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Teaching & Learning Step by -Step Guide: Land use Mix Analysis

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Publisher

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PREFACE

This book serves as open educational material for both undergraduate and postgraduate degree programs, offering a detailed, step-by-step guide to mapping the landaus mix of a particular area using GIS technology.

Land use mix analysis delves into the intricate arrangement and diversity of land use within a defined area, often at the scale of a neighborhood or urban region. This analysis meticulously evaluates how various land uses such as residential, commercial, industrial, recreational, and green spaces or Live, Work, and Visit—interact and are distributed spatially. By quantifying the blend and proximity of these land uses, the analysis illuminates the area's spatial structure, functionality, and vibrancy. Whether you are a student aiming to master mobile mapping and geographic information systems, a teacher looking for robust educational tools, or a practitioner in need of refining your technical expertise, this book offers invaluable guidance and support. It ensures that users at all levels gain proficiency in leveraging modern technologies to explore and solve geographic challenges effectively.

This understanding of land use mix is paramount for urban planners, policymakers, and researchers alike. It serves as a cornerstone for fostering sustainable development, enriching livability, nurturing walkable communities, and bolstering social and economic prosperity.

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1. MAPPING PROCESS



Table 1 -Mapping Process

2. REQUIRED TOOLS / SOFTWARE AND EQUIPMENT

QGIS is a free, open-source software that allows users to create, edit, analyze, and visualize geospatial data and maps. Its compatibility with various data formats, plugins, and support for projections make it a versatile tool for geographic information.





Figure 1 - QGIS Interface

3. STEPS

Land use Mix for Dambulla MC

The completed land use mix map provides a visual representation of the varied land uses found in our research zone. This map serves as a comprehensive overview, allowing us to understand the dynamic landscape and how different land uses interact and coexist within our study area. By visually representing Live, Work, Visit, Live and Work, Live and Visit, Work and Visit, and the live, work, and visit according to the use, the map provides valuable insights into the spatial arrangement and interaction of these elements. Figure 2 shows the final output of this process, the Landuse Mix of the Dambulla municipal council area.

Functional Mix Map of Dambulla MC



Figure 2 - landuse mix map of Dambulla MC

Step 01

For creating the land mix (Functional Mix) map for an area we have to have a Building layer of that area including land uses. If not, we have to create it Using OpenStreetMap (OSM) which is an Open source software, with data as a base and then digitizing missing buildings using the following steps is one approach to creating a building layer.

I. Download OSM Data - Access OSM data for the study area by downloading OSM data.

• Go to the OpenStreetMap website (www.openstreetmap.org) >>Sign in



Note - If any building layer is available with the land uses for the study area you can use it.

• Use the provided interface to select the study area or specify a bounding box for the study area.



ii. For digitizing missing buildings, first use the Edit tool to digitize buildings.



Figure 5- Edit Tool

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- Click on 'Area'>> Draw the shape of the building>>save

Now we can download the data



• When exporting the date, automatically download the data.

Figure 6 -Export Data

iii. Import the OSM data into QGIS.

• Install QuickOSM Plugin (if not already installed) - Plugins>>Manage and Install plugins.



Figure 7 -Install Plugins

• In the Plugins Manager window, search for "QuickOSM" and install it.

Q Plugins | All (1208) Х Step1 Q Quickosm $\langle \times$ All 🖕 🕒 uickOSM QuickOSM Installed Not installed Download OSM data thanks to the Overpass API. You can also open local OSM or PBF files. A special parser, on top of OGR, is used to let you see all 💛 Upgradeable Step2 OSM keys available. Install from Execute customs Overpass queries in QGIS to get OSM data. ZIP ☆☆☆☆☆ 330 rating vote(s), 1624199 downloads Settings Tags openstreetmap, josm, osm, processing, download, overpass, pbf, remote, osmdownload, modeler More info homepage bug tracker code repository Step3 Author Etienne Trimaille Available version (stable) 2.2.3 updated at Thu Aug 10 07:43:30 2023 GMT Upgrade All Install Pluce Close Help

Search 'QuickOSM' in the searching box.>> Select the 'QuickOSM' >>Install the plugging.

Figure 8 - Install QuickOSM plugin.

• When we install the QuickOSM plugin successfully, it appears as this.



Figure 9 -OSM Plugin

• Now we can import the buildings which we digitize in OSM, to the QGIS using this tool.

Click on the QuickOSM plugin>> choose 'Buildings' in the preset box.



Figure 10- Import Buildings

• Give the 'layer extent' as the spatial extent>>select the study area using the drop bar. (Configure the query parameters according to your requirements.)

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Figure 11 -Layer Extent

• Run the Query- After specifying the query parameters, click on the "Run Query" button to execute the query. QuickOSM will create building data based on the criteria.



Figure 12 -Imported Building layer from OSM

• Delete unwanted polygons using attributes.

I. Select the layer>> click on the toggle editing tool



Figure 13 - Deleting.

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34	JULL	NULL	2	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
35	JULL	NULL	NULL	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
36	JULL	NULL	NULL	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
37	JULL	NULL	NULL	place_of_worship	NULL	attraction	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
38	JULL	NULL	NULL	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
39	JULL	NULL	2	NULL	NULL	NULL	residential	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
40	JULL	NULL	NULL	parking	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
41	JULL	NULL	NULL	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
42	JULL	NULL	NULL	NULL	NULL	NULL	yes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
4															•

ii . Open the attribute table by right-clicking on this layer(imported layer from the open street map).

🛅 Show All Features 🖕

Figure 14 -Attribute table of Building layer

3 🛅

• When opening the attribute table, we can see a field called 'buildings'. The polygons that are 'NULL' in this column are not buildings and we have to delete them. Select the unwanted polygons by using the 'select by attribute' tool.

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r13814282	13814282	relation	NULL	NL			Maps				VULL	NULL	NULL	NULL
r17540638	17540638	relation	NULL	NL			Operators				VULL	NULL	NULL	NULL
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Figure 15 -Select By Expression

• Extract the Fields and Values using the drop bar.

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23	VULL	NULL	NULL	NULL	NUL				Conditionals				NULL	NULL	NULL	NULL
24	VULL	NULL	NULL	NULL	lake				 Conversions Date and Time 				NULL	NULL	NULL	NULL
25	VULL	NULL	NULL	NULL	lake				 Fields and Values NULL 				NULL	NULL	NULL	NULL
26	VULL	NULL	NULL	NULL	NUL				abc full_id				NULL	NULL	NULL	NULL
27	JULL	NULL	NULL	NULL	NUL				abc osm_type				NULL	NULL	NULL	NULL
28	JULL	NULL	NULL	NULL	NUL				^{abc} house abc animal_bree	ding			NULL	NULL	NULL	NULL
29	oark	NULL	NULL	NULL	NUL				^{abc} animal_boar	ding			NULL	NULL	NULL	NULL
30	ark	NULL	NULL	NULL	NUL				abc roof:height				NULL	NULL	NULL	NULL
31	VULL	NULL	NULL	NULL	NUL				abc access abc surface				NULL	NULL	NULL	NULL
32	wimming_pool	NULL	NULL	NULL	NUL				abc contact:webs	site			NULL	NULL	NULL	NULL
33	VULL	NULL	NULL	NULL	NUL				abc contact:fax	ie ie			NULL	NULL	NULL	NULL
34	VULL	NULL	2	NULL	NUL				abc contact:ema abc addr:suburb	il			NULL	NULL	NULL	NULL
35	VULL	NULL	NULL	NULL	NUL				abc addr:postcoo	de			NULL	NULL	NULL	NULL
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40	VULL	NULL	NULL	parking	NUL	L	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
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	Show All Features															

Figure 16 -Select Fields and Values

• Select the buildings>>double click on it. It appears in the vacant space in the left top corner of the window.



