

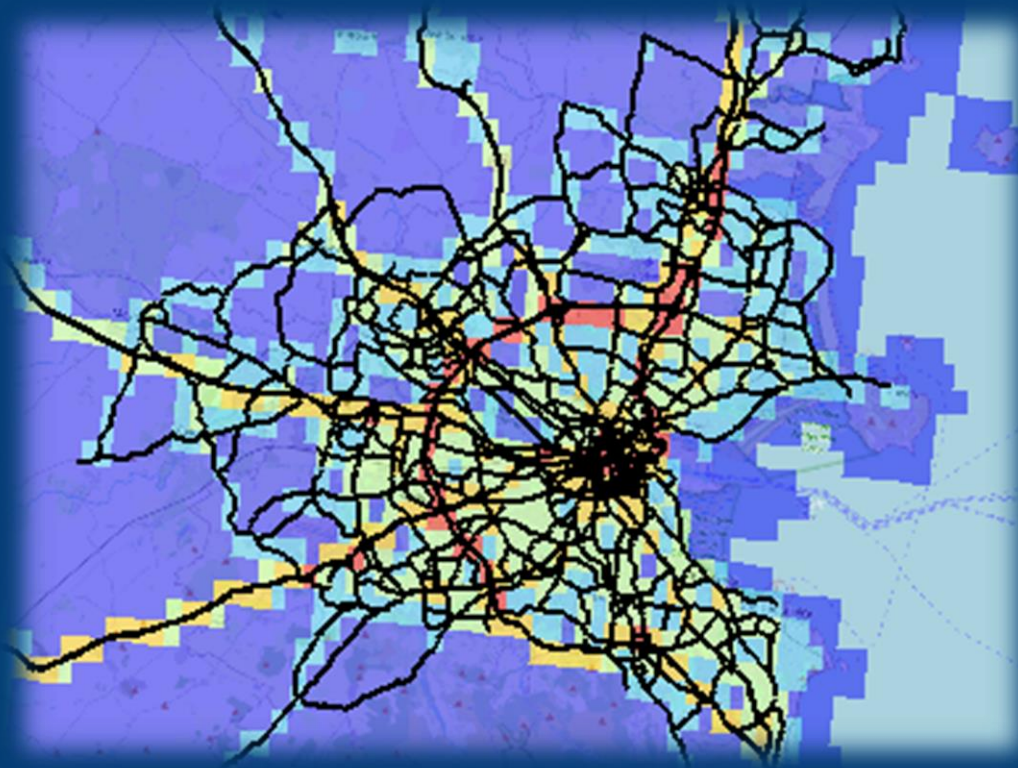
Street-scale emissions inventory for Ireland

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ADMS-Urban & ADMS-Roads User Group Meeting

30 November 2023

York



Introduction

A street scale emissions inventory was created for the Republic of Ireland for the emission year 2019. **Motivation:** for regional-to-local scale modelling of Ireland (ADMS-Urban coupled to a regional model).

- The street scale inventory consisted of:
 - Gridded emissions
 - Point sources
 - Road traffic emissions
- This talk describes the processing for each emission type in turn
- Contributors:
 - Irish EPA
 - National Transport Authority
 - Transport Infrastructure Ireland (TII)
 - Aarhus University



EMIT inventory showing gridded emission groups

EMIT Inventory - MapEire_EMEP_E.MDB, Inventory: Map Eire data by SNAP Sector

Name: Map Eire data by SNAP Sector
Description: Import from EMEP lat-long by sector, export in polar stereographic 3D

Inventory Totals
Last recalculated on: 03/11/2022 09:24:08
Buttons: Calculate, View Totals, Export Totals
Inventory totals out of date
Aggregate for export to ADMS-Urban

Groups

Group	Source Type	Emission Factors	Year	Recalc	Changed
SNAP1	CANDD		2019	Y	Y
SNAP10	CANDD		2019	Y	Y
SNAP11	CANDD		2019	Y	N
SNAP2	CANDD		2019	Y	Y
SNAP3	CANDD		2019	Y	Y
SNAP5	CANDD		2019	Y	Y
SNAP6	CANDD		2019	Y	Y
SNAP7	CANDD		2019	Y	Y
SNAP8	CANDD		2019	Y	Y
SNAP9	CANDD		2019	Y	Y

Buttons: Add..., Remove..., Export Group..., Modify Group..., Open Group, Close, Cancel, Apply, Inventory Properties...

