USING SPATIAL INFORMATION TO SUPPORT DECISIONS ON SAFEGUARDS AND MULTIPLE BENEFITS FOR REDD



STEP-BY-STEP TUTORIAL:

How to produce a matrix style legend with raster data using arcgis **10**





The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP).

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

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1. Introduction

Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. "REDD+" goes beyond deforestation and forest degradation, to include the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. This will involve changing the ways in which forests are used and managed, and may require many different actions, such as protecting forests from fire or illegal logging or rehabilitating degraded forest areas.

REDD+ has the potential to deliver multiple benefits beyond carbon. For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation, erosion control and non-timber forest products. Some of the potential benefits from REDD+, such as biodiversity conservation, can be enhanced through identifying areas where REDD+ actions might have the greatest impact using spatial analysis.

GIS software can be used to undertake spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+. This tutorial enables a user to produce matrix style legend in ArcGIS using raster data.

2. Creating a map with a matrix style legend

Displaying two thematic wall-to-wall datasets on the same map can help to visualize the relationships between two datasets. This graphical technique of creating a two-dimensional legend was first developed by Paul Williams at the Natural History Museum in the UK in a piece of software called WorldMap where it was used to display the spatial relationship of species richness between different groups of species (Williams et al, 1998). (See <u>http://www.nhm.ac.uk/research-curation/research/projects/worldmap/rarity/index.html</u>).

It is not possible to automatically create a 2-way matrix style legend in ArcGIS (or in any of the other GIS software that we are aware), therefore this tutorial takes users through a series of simple steps to manually prepare the data for display in a matrix format.

This tutorial will demonstrate the following example: Biomass carbon and threatened species richness

2.1. Select datasets for which to map with a matrix legend

a. Choose two themes to map.

At this stage it is important to note that some of the data may be in raster format and some are vector. The analysis will be undertaken as a raster analysis.

In this example:

The **carbon** is a **raster dataset** showing **above and below ground biomass carbon density** in tonnes/ha (in 500m resolution cells).

The **threatened species** dataset is a **vector** dataset of hexagons with an attribute indicating the **number of threatened species.**

The X axis of the matrix will be the biomass carbon and the Y axis of the matrix will be the threatened species richness.

b. Double click on Tool 3 in the ExploringMultipleBenefits toolbox to run the tool to convert the vector data to raster. A dialogue window will open. Note that there are various environment setting that need to be filled out (namely Snap Raster, Mask, Output Cell Size and Extent).

If one of the datasets being used for the matrix legend is already a raster you will make use this for the environment settings to ensure the new raster you are creating aligns correctly to it. If both of the datasets are vectors you will first need to run Tool1a to create a Snap Raster from a vector boundary file and then use that for the environment settings.

c. Fill out all the parameters in the white boxes (as in the example below)

In this example, the biomass carbon raster will be used for the environment settings **Snap Raster, Mask, Output Cell Size and Extent**. Set the output coordinate system to an equal area projection e.g. in this example **VN2000 UTM Zone 48N**.

De Tool 03: ConvertVectorToRasterDataset	
Input Vector Dataset	OutputName
Biodiversity\ThreatenedSpecies 🗾 📝	
Expression (optional)	Name of the new output raster dataset
Value Field	
crenvu_runsp29.csv.FCOUNT	▼
Snap Raster	
Carbon\bacc_laocai 🗾 🗹	
Mask	
Carbon\bacc_laocai	
Output cell size	
500	
Extent	
Same as layer bacc_laocai 🔹	
Тор	
2526868.290794	
348722.576349 461722.576349	
Bottom	
2418868.290794	
Input 'snapgrid' or feature mask data	
Carbon\bacc_laocai 🗾 🛃	
Output Coordinate System	
VN2000_UTM_Zone_48N	
outputworkspace	
C:\Vietnam	
OutputName	
thr_sp	🖆 👻
OK Cancel Environments << Hide H	: Help Tool Help

2.2. For the each raster dataset display the data in 5 class breaks

In order to create a 5 by 5 matrix the two datasets need to be **grouped into classes**. Remember in this example, the first dataset that will be displayed along the **X axis of the matrix** is the **biomass carbon** and the second dataset that will be displayed along **the Y axis of the matrix** is **threatened species richness**.