Figure 17 - Select Building

• Type 'is' after the building >>All Unique>>double click on 'NULL'>>Click on select Fetchers>>close



Figure 18 -Select by Attribute

- Project Edit View Layer Settings Plugins Vector Raster Web Mesh Processing Help - D 🖿 🖥 🖬 🕄 🛍 : 🕐 🖗 🕫 🎜 🥦 💬 🖗 🧛 🖓 🔚 🧠 🌜 🖤 🛇 🈂 : 🔜 + 🖏 + 🥾 - 🔍 📾 🎆 Σ 💷 + 🚍 + 🦻 🎕 + 🤹 🏟 Vi 🖍 🖏 🔢 🔯 | 🗶 🖉 🖶 😤 🎘 - 🕱 🗑 🗠 🖻 🗄 🤟 🗢 🔍 🛥 🗨 🧠 🧠 🧠 🖷 🖷 🖷 🐇 🐇 🛕 🚳 🛠 👌 🛃 📳 · • 🖫 • 🐂 🐄 🗞 🖓 🖓 📽 📽 😭 🖗 🍼 🗍 · 👭 👷 🖤 葉 🕐 • D 🕅 ßX Processing Toolbox ØX Layers v 🖌 🖉 👒 🏆 🏭 🕈 🖬 🖬 🗔 🎭 🔩 🕓 📄 i 🤛 i 🔧 . V 🚺 Q Search.. ✓ DambullaMC ▼ ✓ F Google Maps • Q File tools × Q GPS 9. Interpolation Q Layer tools Mesh ίe. Retwork analysis Receiption Plots Raster analysis Raster creation Raster terrain analysis Raster tools Q Vector analysis Q Vector creation Vector general Q Vector geometry Q Vector overlay Q Vector selection Q Vector table Q Vector tiles 🕨 🚵 GDAL nable a লিম Search QMS Search string .. Filter by extent All Last used: Google Satellite Hybrid TMS details, report a problem Add e Constantes Maria A Fresh geodata for your project
- Delete the selected unwanted polygons that are not buildings using the delete tool.



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• If there are buildings outside of the study area boundary you can delete them.

Select those buildings. By holding the shift key select all buildings that are outside of the boundary of the study area. Then delete them.



Figure 20 -Delete buildings which are outside of the boundary

• Now we can delete the unwanted columns from the attribute table of the building layer.

Open attribute table>>click on toggle editing>>click on delete field>>select the names of unwanted fields>>OK

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w200769985	200769985	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w267792807	267792807	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
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w431489400	431489400	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w431489518	431489518	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w431489519	431489519	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w434725307	434725307	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w462516182	462516182	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w462516183	462516183	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w462516184	462516184	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
w478697717	478697717	way	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 21 -Select unwanted Columns.

• Save the layer.

Click on toggle editing>>yes. -Now we have the building layer of our study area.



Figure 22 -Building layer

Step 02

We have to have land use for each building for this analysis. For that,

i. Open the attribute table of the building layer by right-clicking on the layer.



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	latitude	longitude	area_in_me	confidence	full_plus_
1	7.85619114000	80.6550586799	136.3840999999	0.8504	6MV2VM44+F2
2	7.85206145000	80.6558336100	36.78249999999	0.6816	6MV2VM24+R8
3	7.85110933000	80.6540884599	32.87299999999	0.6997	6MV2VM23+CJ
4	7.85085545000	80.6550881000	147.866399999	0.861	6MV2VM24+82
5	7.85339178000	80.6546113800	130.150700000	0.683	6MV2VM33+9R
6	7.85503781000	80.6551788000	53.10029999999	0.7191	6MV2VM44+23
7	7.85654983000	80.6561935799	134.262499999	0.8141	6MV2VM44+JF8R
8	7.85304112000	80.6549067600	50.8556999999	0.8303	6MV2VM33+6X7J
9	7.85616451000	80.6544944999	33.0638999999	0.8186	6MV2VM43+FQ
10	7.85432756000	80.6541885599	29.4812000000	0.7381	6MV2VM33+P
11	7.85541383000	80.6554347999	125.371399999	0.7582	6MV2VM44+55
12	7.85055452000	80.6554593000	161.790300000	0.6945	6MV2VM24+65
13	7.85231165000	80.6546857999	81.6855000000	0.7742	6MV2VM23+W
14	7.85208745000	80.6563912900	54.62899999999	0.6915	6MV2VM24+RH
15	7.85571889000	80.6556222899	22.52199999999	0.7201	6MV2VM44+76
16	7.85402082000	80.6559043000	39.3331000000	0.652	6MV2VM34+J92X
17	7.85748841000	80.6568236300	46.5989000000	0.73	6MV2VM44+XP
18	7.85579453000	80.6551276000	44.8502999999	0.8067	6MV2VM44+836J
19	7.85470836000	80.6547734899	180.3105999999	0.7881	6MV2VM33+V
20	7.85644683000	80.6552911600	119.544200000	0.7032	6MV2VM44+H4
21	7.85610235000	80.6543229499	93.2158000000	0.6882	6MV2VM43+CP
22	7.85464722000	80.6554732000	18.7348000000	0.6568	6MV2VM34+V5
23	7.85521685000	80.6546303599	38.9286000000	0.7342	6MV2VM43+3VJJ
24	7.85518687000	80.6551910700	43.9412000000	0.7971	6MV2VM44+33
T Sho	w All Features 🖕				

• Add a new field for landuse.

Click on toggle editing >>click on New Field>>Name=Landuse, Type= Text>>OK

Buildings_MC — Fea	tures Total: 14326, F	iltered: 14326, Selecte	ed: 0	- 0 X	
	× 🖉 🖺 I 🗞 블	S 🗣 🕇 🕱 🖗 🌶			
2 latitude 👻 = 8	1.2			Update All Update Selected	
7.85619114000	80.6550586709	area_in_me	0.8504 6MV2VM44+F2		
7.050051140000	00.0330300735	26 702 4020000			
7.85206145000.	80.0558330100	. 36.78249999999	0.0816 0MV2VM24+R8		– <mark>St</mark>
7.85110933000.	80.6540884599	. 32.87299999999	0.6997 6MV2VM23+CJ		
7.85085545000.	80.6550881000	. 147.866399999	0.861 6MV2VM24+82		
7.85339178000.	80.6546113800	. 130.150700000	0.683 6MV2VM33+9R		
7.85503781000.	80.6551788000	. 53.10029999999	0.7191 6MV2VM44+23		— St
7.85654983000.	80.6561935799	. 134.262499999	0.8141 6MV2VM44+JF8R		
7.85304112000.	80.6549067600	. 50.8556999999	0.8303 6MV2VM33+6X7J	Q Add Field X	
7.85616451000.	80.6544944999	. 33.0638999999	0.8186 6MV2VM43+FQ	Name Landuse	
7.85432756000.	80.6541885599	. 29.4812000000	0.7381 6MV2VM33+P	Comment	
7.85541383000.	80.6554347999	. 125.371399999	0.7582 6MV2VM44+55	Type Text (string)	31
7.85055452000.	80.6554593000	. 161.790300000	0.6945 6MV2VM24+65	Provider type string	
7.85231165000.	80.6546857999	. 81.6855000000	0.7742 6MV2VM23+W	Length 10	
7.85208745000.	80.6563912900	. 54.6289999999	0.6915 6MV2VM24+RH	OK Cancel	
7.85571889000.	80.6556222899	. 22.52199999999	0.7201 6MV2VM44+76		
7.85402082000.	80.6559043000	. 39.3331000000	0.652 6MV2VM34+J92X		
7.85748841000.	80.6568236300	46.5989000000	0.73 6MV2VM44+XP		
7.85579453000.	80.6551276000	. 44.8502999999	0.8067 6MV2VM44+836J		
7.85470836000.	80.6547734899	. 180.310599999	0.7881 6MV2VM33+V		
7.85644683000.	80.6552911600	. 119.544200000	0.7032 6MV2VM44+H4		
7.85610235000.		93.2158000000	0.6882 6MV2VM43+CP		
7.85464722000	80.6554732000	. 18.7348000000	0.6568 6MV2VM34+V5		
7.85521685000	80 6546303599	38 9286000000	0.7342 6MV2VM43+3VII		
7.05321003000.	00.6551010700	42.0412000000	0.7071 644/0/0444.22	v	
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Figure 25 - Add New Filed

•	Now the land	use column	was added	for the	attribute	table (of the	building	layer.