List of inventory contents

MapEire – grid source emission inventory for Eire

GNFR to SNAP mapping

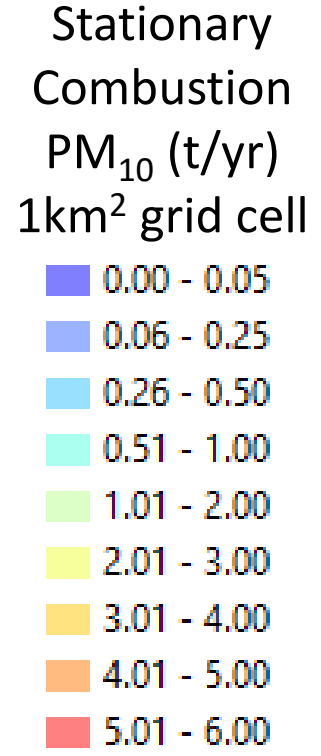
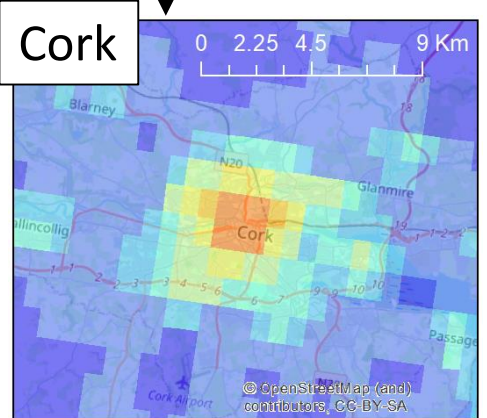
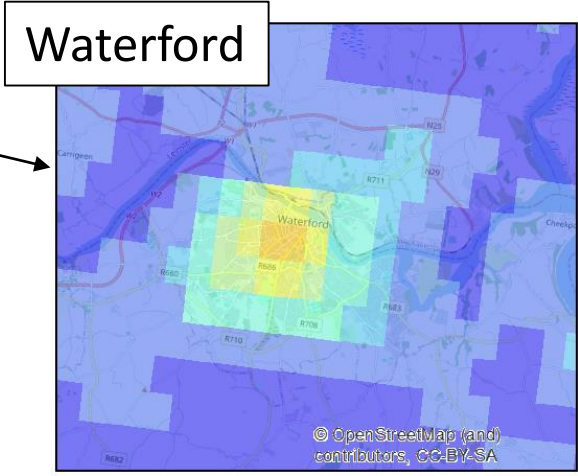
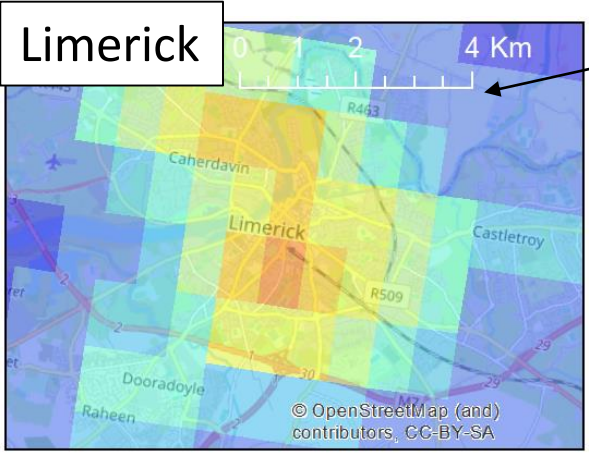
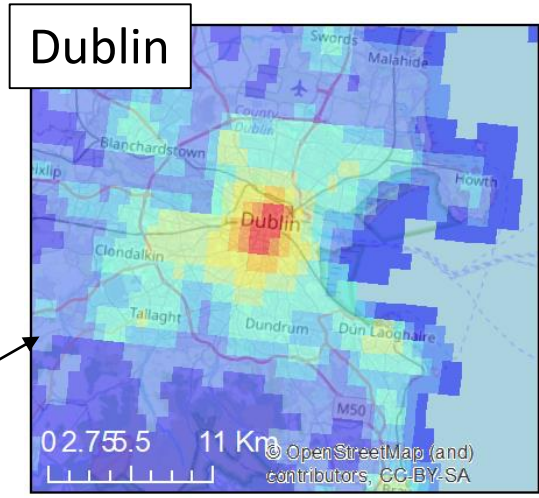
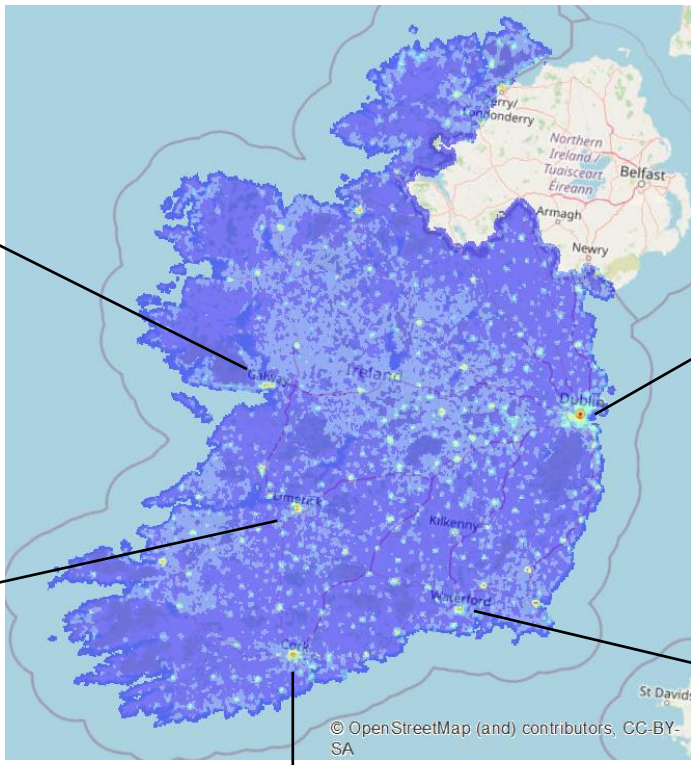
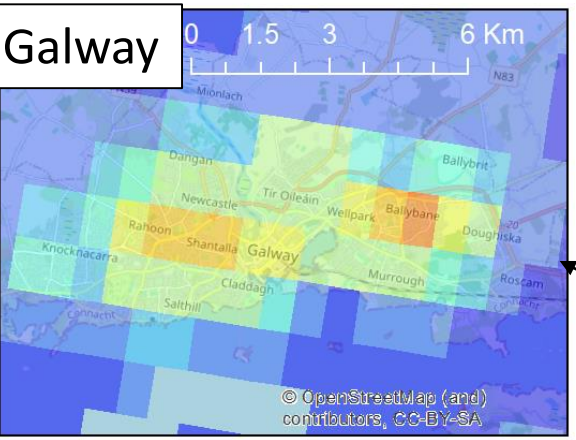
GNFR (MapEire category)		SNAP (EMEP category)	
ID	Sector	ID	Sector
A	Public power	1	Combustion in energy production and transformation
C	Other stationary combustion	2	Combustion in commercial, institutional, residential and agriculture
B	Industry	3	Combustion in industry
-	-	4	Production Processes
D	Fugitive	5	Extraction and distribution of fossil fuels
E	Solvents	6	Solvent use
F	Road transport	7	Road transport
G	Shipping (domestic and international)	8	Other transport and mobile machinery
H	Aviation (domestic and international)		
I	Off road transport		
J	Waste	9	Waste treatment and disposal
K	Agriculture (livestock)	10	Agriculture, forestry and land use change
L	Agriculture (other)		
Q	Land use change and forestry		
N	Natural	11	Nature
O	Aviation cruise	-	Emissions from the cruise phase of flights. These emissions are allocated evenly over the Irish grid and do not represent release location. They are assumed to be released at heights which do not directly affect near-ground air quality.
P	International shipping	-	International shipping emissions allocated to Ireland. The EMEP model uses a different dataset for international shipping emissions.