***It is important to note that the consideration of the classification scheme applied to group your dataset is important as different ways of partitioning data can lead to vastly different maps. ***

In the **quantile classification method**, each class contains the same number of pixels. Quantiles are best suited for data that is linearly/evenly distributed-; i.e. this means that the classes cover the same amount of area on the map. There can be a disproportionate number of features with a similar value in the dataset - class break values are determined by trying to have about the same area of each class covering the map. In the **equal Interval classification method**, each class has an equal range of values; that is, the difference between the high and low value is equal for each class. The equal interval method divides the range of attribute values into equal sized sub-ranges. Then the features are classified based on those sub-ranges.



Add the dataset to be used for the x-axis into ArcMap i.e. in this example the biomass carbon dataset. Decide on a classification scheme and symbolise the data into 5 classes. The quantile is often the best method to show the variation in pattern of carbon distribution (see maps above).

b. Add the dataset to be used for the y-axis data into ArcMap i.e. in this example the threatened species richness dataset. Decide on a classification scheme and symbolize the data into 5 classes (see maps below, different classifications will alter the result)



2.3. Create two new simplified raster datasets based on the chosen class breaks

In order to map the two dataset on an x and y axis, it is necessary to simplify each dataset based on the class breaks defined in step 1.

a. Run the **Reclassify tool** in the standard ArcGIS toolbox to reclassify the **x-axis** dataset (i.e.in this example, biomass carbon). Save the new output raster with a name that reflects the new classes e.g. bcar5cl.

Input raster Carbon\bacc_laocai Redass field					Reclassify Reclassifies (or changes) the values in a raster.
Redassification Old values 0 - 91 91 - 118 118 - 151 151 - 235 235 - 378 NoData Load Save Output raster C: \/ietham\bcar5class Change missing values to NoDat	New values	Classify Unique Add Entry Delete Entries Precision		e	
		K Cancel	Environments	<< Hide Help	Tool Help

The Result of reclassification of biomass carbon is presented here: Each of the classes has been assigned a new value from 1-5.



b. Run the **Reclassify tool again** but this time to reclassify the **y-axis** dataset (i.e.in this example, run the tool for the **threatened species richness**. Save the new output raster with a name that reflects the new classes e.g. thsp5class

Reclassify					
Input raster				^ -	Output raster
thr_sp Reclass field			•		The output reclassified
VALUE				-	nuoton.
Reclassification					The output will always be of
Old values	New values	Classify			integer type.
18 - 20.2	1				
20.2 - 22.4	2	Unique			
22.4 - 24.6	3				
24.6 - 26.8	4				
26.8 - 29	5	Add Entry			
NoData	NoData				
		Telete Entries			
Load Save	Reverse New V	alues Precision			
Output raster					
C:\Vietnam\thsp5class					
Change missing uplying to N	Data (antianal)			_	
Criange missing values to IV	obala (oplional)			~	-
		OK Cancel	Environments	iide Help	Tool Help



The Result of reclassification of threatened species richness is presented here: Each of the classes has been assigned a new value from 1 - 5.

2.4. Combine two 2 simplified datasets together

Now that the two datasets both have only 5 values the next step is to combine the two new rasters together.

a. Double click on Tool 05: OverlayRastersForMapOutputsAndStatistics in the ExploringMultipleBenefits toolbox to run the tool.

This tool the **ArcGIS COMBINE function** to combine multiple raster input datasets to produce an output dataset containing a unique combination of the inputs. The output raster contains a VALUE and COUNT field and two extra individual fields for each of the VALUE fields from the input datasets, these fields are given the name of the original input datasets.

Usage Tips

<u>Before</u> running this model, ensure that all datasets have been checked and that 'Tool 3' has been used to convert any "nodata" values to 0. If any of the dataset have "nodata" values within the analysis extent, those cells will be excluded from the analysis.

After running the model check the Output Raster in ArcMap.

The combine function will only keep the Value and Count Fields from the Raster datasets being combined. After this tool has run it may be necessary to join on any missing attributes (see Tool 06).

b. In the dialogue box which appears (see below), fill in the white boxes (parameters) accordingly as specified below. Make the snap raster, mask and cellsize the same as one of the input rasters e.g. bcar5class.

