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Residential Solid Fuel Burning in Irish Towns and Cities

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Environmental Research Institute

1980s Dublin

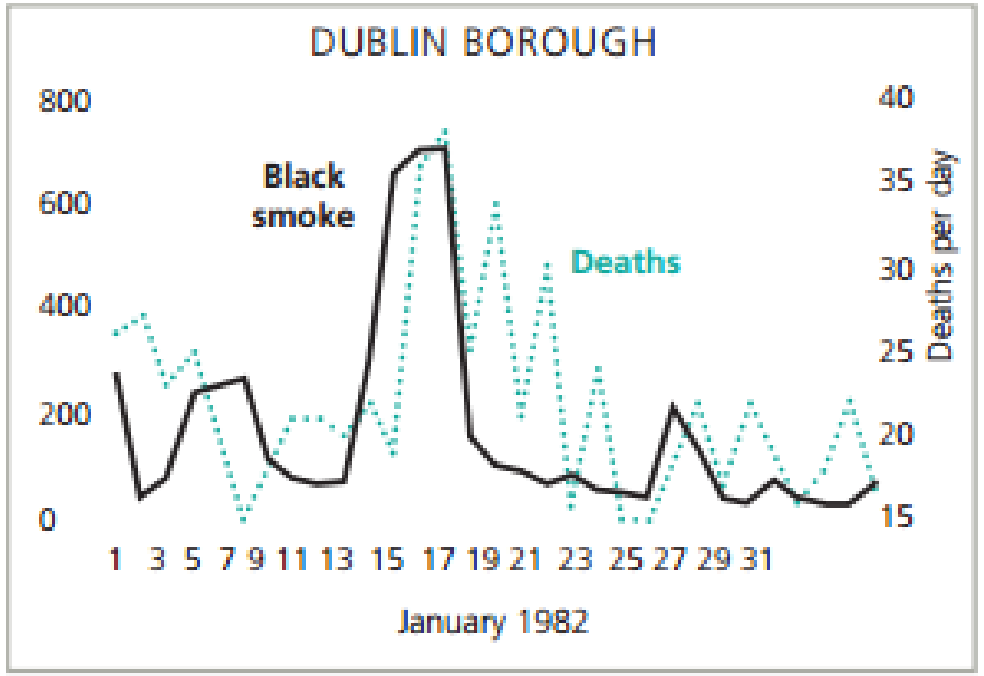
https://www.rte.ie/archives/

Dublin Smog 1982

Mortality in a General Hospital and Urban Air Pollution

Ian Kelly and Luke Clancy,

Irish Medical Journal, 1984, 77, 322-4



- Cold weather, temperature inversion, low wind speeds
- Very high levels of black smoke and sulphur dioxide
- Number of deaths per day doubled during the smog event and remained high for days afterwards

The New York Times

Dublin Journal; Fair Is City but Foul Is Air When Smog Creeps In

By SHEILA RULE, Special to the New York Times
Published: January 18, 1989

The smog creeps menacingly through doors and windows here. It attacks throats and lungs. It sometimes invades Dublin to such a degree that night appears to fall by midday.

Ballyfermot, Thursday 24 November 1988, 4pm

Tony Gavin

Tony Gavin

Dublin city centre, Friday 25 November 1988, 2pm

Ban on Bituminous (Smoky) Coal in Dublin

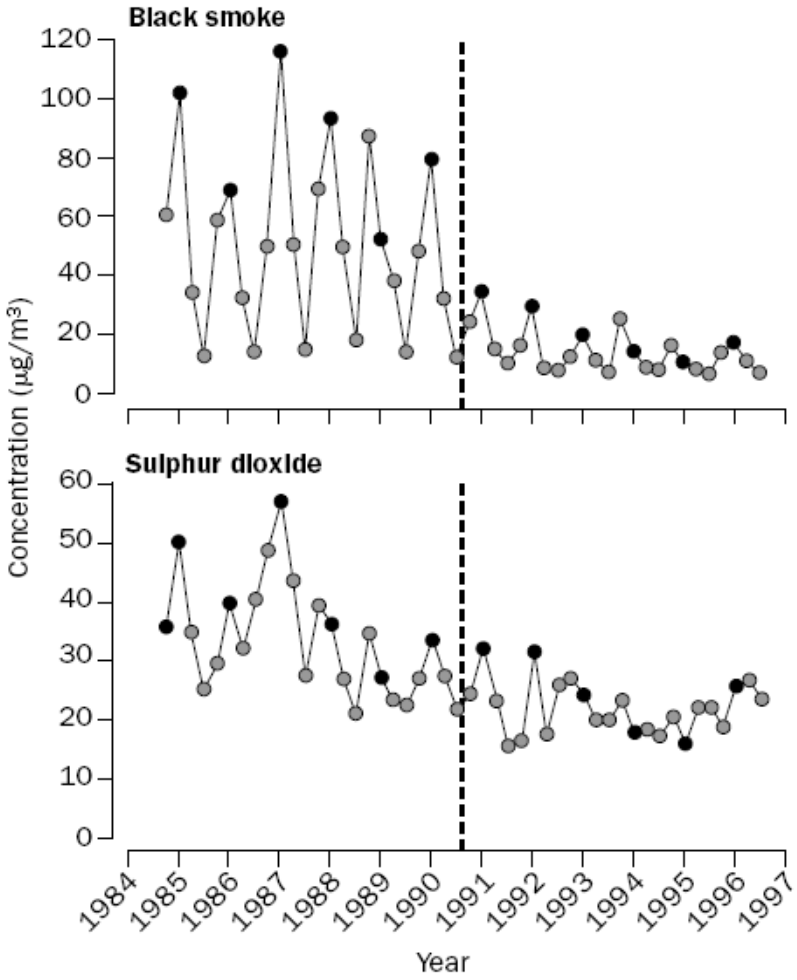


Figure 1: **Seasonal mean black smoke (upper) and sulphur dioxide (lower) concentrations, September 1984–96**
Vertical line shows date sale of coal was banned in Dublin County Borough. Black circles represent winter data.

1st September 1990

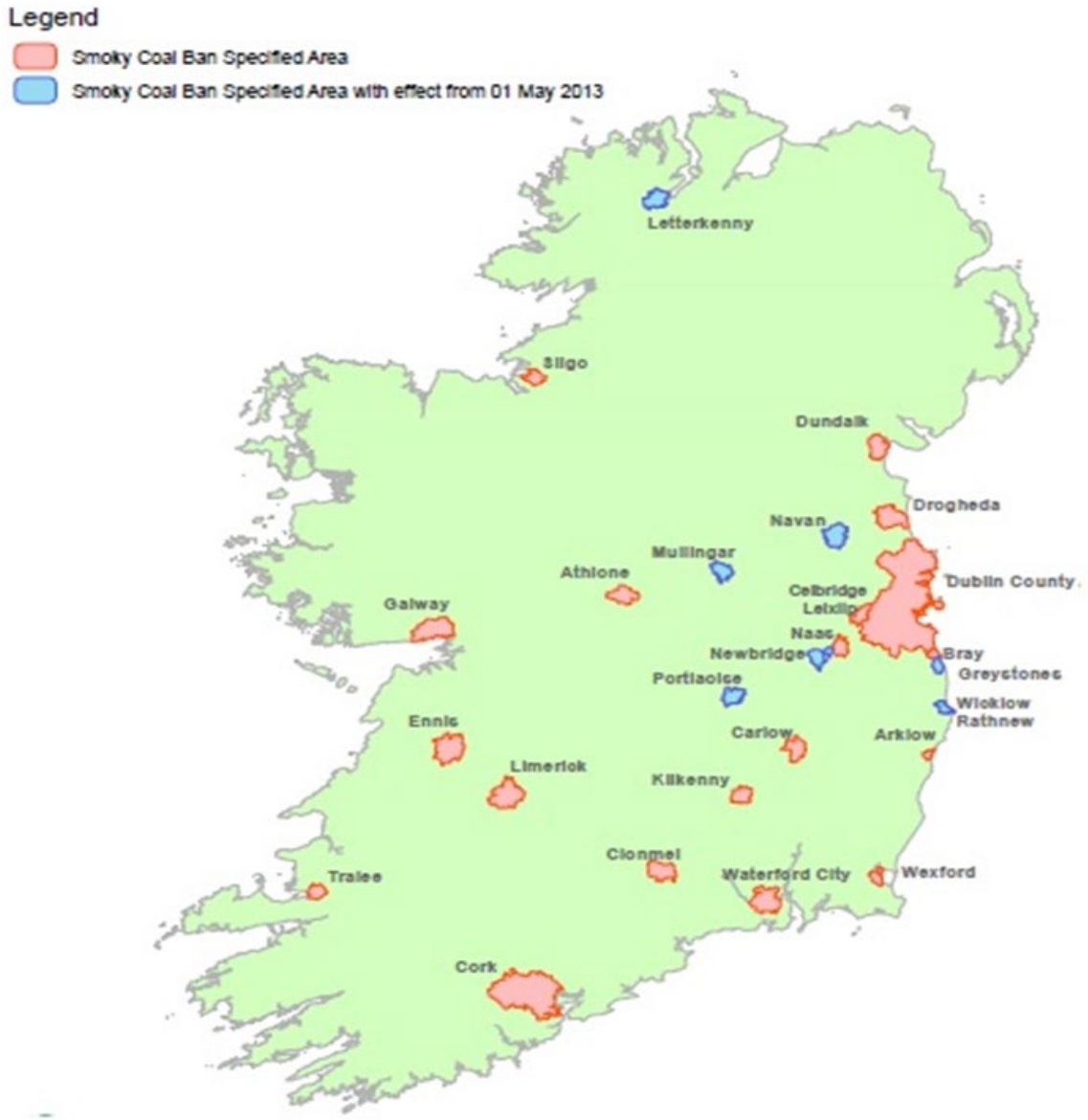
70% reduction in black smoke

34% reduction in sulphur dioxide

On average per year:
116 fewer respiratory deaths
243 fewer cardiovascular deaths

Clancy et al., Lancet 2002

Extent of Bituminous Coal Ban 2014



Research: Quantifying sources of $PM_{2.5}$ in Cork City

	$PM_{2.5}$ average ($\mu g/m^3$)	Solid Fuel Burning %	Traffic %	Other Local Sources %	Regional Sources %
August 2008	9.7	5	23	24	26
February 2009	16.2	50	19	21	10

https://acp.copernicus.org/articles/10/9593/2010/acp-10-9593-2010.html

https://acp.copernicus.org/articles/13/4997/2013/acp-13-4997-2013.html

The Burning Question

- What is the contribution of residential solid fuel burning to air pollution levels in towns where the Ban on Bituminous Coal is **not** in place?