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latitude 💌 = E	1.2				Update
latitude	longitude	area_in_me	confidence full_pl	lus_ 🔺 Landuse	
7.79694509000.	80.6662508299	90.0948000000	0.8676 6MV2QM	1W8+Q NULL	
7.79692023000	80.6664303999	20.6091000000	0.6518 6MV2QM	1W8+Q NULL	
7.79696759000	80.6667317099	100.7772999999	0.8408 6MV2QM	1W8+Q NULL	
7.79746882000	80.6685865000	227.209599999	0.8468 6MV2QM	1W9+X NULL	
7.79758341000	80.6664208899	38.9198000000	0.7346 6MV2QM	1X8+2 NULL	
7.79940965000	80.6664547099	19.8978000000	0.6668 6MV2QM	1X8+Q NULL	
7.79768271000	80.6682295399	105.373199999	0.8243 6MV2QM	1X9+37 NULL	
7.79762837000	80.6683432899	82.6025999999	0.7595 6MV2QM	1X9+38 NULL	
7.79872432000	80.6689085900	69.0197000000	0.7647 6MV2QM	1X9+F NULL	
7.79951495000	80.6678753599	23.1465000000	0.7212 6MV2QM	1X9+R5 NULL	
7.79954837000	80.6682257700	296.807599999	0.7996 6MV2QM	1X9+R7 NULL	
7.79972566000	80.6687115600	75.0189000000	0.8774 6MV2QM	1X9+VF NULL	
7.79980824000	80.6688568499	92.660200000	0.8561 6MV2QM	1X9+W NULL	
7.79990052000	80.6690083900	77.0173000000	0.8788 6MV2QM	1X9+XJ NULL	
7.79950150000	80.6717098900	26.4554000000	0.763 6MV2QM	IXC+R NULL	
7.79955498000	80.6719664000	30.9161000000	0.7865 6MV2QM	IXC+R NULL	
7.79961992000	80.6719771900	96.4059000000	0.8644 6MV2QM	IXC+R NULL	
7.79953973000	80.6722227500	113.755300000	0.8993 6MV2QM	IXC+R NULL	
7.79966547000	80.6716679999	149.309699999	0.7587 6MV2QM	IXC+V NULL	
7.79891438000	80.6748575099	33.05579999999	0.7978 6MV2QM	IXF+H NULL	
7.79979818000	80.6725500799	45.1672000000	0.676 6MV2QM	IXF+W NULL	
7.79985493000	80.6725429800	93.8915999999	0.851 6MV2QM	1XF+W NULL	
7.79986059000	80.6726066899	13.1564000000	0.7579 6MV2QM	IXF+W NULL	
7 70002011000	00 6721 200 400	14006700000	0.725 614/2014		
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Figure 26 -Add Columns
• Now it should be filled land use column by using observations or Google Street View.

Examples of land uses- are houses, shops, schools, temples, libraries, banks, offices, etc.

Using the following steps, we have to fill the whole land use column according to the land use of each building.

Process- Observe the use of the building that is shown in yellow color in Figure A, by using Google Street View according to Figure When opening the attribute table, That selected building is shown in Figure C. We can fill the land use column according to the observed use of that building in Figure D.





Figure B

Figure 28 - Google Street View

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	latitude	longitude	area_in_me	confidence	full_plus_ 🔺	Landuse
15	7.83861423000	80.6421047599	30.6593000000	0.8142	6MV2RJQR+CRXF	NULL
116	7.83868425000	80.6412294999	50.7978999999	0.6785	6MV2RJQR+FFH7	NULL
117	7.83878915000	80.6417671100	147.793299999	0.8023	6MV2RJQR+GP6G	NULL
118	7.83907121000	80.6419555699	216.047899999	0.9234	6MV2RJQR+JQ	NULL
119	7.83935556000	80.6416414100	36.2989000000	0.6516	6MV2RJQR+PM	NULL
120	7.83937518000	80.6417171100	112.337100000	0.8094	6MV2RJQR+QM	NULL
121	7.83761740000	80.6438960600	141.111300000	0.8634	6MV2RJQV+2HRP	NULL
122	7.83771960000	80.6441842600	104.549499999	0.8447	6MV2RJQV+3M	NULL
123	7.83767883000	80.6444854100	88.3717000000	0.8038	6MV2RJQV+3Q	NULL
124	7.83780204000	80.6435182000	184.929800000		6MV2RJQV+4CC4	NULL
125	7.83778426000	80.6439312499	86.5071999999	0.8359	6MV2RJQV+4H79	NULL
126	7.83780800000	80.6443931299	67.71829999999	0.7093	6MV2RJQV+4QC8	NULL
127	7.83791213000	80.6440126400	51.2794999999	0.7417	6MV2RJQV+5J6F	NULL
128	7.83856556000	80.6444628800	76.6706999999	0.7646	6MV2RJQV+CQ	NULL
129	7.83874970000	80.6444643800	47.9562000000	0.7301	6MV2RJQV+FQ	NULL
130	7.83887737000	80.6447969700	193.7779999999	0.8136	6MV2RJQV+H	NULL
131	7.83990823000	80.6441399499	156.590800000	0.7978	6MV2RJQV+XM	NULL
132	7.83841324000	80.6469267500	156.015800000	0.8798	6MV2RJQW+9Q	NULL
133	7.83869095000	80.6474718999	76.9827999999	0.8089	6MV2RJQW+FX	NULL
134	7.83909444000	80.6474411300	52.4273000000	0.7837	6MV2RJQW+JXPJ	NULL
135	7.83913387000	80.6451152700	150.251499999	0.8747	6MV2RJQW+M	NULL
36	7.83949775000	80.6450193900	138.511200000	0.7729	6MV2RJQW+Q2	NULL
37	7.83951397000	80.6450860900	51.4380000000	0.6834	6MV2RJQW+R2	NULL
00	7 0207255 4000	00 6471017200	00.056000000	0 7000	GMANODIOM . MA	NII II I

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	latitude	longitude	area_in_me	confidence	full_plus_	Landuse
115	7.83861423000	80.6421047599	30.6593000000	0.8142	6MV2RJQR+CRXF	NULL
116	7.83868425000	80.6412294999	50.7978999999	0.6785	6MV2RJQR+FFH7	NULL
117	7.83878915000	80.6417671100	147.793299999	0.8023	6MV2RJQR+GP6G	NULL
118	7.83907121000	80.6419555699	216.0478999999	0.9234	6MV2RJQR+JQ	NULL
119	7.83935556000	80.6416414100	36.2989000000	0.6516	6MV2RJQR+PM	NULL
120	7.83937518000	80.6417171100	112.337100000	0.8094	6MV2RJQR+QM	NULL
121	7.83761740000	80.6438960600	141.111300000	0.8634	6MV2RJQV+2HRP	NULL
122	7.83771960000	80.6441842600	104.549499999	0.8447	6MV2RJQV+3M	NULL
123	7.83767883000	80.6444854100	88.3717000000	0.8038	6MV2RJQV+3Q	NULL
124	7.83780204000	80.6435182000	184.929800000	0.7773	6MV2RJQV+4CC4	Bus stand 🛛 🖾
125	7.83778426000	80.6439312499	86.50719999999	0.8359	6MV2RJQV+4H79	NULL
126	7.83780800000	80.6443931299	67.71829999999	0.7093	6MV2RJQV+4QC8	NULL
127	7.83791213000	80.6440126400	51.2794999999	0.7417	6MV2RJQV+5J6F	NULL
128	7.83856556000	80.6444628800	76.67069999999	0.7646	6MV2RJQV+CQ	NULL
129	7.83874970000	80.6444643800	47.9562000000	0.7301	6MV2RJQV+FQ	NULL
130	7.83887737000	80.6447969700	193.7779999999	0.8136	6MV2RJQV+H	NULL
131	7.83990823000	80.6441399499	156.590800000	0.7978	6MV2RJQV+XM	NULL
132	7.83841324000	80.6469267500	156.015800000	0.8798	6MV2RJQW+9Q	NULL
133	7.83869095000	80.6474718999	76.9827999999	0.8089	6MV2RJQW+FX	NULL
134	7.83909444000	80.6474411300	52.4273000000	0.7837	6MV2RJQW+JXPJ	NULL
135	7.83913387000	80.6451152700	150.2514999999	0.8747	6MV2RJQW+M	NULL
136	7.83949775000	80.6450193900	138.511200000	0.7729	6MV2RJQW+Q2	NULL
137	7.83951397000	80.6450860900	51.4380000000	0.6834	6MV2RJQW+R2	NULL
400	7 0207255 4000	00 6471017200	00.056000000	0 7000	GMUODIOW - MU	NII II 1