These parameters are environment setting which are usually hidden under the environments tab on the standard ArcGIS tools. These are set to make sure the cells in the output raster are the same size as and align with the cells in the specified input raster. When each is clicked on, explanations/help appear in the panel on the right. The parameter descriptions are also described in the box below.

Parameter Descriptions

Expression	Explanation
<input_rasters></input_rasters>	Add all the input rasters to be combined
<snap_raster></snap_raster>	The snap raster is used to ensure that the cell alignment of the output raster matches to a chosen existing raster. Set the Snap Raster to be the same as the Mask_Raster
<mask></mask>	The mask will be used to Identify those cells within the analysis extent that will be considered. Set the analysis mask to ensure that processing will occur on all the cells within the analysis extent. Set the mask to be the same as the Snap_Raster
<cell_size></cell_size>	Specify the output cell size to be used for the analysis (this will be the same as the Snap Raster)
<outputworkspace></outputworkspace>	Workspace in which to save the output Raster
<outputname></outputname>	Name of the new output raster dataset

- c. In the Input rasters, select the two 5 class input rasters to be combined i.e in this example, bcar5class and thsp5class.
- **d.** Give the **new raster a name to reflect the order of the combination** i.e. In the name specify the **X-axis first** and the **Y-axis second** (e.g. **bcar_thsp**).

눡 Tool 05: OverlayRastersForMapOutputsAndStatistics	
Input rasters	Add all the input rasters to be combined.
Snap Raster bcar5class Mask bcar5class Cell Size Same as layer bcar5class	
500 outputworkspace C:\Vietnam OutputName bcar_thsp	*
OK Cancel Environments << Hide Help	Tool Help

- e. Click OK to run the tool.
- f. The new raster **does not automatically add to map** so navigate to the output workspace and **add the new raster to the ArcMap session**.

g. The combined output raster with 25 possible classes. Open the attribute table and see that it contains a VALUE and COUNT field and individual fields for each of the VALUE fields from the input datasets, and that these fields are given the name of the inputs.



2.5. Create new field in attribute table to contain combined matrix value

 Add a field to the attribute table of your new raster produced as a result of the combine, named bcar_thsp of type Long Integer

Parser Parser VB Script Python Fields: Python Rowid VALUE COUNT COUNT BCARSCLASS THSPSCLASS BCAR_THRSP Show Codeblock PAR <therp< td=""> Property</therp<>	Type: (a) Number (b) String (c) Date (c) (c) (c) (c) (c) (c) (c) (c) (c) (c)	Functions: Abs () Atn () Cos () Exp () Fix () Int () Log () Sin () Sdr () Tan () / & + - =
[BCAR5CLASS] & [THSP5CLASS]		*

Add Field						
<u>N</u> ame:	bcar_thrsp					
<u>T</u> ype:	Long Integer		•			
Field Prope	rties					
Precision		0				
		ОК	Cancel			

b. Calculate bcar_thsp to equal[bcar5class] & [sp5class]

See the result of the calculation in the table below. See for example, where **bcar5class is 4** and **thsp5class is 3** the combined field **bcar_thsp becomes 43**.

The definitions of numbers for the combined species/carbon field [BCAR_THRSP] are:

- 11 Low carbon, low species richness
- **12** Low carbon, medium low species richness
- **13** Low carbon, medium species richness
- **14** Low carbon, medium high species richness
- 15 Low carbon, high species richness

21 Medium low carbon, low species richness

- 22 Medium low carbon, medium low species richness
- 23 Medium low carbon, medium species richness
- 24 Medium low carbon, medium high species richness
- 25 Medium low carbon, high species richness
- **31** Medium carbon, low species richness
- 32 Medium carbon, medium low species richness
- **33** Medium carbon, medium species richness
- 34 Medium carbon, medium high species richness
- 35 Medium carbon, high species richness
- 41 Medium high carbon, low species richness
- **42** Medium high carbon, medium low species richness
- **43** Medium high carbon, medium species richness
- **44** Medium high carbon, medium high species richness
- 45 Medium high carbon, high species richness
- **51** Very High carbon, low species richness
- **52** Very High carbon, medium low species richness
- **53** Very High carbon, medium species richness
- **54** Very High carbon, medium high species richness
- 55 Very High carbon, high species richness

2.6. Create new raster from combined values field

Run Tool 11: CreateRasterFromRasterAttribute_new which uses the ArcGIS **LOOKUP** tool to create a new raster by looking up values found in another field in the table of the input raster.