The **MapEire** project funded by Irish EPA and carried out by the Department of Environmental Science (ENVS) at Aarhus University (AU), created inventories for 2015, 2016 & 2019

- 2019 data used for this study
- Ireland covered at 1 km² resolution using the TM65 Irish Grid coordinate system
- 138 NFR (Nomenclature For Reporting) source sectors and 32 pollutants
- 138 NFR sectors assigned to 16 aggregated GNFR (Gridded Nomenclature for Reporting) sectors

GNFR sectors assigned to SNAP sectors and coordinates changed to enable coupling to EMEP later

Example MapElre emissions – Commercial & residential combustion

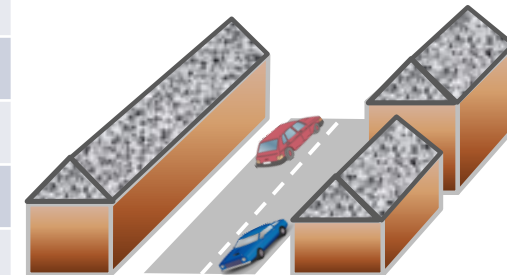
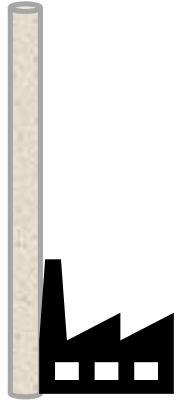


Irish EPA currently looking at improvements to the residential solid fuel inventory under the LIFE Emerald project.

Vertical profiles input into EMIT

- 3D grids are necessary in the coupled system, and optional in ADMS-Urban as a stand alone model
- The table shows the percentage of emissions in each group attributed to each height
- Vertical heights consistent with EMEP, except an extra layer at the surface*, and merged upper heights
- The heights represent effective heights, i.e. release height plus buoyancy effects

Height (m)	Energy Production	Stationary Combustion	Industrial Combustion	Production Processes	Fossil Fuels	Solvents	Road Transport	Other Transport	Waste	Agriculture	Nature
324 - 1106	85								2		
184 - 324	14.75		3	10	30				57		
92 - 184	0.25		75	70	60				41		
45 - 92			16	15	8						
10 - 45			6	5	2			100			
0 - 10		100				100	100			100	100



* The coupled system modelling used 2 sets of 3D grids: one with heights consistent with EMEP for grid source only runs; a second with two vertical grid cells between 0 and 45 m to improve the representation of surface emissions.

