SRA_Ch4: Creating preliminary spatial risk layers



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- 4.1 Spatial areal risk factors
- 4.2 Spatial points risk factors
- 4.3 Spatial lines risk factors
- 4.4 Final processing of preliminary raster layers
- **Exercise 4.1: Considerations when creating spatial risk surfaces**

Introduction

The goal of SRA is to create a final spatial risk layer (or surface) on a map of the study area (Figure 4.1). Because the final spatial risk layer is in a raster format, we need to convert the vector risk layers to the same raster format to enable them to be combined. The objective of this section is to create these preliminary raster risk layers."



Figure 4.1: Spatial risk assessment steps



4.1 Spatial areal risk factors



"No areal risk factors were investigated in our example, but if there were, the goal of preparing an areal risk factor layer is to create a heat map of risk factor density attributes from centroids of spatial polygons. These might optionally be weighted by an attribute variable that is associated with the risk. For example, if animal movements into a region were only available as aggregated counts for a region instead of to point locations, the attribute of number of animal movements into a region could provide a weighting for that region, as described in the next section."

CONTINUE

4.2 Spatial points risk factors



⁶Create a kernel-smoothed surface of distance from points. This surface can optionally be weighted by an attribute e.g. no. of animal movements, but these data are not available for this example:"

- In the Layers Pane highlight spatial point data file MMRMarketsActv
- Menu bar -> Processing -> Toolbox -> (Type "Heatmap" search bar) -> Interpolation -> Heatmap (Kernel Density Estimation)
- Double click to open dialog box (Figure 4.2)
- Parameters tab:
- 1. Point layer: MMRMarketsActv [EPSG:32646]
- 2. Radius: set to a maximum distance e.g. 50000m (50 km) over which the locations might affect the risk of disease within that radius
- 3. Output raster size (set Rows to 200 and columns will set to appropriate number)
- 4. Click Run
- 5. Click Close (when finished)

🔇 Heatmap ((Kernel Density Estir	mation)			1	×			
Parameters	Log								
Point layer						1			
° MMRMar	MMRMarketsActv [EPSG:32646]								
Selected f	Selected features only								
Radius				2					
50000.00000	00			2	🖾 🗘 me	ters 🔻			
Output raster	size								
Rows	200	Columns	84	\$	3				
Pixel size X	3724 307250	Pixel size Y	3724, 307250		$\overline{}$				
That blee A	572 11507250	+ HACIBLE I	072 11007200						
Advance	ed Parameters								
Radius from	field [optional]								
						-			
Weight from	n field [optional]								
						•••••••••••••••••••••••••••••••••••••••			
Kernel shap	e								
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				4	5				
		0%)			Cancel			
Run as Batch F	Process			Run	Close	Help			

Figure 4.2: Dialog box of settings for heatmap

(i) For further explanation about heatmaps one useful site for information is <u>https://www.qgistutorials.com/en/docs/3/creating_he</u> <u>atmaps.html</u> and its link to 'QGIS Heatmap Using Kernel Density Estimation Explained' at <u>https://www.geodose.com/2017/11/qgis-heatmap-using-</u> <u>kernel-density.html</u>

CONTINUE

Save image as a raster object and project to Project CRS:

- Right click newly-created "Heatmap" in Layers Pane
- Save Raster Layer as ... -> dialog box (Figure 4.3)
- 1. Format- GeoTIFF (denotes it is a raster file type)
- 2. File name- "ResData/Geo-Features/MMRMarketsActv_Rast"
- 3. CRS- Project CRS
- 4. Extent -> Calculate from Layer -> Select "MMR_0" (the polygon shape file of study area boundary)
- 5. Click OK

🔇 Save Ra	aster Lay	yer as			×			
Output mode Raw data Rendered image								
Format	Geo	тіғғ 1			▼ Create VRT			
File name 21\CourseNotes\Data\MMR 2 w\ResData\Geo-Features\MMRMarketsActv_Rast.tif 🖾								
Layer name	Layer name							
CRS	Proje	ect CRS: EPSG:32646 - WGS	84 / UTM z	one 46N	3			
▼ Exte	nt (cur	rent: MMR_0)						
		North 3165	5948.5370		4			
West	414100.	.9881		East 134845	57.5904			
		South 9788	344.6055					
a	urrent La	ayer Extent Calcula	ate from La	ayer * Map C	anvas Extent			
Reso	olution	(current: layer)						
• Hor	rizontal	3724.31	Vertical	3724.31	Layer Resolution			
	lumns	251	Rows	587	Layer Size			
v o	Create Options							
Profile	Defaul	1+						
Name Value								
				5				
		Validate Help						
		✓ Add saved	l file to ma	рОК	Cancel Help			