What is the contribution of each fuel type?

Bituminous (Smoky) Coal

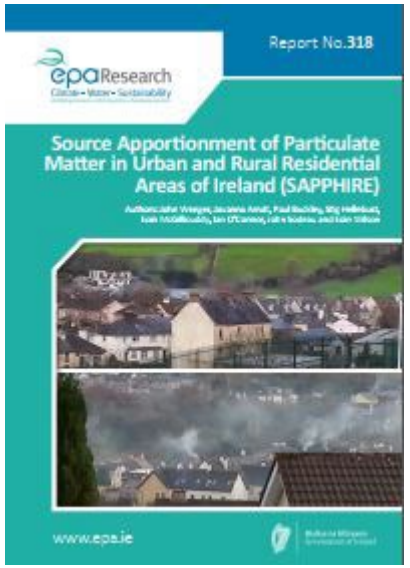
“Smokeless” Coal

Wood

Sod Peat (Turf)

Peat Briquettes

Source Apportionment of Particulate Matter in Urban and Rural Residential Areas of Ireland (SAPPHIRE)



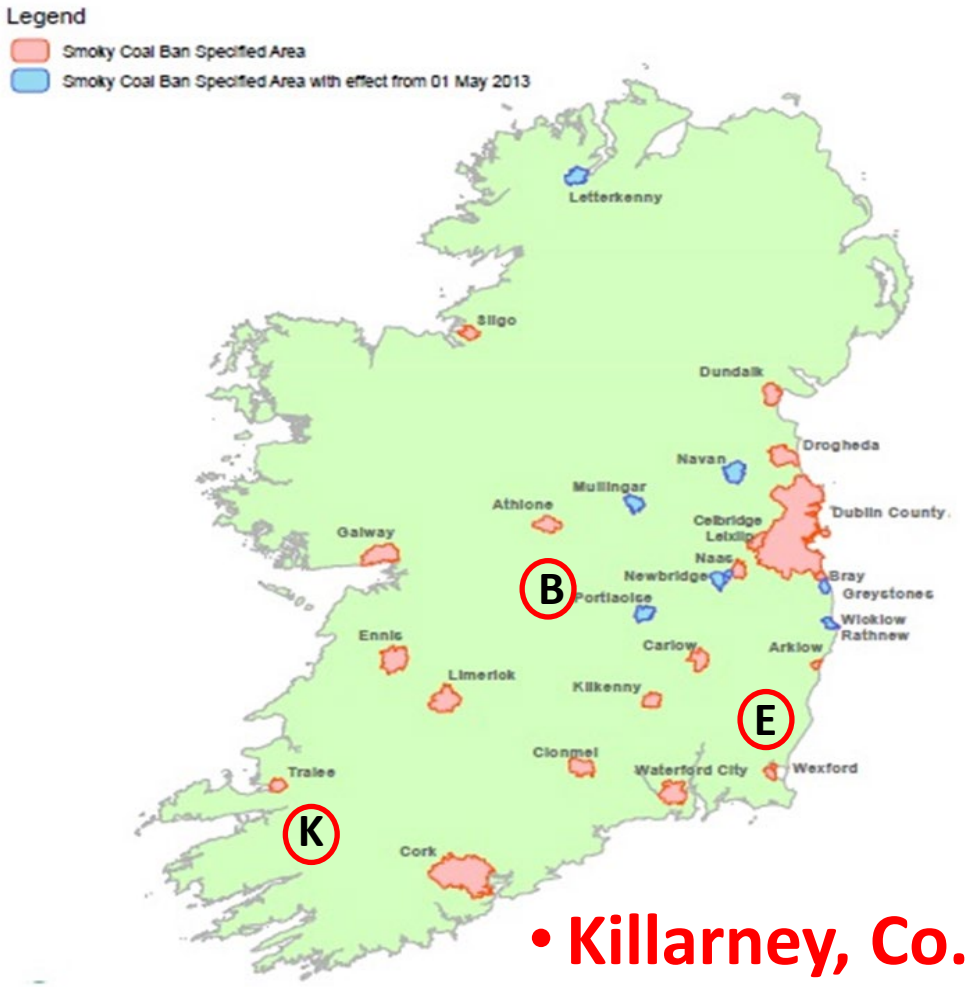
2014-2016

Link to published report

Field Measurements

Mobile Air Monitoring Laboratory for measuring gases and properties of particles

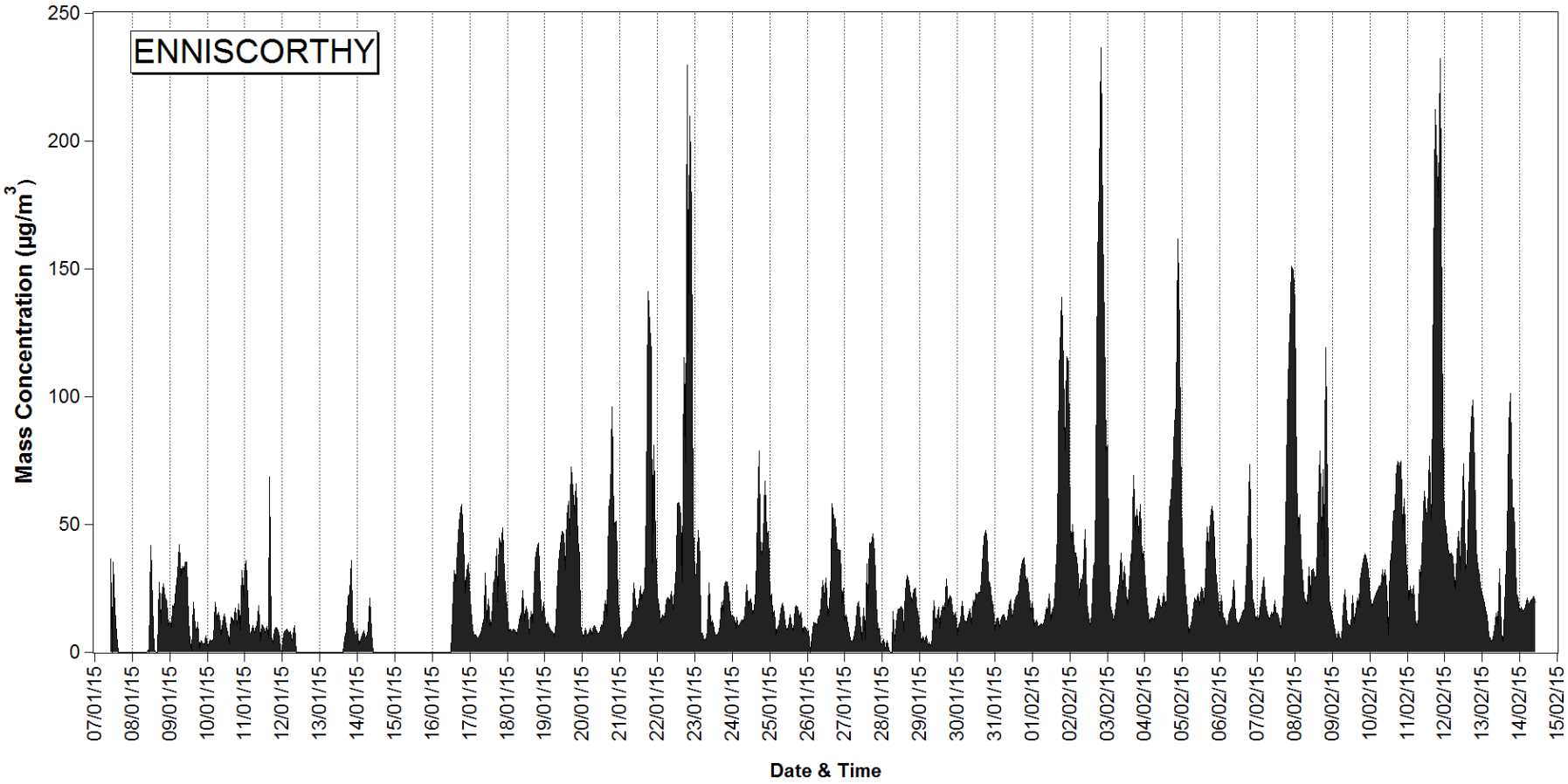
SAPPHIRE Monitoring Locations



- Outside the Smoky Coal Ban Area (pop. < 15,000)
- No natural gas supply
- High usage of solid fuels (coal, peat/turf & wood)