Major Industrial Point Sources

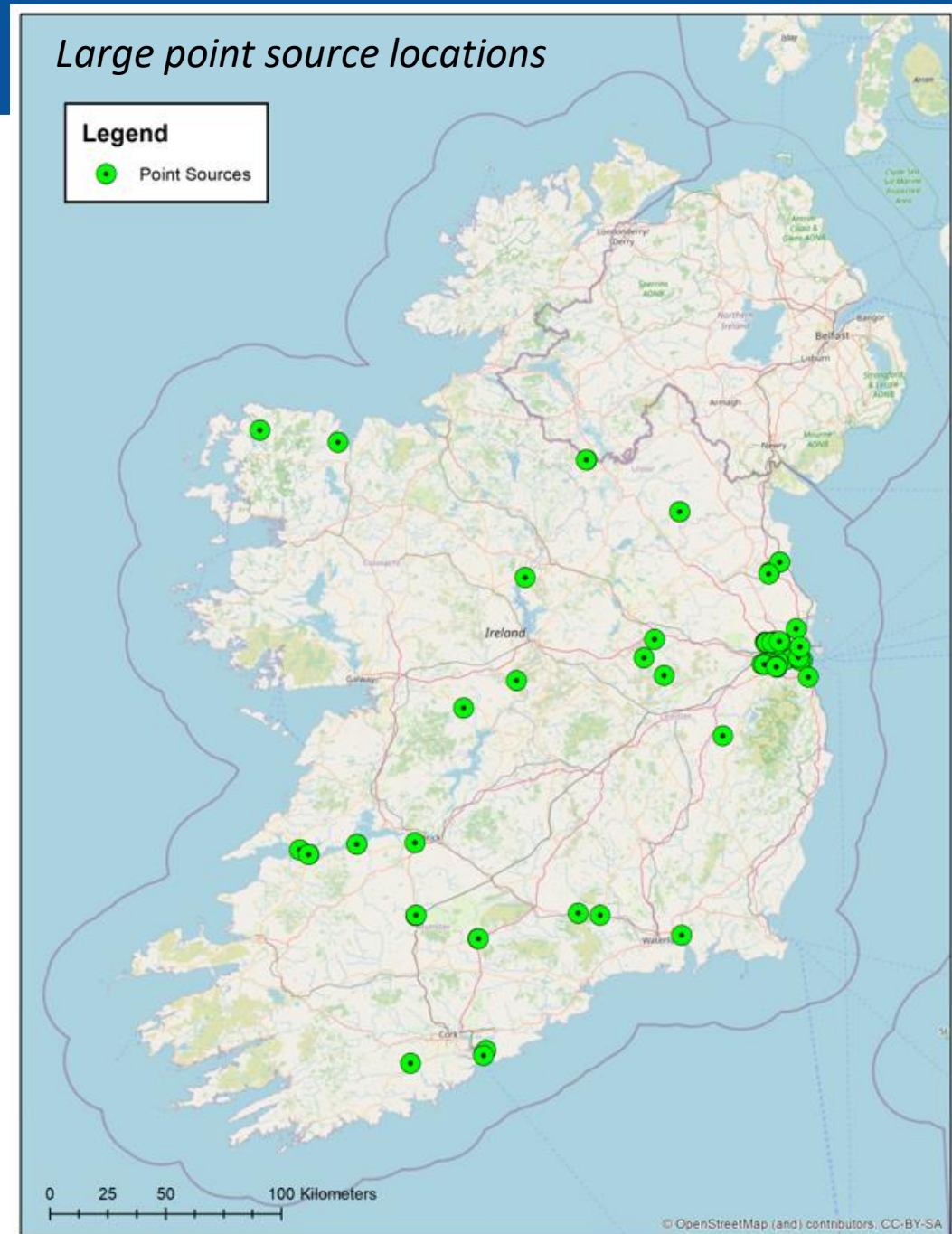
Irish EPA provided:

- 2019 national industrial emission point sources
- The industrial emission monitoring reports

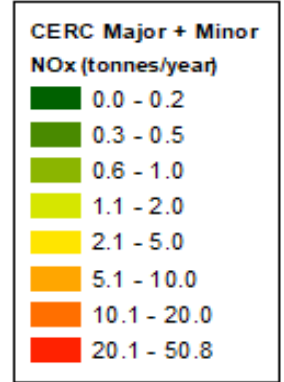
The source types cover power generation and large industrial processes such as quarries, food production and chemical production.

Point source emissions already included in the MapElre grid sources.

Be careful not to double count emissions in EMIT!