Figure 4.3: Dialog box of settings to save heatmap as a raster file



Optional- Enhance the appearance of the raster layer (note that changing the symbols does not change the underlying data):

- Layers Pane- Right click on "MMRMarketsActv_Rast
- Properties -> Symbology -> Dialog box (Figure 4.4)
- 1. Render type- Singleband pseudocolor
- 2. Color ramp -> All color ramps -> OrRd
- 3. Click OK

Q Layer Prop	erties — MMRMarketsActv_Rast	— Symbology				×		
Q	Band Renderin	Band Rendering						
🕡 Informati	on Render type Sing	Render type Singleband pseudocolor 👻 1						
Source	Band	Band 1 (Gr	ay)			-		
Symbolo	^{gy} Min / Max V	o	Мах		2.6457031			
Transpare	ncy Interpolation	2	Linear			-		
📐 Histogran	Color ramp							
🞸 Renderin	Label unit suffix		4					
🕓 Temporal	Value	Color Label						
Pyramids	0	0.0000						
📝 Metadata	0.6614258	0.6614						
Legend	1.3228515	1.3229						
Quis sen	er 1.9842773	1.9843						
	2.6457031	2.6457						
	Mode Continuou Classify Clip out of ran	s 🔹			Classes 5	*		
	▼ Color Renderin	g						
	Blending mode No Brightness Gamma	rmal		Contrast	• R	eset		
	Style *		3	OK Off	Apply	+ +		

Figure 4.4: Dialog box of settings to edit settings for symbols of heatmap raster file

CONTINUE

Click \blacktriangleright to play the video





4.3 Spatial lines risk factors



["]Examples of spatial lines risk factors are the road network as proxy variables for legal (primary roads) or illegal animal/animal product movements (secondary roads). The aim of this section is to create a continuous representation of the proximity of locations in the study area to the different road types.

The first task is to convert the polylines spatial vector file of roads to a raster file. This is necessary because the following steps need to work with raster and not vector spatial file types:"

- Menu bar: Raster -> Conversion -> Rasterize (Vector to Raster) -> Dialog box ... (Figure 4.5)
- 1. Input shape file ("ResData/Geo-Features/MMRRoadsPrim")
- 2. A fixed value to burn [optional]: Set to 1
- 3. Output raster size units: Select "Georeferenced units"
- 4. Width/Horizontal resolution = 1000

[•] Layers Pane: Select and highlight polylines spatial object for analysis (ResData/Geo-Features/MMRRoadsPrim)

- 5. Height/vertical resolution = 1000
- 6. Output extent Click button on right -> Calculate from layer -> "MMR_0" (with polygon icon) and the extent should read as displayed
- 7. Assign a specified nodata value to output bands [optional]: Toggle to "Not set"
- 8. Click Run, and when finished click Close

🔇 Rasterize (Vector to Raster)		×
Parameters Log		
Input layer	1 - 0	2
Selected features only		
Field to use for a burn-in value [optional]		
A fixed value to burn [ontional]		-
1.000000		
Output raster size units		
Width/Horizontal resolution		
1000.000000		
Height/Vertical resolution 1000.000000 5		
Output extent 414100.9881.1348457.5904.978844.6055.3165948.5370 [EPSG:	32646] 6	
Assign a specified nodata value to output bands [optional]		
Not set		÷ -
0%	8	Cancel
Run as Batch Process	Run Close	Help

Figure 4.5: Dialog box of settings to create a raster file of primary roads

- Right-click the newly-created layer "Rasterized" -> Export -> Save As -> Dialog box:(Figure 4.6)
- 1. "ResData/Geo-Admin/MMRRoadsPrim_Rast"
- 2. Click OK

Q Save Rast	er Layer as						\times	
Output mode Format	Raw data GeoTIFF	Rendered imag	e	1		- Create	VRT	
File name	2021\CourseNote	s\Data\MMR-FMD	-new\Resi	Data\Geo-Feat	ures\MMRRoad	dsPrim_Rast.tif 📧		
Layer name								
CRS	EPSG:32646 - W	EPSG: 32646 - WGS 84 / UTM zone 46N 🔹						
▼ Extent	(current: layer	•)					Â.	
		North 3165	948.5370]			
West 41	4100.9881			Eas	t 1348100.98	381		
		South 9789	48.5370]			
Curre	ent Layer Extent	Calcula	te from La	ayer *	Map Canva	as Extent		
🔻 Resolu	ition (current: l	ayer)						
Horizo	ontal 1000		Vertical	1000		Layer Resolution		
	nns 934		Rows	2187		Layer Size		
The Cree	ate Options							
Profile D	Default							
		Name				Value		
	Validate	Help Add saved	file to ma	2	Ca	ncel Help	-	