Figure D

Figure C

Figure 29 -Attribute table of Building layer

Figure 30 -Attribute table of Building layer.

	latitude	longitude	area_in_me	confidence	full_plus_ 🔺	Landuse
115	7.83861423000	80.6421047599	30.6593000000	0.8142	6MV2RJQR+CRXF	NULL
116	7.83868425000	80.6412294999	50.7978999999	0.6785	6MV2RJQR+FFH7	NULL
117	7.83878915000	80.6417671100	147.793299999	0.8023	6MV2RJQR+GP6G	NULL
118	7.83907121000	80.6419555699	216.0478999999	0.9234	6MV2RJQR+JQ	NULL
119	7.83935556000	80.6416414100	36.2989000000	0.6516	6MV2RJQR+PM	NULL
120	7.83937518000	80.6417171100	112.337100000	0.8094	6MV2RJQR+QM	NULL
121	7.83761740000	80.6438960600	141.111300000	0.8634	6MV2RJQV+2HRP	NULL
122	7.83771960000	80.6441842600	104.549499999	0.8447	6MV2RJQV+3M	NULL
123	7.83767883000	80.6444854100	88.3717000000	0.8038	6MV2RJQV+3Q	NULL
124	7.83780204000	80.6435182000	184.929800000	0.7773	6MV2RJQV+4CC4	Bus stand
125	7.83778426000	80.6439312499	86.50719999999	0.8359	6MV2RJQV+4H79	NULL
126	7.83780800000	80.6443931299	67.71829999999	0.7093	6MV2RJQV+4QC8	NULL
127	7.83791213000	80.6440126400	51.2794999999	0.7417	6MV2RJQV+5J6F	NULL
128	7.83856556000	80.6444628800	76.6706999999	0.7646	6MV2RJQV+CQ	NULL
129	7.83874970000	80.6444643800	47.9562000000	0.7301	6MV2RJQV+FQ	NULL
130	7.83887737000	80.6447969700	193.7779999999	0.8136	6MV2RJQV+H	NULL
131	7.83990823000	80.6441399499	156.590800000	0.7978	6MV2RJQV+XM	NULL
132	7.83841324000	80.6469267500	156.015800000	0.8798	6MV2RJQW+9Q	NULL
133	7.83869095000	80.6474718999	76.9827999999	0.8089	6MV2RJQW+FX	NULL
134	7.83909444000	80.6474411300	52.4273000000	0.7837	6MV2RJQW+JXPJ	NULL
135	7.83913387000	80.6451152700	150.251499999	0.8747	6MV2RJQW+M	NULL
136	7.83949775000	80.6450193900	138.511200000	0.7729	6MV2RJQW+Q2	NULL
137	7.83951397000	80.6450860900	51.4380000000	0.6834	6MV2RJQW+R2	NULL

Figure 31 -Fill in the Land use column

- Save the layer by using the toggle editing tool. Click on toggle editing>>ok
- Using the above process, we can fill the Landuse column by using the use of buildings.

This is the attribute table of the building layer within the land use for each building.

	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use
13	7.84295309000	80.6464940799	51.3607000000	0.6997	6MV2RJVW+5H	Houses
14	7.84496085000	80.6701122700	82.9535000000	0.8121	6MV2RMVC+X2	Houses
15	7.90230404000	80.6428897899	7.23220000000	0.672	6MV2WJ2V+W5	Houses
16	7.90715700000	80.6685230599	169.580800000	0.7776	6MV2WM49+V	Houses
17	7.89671492000	80.6706302599	434.917700000	0.9333	6MV2VMWC+M	Warehouse
18	7.87873187000	80.6237491100	34.8791000000	0.7804	6MV2VJHF+FFX9	Houses
19	7.90542638000	80.6695553200	63.8934000000	0.7605	6MV2WM49+5	Houses
20	7.89951357000	80.6387449500	37.6246000000	0.7518	6MV2VJXQ+RF5H	Houses
21	7.84697714000	80.6653756900	14.2409000000	0.6758	6MV2RMW8+Q	Houses
22	7.89905289000	80.6722281600	10.62839999999	0.7225	6MV2VMXC+JV	Warehouse
23	7.83840450000	80.6732793099	47.369000000	0.8062	6MV2RMQF+98	Houses
24	7.89675290000	80.6399086499	79.18089999999	0.6726	6MV2VJWQ+PX	Houses
25	7.90114896000	80.6641178699	13.8482000000	0.6751	6MV2WM27+FJ	Houses
26	7.89546041000	80.6737475200	458.944200000	0.7801	6MV2VMWF+5F	Warehouse
27	7.84732936000	80.6672941300	52.8038000000	0.6597	6MV2RMW8+W	Houses
28	7.89574507000	80.6344825000	78.1805999999	0.7887	6MV2VJWM+7	Houses
29	7.90496262000	80.6696090199	101.043099999	0.8309	6MV2WM39+X	Hotel & Motel
30	7.91467024000	80.6792863799	148.973800000	0.6509	6MV2WM7H+V	Houses
31	7.90797795000	80.6737709599	173.6485999999	0.886	6MV2WM5F+5	Hotel & Motel
32	7.89550459000	80.6341837500	73.9539999999	0.7397	6MV2VJWM+6	Houses
33	7.84641391000	80.6669702899	686.567800000	0.8339	6MV2RMW8+H	Warehouse
34	7.84914720000	80.6694107499	42.8795000000	0.7164	6MV2RMX9+M	Houses
35	7.84265138000	80.6471202099	113.272900000	0.9004	6MV2RJVW+3R95	Houses
36	7.90681803000	80.6673002400	112.2614999999	0.8036	6MV2WM48+P	Houses

Figure 32 -Attribute table of building layer.

Step 03

Land uses have been categorized into seven different types, Live, Work, Visit, Live Work, Live&Visit, Work &Visit, Live, Work &Visit.



Figure 33 -Live, Work, and Visit Triangle

• Add a new field (Step02-ii), in the attribute table of the building layer called Functional mix according to this categorization.

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	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use	Func_Mix
1	7.85619114000	80.6550586799	136.3840999999	0.8504	6MV2VM44+F2	Houses	Live
2	7.85206145000	80.6558336100	36.7824999999	0.6816	6MV2VM24+R8	Hotel & Motel	Live
3	7.85110933000	80.6540884599	32.87299999999	0.6997	6MV2VM23+CJ	Houses	Live
4	7.85085545000	80.6550881000	147.866399999	0.861	6MV2VM24+82	Houses	Live
5	7.85339178000	80.6546113800	130.150700000	0.683	6MV2VM33+9R	Houses	Live
6	7.85503781000	80.6551788000	53.10029999999	0.7191	6MV2VM44+23	Houses	Live
7	7.85654983000	80.6561935799	134.262499999	0.8141	6MV2VM44+JF8R	Houses	Live
8	7.85304112000	80.6549067600	50.8556999999	0.8303	6MV2VM33+6X7J	Houses	Live
9	7.85616451000	80.6544944999	33.06389999999	0.8186	6MV2VM43+FQ	Houses	Live
10	7.85432756000	80.6541885599	29.4812000000	0.7381	6MV2VM33+P	Houses	Live
11	7.85541383000	80.6554347999	125.371399999	0.7582	6MV2VM44+55	Houses	Live
12	7.85055452000	80.6554593000	161.790300000	0.6945	6MV2VM24+65	Houses	Live
13	7.85231165000	80.6546857999	81.6855000000	0.7742	6MV2VM23+W	Houses	Live
14	7.85208745000	80.6563912900	54.62899999999	0.6915	6MV2VM24+RH	Houses	Live
15	7.85571889000	80.6556222899	22.52199999999	0.7201	6MV2VM44+76	Houses	Live
16	7.85402082000	80.6559043000	39.3331000000	0.652	6MV2VM34+J92X	Houses	Live
17	7.85748841000	80.6568236300	46.5989000000	0.73	6MV2VM44+XP	Houses	Live
18	7.85579453000	80.6551276000	44.8502999999	0.8067	6MV2VM44+836J	Houses	Live
19	7.85470836000	80.6547734899	180.310599999	0.7881	6MV2VM33+V	Houses	Live
20	7.85644683000	80.6552911600	119.544200000	0.7032	6MV2VM44+H4	Houses	Live
21	7.85610235000	80.6543229499	93.2158000000	0.6882	6MV2VM43+CP	Houses	Live
22	7.85464722000	80.6554732000	18.7348000000	0.6568	6MV2VM34+V5	Houses	Live
23	7.85521685000	80.6546303599	38.9286000000	0.7342	6MV2VM43+3VJJ	Houses	Live
24	7.85518687000	80.6551910700	43.9412000000	0.7971	6MV2VM44+33	Houses	Live

Figure 34 -Attribute table of Building layer

Step 04

This approach is to analyze the urbanity level in this area. For that, we have created a raster file by assigning the above categories. To create this raster layer we have to interpolate the building layer of the study area. For interpolation,

We have to convert this building into points. For that, it is used the Processing Toolbox.



