



AIRPORT ENVIRONMENTAL MANAGEMENT

04-08 October 2015

Abu Dhabi, UAE

Module 11: Local Airport Air Quality

Module objectives

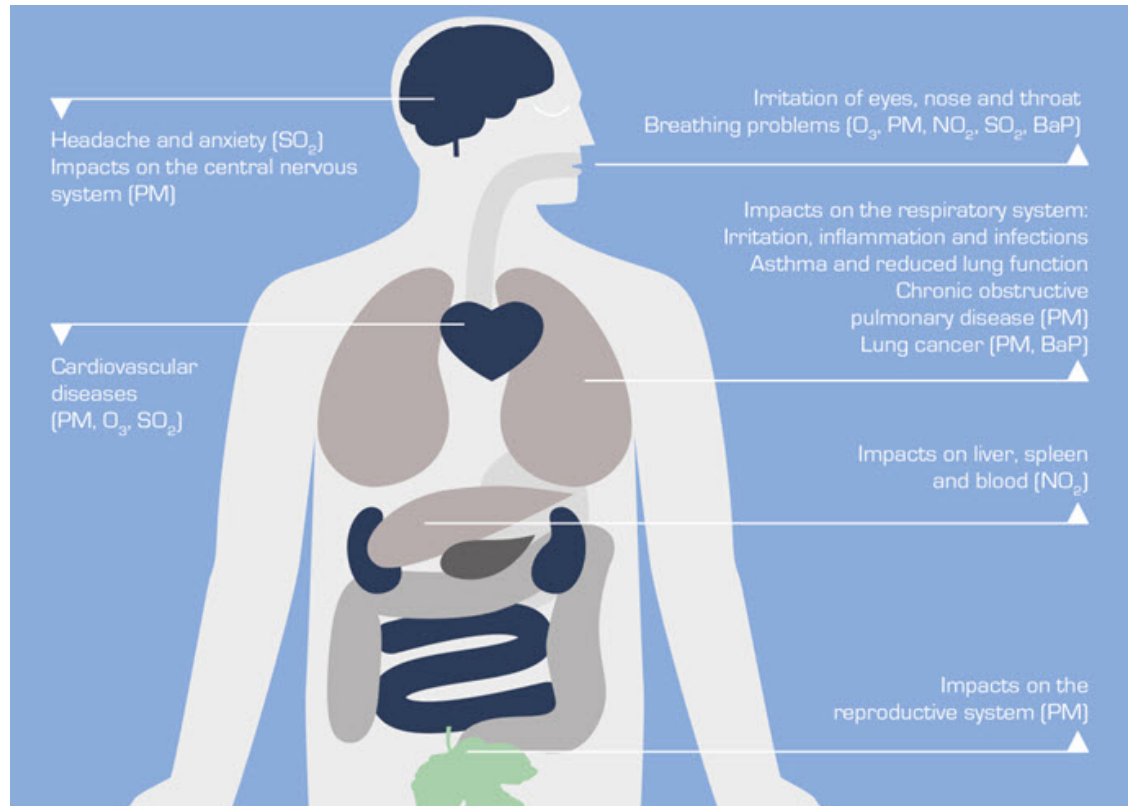
- To illustrate the extent of the air quality challenge at airports
- To understand the complex array of emission sources at airports
- To identify and understand the various techniques for the monitoring of air quality
- To appreciate the need for air quality modelling
- To identify air quality management strategies designed to reduce environmental and health impacts

What is air quality?

Pollutants of concern

- **Oxides of nitrogen**
- Carbon monoxide
- Hydrocarbons
- **Particulate matter**
- Sulphur dioxide

NOT Carbon dioxide!



European Environment Agency, 2013

Nitrogen oxides

- Covers both nitric oxide (NO) and nitrogen dioxide (NO₂)
- On a local scale NO₂ can cause respiratory problems
- On a regional scale NO_x causes emissions contribute to the formation of photochemical smog



Particulate matter (PM₁₀/PM_{2.5})

- Very fine particles may cause or enhance respiratory disease.
- Elevated levels of particulates are associated with increases in mortality and morbidity



Primary vs. secondary pollutants

The regulated pollutants are not necessarily those directly emitted by the source!

- The overwhelming majority of the NO_x emitted by an aero-engine is as NO . *Subsequent reactions with O_3 etc. in the air convert this to the more toxic NO_2 .*
- Most of the PM emitted is as fine (~ 100 nm) soot, or ultra-fine sulphate. These particles aggregate as the plume evolves. *It is not clear what their toxicity is relative to that of general fine urban aerosol.*

Air quality standards in the European Union

Pollutant	Concentration	Measured as	Achieved by
Nitrogen dioxide	40µg/m ³	Annual mean	Entered into force 1 January 2005
	200µg/m ³ with up to 18 exceedences per year	1 hour mean	Entered into force 1 January 2005
Particulate matter (PM10)	40 µg/m ³	Annual mean	Entered into force 1 January 2005
	50 µg/m ³ with up to 35 exceedences per year	24 hour mean	Entered into force 1 January 2005

EU Directive 2008/50/EC

Air quality standards in Abu Dhabi

- <http://www.adairquality.ae/en/home/theme.aspx?ThemeID=bc1b661a-ba6e-4ef9-866a-639bb1e5bfde>

Substance	Symbol	Max Allowable Limits	Average
Sulphur Dioxide	SO ₂	350 µg/m ³ 150 µg/m ³ 60 µg/m ³	1 hour 24 hours 1 year
Carbon Monoxide	CO	30 µg/m ³ 10 µg/m ³	1 hour 8 hours
Nitrogen Dioxide	NO ₂	400 µg/m ³ 150 µg/m ³	1 hour 24 hours
Ozone	O ₃	200 µg/m ³ 120 µg/m ³	1 hour 8 hours
Particulate Matter	PM10	150 µg/m ³	24 hours
Total Suspended Particles	TSP	230 µg/m ³ 90 µg/m ³	24 hours 1 year
Lead	Pb	1 µg/m ³	1 year

Sources of air pollutant at airports

- Aircraft
- Ground support equipment
- Airside vehicles
- Landside vehicles
- Point sources (electricity generation)
- Fuel storage
- Engine testing / fire training



Air quality – an issue of concern?