- a. For the Input raster select the combined biomass carbon and threatened species richness i.e. in this example the combined raster called bcar_thsp
- **b.** For the Lookup Field select the field containing the combined biomass carbon and threatened species richness values bcar_thrsp

able								
ocar_thsp ×								
]	Rowid	VALUE	COUNT	BCAR5CLASS	THSP5CLASS	BCAR_THRSP		
	16	17	2820	1	1	11		
	5	6	1599	1	2	12		
	4	5	526	1	3	13		
	15	16	199	1	4	14		
	17	18	103	1	5	15		
	14	15	2708	2	1	21		
	6	7	1319	2	2	22		
	2	3	543	2	3	23		
	10	11	374	2	4	24		
	20	21	241	2	5	25		
	21	22	2255	3	1	31		
	3	4	1163	3	2	32		
]	1	2	722	3	3	33		
]	9	10	623	3	4	34		
]	19	20	231	3	5	35		
]	22	23	1534	4	1	41		
	7	8	958	4	2	42		
]	0	1	991	4	3	43		
	8	9	1044	4	4	44		
]	18	19	464	4	5	45		
	23	24	239	5	1	51		
]	12	13	840	5	2	52		
	13	14	1662	5	3	53		
	11	12	1529	5	4	54		
	24	25	674	5	5	55		
ŀ		0	► ►L	🔲 🔲 (0 out (of 25 Selected)			

c. For the Output raster navigate to an output workspace and save the new raster as a .tif file with the same name as the Input file with the ending _matrix.tif i.e. in this example c:\Vietnam\bcar_thsp_matrix.t

Po Tool 11: CreateRasterFromRasterAttribute_new		
Input raster	<u>^</u>	Tool 11:
bcar_thsp	·] 🔁	CreateRasterFromRast
Lookup field		
BCAR_THRSP	-	
Output raster		
C:\Vietnam\bcar_thsp_matrix.tif	6	
	_	
	~	
	- F	→ III →
OK Cancel Environments <<	Hide Help	Tool Help

2.7. Create 5 subsets of the combined layer for the Matrix Legend

- a. Next Double click on the tool 'Tool 23_CreateSubsetDatasetsForMatrix
 Legend. This will split the 25 class matrix.tif into 5 new subsets which can easily be shaded as individual colour ramps to produce the matrix style legend.
- **b.** Click OK to run the tool.

2.8. Example results and guidance on creating the matrix colour ramps

This section describes the example results from Tool 23 and provides detailed guidance on symbolizing the mapped data using the matrix colour ramps. The illustration below helps demonstrate how you will need to define the colour ramps.

Tool 23_CreateSubsetDatasetsForMatrix Legend	
InnutRaster	*
bcar_thsp_matrix.tif	2
Where dause	_
"VALUE" >=11 AND VALUE <=15	SQL
Where clause (3)	
"VALUE" >=21 AND VALUE <=25	SQL
Where dause (2)	
"VALUE" >=31 AND VALUE <=35	SQL
Where dause (4)	
"VALUE" >=41 AND VALUE <=45	SQL
Where dause (6)	
"VALUE" >=51 AND VALUE <=55	SQL
outputworkspace	
C: (Vietnam	
<	•
	la Halo
Environments	ie neip

Upon running the Tool, **each 'where clause**' produces a raster **each with 5 classes**. The first raster that is created using the 'where clause' "VALUE" >=11 AND "VALUE" produces a raster containing values 11,12,13,14 and 15. This shades the first column of the matrix legend as illustrated below from 11-15, representing:

Low species richness - low carbon (11) to high species richness – low carbon (15)



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- a. Double click on the layer bcar_thsp_matrix11_15.tif to open the layer properties.
- b. Change the classification to Classified and 5 classes.

ayer Properties								
General Source Key M	Netadata Extent Display Symbols	gy Fields Joins & Relates						
Show: Unique Values	Draw raster grouping values i	nto classes 🔁 🔒						
Stretched Discrete Color	Fields Value Value	✓ Normalization						
	Color Ramp	Qasses 5 ▼ Classify						
	Symbol Range	Label						
	11	11						
	11 - 12	11.00000001 - 12						
	12 - 15	13.0000001 - 13						
1. 1 . 1. 1.	14 - 15	14.00000001 - 15						
About symbology	Show class breaks using cell val	Z: 1 Display NoData as						
		OK Cancel Apply						