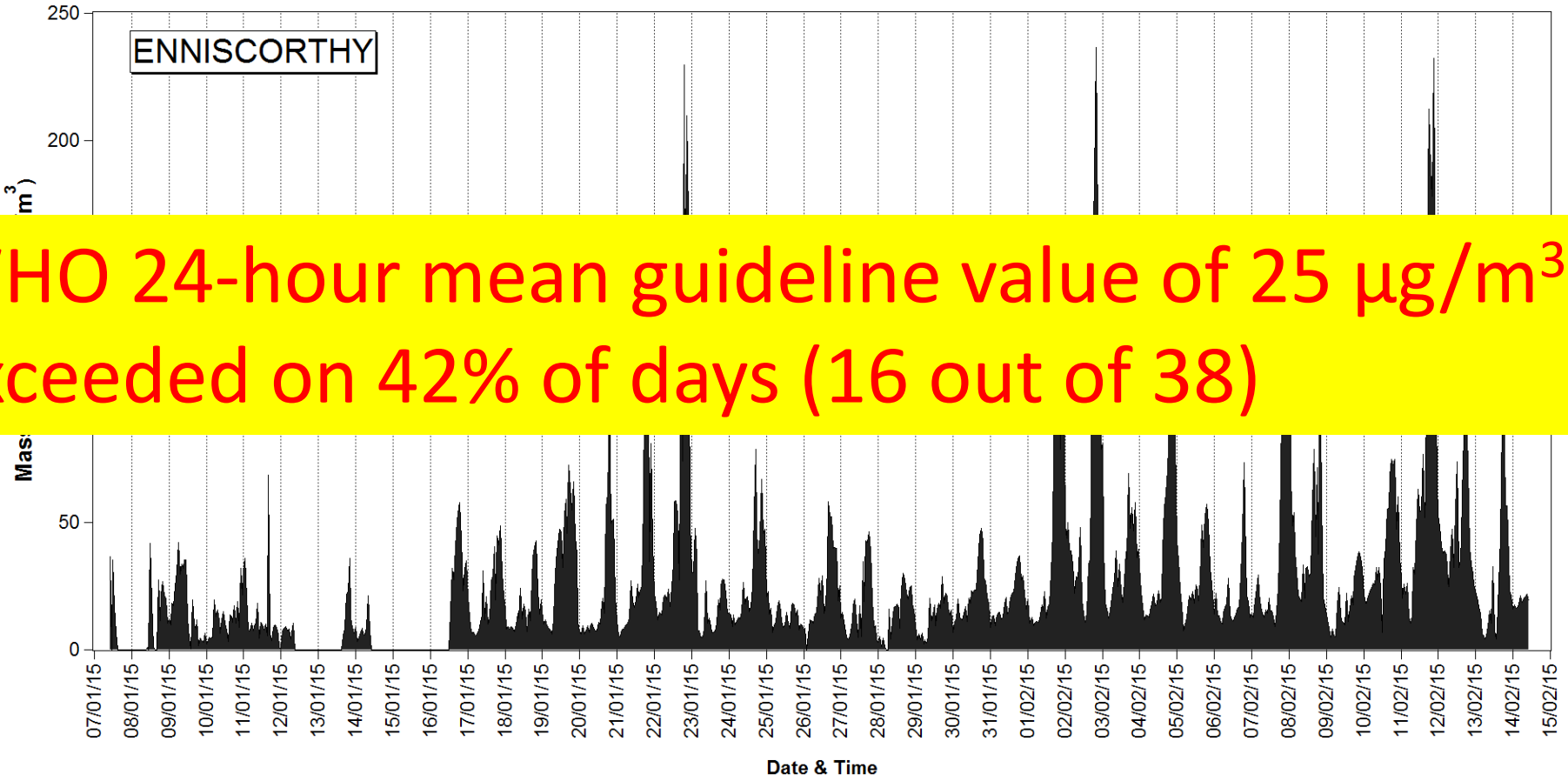
- **Killarney, Co. Kerry (Nov & Dec 2014)**
- **Enniscorthy, Co. Wexford (Jan & Feb 2015)**
- **Birr, Co. Offaly (Nov & Dec 2015)**

$PM_{2.5}$ Mass Concentration: Enniscorthy



- Average = 29 µg/m³; Range = 0 - 237 µg/m³
- $PM_{2.5}$ over 50 µg/m³ most evenings

$PM_{2.5}$ Mass Concentration: Enniscorthy



WHO 24-hour mean guideline value of 25 µg/m³ exceeded on 42% of days (16 out of 38)

- Average = 29 µg/m³; Range = 0 - 237 µg/m³
- $PM_{2.5}$ over 50 µg/m³ most evenings

THE IRISH TIMES

Tue, Oct 6, 2020

Air pollution turning Enniscorthy into 'New Delhi' of Ireland

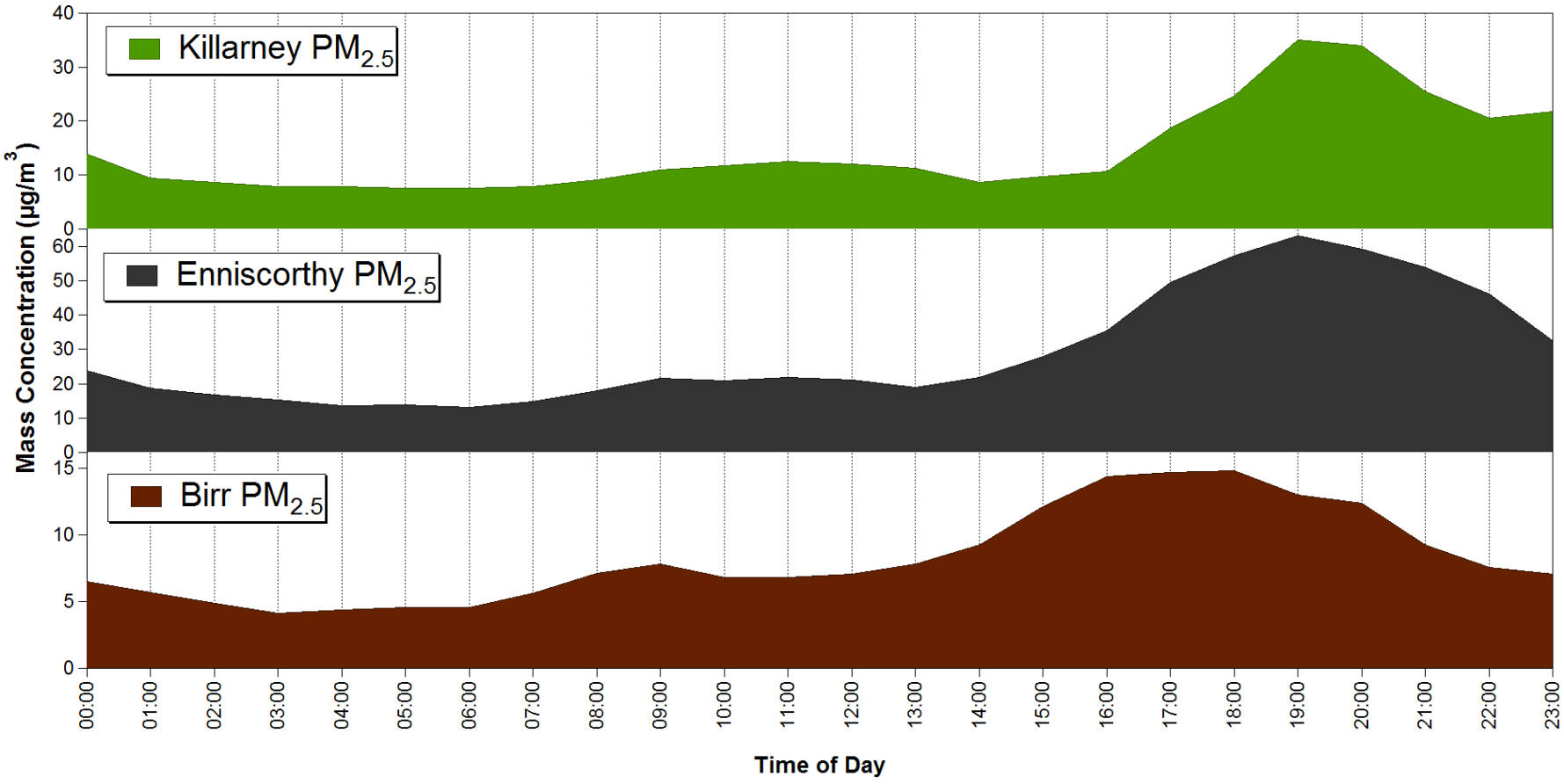
UCC professor says nationwide smoky coal ban must be implemented immediately

Tue, Jun 4, 2019, 19:31 | Updated: Tue, Jun 4, 2019, 19:33

Sorcha Pollak

A UCC professor has warned that Enniscorthy in Co Wexford is becoming the New Delhi of Ireland due to high levels of air pollution. File photograph: Getty Images.

Diurnal Variation in $PM_{2.5}$



- $PM_{2.5}$ levels peak in evening – residential solid fuel burning?

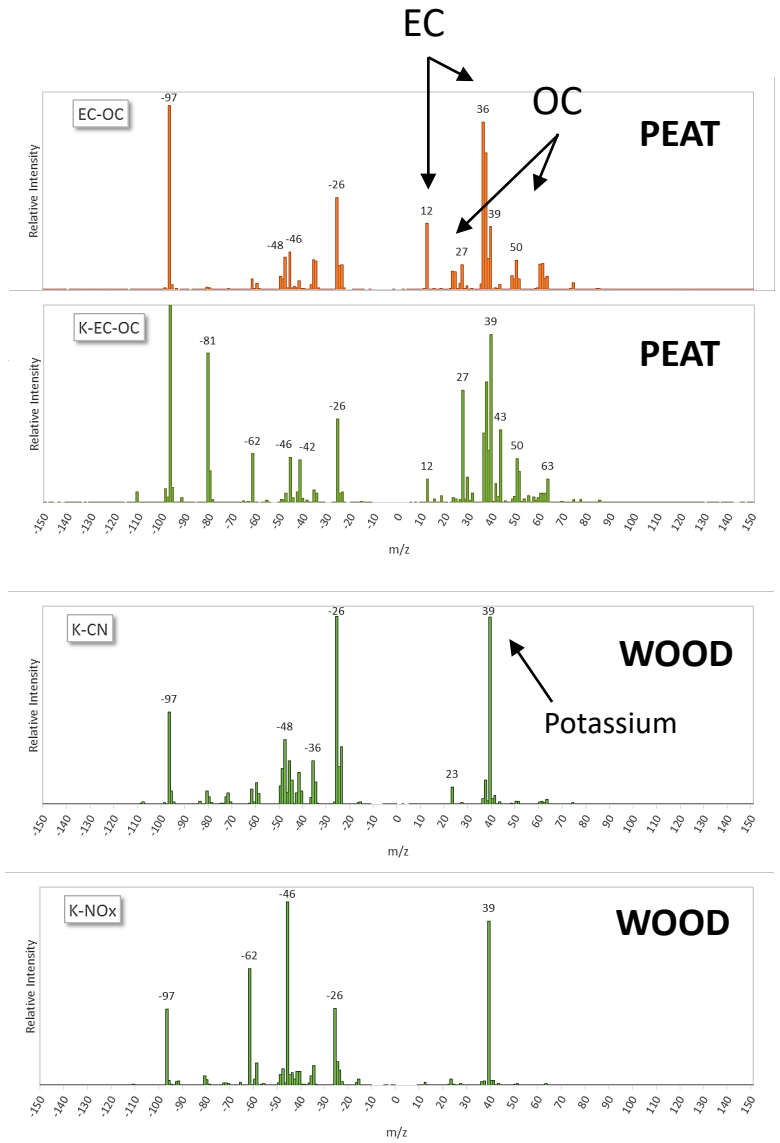
Aerosol Time-of-Flight Mass Spectrometer