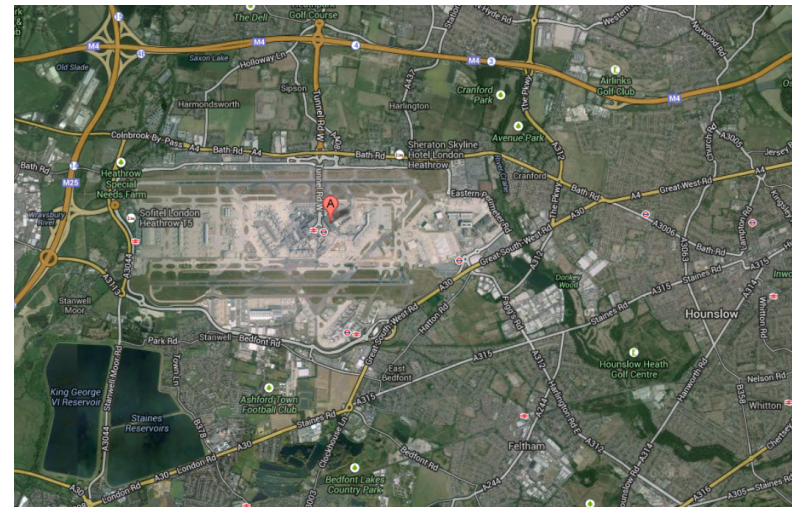
It is in Europe and North America

‘....another runway at Heathrow could not be considered unless the Government could be confident that levels of all the relevant pollutants could be consistently contained within EU limits.

See below for the Secretary of State decision:

http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/15_01_09decision_doc.pdf

The development of Heathrow





Aircraft technology has developed rapidly



Some of the old-time local barnstormers gathered at Eddie Martin's Airport.
From left: Howard Maish, George Leonard, Ernie Mobbs, John Martin,
Harry Menephy and Edward Martin.



Exercise: Stakeholder views of LAQ

How would these stakeholders view the issue of air quality?

- Airline
- Airport
- NGO
 - What would their concerns be?
 - Are there any unknowns?
 - What could they do?

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What would their concerns be? Are there any unknowns? What could they do?

Airline

- Concerns
- Unknowns
- Actions

Airport

- Concerns
- Unknowns
- Actions

NGO

- Concerns
- Unknowns
- Actions

Airport issues

- Constraint to growth –
exceedence of standards
- Human health impacts
- Community relations
- Ecological impacts



Airports - unknowns

- Pollutants (quantity and type)
- Source strengths
 - Aircraft performance data
- Behaviour of emissions
- Source apportionment
- Impacts
 - Human
 - Ecological



Airports - actions

- Measurements
- Modelling
- Assessments
- Reduction strategies
 - Emission charges
 - APU / FEP / GPU / PCA
 - Airside vehicles
 - Landside access / public transportation



Airline - issues

- Growth constraints
- Economic impacts
 - Emission charging
 - Change to fleet
 - APU usage
- Environmental impacts



Photo by Thomas Reich

<http://www.Airliners.net>

Airlines - actions

- Investment in 'Greener' aircraft
- Operational measures
- APU usage
- Measurements?



Photo by Thomas Reich

<http://www.Airliners.net>

NGO - Issues

- Impacts
 - Human Health
 - Environment
 - Air Quality Standards
- Capacity limits



NGO - actions

- Lobby industry, Government...
- Campaigning
- Raise the profile – focus on potential environmental and human impacts



Different players – different views

- The need for dialogue
- The need for appreciating different views and perspectives
- The need for common data sets

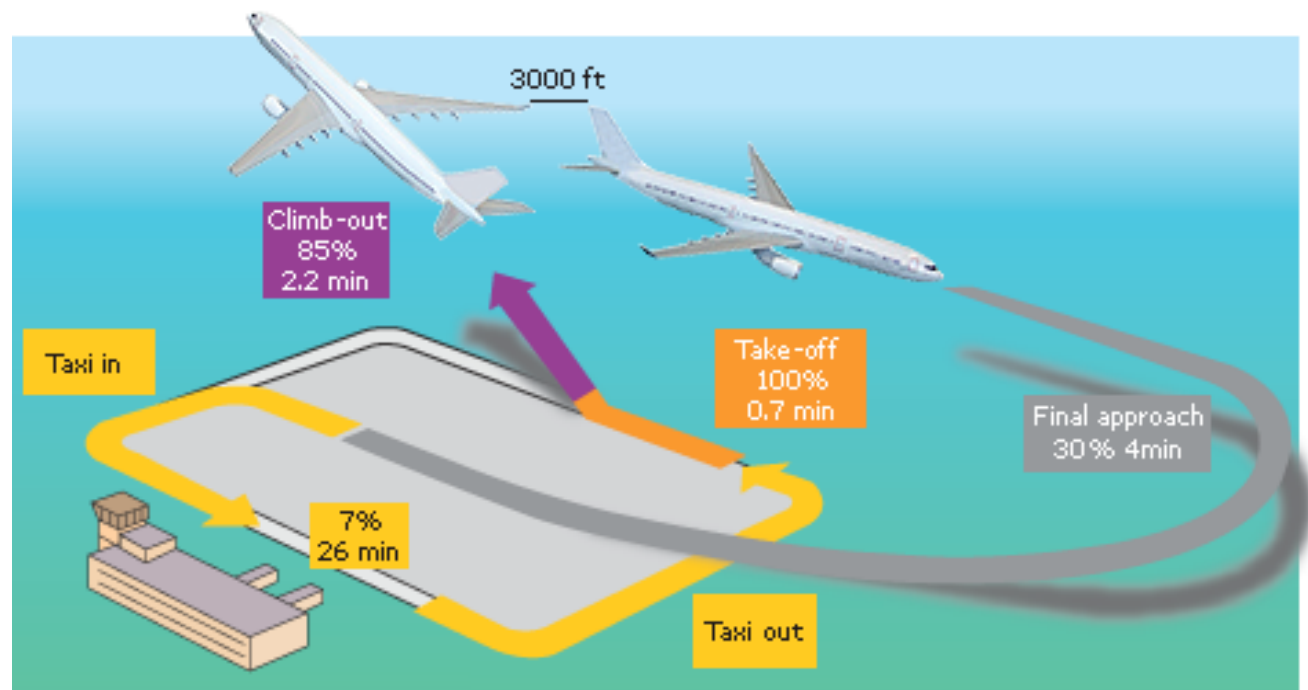


Findings

- Air quality is a capacity constraint issue
- Significant unknowns
 - Pollutant profile
 - Plume dynamics and chemistry
 - Source strengths
 - Impacts on human health
 - Impacts on the environment