Figure 35 -Processing Tool Box

• Then, Search the "Centroids" Tool in the Processing Toolbox.



Figure 36 -Select 'Centroids' in the Processing toolbox.

In that window,

- i. Enter the building layer which we created, as the input layer
- ii. Tick on the 'create centroids for each part'
- iii. Give a path for the output layer
- iv. Run the tool



Figure 37 -Centroids

Error:

When running this, this error occurred



Figure 38 -Centroid error

To solve that, it can be used "Check Validity" tool to identify invalid features. According to the above step, we can search in the processing toolbox "check Validity".



Figure 39 -Select the 'check validity' tool.

Then follow these steps.

i. Enter the building layer as the input layer

ii. Run the tool

it will generate 3 temporary layers.

Q Check Validity			×
Parameters Log		•	Check validity
Input layer		•	This algorithm performs a validity check on the geometries of a vector layer.
Selected features only Method The one selected in digitizing settings QGIS Ignore ring self intersections Valid output [optional] [Create temporary layer] ✓ Open output file after running algorithm Invalid output [optional]			The geometries are classified in three groups (valid, invalid and error), and a vector layer is generated with the features in each of these categories. By default the algorithm uses the strict OGC definition of polygon validity, where a polygon is marked as invalid if a self- intersecting ring causes an interior hole. If the "Ignore ring self intersections" option is checked, then this rule will be ignored and a more lenient validity check will be performed.
[Create temporary layer]	•••		
Open output file after running algorithm		-	
[Create temporary laver]		•	
0%			Cancel
Run as Batch Process			Run Close Help

Figure 40 -Check Validity

• Using the "Fix Geometries" tool we can repair the geometry. Search the tool in the processing toolbox,



Figure 41 -Select 'Fix Geometries'

Enter the 'valid output' layer as the input layer which is generated by the check validity tool. Then give a path to the output layer and run the tool.

Q Fix Geometries	×
Parameters Log	Fix geometries
Input layer Imput layer Impu layer <td< th=""><th>This algorithm attempts to create a valid representation of a given invalid geometry without losing any of the input vertices. Already-valid geometries are returned without further intervention. Always outputs multi-geometry layer.</th></td<>	This algorithm attempts to create a valid representation of a given invalid geometry without losing any of the input vertices. Already-valid geometries are returned without further intervention. Always outputs multi-geometry layer.
D:/Manual/Buildings_Fixed.shp 🛛 🔍	NOTE: M values will be dropped from the
✓ Open output file after running algorithm	
0%	Cancel
Run as Batch Process	Run Close Help

Figure 42 -Fix Geometries

• After fixing the geometry, it can be rerun the centroid tool using those steps.

Now, that error is solved. Then it can create a point layer for the Building in Dambulla MC for using the centroid tool again.

Q Centroids		>
Parameters Log	•	Centroids
Input layer Buildings_Fixed [EPSG:4326] Selected features only Create centroid for each part		This algorithm creates a new point layer, with points representing the centroid of the geometries in an input layer. The attributes associated to each point in the output layer are the same ones associated to the original features.
Centroids		
♥ Open output file after running algorithm		
0%		Cancel
Run as Batch Process		Run Close Help

Figure 43 – Centroids

- 🔇 *Func_Mix QGIS Project Edit View Layer Settings Plugins Vector Raster Web Mesh Processing Help || //. / 時代版+麗商米的目もは|| = 4. | = = 1. = 5. = 5. = 1. 🛆 🔍 🔞 🔮 | 🛃 | 🖬 | 🗐 🦛 📽 Vî 🌈 🖏 🎇 🕅 Layers ØX V Layer Exported: Successfully saved vector layer to D:\Manual\Buildings_points.shp Processing Toolbox Θ v 💉 এ 🔍 🌄 일 🗸 🗐 🖓 🍬 🔩 🕓 🖹 🐤 🔦 Valid output Q Centro • Invalid output Q Vector creation . Error output 0 👬 Generate points (pixel c... 2 — Roads_MC_Dambulla Renerate points (pixel c... ✓ • Buildings points Q Vector geometry Po 💭 Buildings_MC Centroids 97 97 Buildings_Fixed @ Point on surface ✓ DambullaMC Pole of inaccessibility Search QMS ßX Search string. Filter by extent All * Last used: Google Satellite Hybrid Add TMS details, report a prot Google Maps TMS details, report a prot Add Google Terrain Hybrid 2 Add TMS details, report a pro Georgia NAPR – aerial photos (greyscale) – 2000
 Add
 TMS details, report a problem OpenStreetMap TMS details, report a problem Add ll b 🐥 Fresh geodata for your project Q, Type to locate (Ctrl+K) Coordinate 80.6724,7.8872 🛞 Scale 1:84546 🔻 🔒 Magnifier 100% 💠 Rotation 0.0 ° 🗘 🗸 Render @EPSG:4326 📿
- This is the point layer of the building layer of the study area.

Figure 44 -Points layer of buildings

Step 05

Now before doing interpolation, we have to Code that building layer according to the above seven categories as below.

i. Open the attribute table of the point layer by right click on it.

ii. Create a new field (Step02-ii)

Name- code, Type=whole number>>OK

/ #		< D 🖸 🖌 🚍	🔊 🔩 🍸 🗷 🌸 !	₽ 16 16 11 11	E 6 Q			
1.2 latit	ude 💌 = E	1.2						
	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use	Func_Mix	
1	7.85619114000	80.6550586799	136.3840999999	0.8504	6MV2VM44+F2	Houses	Live	
2	7.85206145000	80.6558336100	36.78249999999	0.6816	6MV2VM24+R8	Hotel & Motel	Live	
3	7.85110933000	80.6540884599	32.8729999999	0.6997	6MV2VM23+CJ	Houses	Live	
4	7.85085545000	80.6550881000	147.866399999	0.861	6MV2VM24+82	Houses	Live	
5	7.85339178000	80.6546113800	130.150700000	0.683	6MV2VM33+9R	Houses	Live	
6	7.85503781000	80.6551788000	53.10029999999	0.7191	6MV2VM44+23	Houses	Live	
7	7.85654983000	80.6561935799	134.262499999	0.8141	6MV2VM44+JF8R	Houses	Live	
8	7.85304112000	80.6549067600	50.8556999999	0.8303	6MV2VM33+6X7J	Houses	Add Fie	ld X
9	7.85616451000	80.6544944999	33.06389999999	0.8186	6MV2VM43+FQ	Houses	I Aud Fie	~
10	7.85432756000	80.6541885599	29.4812000000	0.7381	6MV2VM33+P	Houses	Name	code
11	7.85541383000	80.6554347999	125.371399999	0.7582	6MV2VM44+55	Houses	Type	Whole number (integer 64 bit) 💌
12	7.85055452000	80.6554593000	161.790300000	0.6945	6MV2VM24+65	Houses	Provider type	integer64
13	7.85231165000	80.6546857999	81.6855000000	0.7742	6MV2VM23+W	Houses	Length	10 \$
14	7.85208745000	80.6563912900	54.6289999999	0.6915	6MV2VM24+RH	Houses		OK Cancel
15	7 85571889000	80.6556222899	22 5219999999	0.7201	6MV2VM44+76	Houses	Live	
16	7 95402092000	90.6559042000	20 2221000000	0.652	6MV2VM24+192V	Houses	Live	
17	7.05740041000	00.6560226200	46 500000000	0.052	6MU2VM444 - VD	Heuses	Live	
17	7.05740041000	00.0300230300	44.0502000000	0.00	CM0/2241/144+AP	Hauses	Live	
18	7.65579453000	00.0001276000	44.00029999999	0.8067	01111211144+836	nouses	Live	
19	7.85470836000	80.654/734899	180.3105999999	0.7881	6MV2VM33+V	Houses	Live	
20	7.85644683000	80.6552911600	119.544200000	0.7032	6MV2VM44+H4	Houses	Live	
21	7.85610235000	80.6543229499	93.2158000000	0.6882	6MV2VM43+CP	Houses	Live	
22	7.85464722000	80.6554732000	18.7348000000	0.6568	6MV2VM34+V5	Houses	Live	
23	7.85521685000	80.6546303599	38.9286000000	0.7342	6MV2VM43+3VJJ	Houses	Live	
Sho	7 OFF10C07000	00.0001010700	42.0412000000	0 7071	GAAV/31/8444-33	Houses	Line	