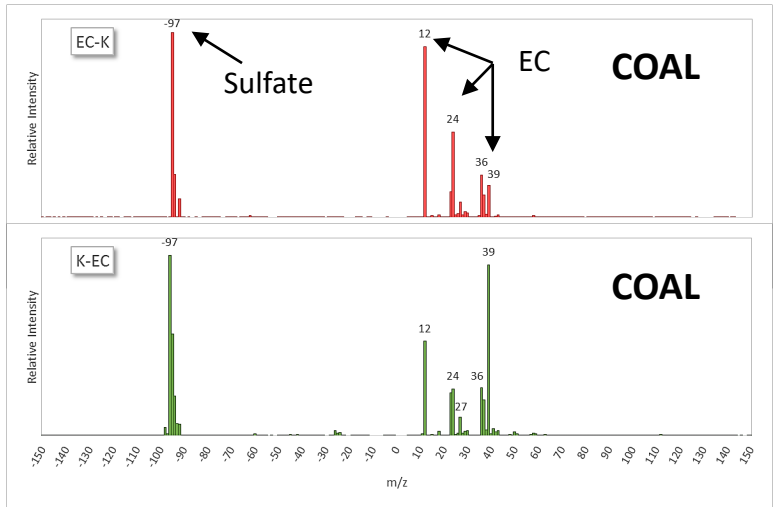
- Measures chemical composition of single particles in real-time
- Enables monitoring of particles from various sources continuously
- Uses a chemical fingerprint for different sources

Realistic fuel burning experiments

- Solid fuel stove
- House in remote location in Co. Tipperary

“Fingerprints” of Solid Fuel Combustion





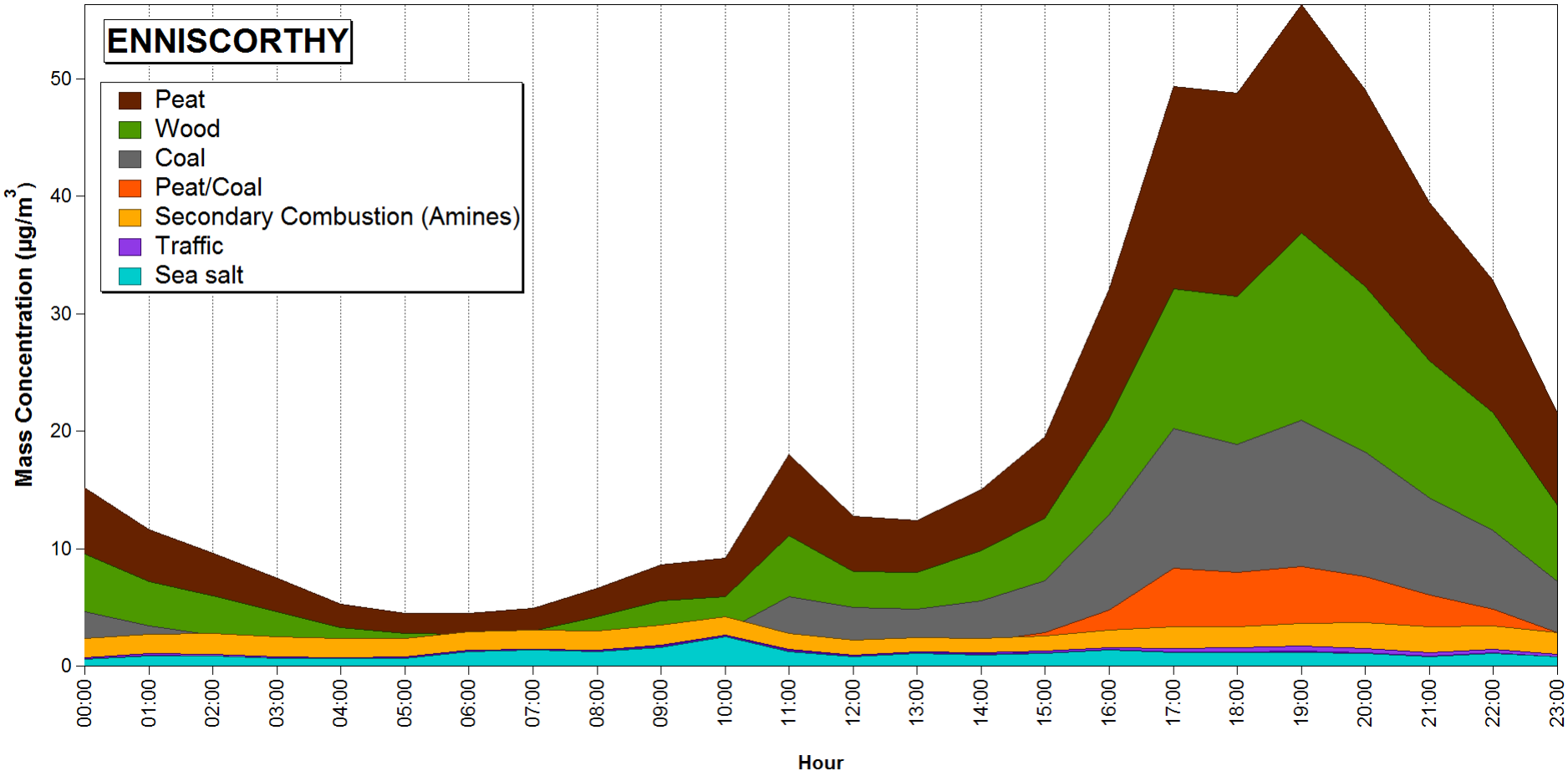
Assigned on the basis of combustion experiments

