the table should include fields named Z1_Cost, Z1_Status, Z2_Cost, Z2_Status, Z3_Cost and Z3_Status.

Field Name	Field Type	Field Width	Decimal places	Notes
Z Cost (e.g., Z1_Cost)	Number	-	-	This field should contain data on the cost of including each planning unit in the portfolio. You should assume that the cost value is the same as the area value if no other data are available.
Z Status (e.g., Z1_Status)	String	10	-	This field contains data on the conservation status of each planning unit, which must be listed as ***Locked In***, ***Earmarked***, ***Unassigned*** or ***Excluded***

Other things to note are:

1. Each row in the unit layer table must have a unique **Unit_ID** value. If you have a planning unit that consists of several polygons then use the **Dissolve** option in **GeoProcessing Tools** in QGIS to ensure that each planning unit is represented by only one row in the unit layer table.

2. The planning unit layer table can contain any other fields that you require.

The CLUZ target table

The target table is a comma delimited text file (csv) that describes the information about each feature. It lists the unique ID, name and target for each feature, zone specific information, and summarises the

amount included in each zone and the total amount in the planning region. This table must include the following fields with the following format:

Field Name	Field Type	Notes
Id	Integer	The id code of each feature must be a unique integer.
Name	String	This field should contain the name of the conservation feature. These names can be in two formats: (a) with spaces but no numbers or (b) with numbers but no spaces, ie “cloud forest” or “forest_type_2” is OK, “forest type 2” is not.
Target	Number	This field should contain data on the overall target for each feature, which is the amount of each feature in every zone that should appear in the final portfolio.
Spf	Number	This field lists the Spf value (species penalty factor or feature penalty factor) used by Marxan with Zones to ensure the feature target is met.
Ear+Lock	Number	This field lists the amount of each feature that is found in ***Earmarked*** and ***Locked In*** units, based on the data in the unit layer and abundance tables (calculated as the total amount in each zone multiplied by the associated Zone proportion values). Update these conserved values using the **Recalculate target table data** function if the original data have been edited without using CLUZ.
Total	Number	This field lists the total amount of each feature recorded in the abundance table. Update these total values using the **Recalculate target table data** function if the abundance data have been edited without using CLUZ.
PC_Target	Number	This shows the percentage of the target that has been met, based on the values in the **Target** and **Ear+Lock** fields. The values are recalculated each time the user opens the target table or uses the **Recalculate target table data** function. Values that are less than the target are shown in **red**, values that equal or are above the target are shown in **green**. If no target is set then the value is shown as **-1 in grey**.

The CLUZ target table should also include three fields for each specified zone. The field name will begin with a ‘Z’ and then the user specified id value for that zone, e.g. if the user specified three zones with id values of 1, 2 and 3 then the table should include fields named Z1_Prop, Z1_Target, Z1_Ear_Lock, Z2_Prop, Z2_Target, Z2_Ear_Lock, Z3_Prop, Z3_Target and Z3_Ear_Lock.

Field Name	Field Type	Notes
Z Prop (e.g., Z1_Prop)	Number	The Z prop value for each zone should be a number between 0 and 1. It specifies the proportion of the amount of each feature that should contribute towards its targets if a planning unit is assigned to the associated zone. For example, in a scenario with three zones (1 = Fully protected, 2 = Partially protected, 3 = No protection), the prop values for giraffes could be Z1_prop = 1, Z2_prop = 0.5, Z3_prop = 0.1). This means that if a planning unit potentially contains habitat for 20 giraffes, Marxan with Zones will assume it will contain 20 giraffes if assigned to Zone 1, 10 giraffes if assigned to Zone 2 and 2 giraffes if assigned to Zone 3.
Z Target (e.g., Z1_Target)	Number	This field should contain data on the target for each feature in each zone, which is the amount of each feature that should appear in each zone in the final conservation portfolio. In many cases, the zone target will be 0 when the user is

		only interested in meeting the overall target specified in the **Target** field.
Z Ear+Lock (e.g., Z1_ Ear+Lock)	Number	This field lists the amount of each feature that is found in ***Earmarked*** and ***Locked In*** units, based on the data in the unit layer and abundance tables (calculated as the amount in each zone multiplied by the associated Zone proportion values). Update these conserved values using the **Recalculate target table data** function if the original data have been edited without using CLUZ.

Other things to note are:

1. You will need to edit the values in the CLUZ target table using Excel or a similar software package that can manipulate and save csv files.

2. The target table can contain any other fields that you require.

3. Name formatting is a common source of errors in Marxan, so CLUZ will edit names containing numbers whenever it produces the spec.dat file for Marxan. This has no impact when displaying the results in CLUZ.

The CLUZ zone table

The zone table is a comma delimited text file (csv) that lists the unique ID and name for each zone. This table must include the following fields with the following format:

Field Name	Field Type	Notes
Id	Integer	The id code of each zone must be a unique integer.
Name	String	This field should contain the name of the zone.

References

Ball, I, Possingham, H, and Watts, M (2009). Marxan and relatives: Software for spatial conservation prioritization. In A. Moilanen, K. Wilson, & H. Possingham (Eds.), Spatial conservation prioritisation: Quantitative methods and computational tools (pp. 185–195). Oxford University Press.

Smith, RJ (2019). The CLUZ plugin for QGIS: designing conservation area systems and other ecological networks. Research Ideas and Outcomes 5, e33510. Download here.