



Ricardo
Energy & Environment

Open Data Services for Air Quality Scotland

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22 March 2016

Agenda for this session

- Introduction to Open Data Services?
- Why have they been introduced?
- What are the benefits & objectives?
- Demonstration of the new Air Quality Scotland open data services
- Some helpful URLs to wider open data sharing initiatives

What are Open Data Services for air quality?

- A new data sharing mechanism for Air Quality Scotland & Europe
- A mechanism based on recognised internet & open data standards
- Data download can be automated
- Machine readable – based on XML encoding
- Support machine to machine data exchange
- Easily configurable to be human readable
- An API type interface to Air Quality Scotland
- Harmonised data model & vocabulary for Europe
- 28+ countries across Europe using the same air quality language

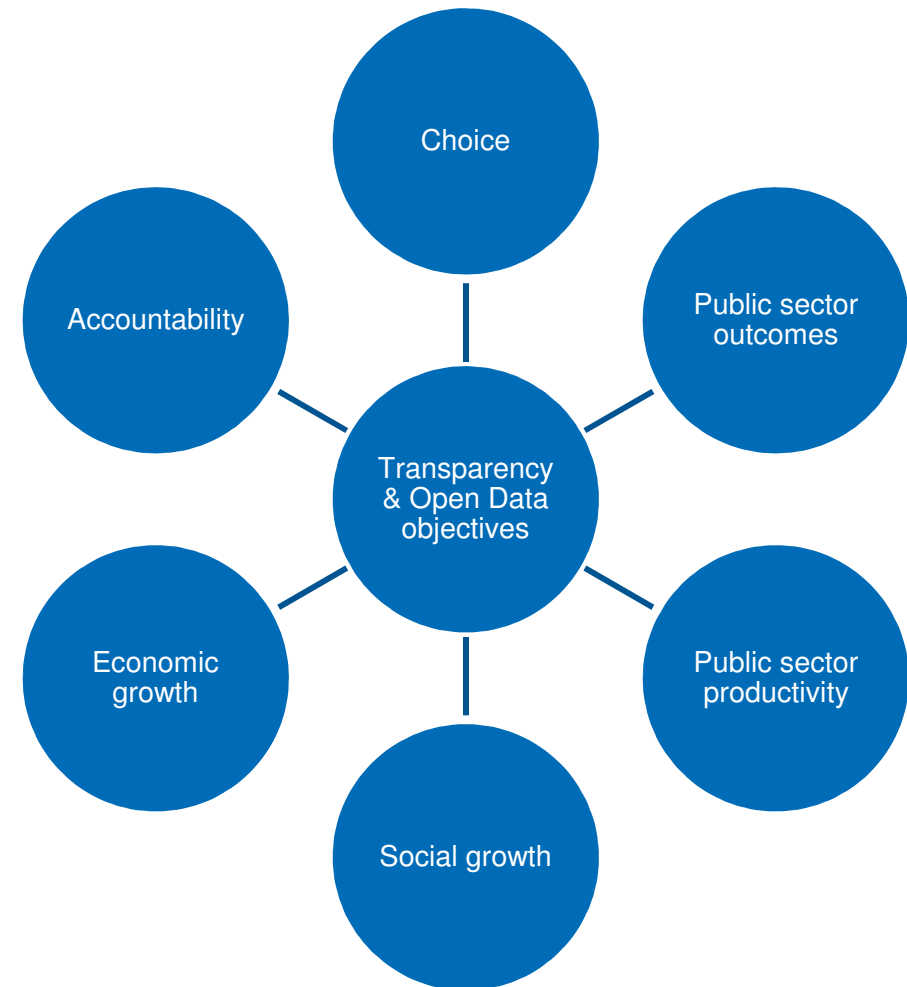
Why are they needed?

Multiple drivers

- Changing data landscape, many common themes and drivers
- The Ambient Air Quality Directive e-Reporting
- INSPIRE Directive
- Cabinet Office Transparency and Open Data agenda committed Government at all levels to
 - A 'right to data'
 - Releasing the potential of Public Sector Information wherever possible
- Changing appetite in the developer community