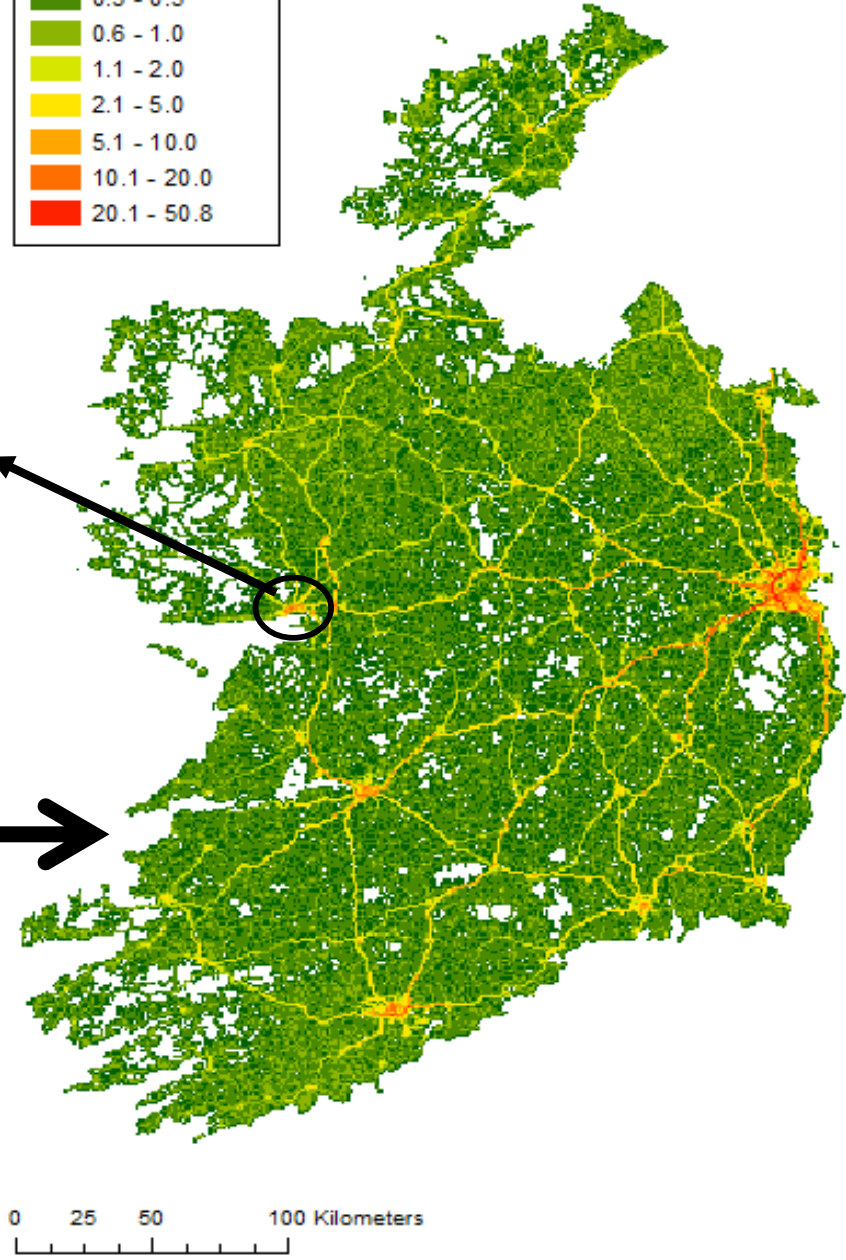
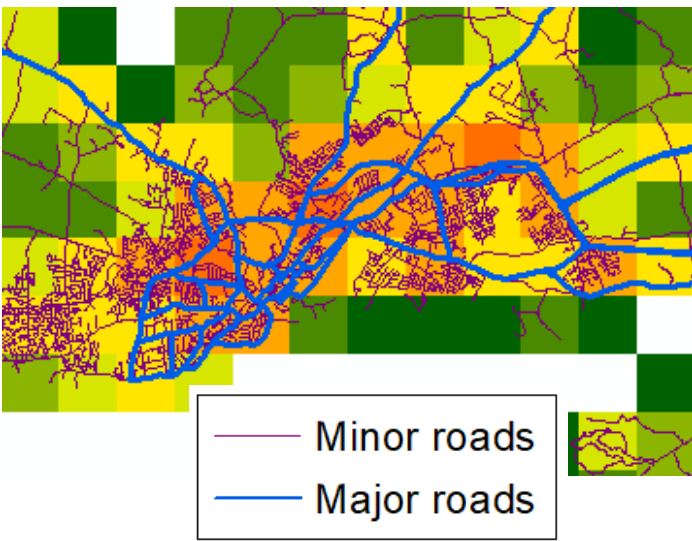
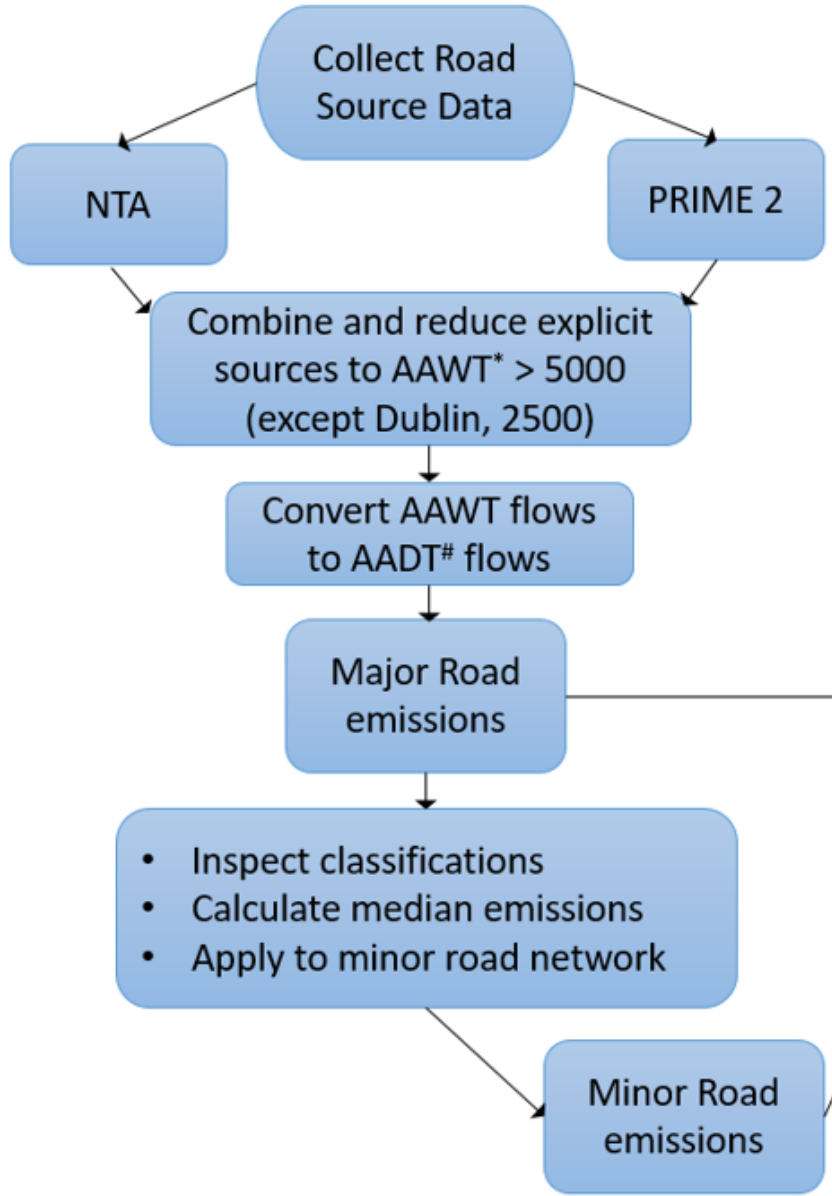