Figure 45-Add a new field for Code.

A code column is added.

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	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use	Func_Mix	code1
1	7.85619114000	80.6550586799	136.3840999999	0.8504	6MV2VM44+F2	Houses	Live	NULL
2	7.85206145000	80.6558336100	36.7824999999	0.6816	6MV2VM24+R8	Hotel & Motel	Live	NULL
3	7.85110933000	80.6540884599	32.87299999999	0.6997	6MV2VM23+CJ	Houses	Live	NULL
4	7.85085545000	80.6550881000	147.866399999	0.861	6MV2VM24+82	Houses	Live	NULL
5	7.85339178000	80.6546113800	130.150700000	0.683	6MV2VM33+9R	Houses	Live	NULL
6	7.85503781000	80.6551788000	53.10029999999	0.7191	6MV2VM44+23	Houses	Live	NULL
7	7.85654983000	80.6561935799	134.262499999	0.8141	6MV2VM44+JF8R	Houses	Live	NULL
8	7.85304112000	80.6549067600	50.8556999999	0.8303	6MV2VM33+6X7J	Houses	Live	NULL
9	7.85616451000	80.6544944999	33.0638999999	0.8186	6MV2VM43+FO	Houses	Live	NULL
10	7 85432756000	80 6541885599	29.4812000000	0.7381	6MV2VM33+P	Houses	Live	NULL
11	7 05541202000	00.6554247000	125 271200000	0.7501	6M//2//M44 : 55	Houses	Livo	NULL
	7.05341505000	00.0334347999	123.3713999999	0.7362	010102010144+55	Houses	Live	NOLL
12	7.85055452000	80.6554593000	161.790300000	0.6945	6MV2VM24+65	Houses	Live	NULL
13	7.85231165000	80.6546857999	81.6855000000	0.7742	6MV2VM23+W	Houses	Live	NULL
14	7.85208745000	80.6563912900	54.62899999999	0.6915	6MV2VM24+RH	. Houses	Live	NULL
15	7.85571889000	80.6556222899	22.5219999999	0.7201	6MV2VM44+76	Houses	Live	NULL
16	7.85402082000	80.6559043000	39.3331000000	0.652	6MV2VM34+J92X	Houses	Live	NULL
17	7.85748841000	80.6568236300	46.5989000000	0.73	6MV2VM44+XP	Houses	Live	NULL
18	7.85579453000	80.6551276000	44.85029999999	0.8067	6MV2VM44+836J	Houses	Live	NULL
19	7.85470836000	80.6547734899	180.3105999999	0.7881	6MV2VM33+V	Houses	Live	NULL
20	7.85644683000	80.6552911600	119.544200000	0.7032	6MV2VM44+H4	Houses	Live	NULL
21	7.85610235000	80.6543229499	93.2158000000	0.6882	6MV2VM43+CP	Houses	Live	NULL
22	7.85464722000	80.6554732000	18.7348000000	0.6568	6MV2VM34+V5	Houses	Live	NULL
23	7.85521685000	80.6546303599	38.9286000000	0.7342	6MV2VM43+3VJJ	Houses	Live	NULL
24	7 05510607000	00 655 10 10 700	42.0412000000	0 7071	GNAL/DL/NAAA - 22	Houses	Line	KIL IL I
III S	how All Features 🖕							

Figure 46 -Attribute table of building layer

ii. Code according to the functional mix.

Live-1 Work-2 Visit-3 Live&work-4 Live&Visit-5 Work&Visit-6 Live, Work&Visit-7

For that, first, select all buildings that are in the 'Live' category as below.

Open the attribute table>>click on 'Toggle editing tool'>>Click on 'select by expression tool'

		< 0 6 6	S 🔩 🕆 🗷 🕸 J) 🐔 🕷 🗶 📖	1 II II II II					
x-x la	titude 💌 = E	1.2							♥ Update All	Update Select
	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use	Func_Mix	code1		
25	7.85107831000	80.6568244500	67.6597000000	0.7953	6MV2VM24+CP	Houses	Live	NULL		
26	7.85251895000	80.6541520100	122.525400000	0.6593	6MV2VM33+2	Houses	Live	NULL		
7	7.85567823000	80.6558567099	45.2044000000	0.672	6MV2VM44+78	Houses	Live	NULL		
8	7.85331938000	80.6543232100	124.771500000	0.8675	6MV2VM33+8P	Houses	Live	NULL		
29	7.85513378000	80.6559758100	120.088800000	0.7023	6MV2VM44+3956	5 Houses	Live	NULL		
0	7.85342472000	80.6542519799	69.77729999999	0.8567	6MV2VM33+9P	Houses	Live	NULL		
1	7.85652515000	80.6552697099	24.91359999999	0.6914	6MV2VM44+J464	Houses	Live	NULL		
2	7.85486167000	80.6560456499	17.33719999999	0.7877	6MV2VM34+W	Houses	Live	NULL		
3	7.85674730000	80.6550186500	203.257499999	0.8274	6MV2VM44+M	Houses	Live	NULL		
4	7.85024230000	80.6547139300	70.0512999999	0.7297	6MV2VM23+3V	Houses	Live	NULL		
5	7.85266281000	80.6566257000	153.574199999	0.8722	6MV2VM34+3	Houses	Live	NULL		
6	7.85117014000	80.6548649100	61.9269000000	0.7445	6MV2VM23+F	Houses	Live	NULL		
7	7.85174639000	80.6542200899	161.783800000	0.8106	6MV2VM23+M	Warehouse	Live&Visit	NULL		
8	7.85434643000	80.6555913199	33.2137000000	0.8105	6MV2VM34+P6	Houses	Live	NULL		
9	7.85095080000	80.6568428399	106.8337999999	0.7625	6MV2VM24+9PP5	5 Houses	Live	NULL		
0	7.85265304000	80.6546712600	185.289400000	0.8612	6MV2VM33+3V	Houses	Live	NULL		
1	7.85229684000	80.6551989099	23.3590000000	0.7755	6MV2VM24+W	Houses	Live	NULL		
2	7.85239750000	80.6566889599	34.2029000000	0.686	6MV2VM24+X	Houses	Live	NULL		
3	7.85351830000	80.6559072099	207.840599999	0.8089	6MV2VM34+C93J	Houses	Live	NULL		
4	7.85254685000	80.6551038900	178.713500000	0.8748	6MV2VM34+22	Houses	Live	NULL		
5	7.85240665000	80.6540552299	122.135800000	0.7451	6MV2VM23+XJ79	Houses	Live	NULL		
5	7.85694640000	80.6551699700	38.3755999999	0.6802	6MV2VM44+Q3	Houses	Live	NULL		

Figure 47 - Toggle editing tool

• Extract the 'Fields and Values'>> Double click on the functional mix.