Aircraft emissions

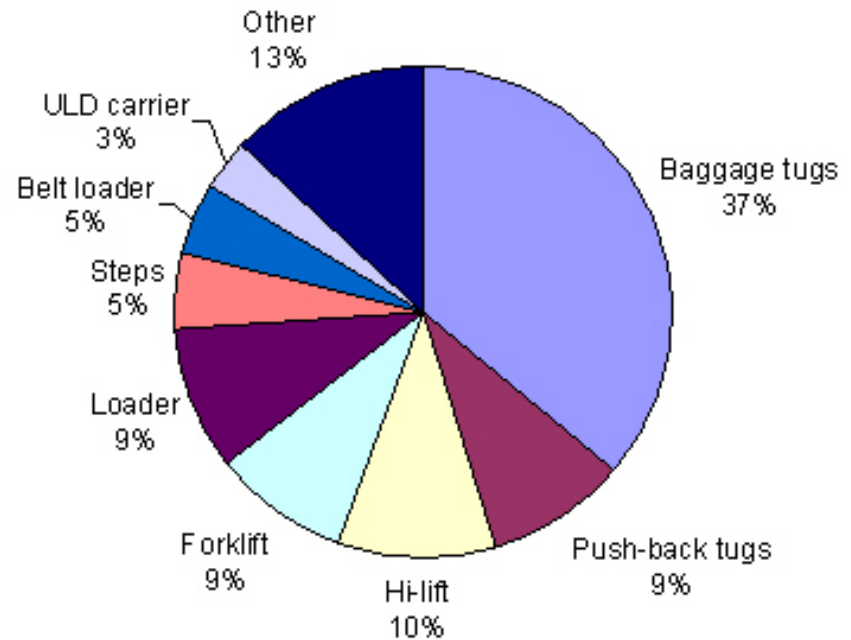
- Landing take off cycle (LTO)
 - taxi
 - idle
 - takeoff
 - approach
 - climb-out
- APU



These operational times are in reality *airport specific / aircraft specific / fleet specific*

Airside emissions

- Ground support vehicles
 - belt loaders
 - tugs
 - catering
 - lav trucks
- Compressors
- Airport vehicles
 - tankers
 - ops



Breakdown of specialist vehicles
at London Heathrow

Airside emissions

- Boiler house / power plant
- Fuel storage
 - breathing loss
 - working loss
 - spillages
- Maintenance

Landside emissions

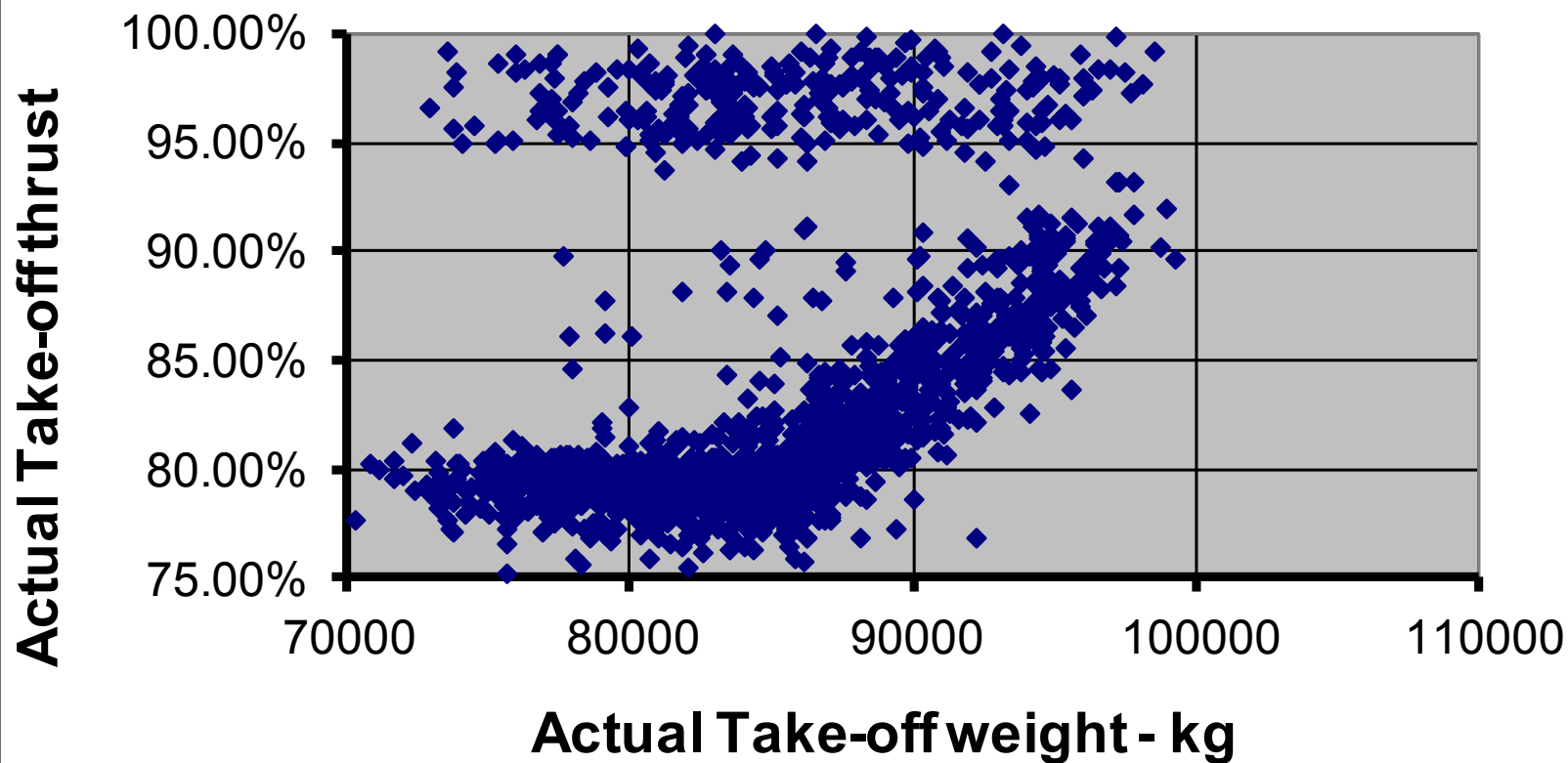
- Road vehicles
 - filling stations
 - car parks
- Coaches
- Heavy rail
- Taxis

Accurate data - fleet mix - speed - number

Typical aero-engine emission indices (g/kg)

Species	Operating Conditions		
	Idle	Take-off	Cruise
CO ₂	3160	3160	3160
H ₂ O	2130	1230	1230
CO	25 (10-65)	<1	1-3.5
HC (as CH ₄)	4 (0-12)	<0.5	0.2-1.3
NO _x -Short haul -Long haul	4.5 (3-6) 4.5 (3-6)	32 (20-65) 27 (10-53)	7.9-11.9 11.1-15.4
SO _x (as SO ₂)	1.0	1.0	1.0