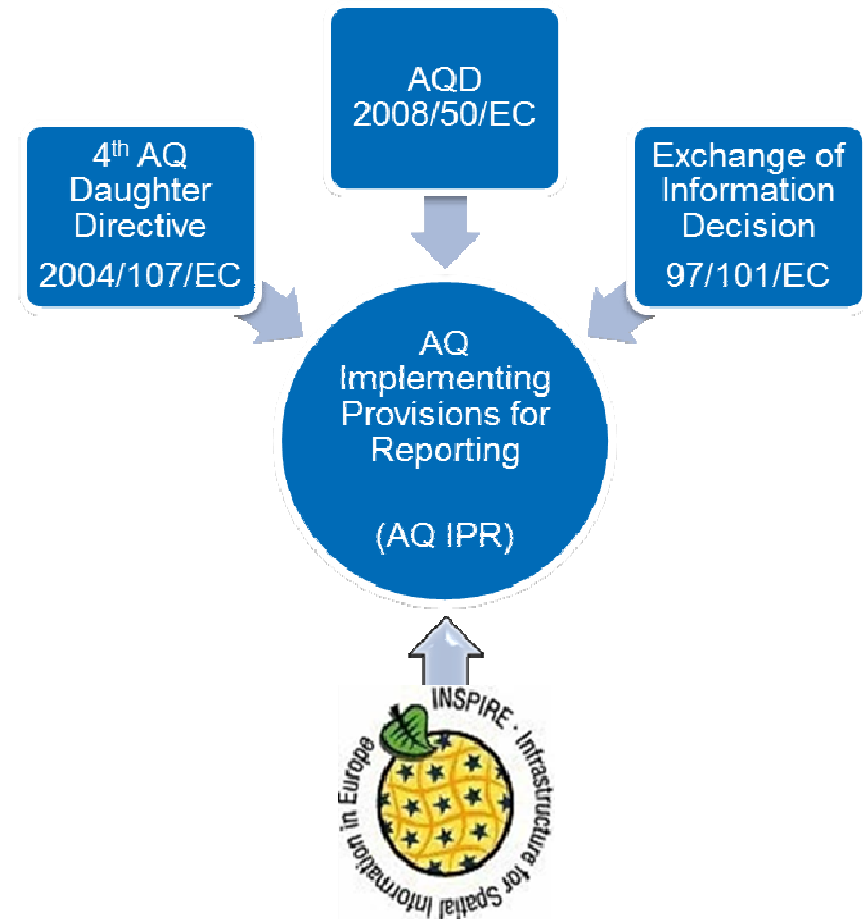
Objectives

- Better evidence base
- Better data sharing
- Better data governance



European Air Quality e-Reporting initiative

- Air Quality Scotland's Open Data Services are based on the European e-Reporting data model
- AQ e-Reporting is outcome of the modernisation programme for reporting under the Air Quality Directive
- AQ e-Reporting provides a new framework for reporting AQ information at a European level under the Air Quality Directive
- Upgrades standards for data encoding and sharing
- Streamlines duplication in reporting
- Reinforces internal consistency
- Uses machine readable formats to facilitate automated sharing QA/QC & processing
- Uses INSPIRE principles, concepts and standards



What does it mean in practice ?

- Human readable reports & report content
- Decision 2004/461/EC, spreadsheet template Form 2 (+ shapefiles)

Form 2 Delimitation of zones and agglomerations (96/62/EC Articles 5 and 11(1b) and 2008/50/EC Articles 4 and 22)					
	Zones				
Full zone name	Greater London Urban Area	West Midlands Urban Area	Greater Manchester Urban Area	West Yorkshire Urban Area	Tyneside
Zone code	UK0001	UK0002	UK0003	UK0004	UK0005
Pollutant(s), possibly separate protection targets, to which the zone applies	A;M	A;M	A;M	A;M	A;M
Type (ag/nonag)	ag	ag	ag	ag	ag
Area (km ²)	1618	605	554	352	221
Population	7807696	2120435	1863849	1176821	731847
Art.22 application	P				
Zone boundary source (geospatial file/ LAU2 list)	+513325.59-000544.48	+523725.58-015507.47	+533841.75-021836.50	+535315.87-014401.38	+545738.94-013634.29
Zone geospatial file name	+512434.95+000558.27	+523623.09-015627.34	+533823.50-021903.59	+535257.63-014334.11	+545704.83-012712.46
LAU2 code(s)	+512434.02+000650.00	+523623.06-015534.17	+533855.86-021903.83	+535257.75-014428.88	+545705.07-012808.67
	+512434.02+000650.00	+523655.43-015534.12	+533856.00-021809.37	+535330.11-014428.68	+545705.32-012904.89

What does it mean in practice ?