Figure 4.6: Dialog box of settings to save image of proximity to primary roads as a raster file



Calculate closest distances to raster map of roads:

- Menu bar: Raster > Analysis > Proximity (Raster Distance)-> Dialog box... (Figure 4.7)
- 1. Input layer- select "ResData/Geo-Admin/MMRRoadsPrim_Rast")
- 2. Distance units- select "Georeferenced coordinates"
- 3. No data value to use for destination proximity raster: Toggle to "Not set"
- 4. Click "Run" and when finished click "Close"

Q Proximity (Raster Distance)		\times
Parameters Log		
Input layer		
MMRRoadsPrim_Rast [EPSG: 32646]	•	
Band number		
Band 1 (Gray)		-
A list of pixel values in the source image to be considered target pixels [optional]		
Distance units		
Georeferenced coordinates		Ţ.
0.000000		÷.
Value to be applied to all pixels that are within the -maxdist of target pixels [optional]		
0.000000		\$
Nodata value to use for the destination proximity raster [optional]		
Not set 3		.
Advanced Parameters		
Additional creation options [optional]		
Profile	*	-
0%	Can	cel
Run as Batch Process Run Close	He	lp

Figure 4.7: Dialog box of settings to create image of proximity to primary roads

CONTINUE

Export and save the newly created "Proximity map" layer:

- Right click "MMRRoadsPrim_Rast_Prox" -> Export -> Save As Dialog box ...(Figure 4.8)
- Name file in "ResData/Geo-Admin/" folder as "MMRRoadsPrim_Rast_Prox
- 2. Click "OK"





["]Repeat process for secondary roads but substitute "Sec" for "Prim" in the file name."

Click \blacktriangleright to play the video



4.4 Final processing of preliminary raster layers



["]The goal of this processing step is to ensure that the pixel values of the different preliminary raster risk layers are in a suitable form to combine, and that their values make logical sense.

The first step is to normalise the raster values within each raster cell by dividing its value by the maximum value in the raster file (the maximum score procedure) to create pixel values <u>between 0 and 1</u>. We will use "MMRRoadsPrim_Rast" as an example:"

- Copy maximum raster layer value to use in next calculation (Figure 4.9)
- 1. Right click on newly-created raster proximity file in Layers Pane -> Properties -> Information ->
- 2. Locate 'Band 1' STATISTICS_MAXIMUM' and copy value to computer clipboard (Control + C) and close information box



Figure 4.9: Raster file properties pane displaying maximum raster value

CONTINUE

• Menu bar: Raster -> Raster calculator -> Dialog box ... (Figure 4.10)

- 1. In the Raster Bands box double click on the chosen file and raster layer to operate so that it appears in the Raster Calculator Expression box
- 2. Raster Calculator Expression: Divide the selected raster layer values by the copied maximum value
- 3. Result layer Output layer: Rename file as "MMRRoadsPrim_Rast_Prox_Norm" in the ResData/Geo-Features folder and click Save
- 4. Output CRS: Should read as the project CRS EPSG:36246 WGS 84 /UTM zone 46
- 5. In dialog box click OK

🔇 Raster Calcul	lator								×
Raster Bands				Result Lav	/er				
Cattle_2010_0 Cattle_2010_0	Cattle_2010_Da_Clip@1 Cattle_2010_Da_Clip_Norm@1			Output layer		MMRRoadsPrim_Rast_Prox_Norm.tif 🛯 🛄] [
MMRMarkets	MMRMarketsActv_Rast@1			Output fo	ormat	GeoTIFF			-
MMRMarkets	sActv_Rast_Norm	_NoNa@1		Selected	Layer Extent				
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MMRRoadsP	rim Rast Prox No rim Rast Prox@1	prm_Inv@1		Y min	978948.5370	\$	Y max	3165948.53700	\$
MMRRoadsS	MMRRoadsSec_Rast@1 1			Columns	934	\$	Rows	2187	\$
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Pig_2010_Da_ Pig_2010_Da_	Pig_2010_Da_Clip_Norm@1 Pig_2010_Da_Clip@1			✓ Add result to project					
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Expression valid									
Expression valid					ſ	OK		ancel H	elp
					l				

Figure 4.10: Raster calculator settings used to normalise raster layer

(i) Repeat these steps for the other raster risk factor layers from the previous operations, renaming them with the same conventions.