COAL → EC & some potassium, sulfate dominates negative spectra

PEAT → EC & OC fragments, some potassium

WOOD → Potassium dominates positive spectra

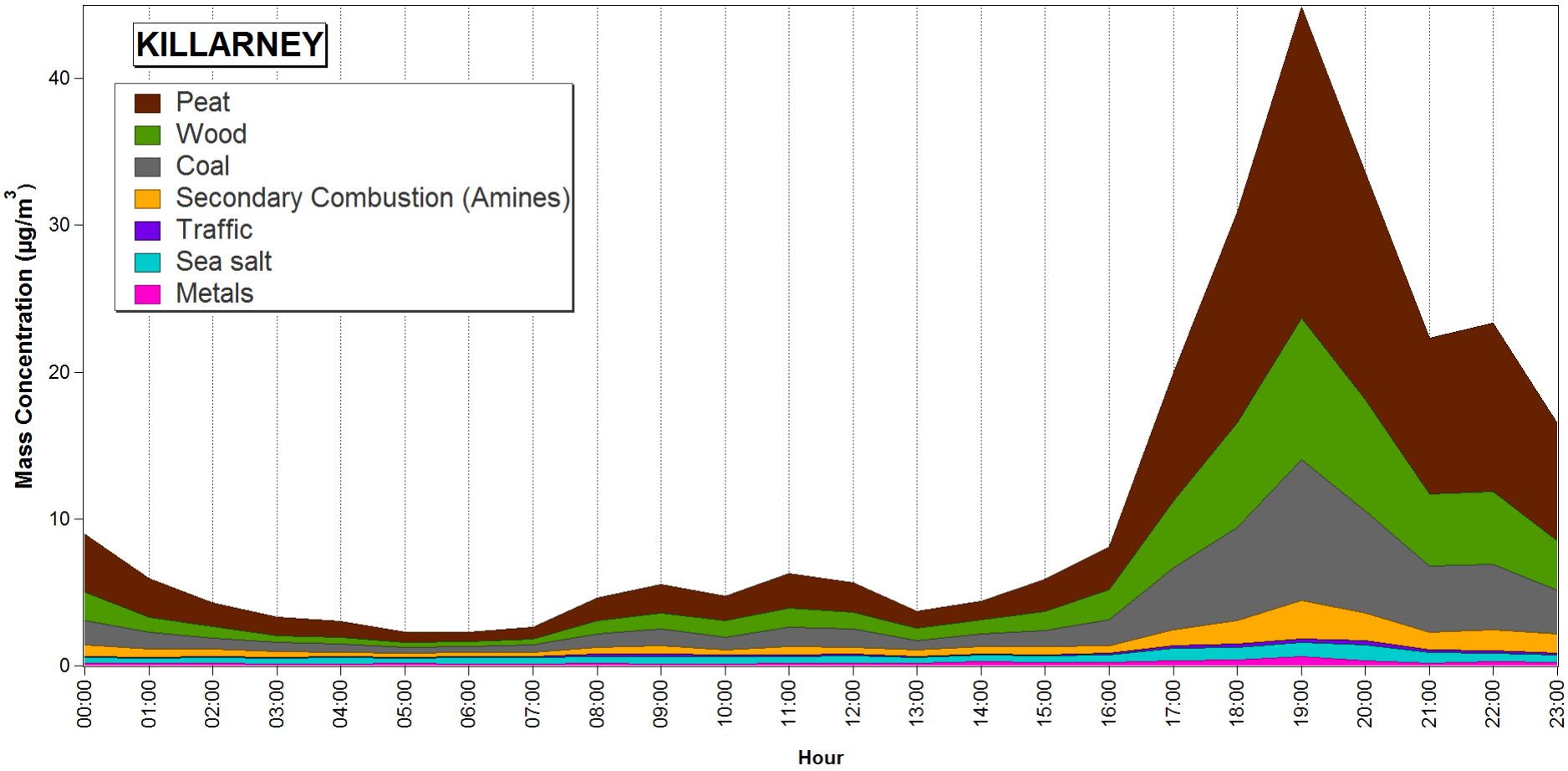
Particle sources: Enniscorthy



- 82% of $PM_{2.5}$ due to residential solid fuel burning

peat 27% **wood 21%** **coal 17%** **peat/coal 11%** **ammonium/amines 6%**

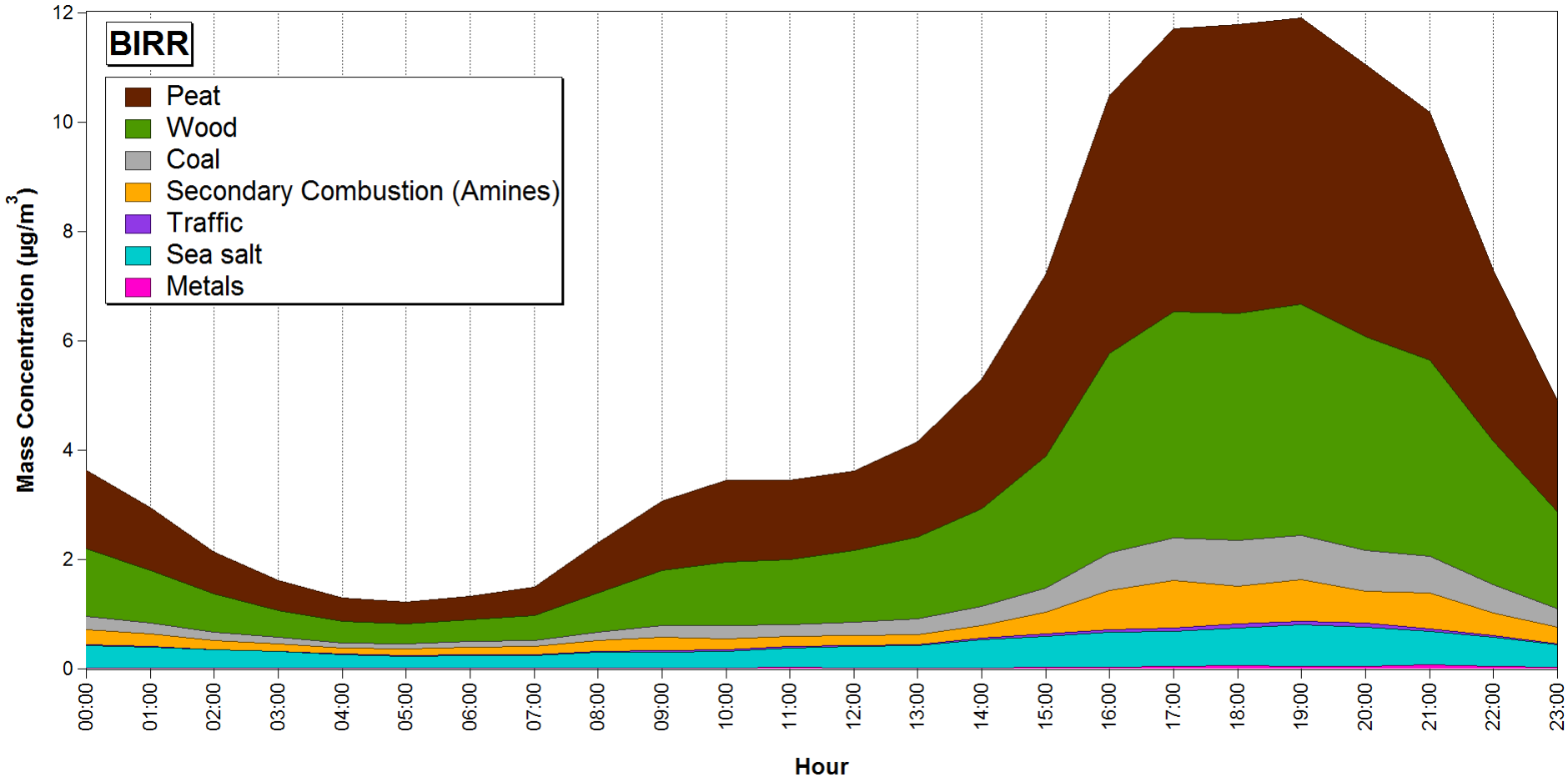
Particle sources: Killarney



- 72% of $PM_{2.5}$ due to residential solid fuel burning

peat 31% **wood 17%** **coal 16%** **ammonium/amines 5%**

Particle sources: Birr



- 60% of $PM_{2.5}$ due to residential solid fuel burning

peat 26% **wood 23%** **coal 5%** **ammonium/amines 5%**

A Nationwide Problem

- Enniscorthy, Birr, Killarney, Cork, Galway, Dublin….

ANALYSIS
https://doi.org/10.1038/s41893-018-0125-x
nature sustainability

Extreme air pollution from residential solid fuel burning

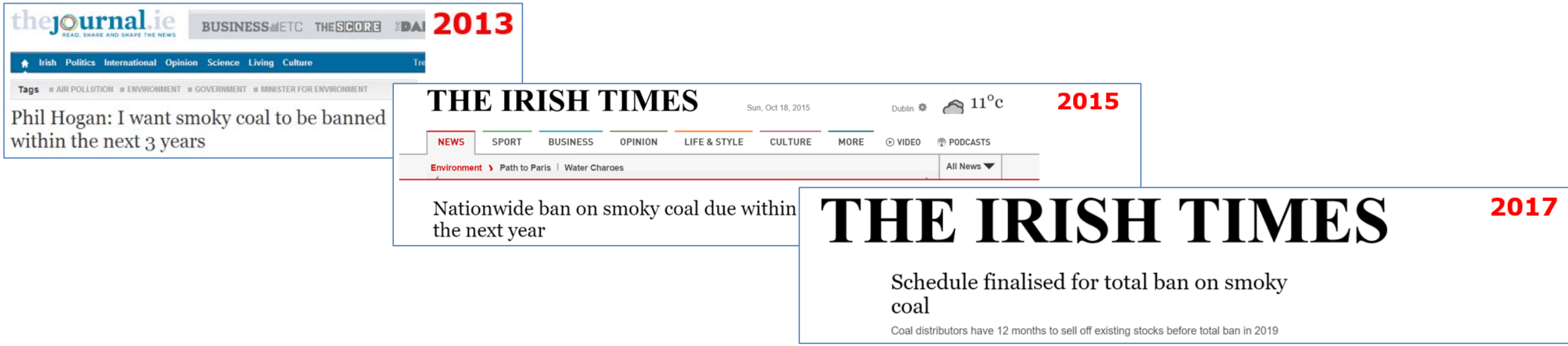
Chunshui Lin[1,2,3], Ru-Jin Huang[1,3]*, Darius Ceburnis[1,2], Paul Buckley[4], Jana Preissler[1,2], John Wenger[4], Matteo Rinaldi[5], Maria Christina Facchini[5], Colin O'Dowd[1,2]* and Jurgita Ovadnevaite[1,2]

Atmospheric aerosol particles (also known as particulate matter) are central to the cause of the two greatest threats to human security: air pollution (~5 million premature deaths per year) and climate change (~0.5 million per year). Addressing these threats requires an understanding of particulate matter sources responsible for both extreme air pollution immediately affecting human health and less extreme levels affecting climate over longer timescales. Here, extraordinary levels of air pollution, with submicrometre aerosol (PM_1) mass concentration surpassing 300 $\mu g\,m^{-3}$, were observed in a moderately sized European city and are attributed to emissions from residential solid fuel—specifically peat and wood, often promoted as 'slow-renewable', 'low-carbon' or 'carbon-neutral' biomass. Using sophisticated fingerprinting techniques, we find that consumption of peat and wood in up to 12% and 1% of households, respectively, contributed up to 70% of PM_1. The results from this approach can better inform emissions reduction policies and help to ensure the most appropriate air pollution sources are targeted. Given the far greater abundance of solid fuels and concomitant emissions required to match the calorific benefit of liquid fuels, even modest increases in the consumption of 'green'-marketed solid fuels will disproportionally increase the frequency of extreme pollution events.

- 50-85% of $PM_{2.5}$ due to solid fuel burning
- Peat > wood > coal
- $PM_{2.5}$ higher in towns than cities

Implications for policy

- A nationwide ban on smoky coal had been previously proposed…



- …But a nationwide policy to reduce emissions from **all** solid fuels would be more successful in improving air quality for all urban centres and especially small towns

2021

Republic of Ireland to ban the sale of polluting solid fuels

7 September 2021

The regulations are expected to be in place before Septemeber 2022

Most polluting solid fuels are to be removed from the Irish market under new rules to be introduced in the Republic of Ireland next year.

2022

This is Europe

‘We’re being left with nothing’: Ireland’s turf wars expose rural grievances

A ban on selling smoky fuels was meant to cut carbon emissions, tackle air pollution and conserve ancient bogs. Instead, it has fuelled a tense narrative of urban elites versus rural poor

by Rory Carroll The Bog of Allen, Ireland

The peat sods lay spread on a field, at the end of which was a mound of earth the colour of dark chocolate. It was the edge of a bog, a habitat thousands of years in the making. A mechanised cutter with steel claws had gouged and sliced some of it into chunks that now covered an area the size of a football pitch. Enough, once dried and bagged, to heat a house for an Irish winter.

Some environmentalists would consider this tableau in County Kildare – one replicated across rural Ireland at this time of year – akin to a crime scene, a mad, destructive assault on a precious natural resource, turning a carbon sink into a smoky fuel.

Ned Phillips, 49, who did the gouging, disagreed. “I’ll not stop cutting turf here no matter what law they pass. It’s our tradition. We’re doing no harm here.” It was his mother’s dying wish that he continue a tradition dating back centuries, a wish he intends to honour, even though the family’s patch of bog is now part of a conservation area. “I’ll fight till my death.”