- c. Click OK.
- **d.** To produce a colour ramp, first choose **a colour to represent low species richness low carbon** (11), and one to represent **high species richness low carbon** (15).
- e. Once you have selected these colours, hold down the Ctrl key and select category 11 and select category 15, then right click and select ramp colours.

iyer Prope	erties											×
General	Source	Key Metad	lata f	Extent	Display	Symbology	Fields	Joins & Rela	ites			
Show: Unique Va Classified	lues	Dr	raw ra	ster g	rouping	values into	classes	5		(2	
Stretched Discrete C	olor	− F Va	ields – alue	Val	lue	Ŧ	Norma	lization	<no< td=""><td>ne></td><td>•</td><td></td></no<>	ne>	•	
		C	Classific	ation Natur	ral Breaks	(Jenks)		Classes	5 🔻	Cla	ssify	
		Co	lor Ran	np	[•	
		S	ymbol	Rang	ge		1	abel 1				
				11 -	12		1	1.00000001 -	12			
				12 -	13		1	2.00000001 -	13			
- 6			-	13 -	14		1	3.00000001 -	14			
	- 21			F	lip Color	s			5			
				R	lamp Co	lors			<u> </u>			
- A - A	bout symbology		Shou	P	Properties for Selected Color(s)		Display NoData as					
About sym		logy Use	Use	P	ropertie	s for All Colo	ors					
				R	leverse S	orting						
					Remove Classes				K	Can	cel A	pply
				F	ormat La	abels				Can		040
				E	dit Desci	ription						
				S	ave Clas	s Breaks						
B S	•			L	oad Clas	s Breaks						

Next you will repeat steps a to d for each your 51-55 category raster to ramp low species richness – high carbon (51) and high species richness – high carbon (55). Therefore, choose a colour to represent low species richness – high carbon (51), and one to represent high species richness – high carbon (55).

- f. Double click on the layer bcar_thsp_matrix51_55.tif to open the layer properties
- g. Change the classification to Classified and 5 classes

Layer Properties					×
General Source Key M	etadata Extent Displa	y Symbology	Fields Joins & Relates		
Show: Unique Values	Draw raster groupin	ng values into d	lasses		
Classified Stretched Discrete Color	Fields Value Value	•	Normalization	<none></none>	-
	Classification Natural Brea	aks (Jenks)	Classes 5	▼ Classify	
	Color Ramp				•
	Symbol Range		Label		
	51		51		
	51 - 52		Flip Colors		
	52 - 53		Ramp Colors		
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	54 - 55	_	Properties for Selecte	ed Color(s)	
			Properties for All Col	lors	
	Show class breaks u	using cell val	Reverse Sorting		2.
About symbology	Use hillshade effect	:	Remove Classes		
			Format Labels		
			Edit Description		
			Save Class Breaks		Apply
			Load Class Breaks		

You will then need to create your ramps for 21 - 25; 31 - 35 and 41 - 45. To do this, you will need to create some temporary colour ramps between the colours you have chosen to represent codes 11, 15, 51 and 55:

	15	25	35	45	55
	14	24	34	44	54
	13	23	33	43	53
	12	22	32	42	52
<	11	21	31	41	51

h. Use your 21 – 25 category raster to create a temporary ramp between the colour you chose to represent number 11 and number 51.

Layer Prop	erties								1 3	×
General	Source	Key Metadata	etadata Extent Display Symbology Fields Joins & Relates							
Show: Unique Values Classified Stretched Discrete Color		Fields Value	Draw raster grouping values into classes Image: Classification Fields Value Value Classification Normalization Natural Breaks (Jenks) Classes 5 T						•	
		Color Ra	amp 21 21 - 2 22 - 2 23 - 2 24 -	ge 22 23 24 25		Flip C Ramı Prop	abel Colors o Colors erties for Select erties for All Co	ed Color(sj)	•
		Sho	w class b hillshade	reaks usir effect	ng cell val	Reve Remo Form Edit I	rse Sorting ove Classes at Labels Description]•
						Save Load	Class Breaks Class Breaks			Apply

- i. Right click on the colour box, and click properties for selected colours... More colours... then you will be shown a box with the HSV colour codes in it.
- j. Write down these numbers this will be

your code for box 21.