Boeing 757-200, RB211-535C, at LHR



Monitoring

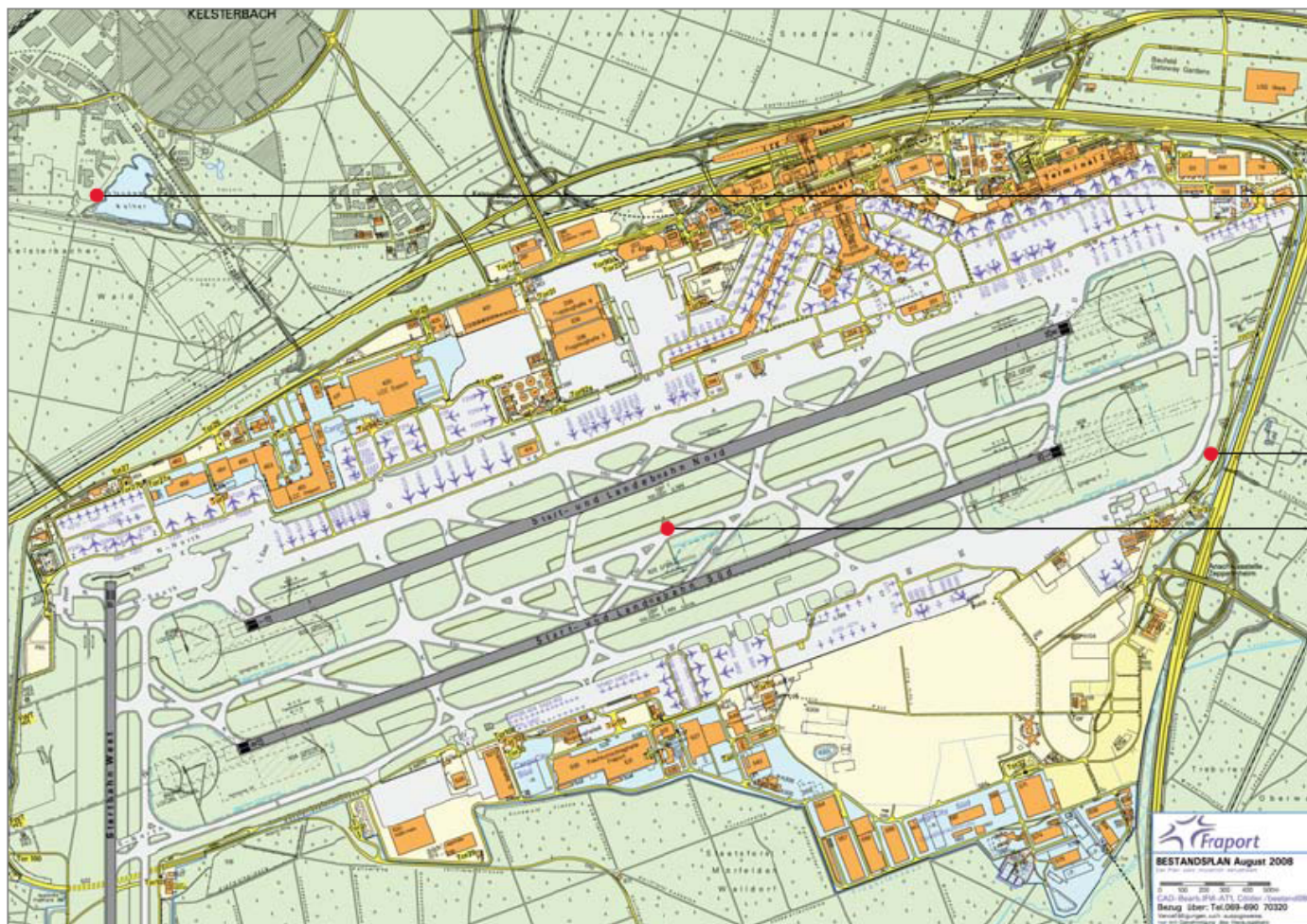
Current routine monitoring permits:-

- Comparison with regulatory limits.
- Identification of trends.
- Some source attribution (*possible, e.g. at Heathrow, where runway usage varies on a strict timetable*).

Practical difficulties:-

- Access to airfield.
- Power, security etc.