● Become machine readable

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Created by GO Publisher Desktop 2.1.2 Build 28125 from 2012-03-22 11:26 -->
<!-- Snowflake Software Ltd. (http://www.snowflakesoftware.com) -->
<gml:FeatureCollection xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:wfs="http://www.opengis.net/wfs/2.0" xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:ows="http://www.opengis.net/ows/1.1" xmlns:fes="http://www.opengis.net/fes/2.0" xmlns:aqd="http://aqd.ec.europa.eu/aqd/0.2" xmlns:base="urn:x-inspire:specification:gmlas:BaseTypes:3.2"
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  xmlns:gts="http://www.isotc211.org/2005/gts" xmlns:gsr="http://www.isotc211.org/2005/gsr" xmlns:base2="http://inspire.ec.europa.eu/schemas/base2/0.1rc2" xmlns:sc="http://www.interactive-
  instruments.de/ShapeChange/AppInfo" xmlns:ad="urn:x-inspire:specification:gmlas:Addresses:3.0" xmlns:bu="http://inspire.jrc.ec.europa.eu/schemas/bu/2.0" xmlns:tn-a="urn:x-
  inspire:specification:gmlas:AirTransportNetwork:3.0" xmlns:tn="urn:x-inspire:specification:gmlas:CommonTransportElements:3.0" xmlns:gn="urn:x-inspire:specification:gmlas:GeographicalNames:3.0" xmlns:net="urn:x-
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  vector="http://inspire.jrc.ec.europa.eu/schemas/su-vector/2.0" xmlns:su-core="http://inspire.jrc.ec.europa.eu/schemas/su-core/2.0" xmlns:hh="http://inspire.jrc.ec.europa.eu/schemas/hh/2.0"
  xmlns:ef="http://inspire.jrc.ec.europa.eu/schemas/ef/2.0" xmlns:om="http://www.opengis.net/om/2.0" xmlns:sd="http://inspire.jrc.ec.europa.eu/schemas/sd/2.0" xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0"
  xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:cp="urn:x-inspire:specification:gmlas:CadastralParcels:3.0" xmlns:am="http://inspire.ec.europa.eu/schemas/am/3.0rc2"
  xmlns:ompr="http://inspire.ec.europa.eu/schemas/ompr/2.9" xmlns:sams="http://www.opengis.net/samplingSpatial/2.0" xmlns:sam="http://www.opengis.net/sampling/2.0"
  xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd http://aqd.ec.europa.eu/aqd/0.2 http://dd.eionet.europa.eu/schemas/id2011850eu_v05/AirQualityReporting.xsd"
  gml:id="zones">
  <gml:featureMember>
    <- aqd:AQD_ReportingHeader gml:id="ReportingHeader_1">
      <aqd:change>false</aqd:change>
      <aqd:changeDescription>Information has not been change since 2000</aqd:changeDescription>
      + <aqd:inspireId>
      + <aqd:reportingAuthority>
      - <aqd:reportingPeriod>
        <- gml:TimePeriod gml:id="ReportingTimePeriod_1">
          <gml:beginPosition>2010-01-01T00:00:00.000</gml:beginPosition>
          <gml:endPosition>2011-01-01T00:00:00.000</gml:endPosition>
          </gml:TimePeriod>
        </aqd:reportingPeriod>
      - <aqd:content>
        <- aqd:AQD_Zone gml:id="Zone_UK0001">
          <- <am:inspireId>
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              <base:namespace>AQD_UK</base:namespace>
            </base:Identifier>
          </am:inspireId>
          <am:name>
            <- <am:geometry>
              <- <gml:Polygon gml:id="FID_1" srsName="urn:ogc:def:crs:EPSG::27700">
                <- <gml:exterior>
                  <- <gml:LinearRing>
