

Ciências ULisboa

Faculdade de Ciências da Universidade de Lisboa







Sustainable Mobility





Information

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Turnos				
Turno	Semanas	Data	Sala	Turma(s)
PL21	1 - 7, 9 - 14	Qui, 09:00 — 12:00	3.1.10	1MEEA



World Business Council for Sustainable Development Sustainable Mobility Project 2.0 (SMP2.0) Indicators Work Stream - 2ndEdition



Mobility space usage

a Definition

Proportion of land use, taken by all city transport modes, including direct and indirect uses.

b Parameter

Square meters of direct and indirect mobility space usage per capita.

c Methodology description

➔ M4: Spatial analysis

The efficiency of mobility space usage is calculated by the ratio of the area covered by all city transport modes, including direct and indirect uses, to the total oppulation of the city. The space usage is preferably measured by using spatial data and GIS, calculating the overlap of the shape file area for city transport and the one of the total area. An alternative is using existing data.

d Formula & Calculation method

Efficiency of land use, taken by all city transport modes, including direct and indirect uses

 $LUM = \frac{\sum_{i} (LD_i + LI_i)}{Cap}$

LUM = Land use for mobility applications [m²] LD_i = Direct Land use for mobility mode i [m²] LI_i = Indirect Land use for mobility mode i [m²] i = Mobility mode(#)

Cap = Capita or number of inhabitants in the city [#]

Efficiency refers indirectly to mobility output by referencing total population.

Direct land use by city transport refers to the area covered by transport infrastructure such as roads and streets and squares used to move people and for vehicles (public areas excluding parks, playgrounds and sport terrains). Airports and sea ports are excluded, inland ports included.

Indirect land use by city transport refers to indirect uses such as off-street parking areas, security areas, service areas, stations, inland port hubs, storage areas and distributions centers for city freight transport. Some suggestions of land use for the calculation:

DIRECT Fast transit roads Other roads Railways Inland ports and water ways INDIRECT Open parking Private parking

Private parking Service area and petrol stations Storage and logistic centres Stations

e Source

Methodology The described methodology is based on information from the Victoria Transport Policy Institute (VPTI, "Evaluating Transportation Land Use Impacts", (2012), p. 11-16)

Data sources:

- Direct and indirect land use for mobility can be extracted from GIS maps (for parking this net land use has to be multiplied with the number of levels).



Land use for car traffic is almost the same amount as for housing (US; source: Litman). A minimum score of

g Notes

125 m² is chosen.

- Direct land use can also be calculated as a product of the total length of the infrastructure category (e.g. secondary roads) multiplied by a standard width per category.
- Indirect land use can also be based on the average unit surfaces for parking and service areas.



To calculate this indicator, we will use the power of QuickOSM (Quick OpenStreetMap) tool in Qgis.

Ciências ULisboa datapoints.) -

I will probably make this file available to you as this requires quite some computing power to download and load in qgis (raw data with millions of datapoints.) – If you are following this at home skip to slide 9.





You can try to use the QuickOSM tool yourself, or even download the already available OSM packages for AML and AMP on the internet. We will talk a little bit about it in class.

Still, since this requires quite some computational power, we will not use it for the final data, but we can tinker with it for smaller regions so you can learn.

Links that might be useful:

<u>https://learnosm.org/en/osm-data/osm-in-qgis/</u> <u>https://gis.stackexchange.com/questions/301221/downloading-road-</u> <u>map-of-specific-country-from-planet-osm-and-using-it-in-arcgis</u> <u>https://www.interline.io/osm/extracts/</u>



At this stage, we should have our OSM roads loaded and ready for the next steps.