Routine monitoring: Frankfurt International Airport

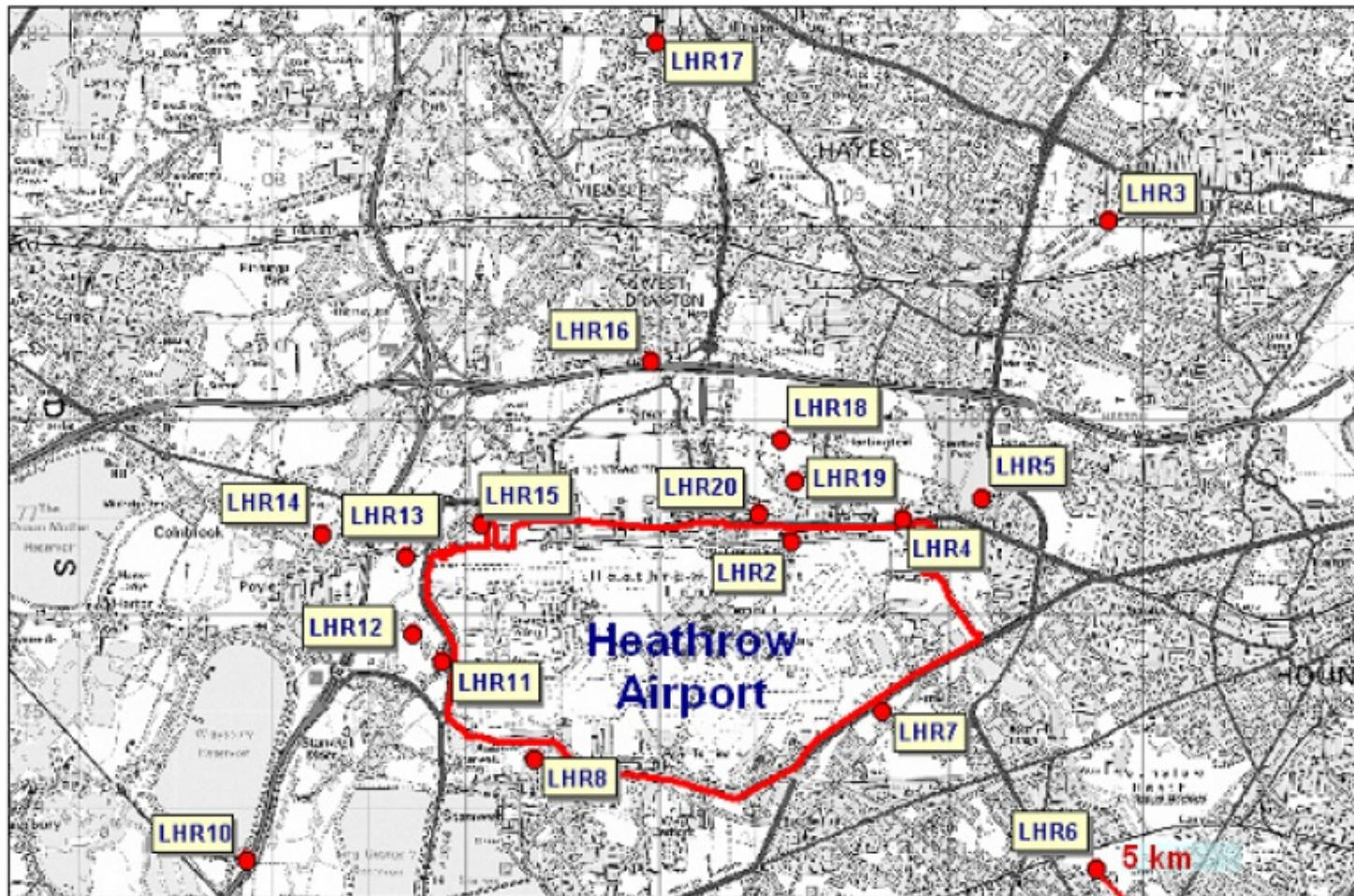


NOx-Sondermessung

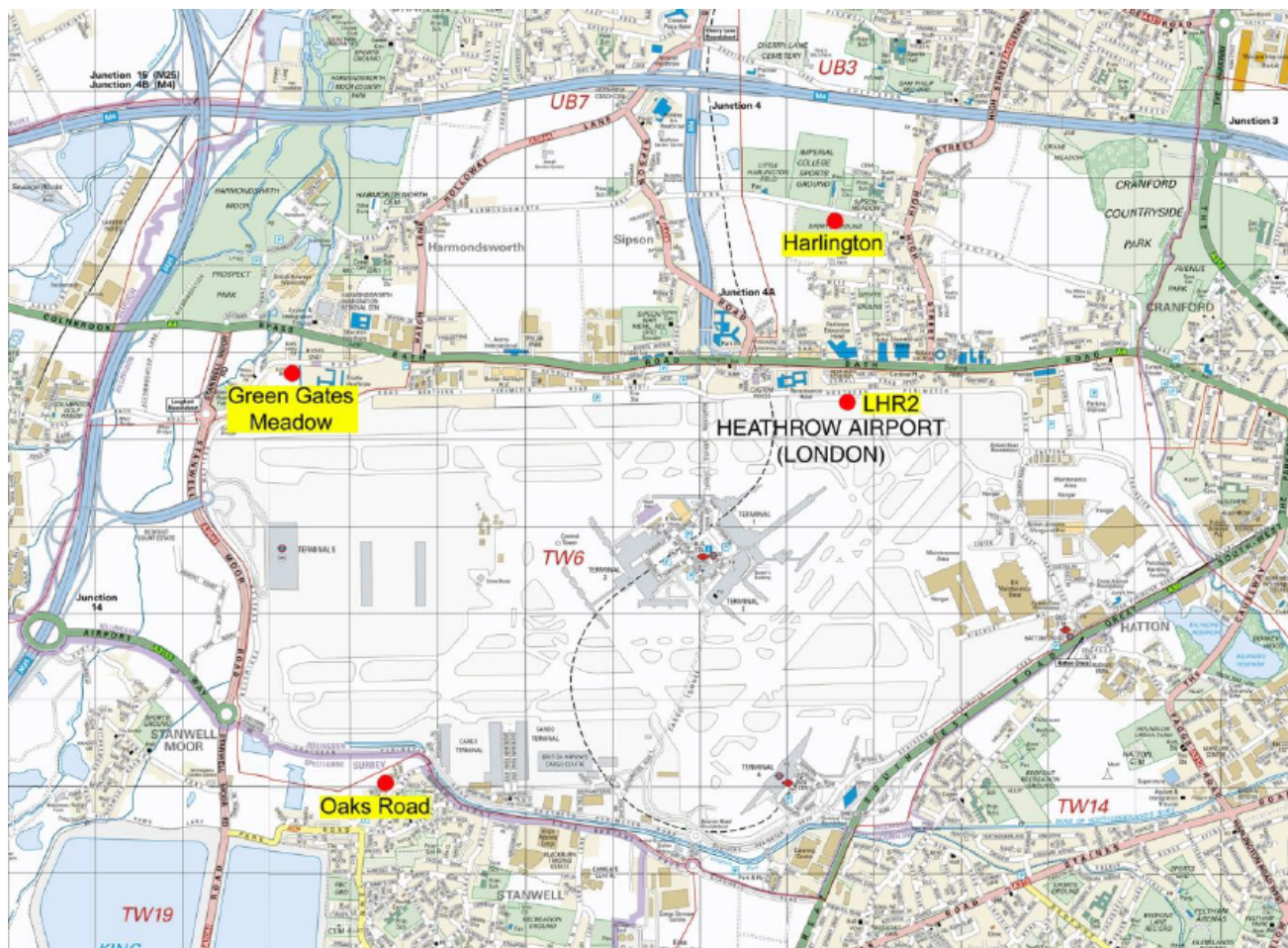
SOMMI 1

SOMMI 2

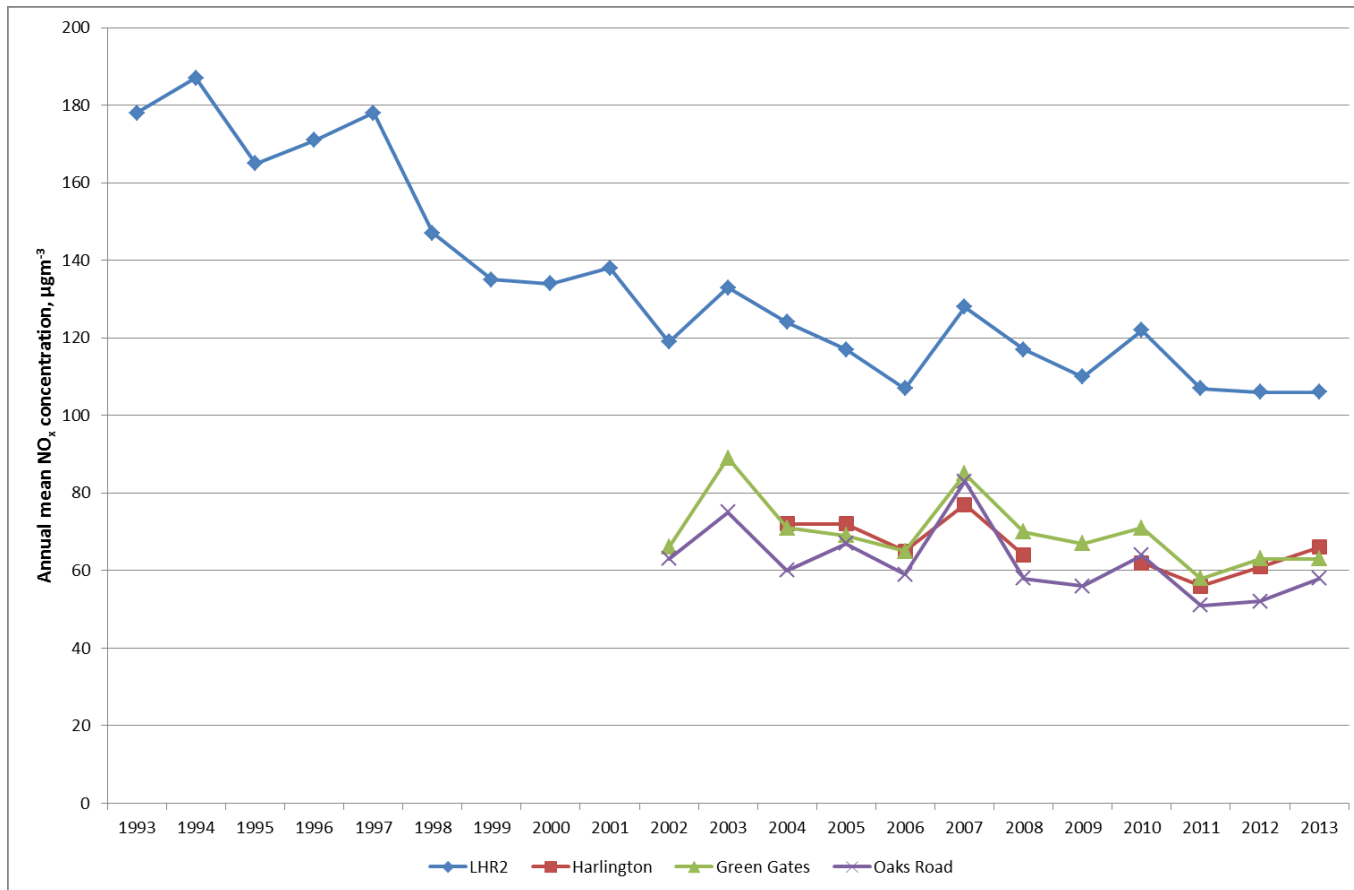
Monitoring at Heathrow Airport for the 'Project for the Sustainable Development of Heathrow'