                    <gml:posList srsDimension="2">527336.6875 159888.671875 527355.75 159897.265625 527355.125 159899.109375 527438.875 159946.5 527581.5 159951.96875 527600.75
                    159968.625 527637 159999.953125 527587.5 160204.546875 527609.875 160398.25 527685.4375 160401.359375 527692.125 160456.15625 527721.6875 160336.75 527648.25
                    160305.3125 527664.5625 160265.734375 527724.5625 160274.484375 527769.9375 160152.140625 527771.875 160035.15625 527852.75 160076.890625 527859.6875
                    160054.03125 527810.3125 159969.578125 527728.3125 159945.5 527701.5 159888.09375 527709.5625 159917.0625 527671.9375 159904.78125 527648.3125 159897.0625
                    527665.8125 159729.609375 527638 159394.640625 527791.0625 159389.203125 527882.875 159385.953125 527844.1875 159281.0625 527819.3125 159213.703125 527826.5
                    159159.703125 527941.125 159035.609375 528060.125 159046.015625 528091 159048.71875 528245.8125 159207.25 528187.3125 528561.125 159648.953125
                    528414.625 159899.5 528358.25 159916.65625 528287.3125 160000 528194 160160.765625 528468 160306.828125 528456.875 160375.40625 528572 160416.578125
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                  </gml:LinearRing>
                </gml:exterior>
              </gml:Polygon>
            </am:geometry>
          </am:name>
        </aqd:AQD_Zone>
      </aqd:content>
    </aqd:ReportingHeader>
  </gml:featureMember>
</gml:FeatureCollection>
```

What's included in Air Quality Scotland's beta services?

Better attribute data

- Large gap filling task carried out
- Ensured consistency data holdings
- Needed to support the e-Reporting data model

A register of air quality objects

- AQ objects (stations, sampling points, inlets) identified by persistent http IDs
- Http IDs make attribute data accessible via the internet

Atom feeds for bulk downloads

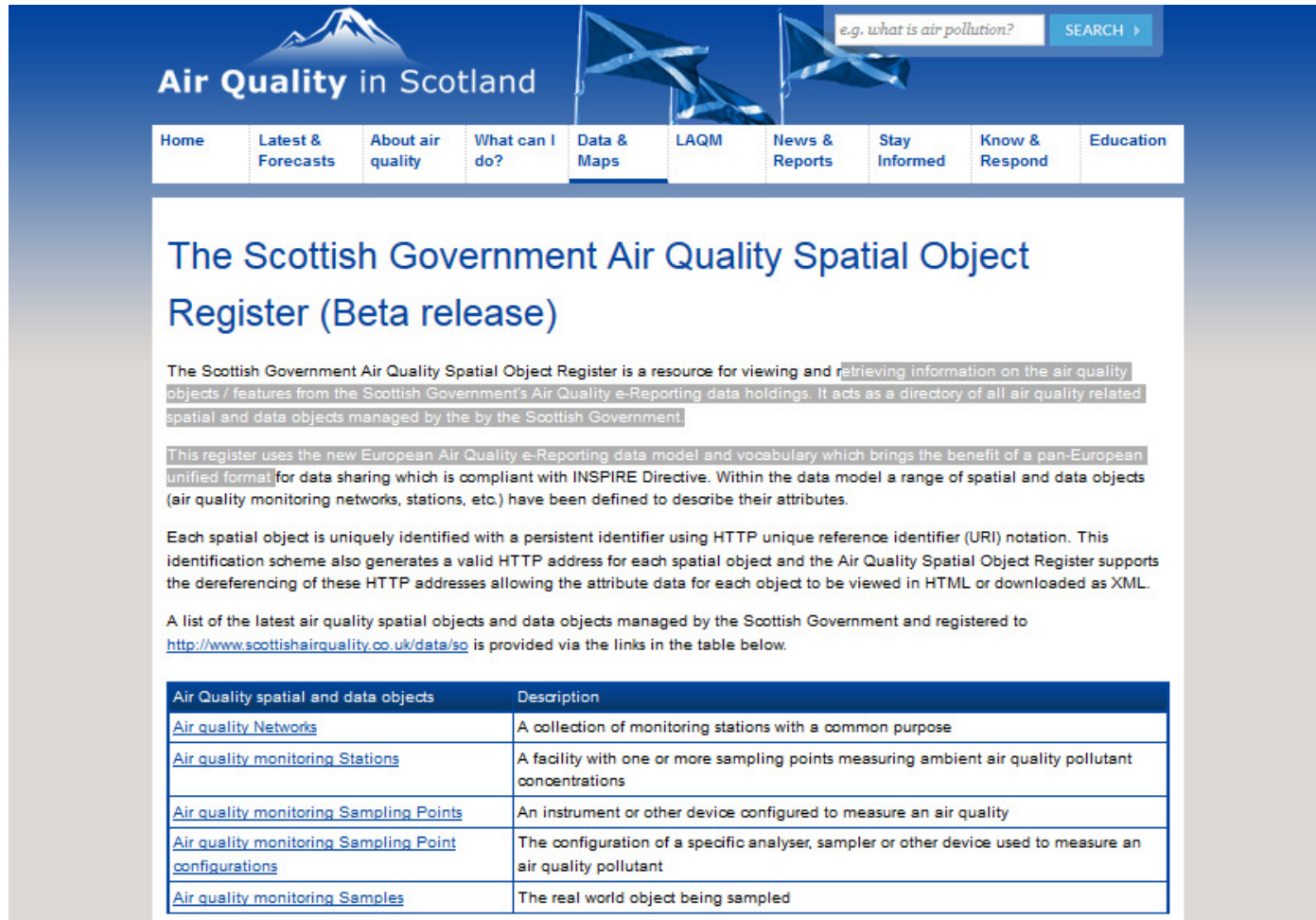
- Support for users wanting to download lots of data
- INSPIRE compliant download service

Sensor Observation Service (SOS)

- User driven API type interface
- Fast & flexible (XML, JSON, REST, SOAP etc.)
- INSPIRE compliant download service

Air Quality Scotland Spatial Objects Register

- Supports governance of Air Quality Scotland & UK air quality data holdings
- <http://preview.scotarc.aeat.com/data/so/about/>



The screenshot shows the 'Air Quality in Scotland' website. The header includes a search bar with the text 'e.g. what is air pollution?' and a 'SEARCH' button. Below the header is a navigation menu with links: Home, Latest & Forecasts, About air quality, What can I do?, Data & Maps, LAQM, News & Reports, Stay Informed, Know & Respond, and Education. The main content area is titled 'The Scottish Government Air Quality Spatial Object Register (Beta release)'. It contains a paragraph explaining the register's purpose, a paragraph about the data model, and a paragraph about the unique identifier (URI) for each spatial object. Below this is a table listing the latest air quality spatial and data objects managed by the Scottish Government.

The Scottish Government Air Quality Spatial Object Register (Beta release)