2022

gov.ie Departments Consultations Publications Policies Languages

Press release

Government agrees new regulations on solid fuels

From Department of the Environment, Climate and Communications
Published on 14 July 2022
Last updated on 7 September 2022

1. Turbary rights
2. Health impacts of poor air quality
3. Notes to the Editor

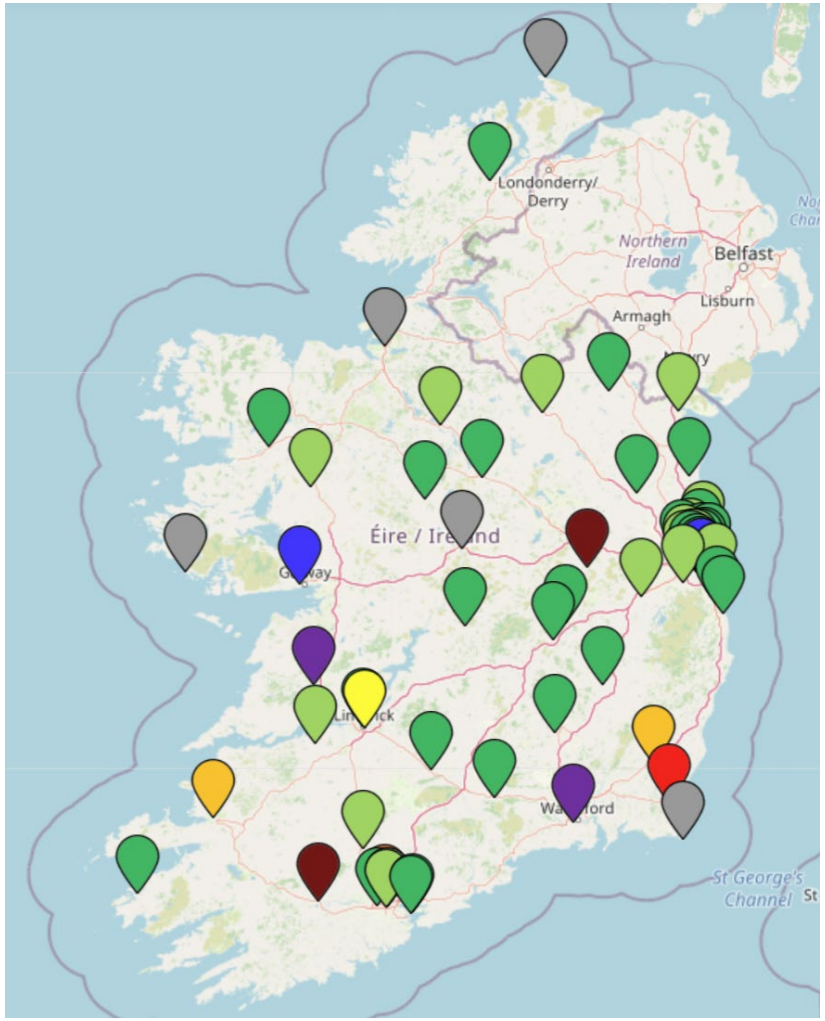
"The primary focus of the regulations is on the large-scale, commercial sale of smoky fuels, including smoky coal, turf and wet wood."

Part of

Policies

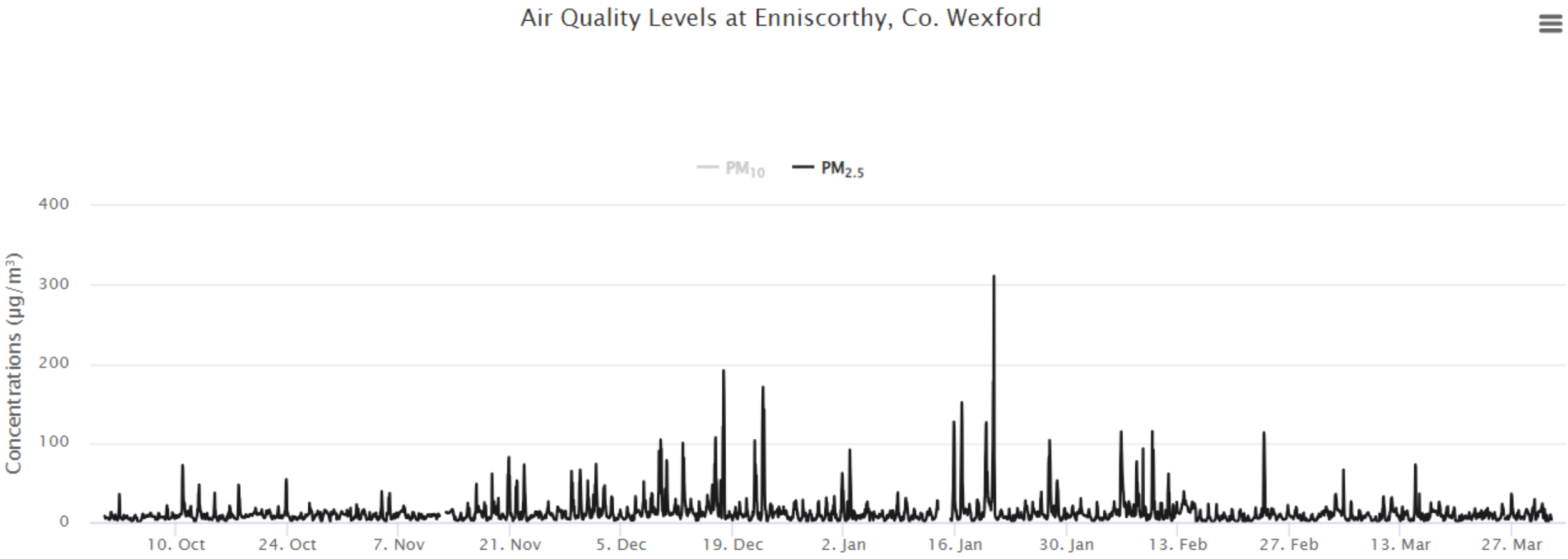
Climate Action and Environment

Air Quality: Monitoring and Reporting



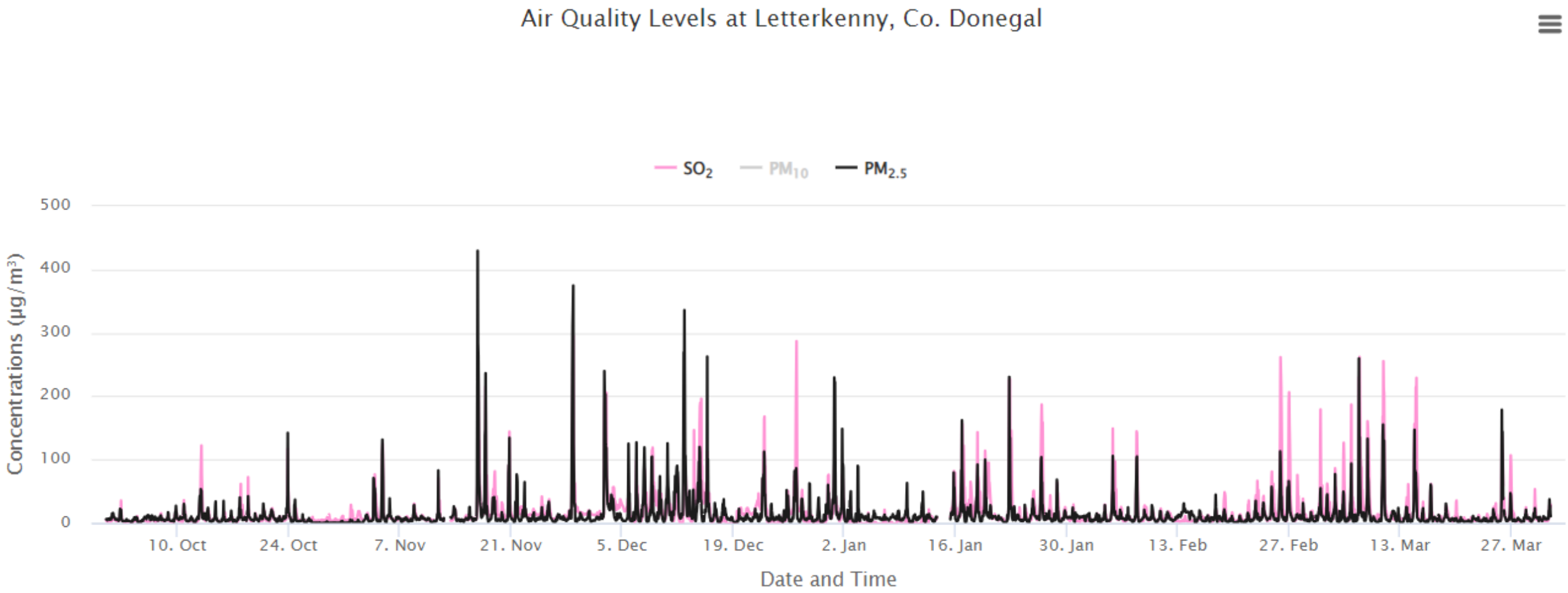
https://www.epa.ie/environment-and-you/air/

Enniscorthy Winter 2022-2023



https://airquality.ie/readings?station=EPA-24

Letterkenny Winter 2022-2023



https://airquality.ie/station/EPA-64

Are We Getting the Full Picture?