Air quality monitoring at Heathrow Airport

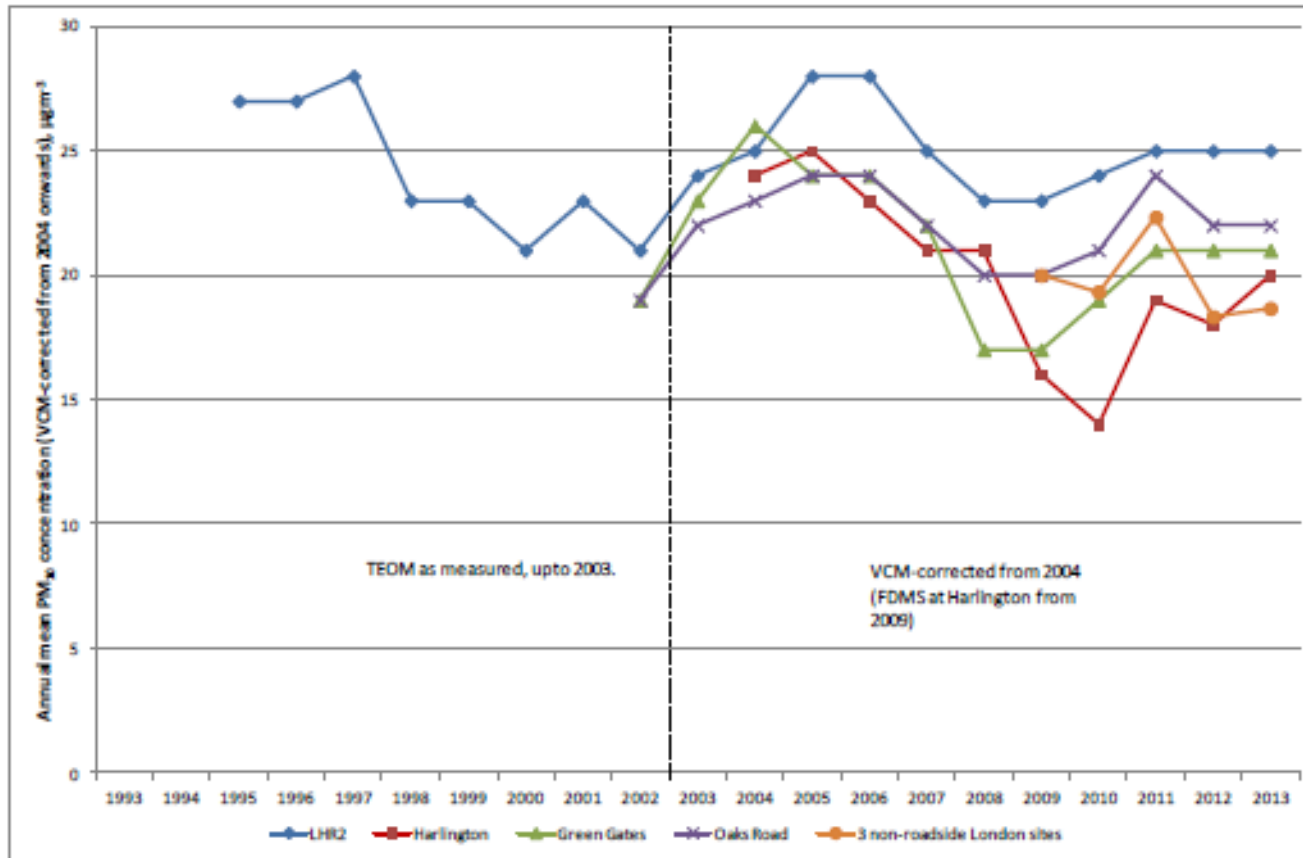


Trend in NO₂ at Heathrow Airport



Ricardo-AEA (2014) Air Quality at Heathrow Airport – Annual Report for 2013, available at <http://www.heathrowairwatch.org.uk/reports>