Road source emissions



1km² major + minor NOx emissions

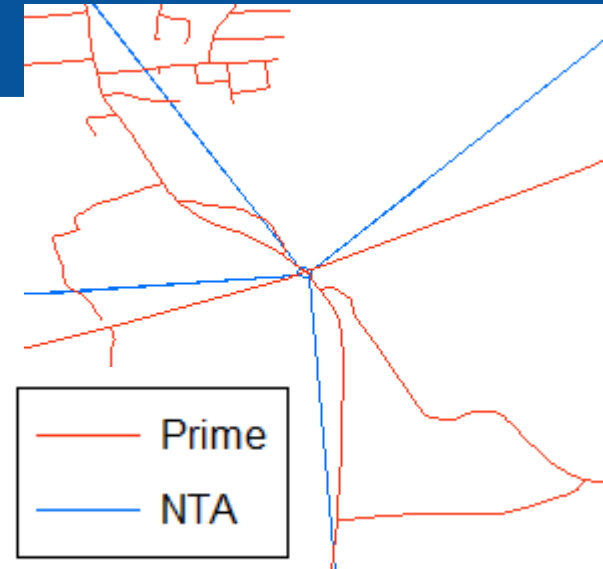
Road emissions methodology



Major road data sources

National Transport Authority dataset (NTA)

- Strategic road network with AM, IP, PM flow information – calculate AAWT & average speed for each traffic type
- Each road assigned to 1 of 5 regions, with an individual main city
- Straight line geometries in IRENET 95 coordinates



Prime2 (similar to OS Mastermap products in UK)

- Infrastructure geodatabase for Ireland including road locations with real-world geometries & buildings in WGS 84 coordinates
- NTA managed the mapping of the flows to the geometries
- Data includes FORM and FUNCTION fields, used to assign initial approximation of road width (later constrained to street canyon widths), also minor road emissions

Five Cities Demand Management Study

- Raw traffic data within each city
- Data includes fuel, engine size and year of manufacture of vehicle
- Used to derive route types for each of the 5 regions

Minor road source emissions

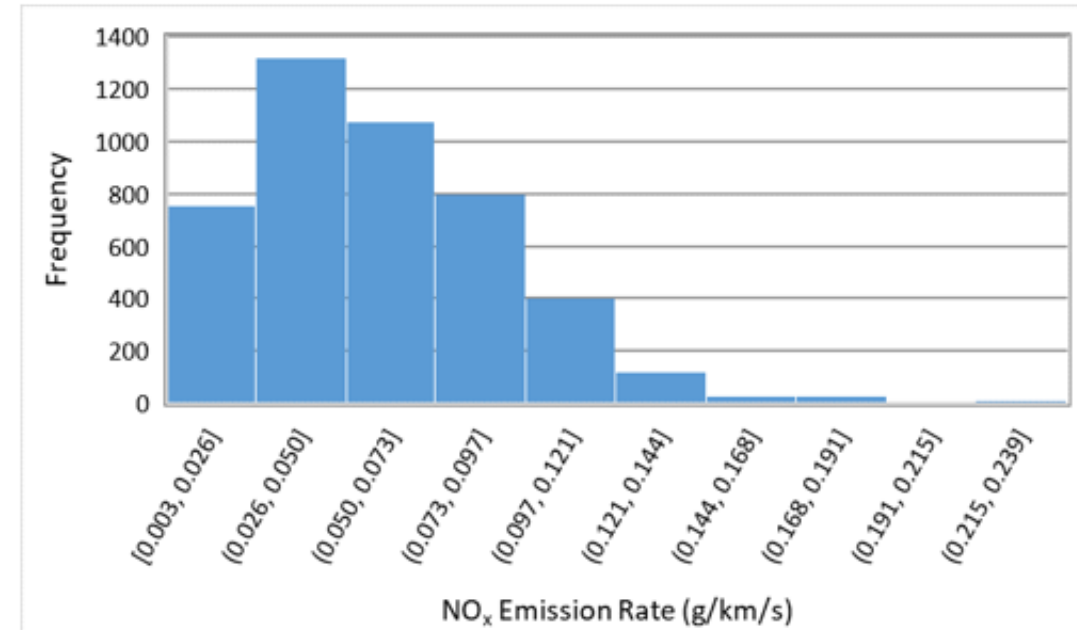
Starting point:

- Minor road Prime2 geometry with FORM and FUNCTION, but no flow data
- Major road emission estimates

Major road FORM and FUNCTION combinations

FORM_FUNC	FORM	FUNC
122_266	Dual Carriageway	Main Road
122_409	Dual Carriageway	Second Class
246_266	Motorway	Main Road
330_409	Roundabout	Second Class
330_266	Roundabout	Main Road
330_179	Roundabout	First Class
330_475	Roundabout	Third Class
362_409	Single Carriageway	Second Class
362_475	Single Carriageway	Third Class
362_179	Single Carriageway	First Class
362_266	Single Carriageway	Main Road
362_191	Single Carriageway	Fourth Class
362_659	Single Carriageway	Motorway Slip Road
362_661	Single Carriageway	National Road Slip Road

Inspection of NO_x emission ranges for a single grouping
Single Carriageway, Second Class



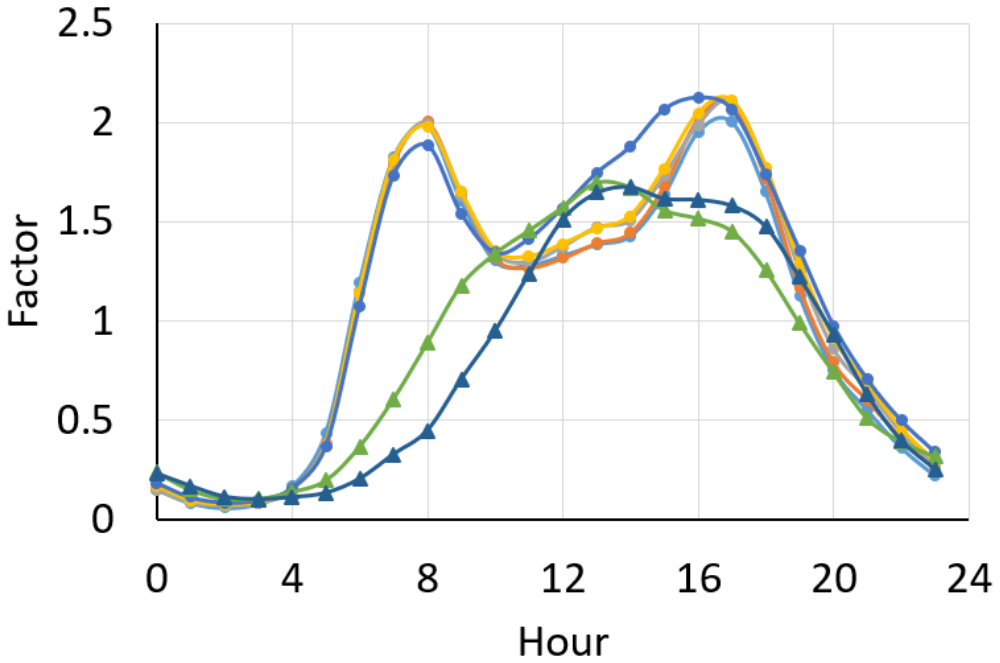
Method

- Look at range of major road emissions by FORM & FUNCTION
- Calculate median emission rate for each class combination
- Apply to minor road network
- Aggregate emissions onto 1km² grid cells
- Sanity check – compare to MapElre data