Network measurements use accurate **reference methods**

Beta Attenuation Monitor (BAM) for $PM_{2.5}$

Automated analyzers for nitrogen oxides and ozone

Which provide **high quality data**, but they come at a high cost (€20k-€40k) and cannot realistically be deployed in every town and city

Air Quality modelling can be used to “fill in the gaps”

Contribution from low cost sensors

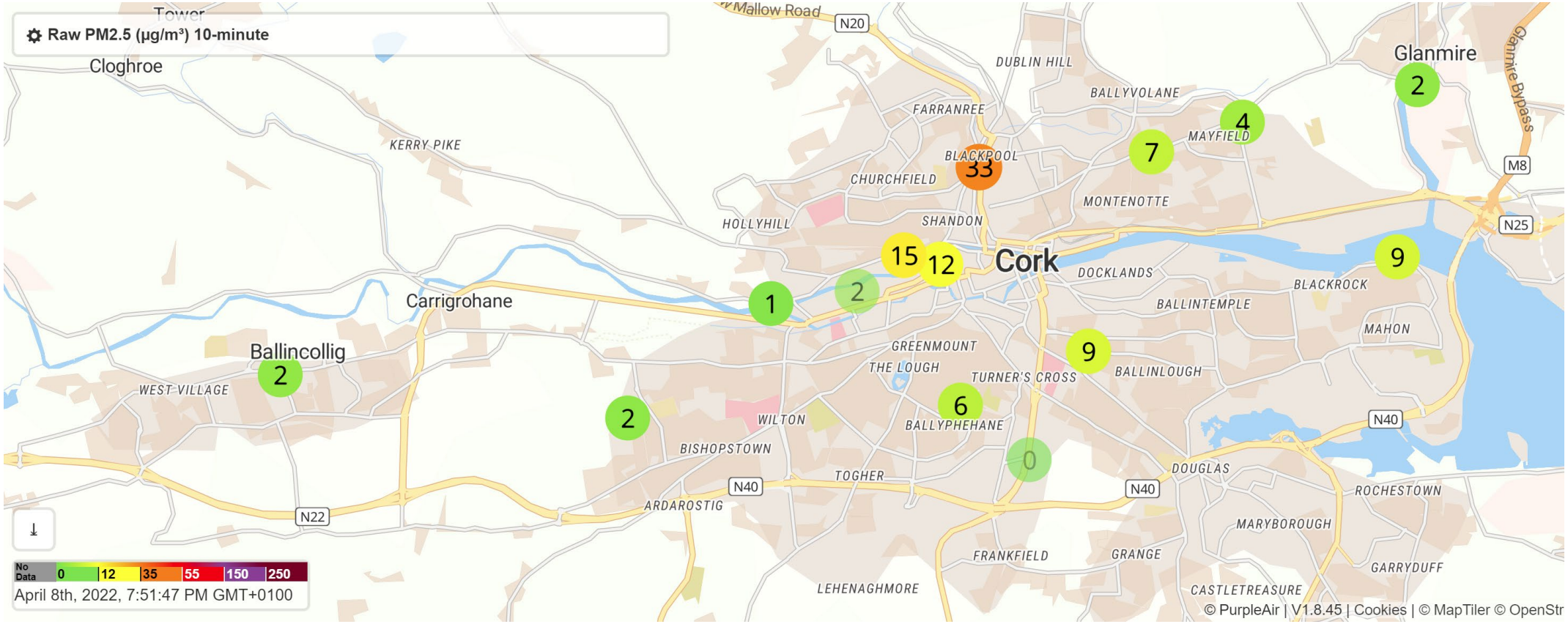
Sensors based on a range of technologies can be packed in a small device at low cost (€30-€2000)

Low-cost sensors only provide **indicative values**

But being **low cost** they can be **widely distributed and used in a network to generate a more detailed map of air quality**

Used by local authorities, citizen science and community level air quality monitoring projects

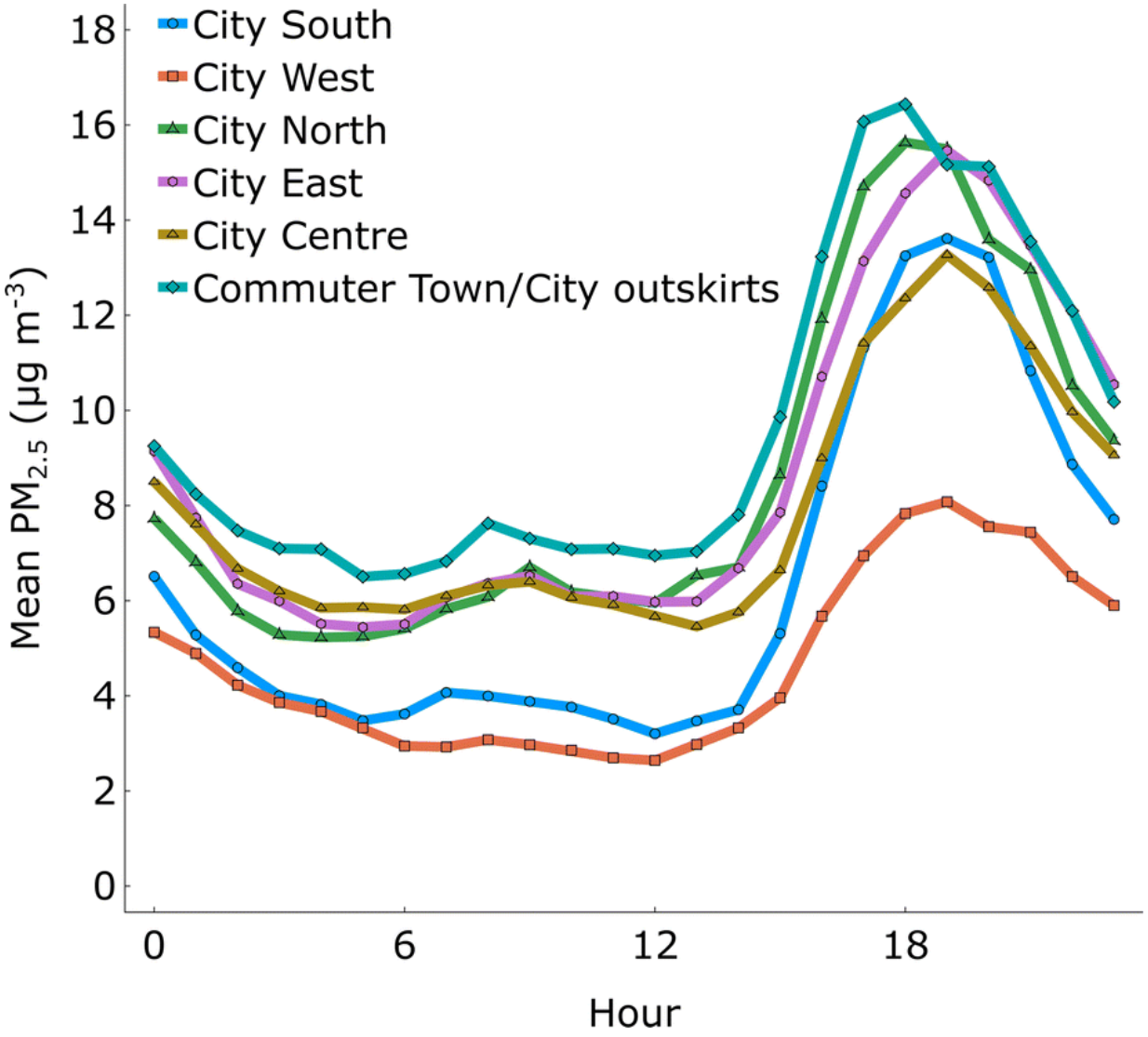
Cork City $PM_{2.5}$ Monitoring Network



- First Air Quality sensor network in Ireland developed in partnership with Cork City Council. Continuous live reporting of $PM_{2.5}$ concentrations to the public.

http://corkairquality.ie/

Comparing Air Quality in Different parts of Cork City



- Analysed data collected by 16 sensors during 2021
- Winter measurements show large evening peaks which vary by location

Environmental Science: Atmospheres

ROYAL SOCIETY OF CHEMISTRY

PAPER

View Article Online
View Journal

Check for updates

Cite this: DOI: 10.1039/d2ea00177b

Highly local sources and large spatial variations in $PM_{2.5}$ across a city: evidence from a city-wide sensor network in Cork, Ireland†

Rósín Byrne, [ab] Kevin Ryan,[c] Dean S. Venables, [ab] John C. Wenger [ab] and Stig Hellebust [*ab]

https://pubs.rsc.org/en/content/articlelanding/2023/ea/d2ea00177b

Summary

- Solid fuel burning is still the dominant source of $PM_{2.5}$ during winter in Ireland
- All solid fuels contribute (peat>wood>coal)
- Pollution in towns is often higher than in cities
- Low-cost sensors have good potential for delivering supplementary $PM_{2.5}$ measurements
- New policy seeks to reduce emissions from solid fuel burning - good implementation is needed
- **Further research will be required to assess the impact of the policy on ambient $PM_{2.5}$**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Atmospheric Chemistry

Extra Slides

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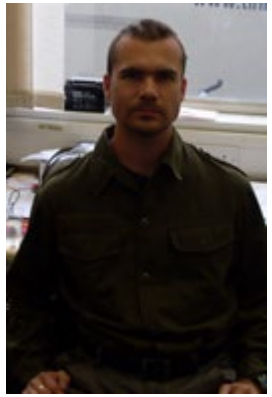

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John Sodeau

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- Ian Plunkett (WCC)
- Patrick Malone (EPA)

Birr site assistance

- Sarah Delahunt (OCC)
- Marian Healy (OCC)

http://www.ucc.ie/en/crac/research/sapphire/

Extension of Smoky Coal Ban

1990	Dublin
1995	Cork City
1996	Arklow, Drogheda, Dundalk, Limerick City, Wexford Town
2000	Celbridge, Galway City, Leixlip, Naas, Waterford City
2003	Bray, Kilkenny, Sligo, Tralee
2011	Athlone, Carlow, Clonmel, Ennis
2013	Greystones, Letterkenny, Mullingar, Navan, Newbridge, Portlaoise