Next steps: Let us focus on calculating how much space roads occupy. For this, we must know the span of a residential, primary, and tertiary road, etc.

fid	full_id	osm_id	osm_type	highway	junction	lanes	oneway
	w2954258	2954258	way	residential	NULL	NULL	no
	2 w3979151	3979151	way	residential	NULL	NULL	no
	8 w3979152	3979152	way	primary	NULL	1	no
	4 w3979153	3979153	way	residential	NULL	NULL	no
-	5 w3979154	3979154	way	residential	NULL	NULL	no
	5 w3979155	3979155	way	steps	NULL	NULL	NULL
	7 w3979156	3979156	way	residential	NULL	NULL	no
	3 w3979157	3979157	way	residential	NULL	NULL	no
-	w3979159	3979159	way	residential	NULL.	NULL	no
0 10	0 w3979160	3979160	way	primary	roundabout	NULL	NULL
1 11	w3979161	3979161	way	residential	NULL	NULL	no
2 12	2 w3979162	3979162	way	primary	NULL	1	yes
3 13	8 w3979163	3979163	way	primary	NULL	2	no
		2070164		recidential	NUUL	NUUL	

After we have an attribute which states how wide a road is (guesstimate based on the available data).



We can use that attribute to create a "buffer" which highlights the area it occupies.



Running the Tool "Statistics by categories" we can see every unique road trait we have. Since we only care about road infrastructure for transport mobility and so forth, we use another Tool "Select by expression" to remove unwanted data.

Q Statistics by Categories	×						
Parametars Log	Statistics by						
Input vector layer	categories						
V Geopackage_Roads_4_Students [EPSG:4326] 🔹 🖏	This algorithm calculates						
Selected features only	on the statistics of heids depending		Contraction of the second		and the second	A state of the sta	12110
Field to calculate statistics on (if empty, only count is calculated) [optional]	Layers 0 ≈ ≪	7.1.		S.A.	1	B. B. B.	c=t.7
abc highway	Statistics by category	Q Statistics by cate	gory — Features Total:	17, Filtered: 17, Selected: ()	7	
Field(s) with categories	✓ — Geopackage_Roads_4_Students	/ # H 14 8 14 8 1					
highway .	✓ — Clean_Roads_layer	highway	count	unique emp	ty	filled min	max
Statistics by category	- OSM Roads	1 residential	91946	1	0	91946 residential	residential
[Create temporary layer]	CountingPoints	2 primary	8808	1	0	8808 primary	primary
Open output me arter running algorithm	👻 🗸 🚰 OpenStreetMap	3 trunk	1747	1	0	1747 trunk	trunk
		4 motorway_link	2646	1	0	2646 motorway_link	motorway_link
		5 unclassified	10731	1	0	10731 unclassified	unclassified
		6 tertiary	12756	1	0	12756 tertiary	tertiary
		7 pedestrian	2858	1	0	2858 pedestrian	pedestrian
		8 service	36602	1	0	36602 service	service
		9 motorway	3266	1	0	3266 motorway	motorway
		10 trunk_link	1154	1	0	1154 trunk_link	trunk_link
AM		11 secondary	7766	1	0	7766 secondary	secondary
U%		12 secondary_link	788	1	0	788 secondary_link	secondary_link
surgranes · nur es decer rickess		13 primary_link	1264	1	0	1264 primary_link	primary_link
		14 tertiary_link	905	1	0	905 tertiary_link	tertiary_link
		15 living_street	1531	1	0	1531 living_street	living_street
		16 construction	264	1	0	264 construction	construction
		17 cycleway	1283	1	0	1283 cycleway	cycleway

Our job is now to attribute "weight", meaning, a width, to each of these highway categories



Considering the following table:

Nível		1º Nível	2º Nível	3º Nível	4º Nível	5° Nível
Designação		Rede estruturante	Rede de Distribuição Principal	Rede de Distribuição Secundária	Rede de Proximidade	Rede de Acesso Local
Objectivos		Suporte a percursos de longa distância	Distribuição inter e intra setores	Distribuição de proximidade	Distribuição no bairro	Proteção e incentivo do modo pedonal e ciclável
Características	Número de sentidos	2	2	1 ou 2	1 ou 2	1 ou 2
Físicas	Número mínimo de vias com 1 sentido de circulação	-	-	2	1	1
	Número mínimo de vias com 2 sentidos de circulação	3 + 3	2 * 2	1 + 1	1 + 1	1+1
	Separação física dos sentidos de circulação	Obrigatória	Desejável	Facultativa	A evitar	Proibida
	Largura mínima das vias (m)	3,25	3,00	3,00	3,00	3,00
	Largura mínima das bermas lado direito (m)	2,50 (em vias novas)	-	-	-	-
	Largura mínima das bermas lado esquerdo (m)	0,50	-	-	-	-
	Largura mínima dos passeios em arruamentos existentes (m)	-	1,50	1,50	1,20	1,20
	Largura mínima dos passeios em novos arruamentos (m)	-	3,00	3,00	3,00	3,00

Figure 1. Taken from CML Public Space Manual

And our clean data (This file is available In Fenix "Clean_roads_4 students):

	highway	count "	' unique	empty		filled	min	max
1	residential	9194	6	1	0	91946	residential	residential
2	service	3660	2	1	0	36602	service	service
3	tertiary	1275	6	1	0	12756	tertiary	tertiary
4	unclassified	1073	1	1	0	10731	unclassified	unclassified
5	primary	880	8	1	0	8088	primary	primary
6	secondary	776	6	1	0	7766	secondary	secondary
7	motorway	326	6	1	0	3266	motorway	motorway
8	pedestrian	285	8	1	0	2858	pedestrian	pedestrian
9	motorway_link	264	6	1	0	2646	motorway_link	motorway_link
10	trunk	174	7	1	0	1747	trunk	trunk
11	living_street	153	1	1	0	1531	living_street	living_street
12	cycleway	128	3	1	0	1283	cycleway	cycleway
13	primary_link	126	4	1	0	1264	primary_link	primary_link
14	trunk_link	115	4	1	0	1154	trunk_link	trunk_link
15	tertiary_link	90	5	1	0	905	tertiary_link	tertiary_link
16	secondary_link	78	8	1	0	788	secondary_link	secondary_link
17	construction	26	4	1	0	264	construction	construction

We must devise a way to attribute appropriate widths to all these different roads.



OSM nomenclature partially helps solve our problems:

https://wiki.openstreetmap.org/wiki/Key:highway

The CML guide helps us complement this information:

https://www.lisboa.pt/fileadmin/cidade_temas/urbanismo/espaco_ publico/Manual_espaco_publico.pdf

(It is in "Espaços de Circulação rodoviária".

Nível		1º Nível	2º Nível	3° Nível	4º Nível	5° Nível
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	Número mínimo de vias com 2 sentidos de circulação	3 + 3	2 * 2	1 + 1	1 * 1	1 + 1
	Separação física dos sentidos de circulação	Obrigatória	Desejável	Facultativa	A evitar	Proibida
	Largura mínima das vias (m)	3,25	3,00	3,00	3,00	3,00
	Largura mínima das bermas lado direito (m)	2,50 (em vias novas)	-	-	-	-
	Largura mínima das bermas lado esquerdo (m)	0,50	-	-	-	-
	Largura mínima dos passeios em arruamentos existentes (m)	-	1,50	1,50	1,20	1,20
	Largura mínima dos passeios em novos arruamentos (m)	-	3,00	3,00	3,00	3,00

Cheats and assumptions for the class:

Motorways and motorway links can be interpreted as 3.25m for each lane + 0.5 kerb width. The rest of the roads we will assume 3m for each lane with no kerb width.