The second step is to correct the pixel values for raster layers of distances from spatial lines so that they make logical sense. Currently, the pixel values reflect the real distance to the closest road, that is, increased distance equates to increased values. But we want pixel values with increased distance to equate to reduced risk e.g. distance to primary roads.

To achieve this, we create a new raster layer calculated as <u>1</u> - <u>normalized value</u>. In this way greater values are nearer the road, denoting increased risk with increased proximity, and lesser values are further from the road, denoting decreased risk with decreased proximity. We achieve this by using the raster calculator again:"

- Menu bar: Raster -> Raster calculator -> Dialog box ... (Figure 4.11)
- Double click on the file and raster layer to operate on ("MMRRoadsPrim_Rast_Prox_Norm@1") so that it appears in the Raster Calculator Expression box
- 2. Raster Calculator Expression: 1 selected raster layer values
- 3. Result file: Rename file as "MMRRoadsPrim_Rast_Prox_Norm_Inv" and click Save
- 4. In dialog box click OK

Q Raster Calcul	lator									×
Raster Bands				_	Result L	aver				
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abs	min	max								
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Figure 4.11: Raster calculator settings used to correct proximity values

(i) Repeat this process for the secondary roads, naming the files with the same conventions.

CONTINUE



["]The third step is to deal with missing or "no data" values. The



raster calculator can't function on pixels in the stacked layers if any of the aligned pixels have missing (no data) values. The next step, therefore, is to remove 'no data' pixels from any raster image where their pixels do not entirely cover the extent of the study area to allow the raster calculator to work with these pixels in other layers. For our exercise, this step applies to the normalised raster file of livestock markets heat map:"

- In Toolbox menu click on Toolbox icon -> Processing Toolbox pane
- Search for "No data"
- Raster tools -> Fill NoData cells
- Double click on Fill NoData cells-> Dialog box (Figure 4.12)
- 1. Select "MMRMarketsActv_Rast_Norm"
- 2. Fill value: Set to 0
- 3. Output raster: Click folder button to right "Save to file ..." and name new file as "MMRMarketsActv_Rast_Norm_NoNA" in "ResData-Features" folder
- 4. Click Run and when finished click Close

🔇 Fill NoData Cells	×
Parameters Log	Fill NoData cells
Raster input	This algorithm resets the NoData values in the
MMRMarketsActv_Rast_Norm [EPSG:32646]	input raster to a chosen value, resulting in a raster dataset with no NoData pixels. This value can be
band Number	set by the user using the Fill value parameter. The algorithm respects the input raster data type (eg.
Band 1 (Gray)	a floating point fill value will be truncated when
Fill value	
0.000000	2
Output raster	
ew/ResData/Geo-Features/MMRMarketsActv_Rast_Norm_NoNA.th	3
Open output file after running algorithm	_
	4
0%	Cancel
Run as Batch Process	Run Close Help

Figure 4.12: Fill NoData cells dialog box used to correct raster layer with no data values

CONTINUE

Click \blacktriangleright to play the video

Lesson 6 of 6

Exercise 4.1: Considerations when creating spatial risk surfaces



["]There are often several choices that need to be made when creating raster spatial risk layers.

Create a table that allows you to answer the following questions:

- 1. For each spatial risk layer, identify the optional values that you could have used when creating the raster risk layer
- 2. Describe the likely effects on the risk layer raster values and what that might mean for the final spatial risk map after the layers are combined

CONTINUE

Have you completed the table as requested?



Table 4.1: Possible effects of changing parameters for GIS functions used to create final spatial risk assessment map for occurrence of FMD in Myanmar

Spatial risk	Parameters with optional	
factor	values	Effect of changing parameters on final risk map
Proximity to	Heatmap (Kernel Density	Increased radius would increase the area around
livestock	Estimation)- Radius	the markets influenced by the market and likely
markets		enclose more actual outbreak locations
	Heatmap (Kernel Density	A view of the possible kernel shapes shows that
	Estimation)- Kernel shape	apart from uniform, they differ little from the
		default quartic shape, so alternate valid shapes
		would likely have little effect
Proximity to	N/A	
roads		
Population	N/A	

density of		
livestock		

Congratulations - end of lesson reached