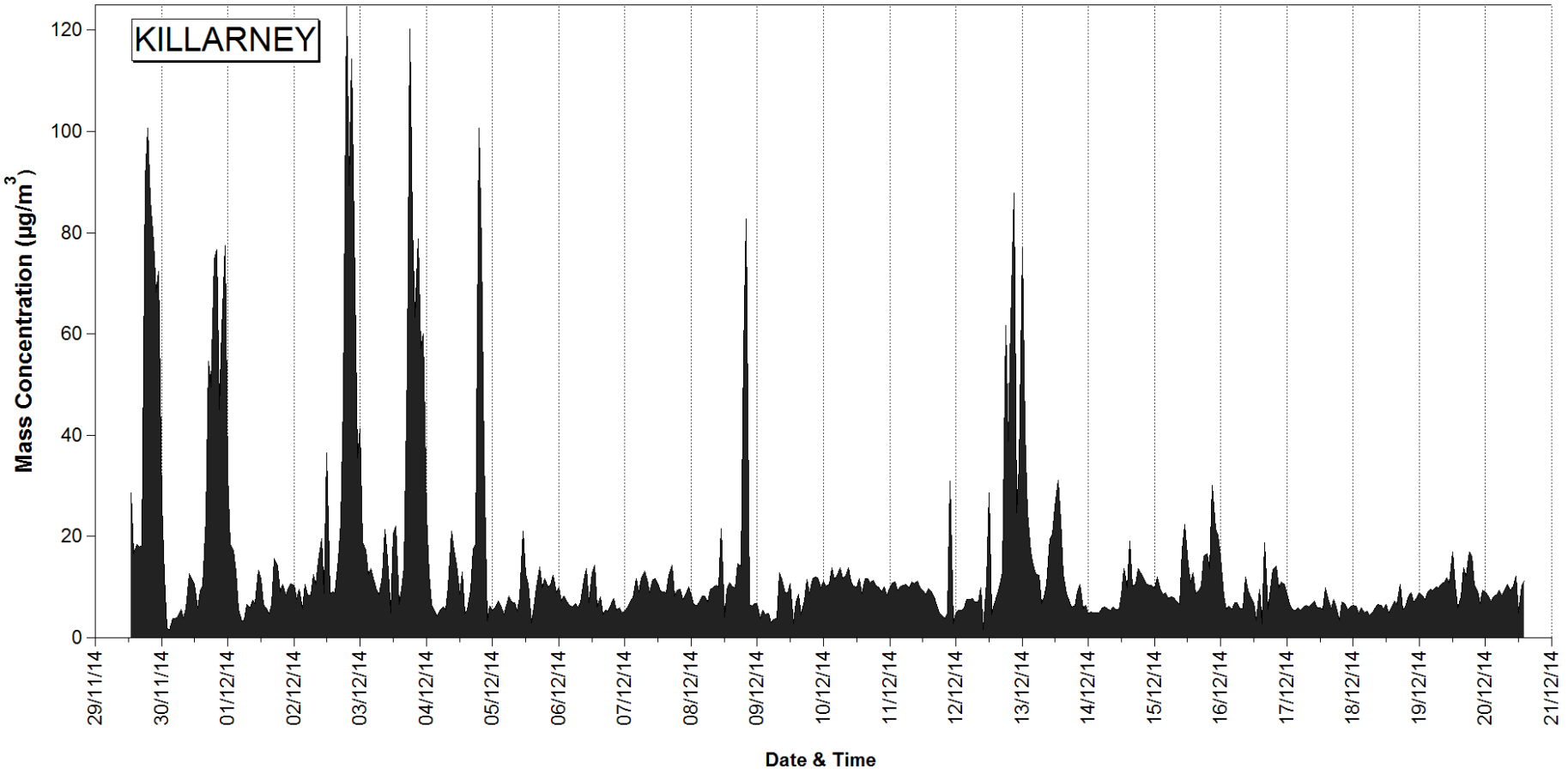
Significant reductions in Black Smoke observed in all cities and towns after the ban (up to 2000)

(Goodman et al, *J. Air & Waste Manage. Assoc. 2009,* **59**:207–213)

Key Instrumentation

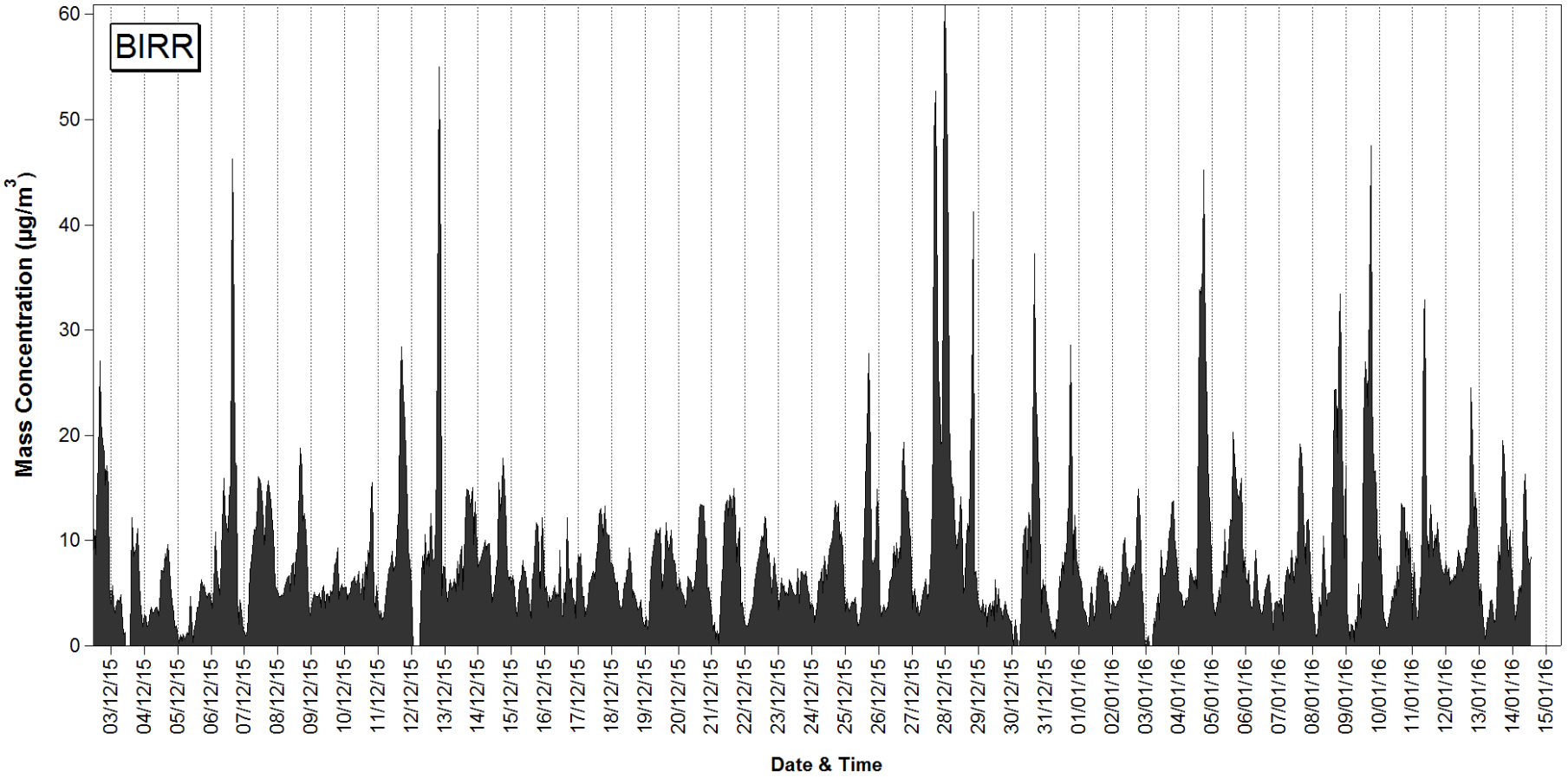
Instrument	Parameter(s) measured	Temporal resolution	
Aerosol time-of-flight mass spectrometer (TSI model 3800)	Single particle chemical composition (100-3000 nm)	1 min	*
Scanning mobility particle sizer (TSI model 3081)	Particle number concentration (10-800 nm)	3 min	
Optical Particle Sizer (TSI model 3330)	Particle number concentration (300-10000 nm)	3 min	
TEOM (Thermo Electron model RP 1400a)	$PM_{2.5}$ mass concentration	30 min	*
Thermal-optical carbon analyser (Sunset Inc. model 3rd generation)	Elemental and organic carbon mass concentrations	2 hr	
7-Wavelength Aethalometer (Model AE33, Magee Scientific)	Black Carbon concentration	1 min	
High volume sampler (Digitel model DHA 80)	Collection of particulate matter ($PM_{2.5}$)	6 hr	

$PM_{2.5}$ Mass Concentration: Killarney



- Average = 15 µg/m³; Range = 1-135 µg/m³
- $PM_{2.5}$ up to 10 times higher during evening hours

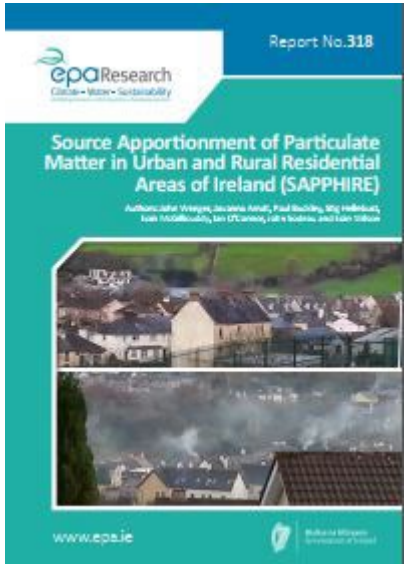
$PM_{2.5}$ Mass Concentration: Birr



- Average = 8 µg/m^3; Range = 0 - 63 µg/m^3
- Stormy weather resulted in lower mass concentrations

Summary

- Regular daily patterns of $PM_{2.5}$ pollution with evening peaks up to ten times higher than daytime levels.
- Huge spikes in pollution when wind speeds and temperatures were low.
- On average 60-82% of the PM2.5 pollution was due to residential solid fuel burning.
- The burning of peat was the dominant source, followed by wood and then coal.



Link to published report

Monitoring Network in Dungarvan

- 25 sensors providing continuous measurements to help validate and improve air quality models used in forecasting

https://www.epa.ie/environment-and-you/air/life-emerald/