Thus, during the class we did the following:

We separated the motorway and motorway_link from the rest of the roads with select or extract by expression and then, through the attribute field calculator we created a new column called "new_width" using the code:

CASE

WHEN "width" IS NOT null THEN width WHEN "lanes" IS NOT null THEN lanes*3.25+0.5 WHEN "oneway" IS null THEN 3.25*2+1 WHEN "oneway" IS 'yes' THEN 3.25+0.5 WHEN "oneway" IS 'no' THEN 3.25*2+1 END

This type of rough approximation can result in some motorways being accurately represented just as it can result in gross misrepresentations of the real width. Tinker with these values and justify your approach.



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The code for the new width column for the rest of the roads differs in the following way:

Ciências _{CASE} WHEN "width" IS NOT null THEN width WHEN "lanes" IS NOT null THEN lanes*3 WHEN "oneway" IS null THEN 3*2 WHEN "oneway" IS 'yes' THEN 3 WHEN "oneway" IS 'no' THEN 3*2 END

The interpretation is the following: When we have a value in the column width, we use that value. If we do not, we then attempt to use the lanes column to devise a width value by multiplying it by the CML "reference" for the lane width. When we do not have such values, we the attempt to at least characterize the street as being one-way or two-way and assume that if it is two-way, then we multiply by 2 (two-lanes of traffic). If we do not have any value, we assume it is a two-way street.

All these assumptions can be tinkered with. We will leave you to justify your approach in the presentation. It is incentivized to try different things.



Make sure you are using ETRS89 / PORTUGAL TM06 before running the mmqgis buffer







After creating our buffers for both motorways and nonmotorways layers, we need to merge them and separate them by AML and AMP. There are several ways to do it, here we propose:

Use your original unaltered CAOP_fix (Fenix), which contains both AMP and AML and let us separate them so we can do the indicator for both AML and AMP.



Encompass the whole AML



Save the selected polygons from this layer to a new layer by saving selected features as. You have isolated AML into a single layer.

Do the same for AMP.





Next, merge your buffers to simplify the process of clipping.

Q Merge Vector Layers		
Parameters Log Input layers		Merge vector layers
AML_CAOP (EPSG:3763) AMLONLY (EPSG:3763)	Select All Clear Selection	This algorithm combines multiple vector layers of the same geometry type into a single one.
AMP_CAOP [EPS0:3763] ✓ buffer_Motorway [EPSG:4326] ✓ Buffer_no_motorway [EPSG:4326]	Toggle Selection Add File(s)	The attribute table of the resulting layer will contain the fields from all input
CountingPoints [EPSG:3763]	Add Directory	layers. If fields with the same name but different types are found then the
		automatically converted into a string type field. New fields storing the original layer name and source are also added. If any input layers contain Z or M values, then the output layer will also contain these values. Similarly, if any of the input layers are multi- part, the output layer will also be a multi-part layer. Optionally, the destination coordinate reference system (CRS) for the merged layer can be set. If it is not set, the CRS will be taken from the first input layer. all layers will
0%		Canc
Advanced 💌 Run as Batch Process		Run Close Help



Clipping:



We only want AML for now (repeat for AMP, same steps).

	Q Clip		×
This means: We want all the buffer points which are contained in the AML_CAOP layer only.	Clip Parameters Log Input layer Buffer_all [EPSG:4326] Selected features only Overlay layer Overlay layer AML_CAOP [EPSG:3763] Selected features only Clipped [Create temporary layer] ✓ ✓ Open output file after running algorithm	 ج (ئ ج 	Clip Inis algorithm clips a vector an additional polygon layer, of the Overlay layer will be added to the resulting bayer. The attributes of the features in the Input layer that fall within the polygons of the Overlay layer will be added to the resulting bayer.
	0% Advanced V Run as Batch Process		Cancel Run Close Help

18



Now that we have AML and AMP only, we will calculate the areas of the buffer in these districts.