S	e n	un	ibers -	-					Ρ
	Col	or Se	elector					Ī	R
	Co	lor	Propertie	s	HSV		D		R
l	н	-0-				17]		F
1	s	_	0			25	%		E I
	۷	_			-0	100	%		Lo
3		-							
1					ок 🛛	Cano	el		

Color Ram	p		▼
Symbol	Range	Label	
	21	21	
	21 - 22 -	Flip Colors	
	24 -	Properties for Selected Color(s)
		Properties for All Colors	
HSV -		Reverse Sorting Remove Classes	NoData as
25		Format Labels Edit Description	
100	%	Save Class Breaks Load Class Breaks	Cancel

- k. Repeat this process and make a note of the codes in boxes 22, and 23. These will be your colour codes for the beginning of your ramp in boxes 31 and 41.
- I. Use the same 21 25 category raster to create a second temporary ramp between the colour you chose to represent number 15 and number 55. Again, make a note of the HSV colour codes shown in boxes 22, 23 and 24. These will be your colour codes for the top of your ramp in boxes 25, 35 and 45.
- m. Once you have the HSV codes that represent the colours at the top and bottom of your ramps for boxes 21 and 25; 31 and 35; 41 and 45 you can make the remaining colour ramps.

Enter the colour codes manually by clicking **properties for selected colours** ... **More colours**... and then **right click** and **ramp colours**.

Layer Properties			×
General Source Key Me Show:	etadata Extent Display	Symbology Fields Joins & Relates	
Unique Values Classified Stretched	Fields	values into classes	
Discrete Color	Value Value	<none></none>	
	Color Ramp	(Jenks) Classes 5	Classify
	Symbol Range	Label	
	21 - 22 22 - 23 23 - 24	Flip Colors Ramp Colors	
1 A.	24 - 25	Properties for Selected Color(s) Properties for All Colors	
	Show class breaks	Reverse Sorting Remove Classes	a as
About symbology		Format Labels Edit Description	
		Save Class Breaks Load Class Breaks	Cancel Apply

n. Once ramps have been created for all 5 datasets, in order to display the colours ramping from light to dark necessary for the legend, all of the colour ramps need to have the option of reverse sorting applied to them.

In the Layer Properties box, Right Click and select Reverse Sorting

Layer Properties		×
General Source Key M Show: Unique Values Classified Stretched Discrete Color	letadata Extent Display Symb Draw raster grouping value Fields Value Value	ology Reids Joins & Relates s into classes
	Classification Natural Breaks (Jenks Color Ramp	Classes 5 V Classify
T A	21 21-22 22-23 23-24 24-25	21 Flip Colors Ramp Colors Properties for Selected Color(s) Properties for All Colors
About symbology	Show class breaks using cell	Reverse Sorting Remove Classes Format Labels Edit Description
		Save Class Breaks Apply

- **o.** Once the reerse sorting has been applied to all 5 ramps format the legend to a into a square legend by:
 - i. Standardise the size for all the boxes to 8 by 8 pt.
 - ii. Clicking on the option to place each legend item into a new column.
 - iii. Clicking on the options to put no space between rows or columns.



p. The final map and legend should look similar to the example below:

Sources: Biomass carbon: Baccini, 2012 Threatened species: TUCN, 2014

Annex: Two Predefine colours schemes for the matrix legend colour ramps

When creating a matrix colour legend, it is advisable to use colours that contrast yet work well together. Below are some codes for matrix ramps that have been used frequently in our maps and work fairly well. The notes in the main document should be followed if you want to generate a new matrix colour ramp from scratch.

Matrix colour codes: (HSV values)

11: 42, 25, 100 15: 120, 35, 70	
21: 17, 25, 100 25: 68, 41, 53	
31: 353, 29, 99 35: 33, 62, 51	
41: 339, 39, 98 45: 18, 81, 49	
51: 331, 50, 96	

11.11.10.100

55: 0, 100, 45

11: 41, 10, 100 **15:** 211, 50, 96

21: 25, 35, 100 **25:** 246, 19, 60

31: 21, 58, 100 **35:** 350, 33, 48

41: 19, 77, 96 **45:** 5, 65, 43

51: 20, 100, 90 **55:** 0, 100, 45