Trend in PM₁₀ at Heathrow Airport



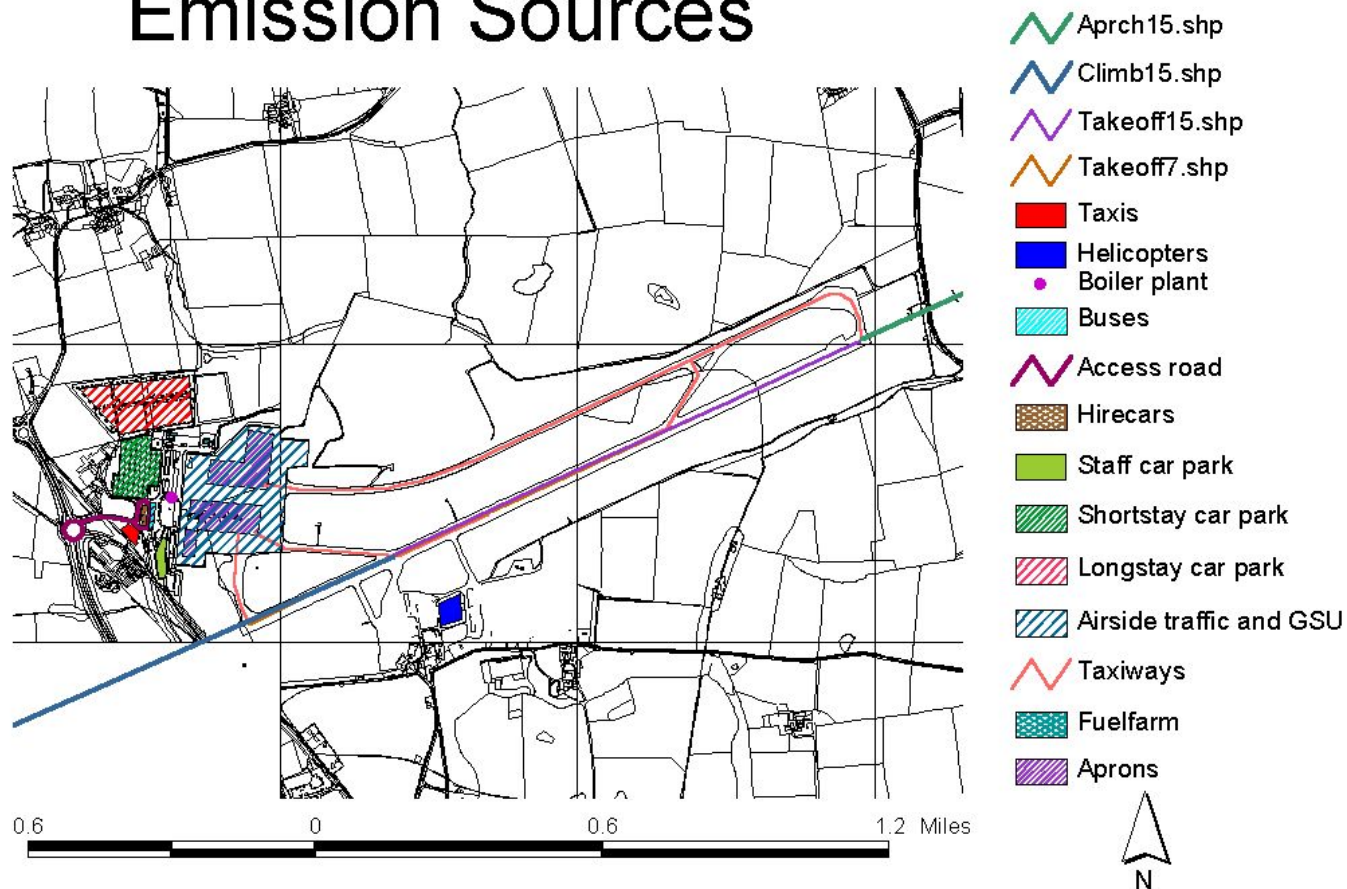
Ricardo-AEA (2014) Air Quality at Heathrow Airport – Annual Report for 2013, available at <http://www.heathrowairwatch.org.uk/reports>

Emissions Inventory – Spatial Scale

- There is no prescriptive way to delimit the inventory
- Need to work with regional partners and stake holders
- Develop emissions inventory so that it is compatible with other inventories