To calculate the buffer areas, we use our trusted field calculator in the attribute fields (we did not do this step in class, I would advise to do so just in case and then confirm the value with the next slide.):

2 7 7 8 0 9 1.2 fid vidth	- Ε 1.2 junction	VIA I	1 X U 3 C 4		Decian	
vidth	junction				Ideas	
1	junction	laner	append with PAIO with laws	Update All Update Selected	Designer	
2	NOLL	2	Q Buffer_AML — Field Cakulator	paur Area_occup		×
	NULL	NULL	Only under a selected feature(c)			
	NULL	1	✓ Create a new field Update existing field			
	NULL NULL		Create virtual field			
4	INLAL C	1	Output field name area 1			
5	NULL	1	Output field length 6 5 Precision 3	e the output fie	eld type is decir	mal
6	NULL	1	Eventerion Eventua Editor			
7	NULL	NULL		0.0	-	1
8	NULL	3	Carea	v, an	ed ead Show Help	Returns the area of the current feature. The area
9	NULL	NULL		- 116	123 Area_occup	calculated by this function respects both the current project's ellipsoid setting and area unit settings. For
10	NULL	2		* Ge	ometry Sarea	example, if an ellipsoid has been set for the project then the calculated area will be ellipsoidal, and if no ellipsoid is
11	NULL	2			area	set then the calculated area will be planimetric.
12	NULL	3			torce_thr simplify_vw	Sarca
13	NULL	1		- LF	Tools	Examples
14	NULL	1	1	+ Mar	riables	 Sazea → 42
15	NULL	2	1	- Re	project_area_units cent (fieldcalc)	
16	NULL	2	1		"Area" * 10^(-6)	
17	NULL	2	1		Sarea	
18	NULL	1			Sarea "Freguesias_pop" / "Area_Freg"	
19	NULL	NULL			"Freguesias_ALL_pop_pop" / "Area"	
20	NULL	ANT N F			rieguesias_nec_pop_pop / { ne	
20	ATTAL	IVILL.				
41	ALCOLD STREET	-				
4	INDILL.	3				
Show All Feet	ures _w					

Run and now you should have a new field added to the table with the area that the AML buffer occupies. (Do the same for AMP obviously.)



1. Use the field calculator to sum these areas.

View > Statistical summary



Statistics			88
Buffer_AML			
1.2 area		Ŧ	3
Statistic	Value		
Count	105826		

Sum	188.977
Mean	0.00178573
Median	0.001
St dev (pop)	0.0037656
St dev (sample)	0.00376561
Minimum	0
Maximum	0.208
Range	0.208
Minority	0.064

0.001

Maiority

This number should be bigger than the one seen here (which is in km2). You should keep it in m2 like you did in class for the indicator Landusage/capita – m2/capita. 2. Lastly, using the scale highlighted below, convert the sum of both motorway+ motorway_links + the remaining roads m2 land usage by the population (for AML and AMP respectively).

Mobility space usage

a Definition

Proportion of land use, taken by all city transport modes, including direct and indirect uses.

b Parameter Square meters of direct and indirect mobility

space usage per capita.

c Methodology description

→ M4: Spatial analysis The efficiency of mobility space usage is calculated by the ratio of the area covered by all city transport modes, including direct and indirect uses, to the total population of the city. The space usage is preferably measured by using spatial data and GIS, calculating the overlap of the shape life area for city transport and the one of the total area. An attemative is using existing data.

d Formula & Calculation method

Efficiency of land use, taken by all city transport modes, including direct and indirect uses



 $\begin{array}{l} \text{LUM} = \text{Land use for mobility applications } \left[m^2 \right] \\ \text{LD}_i = \text{Direct Land use for mobility mode } \left[m^2 \right] \\ \text{Li}_i = \text{Indirect Land use for mobility mode } \left[m^2 \right] \\ \text{i} = \text{Mobility mode } i \end{array}$

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Land use for car traffic is almost the same amount as for housing (US; source: Litman). A minimum score of 125 m² is chosen.

g Notes

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- Indirect land use can also be based on the average unit surfaces for parking and service areas.



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