	Q Buildings_MC — Select by Expression X
	Expression Function Editor
1.3 isthuce * = E 1.2	Updat Al Update Solucid
labitude longitude area_in_me confidence full_plus_ Land_Lise Func_Mix code1	show values group held
25 7.85107031000. 60.5568244500. 67.559700000 9 Q Ruildings_MC - Select by hypersian X	Aggregates Double-click to add field name to expression
76 7.85251895000. 80.5511520100. 122.525400000 0 Parewin Function Editor	Arrays string. Color Right-Click on field name to open context menu
27 7.85567823000 80.8558567099 45.294400000	Conditionals
28 7.85331928000 80.6543232100 124.771500000 0 Aggregates	Conversions Notes
29 7.85513378000 80.6559758100 120.088800000 0 + Color	Date and Time Loading field values from WFS layers isn't
30 /253424/2000. 80.65425/9/PP. 49./7/299999. 0 Conditionals Conversions	Fields and Values Supported, before the layer is actually inserted, Nill is when building queries.
31 7.8565315000. 80.6555957099 240185999999 0 Date and Time	1.2 latitude
22 7.85466167000. 80.6560456499 17.3371999999 0 * Files and Faths	1.2 longitude
33 7.85674730000 80.6550186500 203.257499599 0 Picture and Picture an	1.2 area_in_me
44 7.85024230000. 80.6547139300. 70.0512995959. 0 * Map Layers	1.2 confidence
A 7.85266201000, 80.8566257000, 153.57/195999, 0 Math	abc full_plus_
56 7,05117011000_ 00,0510649100_ 61,926900000_ 0 * Operators	and Lang Use
27 7 85174639000 80.6562200989 161783800000 0 * Record and Attributes	Values Values Values Search
Kiring Kiring Visible Visible	abc Height All Unique 10 Samples
Technic an occupation of the second sec	abc L2
3/3 - Laboratesonom, exclusionaria, localas/sectors, o	abc Func_Mix
	abc Type
	abc Density
12 725/29/3000L 80.066629/99L 94.02/000000.	are Languise
43 7.85351830000 80.6559072099 207.840599999 0 Feature +	
44 7.85254685000. 80.6551038900. 178.71350000 0 Prevent	
45 7,8524066500 80,6540552299 122,135800000 0 Help 🔮 Solert Pentures 👻 gioree	= + - / + - / + - / = - Geometry
44 7.85694640000 80.65551659700 38.37555955599 0.6802 6MV2VM44-Q3 Houses Une NULL	Feature Map Layers
4/ 7.85323761000 80.6513076699 42.020095599 0.6985 6M/V2VM37-7P Houses Live AULL	Preview: Math
TRESONSTAND DOCESERSION TO PORCOMM ACTIVATION OF THE TELEVISION OF THE TELEVIS	
	Help Cose

Figure 49- Select by Expression

×

• Now it appears on the left side vacant space.

Click '='>>click on All Unique>>Double click on 'Live'>>select feachers>>close



Figure 50 - Select features

• Click on 'Show all features'>>click on Show selected features.

<u>x</u> x 19 C 15 6						
3.2 latitude = 2	5 1.2					
	king nude	anea in me	condence full plus	Land Use	Ture Mo	CODET
7,35615(1140)3	50.001010.000					
2 7250061450.0	L SILVESI SOLU	L 3K/3/400000.	UBSIE M/07/98/4488.	Hotel & Mobil		MAR.
3 7,8511093300	1. 80.6540584579	. 32.6729090990.	0.8997 8849298623+CL	Houses		MR.
4 7,8508354500	1. 80.6550581000	. 147.856390990.	0.861 87/72/0024182.			
5 7.8533917800	L. 80.6546113800	130.150700000	0.683 6M/V2VM33 (9R.	Houses		MUL.
6 7.8550378100	80.6551788000	. 53.1002599999	0.7191 6MV2VM44123.	Houses		
7 7.8565458300						
a 7.8530411200		. 50.8556999999				
0 7.8561645100						
10 7.8545275603			0.7381 MAV2VM33+P.,	Houses		
11 /056110000		125.3/1399998	0.7582 MW29M14+55.	Houses		
12 (150555500				Univer		
12 100101000						
15 74525110505			0.0000 00020020400			
14 7/10/10/4503	. 608553912903	. 5-02049494949	0.8515 8947298824+811	. Houses		
15 7,3557101603	L. 3018556722189	. 225219099900.	0.7201 M/029844+76.			
16 7.8540200200	1. 80.6559041000		0.652 8840298034+392			
1/ 7.8574884100	L. 80.6558735300	46.5959000000.	0.73 SM0290644+XP.	Houses	liw	18.2
10 7.8557945300	L. 80.6551276000	44,8502090990.	0.8067_6MV7VM44+836	Houses	Line	NO.
Show All leatures		90.310590999				
E Show Selected Fe	óures.	9.544200000.	0.7032 6MV2VM44 (H4.	Houses	the	MU2.
Show Features Vis	ble On Map	2158000000.	0.6582 6MV2VM43+CP.	Houses		MUL
Show Edited and I	lew Features	17348000000.	0.6568.00/02/0014+05.	Houses		
Field Filter	(acarrica)	1921(000000	0.72/2 (2002/04/2) 22/	Mounter		
* Stored Filter Expre	ssions	,				
Show All Features -						

Figure 51- Show selected features

Figure 52 - Show selected features

• Now we have to code them as '1'. For that, we can use an open-field calculator.

Tick on the Update existing field>> select the code as the field in which we want to enter the data>>type as "1">>OK

I only update 12410 selected features Create a new field Update existing field Output field name 123 code1 Output field name 123 code1 Output field name 10 \$ Precision 3 \$ Expression Function Editor I * Aggregates I * Aggregates I * Color Color Conditionals Conditionals Feeture Feature I * Preview: '1' Operators	Buildings_points — Field Calculator X
Create a new field Output field name Output field name Output field length 10 Precision 3 Expression Function Editor * 1* * 0 Search Show Help * 1* * 0 Search * 0 * 1* * 0 Search * 0 * 1* * 0 * 1* * 0 * 0 * 0 * 0 * 0 * 0 * 0 * 0 * 0 * 0 * 1* * 0 * 0 * 0 * 0 * 0 * 0 * 0 * 1*	Only update 12410 selected features
Create virtual field Output field name Output field length 10 + Precision 3 + Expression Function Editor	Create a new field Vpdate existing field
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Punction Editor Image: Constrained in the image: Const	utput field length 10 ♦ Precision 3 ♦
	<pre>chrome cancel canc</pre>

1.2 lati	itude 🔻 = E	1.2						
	latitude	longitude	area_in_me	confidence	full_plus_	Land_Use	Func_Mix	code1
1	7.85619114000	80.6550586799	136.3840999999	0.8504	6MV2VM44+F2	Houses	Live	
2	7.85206145000	80.6558336100	36.78249999999	0.6816	6MV2VM24+R8	Hotel & Motel	Live	
3	7.85110933000	80.6540884599			6MV2VM23+CJ			
4	7.85085545000	80.6550881000	147.866399999		6MV2VM24+82	Houses		
5	7.85339178000	80.6546113800	130.150700000		6MV2VM33+9R	Houses		
5	7.85503781000	80.6551788000	53.10029999999		6MV2VM44+23	Houses		
7	7.85654983000	80.6561935799	134.2624999999	0.8141	6MV2VM44+JF8R	Houses		
в	7.85304112000	80.6549067600	50.8556999999	0.8303	6MV2VM33+6X7J	Houses	Live	
9	7.85616451000	80.6544944999	33.0638999999	0.8186	6MV2VM43+FQ	Houses		
10	7.85432756000	80.6541885599	29.4812000000		6MV2VM33+P	Houses		
11	7.85541383000	80.6554347999	125.371399999	0.7582	6MV2VM44+55	Houses		
12	7.85055452000	80.6554593000	161.790300000	0.6945	6MV2VM24+65	Houses		
13	7.85231165000	80.6546857999	81.6855000000	0.7742	6MV2VM23+W	Houses	Live	
14	7.85208745000	80.6563912900	54.62899999999	0.6915	6MV2VM24+RH	Houses		
15	7.85571889000	80.6556222899	22.52199999999	0.7201	6MV2VM44+76	Houses		
16	7.85402082000	80.6559043000	39.3331000000	0.652	6MV2VM34+J92X	Houses		
17	7.85748841000	80.6568236300	46.5989000000		6MV2VM44+XP	Houses		
18	7.85579453000	80.6551276000	44.85029999999	0.8067	6MV2VM44+836J	Houses		
19	7.85470836000	80.6547734899	180.3105999999	0.7881	6MV2VM33+V	Houses		
20	7.85644683000	80.6552911600	119.544200000		6MV2VM44+H4	Houses		
21	7.85610235000	80.6543229499	93.2158000000	0.6882	6MV2VM43+CP	Houses		
22	7.85464722000	80.6554732000	18.7348000000	0.6568	6MV2VM34+V5	Houses		
23	7.85521685000	80.6546303599	38.9286000000		6MV2VM43+3VJJ	Houses		
	7.05510507000	00 5551010700	42.0412000000	0.7071	610/200444-22	Houses	Live	

• Now all buildings that are in the 'Live' Category are coded.