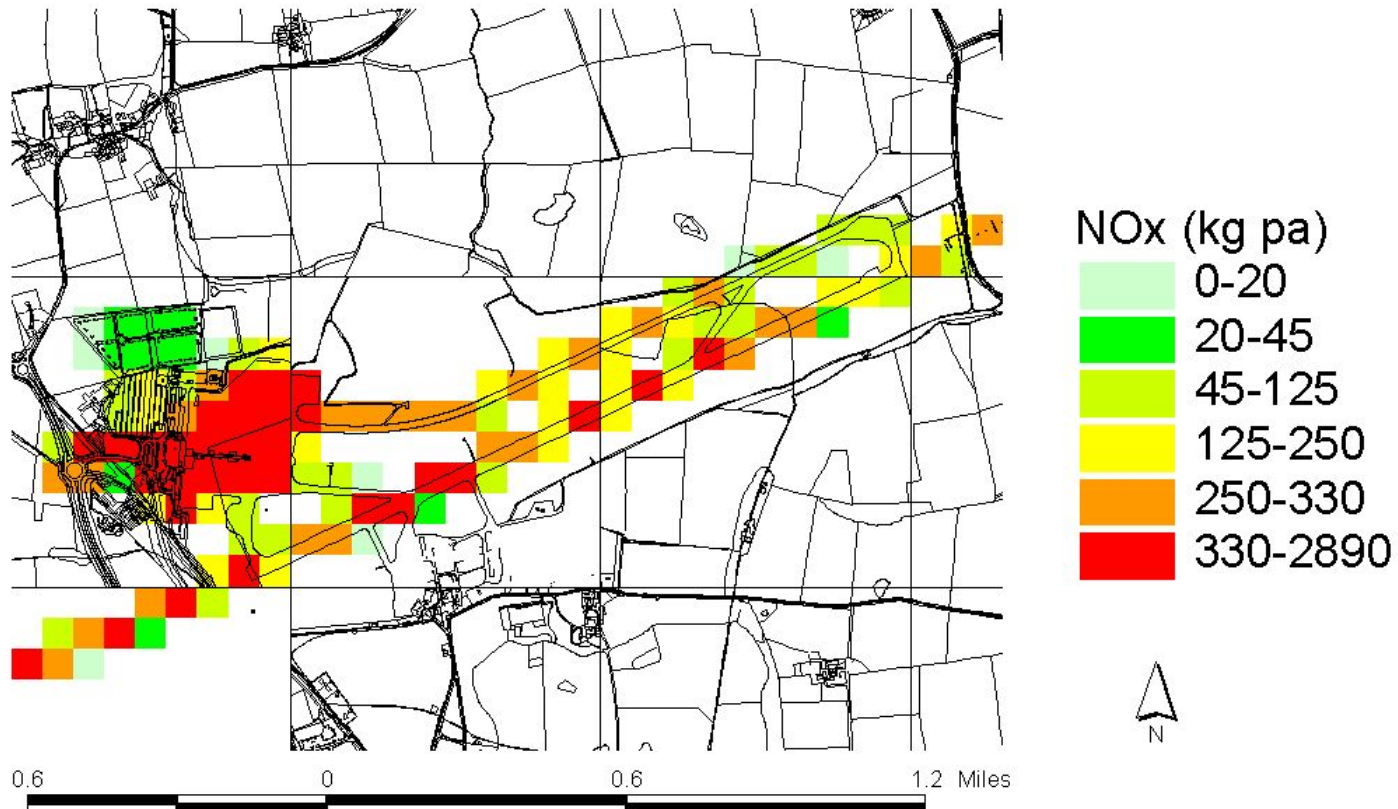
Location of emission sources

Emission Sources



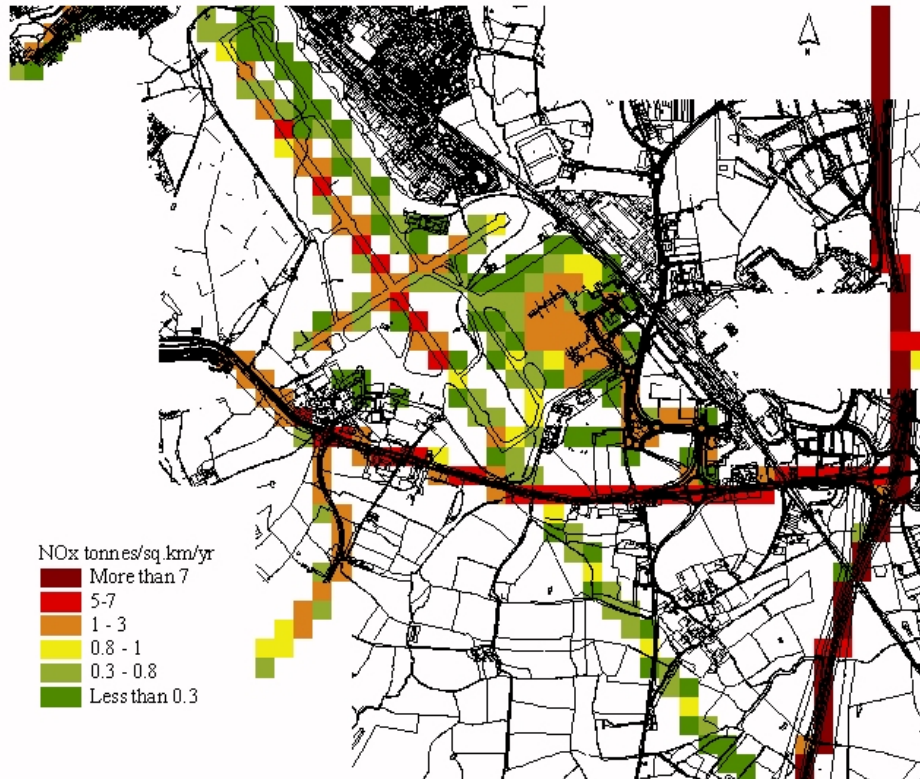
NOx emissions

Nitrogen Oxides Emissions



NOx emissions

Emissions of NOx from all sources at Birmingham International Airport



"Reproduced from the Ordnance Survey Mapping with the permission of the controller of Her Majesty's Stationery Office"

Regional emissions inventory



Modelling

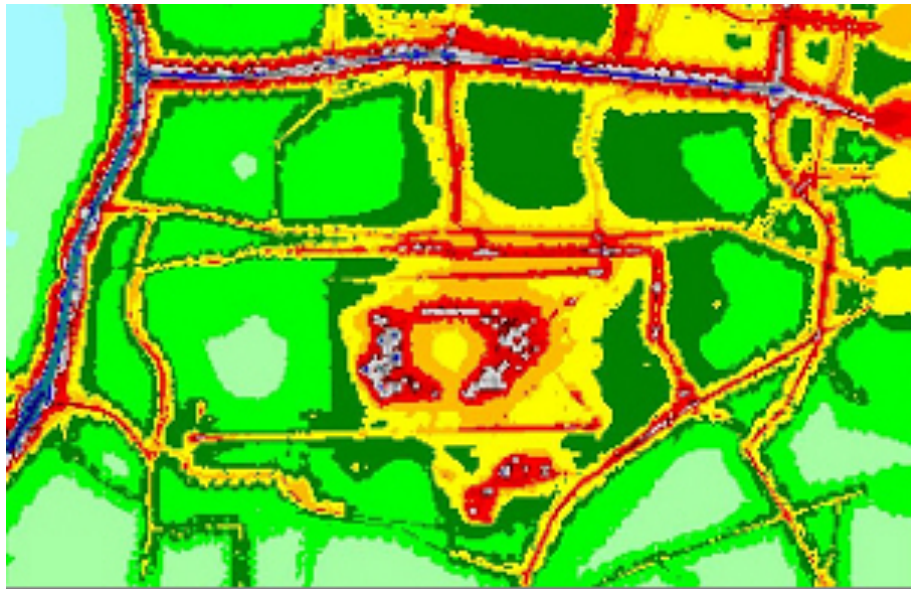
Regulatory modelling of pollution dispersion has two purposes:-

1. Planning for future developments (*e.g. Project for the Sustainable Development of Heathrow*).
2. Attribution of the currently observed concentrations.

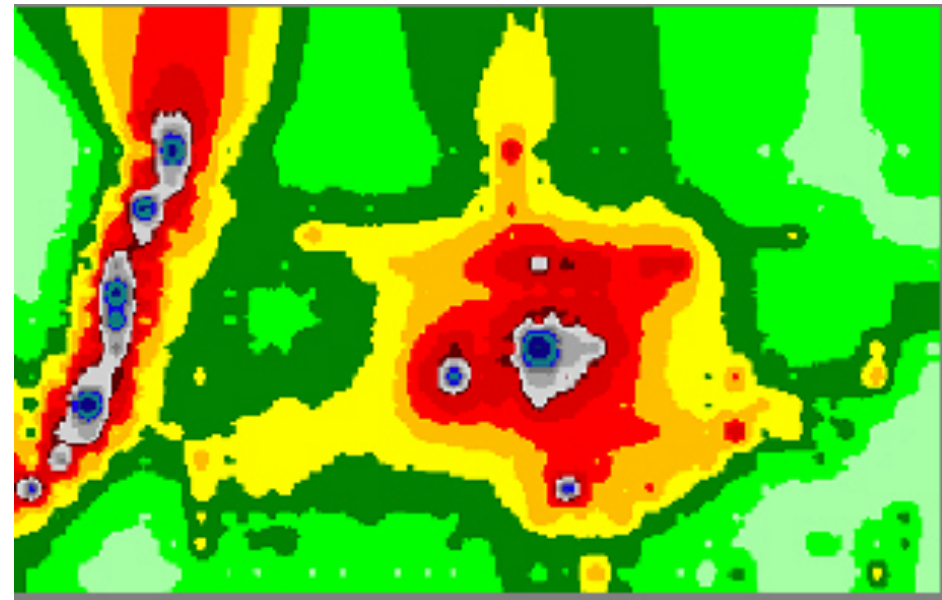
Existing dispersion models (ADMS, Lasport) have been adapted to predict LAQ at airports. (*But an aircraft is not a chimney on its side . . .*)

Emissions inventory for Heathrow contains hundreds of thousand of sources.

Modelling output



Mean annual NO₂ µgm⁻³



Mean annual NO₂ µgm⁻³

Summary

- Air travel is growing by 3 - 5% per annum
- Ground level emissions are increasing from a number of sources around airports
 - intermodal transport hubs
- New air quality legislation (UK and EU)
- Significant unknowns
- Industry response may not be enough to meet new standards

Any questions?