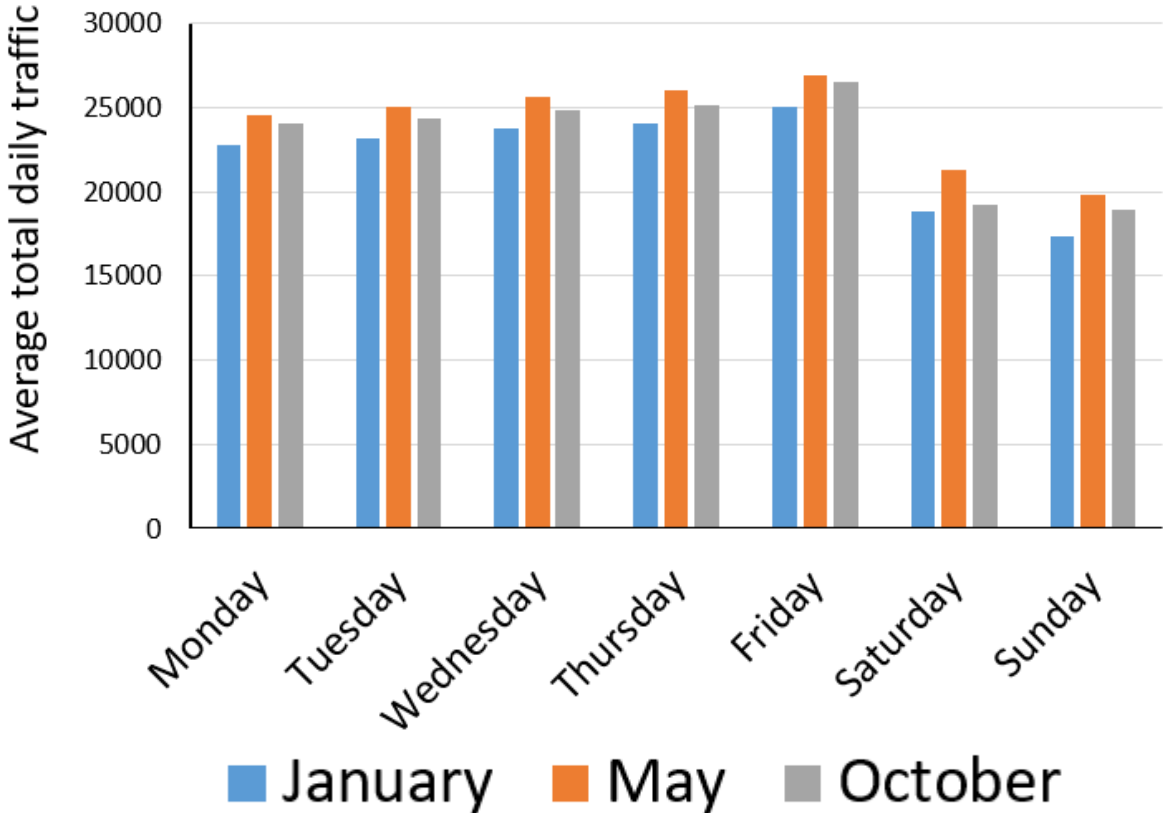
Diurnal profiles for road transport

All Transport Infrastructure Ireland (TII) 24-hour traffic monitoring data for 2019 was used to create diurnal profiles for road transport, and also the AAWT to AADT factors. 3 time periods were inspected which represented term time conditions. 3 time periods were inspected which represented term time conditions.

Diurnal road emission variations



Road emission variation by day of week and month



End point

Output from EMIT:

1. A 3D grid of total emissions with varying emissions for each hour of the year – netCDF format
2. Explicit major road emissions and characteristics – spt format

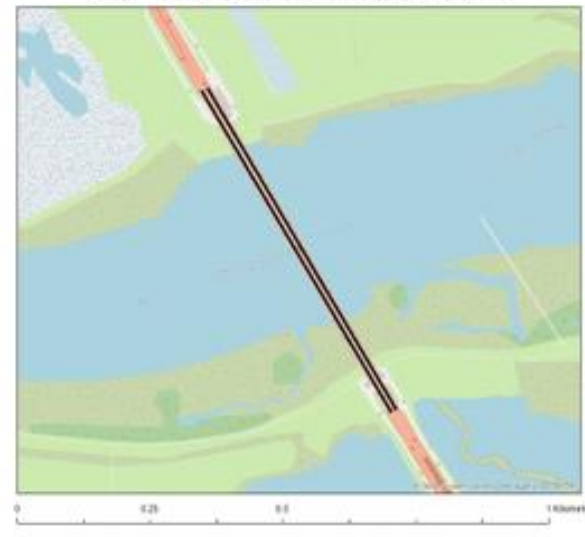
Additional model input created:

1. Advanced canyon file
2. Tunnel definitions
3. Time variation (.fac) file

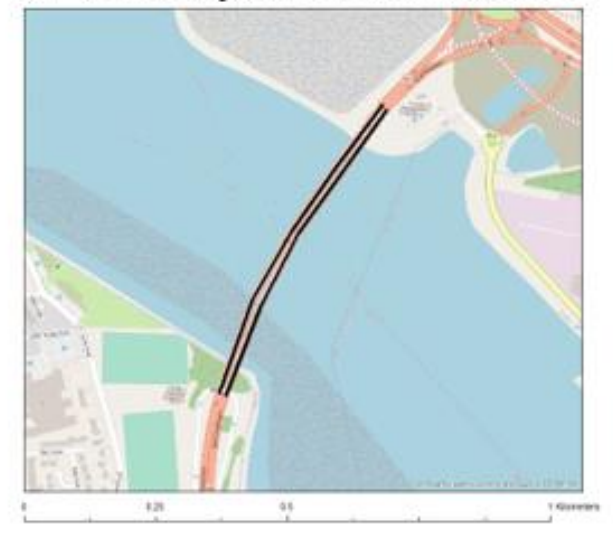
a) Dublin Port Tunnel



b) Limerick Tunnel



c) Jack Lynch Tunnel, Cork



Thank-you for listening

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