Figure 54 - Live Category

Following the above steps, we can code all buildings according to the functional mix.

Live-1	Live&Visit-5
Work-2	Work&Visit-6
Visit-3	Live, Work&Visit-7
Live&work-4	

Step 06:

Using the IDW interpolation tool, we can interpolate the above point layer.

For that, we can use the IDW interpolation tool in the processing toolbox.

I. Search the IDW interpolation tool in the processing toolbox.



Figure 55 -Select 'IDW Interpolation' tool

In IDW Interpolation window

i. Enter the point layer as the input layer.

- ii. The code column is the interpolated attribute.
- iii. Then press '+'

iv. Note- if these are to analyze the urbanity level of this area, we need to make sure that the

functional mix, space matrix, and space syntax layers all have the same pixel size.

v. Give a path for the output.

vi Run



Parameters	Log					IDW interpolation			
Vector lay	er Attribute	ly	pe		-	Constantes an Inverse Distance Weighted			
Buildi	ngs_Fi latitude	Po	Points			(IDW) interpolation of a point vector layer Sample points are weighted during interpolation such that the influence of or			
Distance coef	ficient P					point relative to another declines with distance from the unknown point you wa			
2.000000				\$		to create.			
Extent									
80.62094693	5,80.685412415,7.796	581086,7.91	5437296 [EPSG:4326]						
Output raster	size								
Rows	461	Columns	251						
Pixel size X	0.000258	Pixel size	Y 0.000258						
Interpolated									
[Save to tem	porary file]								
					•				
			00/			Concerned and the second secon			

Figure 56 - IDW Interpolation



This is the output.



Figure 58-Interpolated Output

Step 07

• Now, we have to reclassify this raster layer. For that,

Access the Processing Toolbox >> Search for the "Reclassify by Table" Tool.>>Double click on it



Figure 59 -Select 'Reclassify by table'

i. Enter interpolated layer as input layer>> Enter the maximum and minimum values according to the code which we created above using functional mix>> Give path for the Output.

Reclassify by Table	×					
Reclassify by lable Parameters Log Raster layer Interpolated (EFSC-4326) Band number Band 1 Reclassification table Frond table (6x2) Interpolated Parameters Reclassified raster Contempolate layer layer	Reclassify by table This doorthm reclassifies a raster bend by assignment das values based on the ranges specified in a fixed table.	Portocrifi / b	r Tabla			
Open output file after running algorithm		Parameters Reclassific		Reclassify by table This algorithm reclassifies a raster band		
Run as Batch Process Figure 60 - Reclassify	Cancel Run Close Help	Minim 1 0.5 2 1.5	um Maximum 1.5 2.5	Value 1 2	Add Row Remove Row(s) Remove All	by assigning new class values based on the ranges specified in a fixed table.
		3 2.54 3.5	3.5 4.5	3 4	OK Cancel	
		5 4.5 6 5.5	6.5	5	_	
		Run as Batch Pro	cess	0%		Cancel Run Close Help

Figure 61 -Reclassify by table

This is the output.



Figure 62 -Reclarified Output

Step 08

Now we have to clip this layer with the Dambulla MC layer to define the boundary. For that, it can be used 'Clip Raster by Mask Layer' In the Processing Toolbox panel.

• Go to processing toolbox>>search 'Clip raster by mask layer'



Figure 63 -Clip raster by Mask layer

• Enter Reclassed layer as input layer>>Give the Study area as Mask layer>>Run

Q Clip Raster by Mask Layer	
Parameters Log	
Input layer	
reclass_Landusemix [EPSG:4326]	▼
Mask layer	
DambullaMC [EPSG:4326]	- 🗘 🛶 📖
Selected features only	
Source CRS [optional]	
	▼
Target CRS [optional]	
Assign a specified nodata value to output bands [optional]	
Not set	
Create an output alpha band	
\checkmark Match the extent of the clipped raster to the extent of the mask lay	er
0%	Canc
Run as Batch Process	Run Close Help

Figure 64 – Clip Raster by Mask Layer

This is the output layer.

Figure 65 -Clipped Output

Step09

By right click on that clipped layer,

i. Go to layer properties and symbology.

Q Layer Properties -	– Clipped (mask) — Symbology						×			
Q	▼ Band Render	ring									
🥡 Information	Render type	ingleband gray									
🔏 Source	Gray band Band 1 (Gray)										
Symbology	Color gradient Black to White										
Transparency	Contrast and the second										
	enhancement	Stretch to MinMax						•			
🖌 Renderina											
Temporal											
Pvramids											
📄 Metadata											
	▶ Min / Max	Value Settings									
Ere QGIS Server											
							Legend Settings	s			
	▼ Layer Rende	ring									
	Blending mode	Normal	•				to Reset				
	Brightness			Contrast			0	•			
	Gamma		= 1.00	Saturation			0	\$			
	Invert color	s		Grayscale Off				-			
	Hue	Colorize Strength					100%	Ŷ			
	Resampling										
	Style 🔻				ОК	Cancel Ar	oply Help	p			

Figure 66 - layer properties

ii. Give Platted as render type.

Q Layer Properties –	– Clipped (mask	<) — Symbology	1								×
Q	■ Band Rend	Multiband color Paletted/Unique values									
(i) Information	Render type	Singleband gray	K i								
🍇 Source	Gray band	Singleband pseudocolor Hillshade									-
Symbology	Color gradien	Contours Min 1				Max 6					
Transparency	Contrast	Stretch to MinMax									•
📐 Histogram	ennancemenc										
🞸 Rendering											
🕓 Temporal											
🚵 Pyramids											
📝 Metadata	▶ Min / Max	Value Settings									
- Legend											
📲 QGIS Server											
										Logon	d Sottings
										Legen	u Settings
	▼ Layer Rende	ering									
	Blending mode	Normal			•						👆 Reset
	Brightness			0	-	Contrast				(0 🗘
	Gamma	-		1.00	•	Saturation			0	[0 \$
	Invert color	rs				Grayscale	Off				•
	Hue	Colorize	👻 Strength 드								100% 🤤
	Resampling										
	Style 🔻							ОК	Cancel	Apply	Help

Figure 67- Render type

iii. Give an appropriate color ramp.

Figure 68 - Color ramp.
When it classifies,



Figure 69 -Classifying

iv. Rename according to the above 7 categories.



Figure 70- Rename according to the above 7 categories.

This is the LandUse Mix in Dambulla MC. (Final output)



Figure 71 -Landuse mix in Dambulla MC

This is the final output in this analysis.



Functional Mix Map of Dambulla MC

Figure 72 -Functional Mix Map of Dambulla MC

4. PREPARATION OF MAPS

Use Suitable Colors & Symbols

Show adjacent administration boundaries.

Maximum utilization of map space

Show the Graticule Network with appropriate grid size.

Show the basic elements in the map.

Transportation Networks

Water Bodies

Prepare a descriptive map.

Check the units of the scale bar.

Mention correct units at the legend.

Check the text given in the legend.

Mention the correct sources.





AFTERWORD

In an era where urban sustainability and livability are central to planning discourse, understanding land use mix has never been more vital. This book offers more than just technical instruction—it provides a foundation for spatial thinking that supports balanced, inclusive, and vibrant urban development.

By guiding readers through GIS-based land use mix analysis, we hope to empower future planners, educators, and practitioners to make informed, evidencebased decisions. Let this guide inspire thoughtful application, continued learning, and innovation in shaping cities that are cohesive, walkable, and resilient.







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