The Scottish Government Air Quality Spatial Object Register is a resource for viewing and retrieving information on the air quality objects / features from the Scottish Government's Air Quality e-Reporting data holdings. It acts as a directory of all air quality related spatial and data objects managed by the by the Scottish Government.

This register uses the new European Air Quality e-Reporting data model and vocabulary which brings the benefit of a pan-European unified format for data sharing which is compliant with INSPIRE Directive. Within the data model a range of spatial and data objects (air quality monitoring networks, stations, etc.) have been defined to describe their attributes.

Each spatial object is uniquely identified with a persistent identifier using HTTP unique reference identifier (URI) notation. This identification scheme also generates a valid HTTP address for each spatial object and the Air Quality Spatial Object Register supports the dereferencing of these HTTP addresses allowing the attribute data for each object to be viewed in HTML or downloaded as XML.

A list of the latest air quality spatial objects and data objects managed by the Scottish Government and registered to <http://www.scottishairquality.co.uk/data/so> is provided via the links in the table below.

Air Quality spatial and data objects	Description
Air quality Networks	A collection of monitoring stations with a common purpose
Air quality monitoring Stations	A facility with one or more sampling points measuring ambient air quality pollutant concentrations
Air quality monitoring Sampling Points	An instrument or other device configured to measure an air quality
Air quality monitoring Sampling Point configurations	The configuration of a specific analyser, sampler or other device used to measure an air quality pollutant
Air quality monitoring Samples	The real world object being sampled

Air Quality Scotland Spatial Objects Register

- Supports governance using persistent http identifiers for all Air Quality Scotland objects
- <http://preview.scotarc.aeat.com/data/so/stations/>



The screenshot shows the 'Air Quality in Scotland' website. The header features a blue background with a mountain and flags. A search bar contains the text 'e.g. what is air pollution?' and a 'SEARCH' button. Below the header is a navigation menu with links: Home, Latest & Forecasts, About air quality, What can I do?, Data & Maps (highlighted), LAQM, News & Reports, Stay Informed, Know & Respond, and Education.

Scottish Government's Air Quality Spatial Object Registry (Beta release)

Air quality Stations registered to <http://www.scottishairquality.co.uk/data/so>

- [SCT_Station_ABD](#)
- [SCT_Station_ABD0](#)
- [SCT_Station_ABD1](#)
- [SCT_Station_ABD2](#)
- [SCT_Station_ABD3](#)
- [SCT_Station_ABD8](#)
- [SCT_Station_ACTH](#)
- [SCT_Station_AD1](#)
- [SCT_Station_AFR1](#)
- [SCT_Station_ALO2](#)
- [SCT_Station_ALOA](#)
- [SCT_Station_AYR](#)
- [SCT_Station_BRX](#)
- [SCT_Station_BUSH](#)
- [SCT_Station_CARK](#)
- [SCT_Station_CUMN](#)
- [SCT_Station_CUPA](#)

Air Quality Scotland Spatial Objects Register

- Supports human readable content
- http://preview.scotarc.aeat.com/data/so/SCT_Station_ABD

Air Quality e-Reporting Attribute Data for Scottish Stations

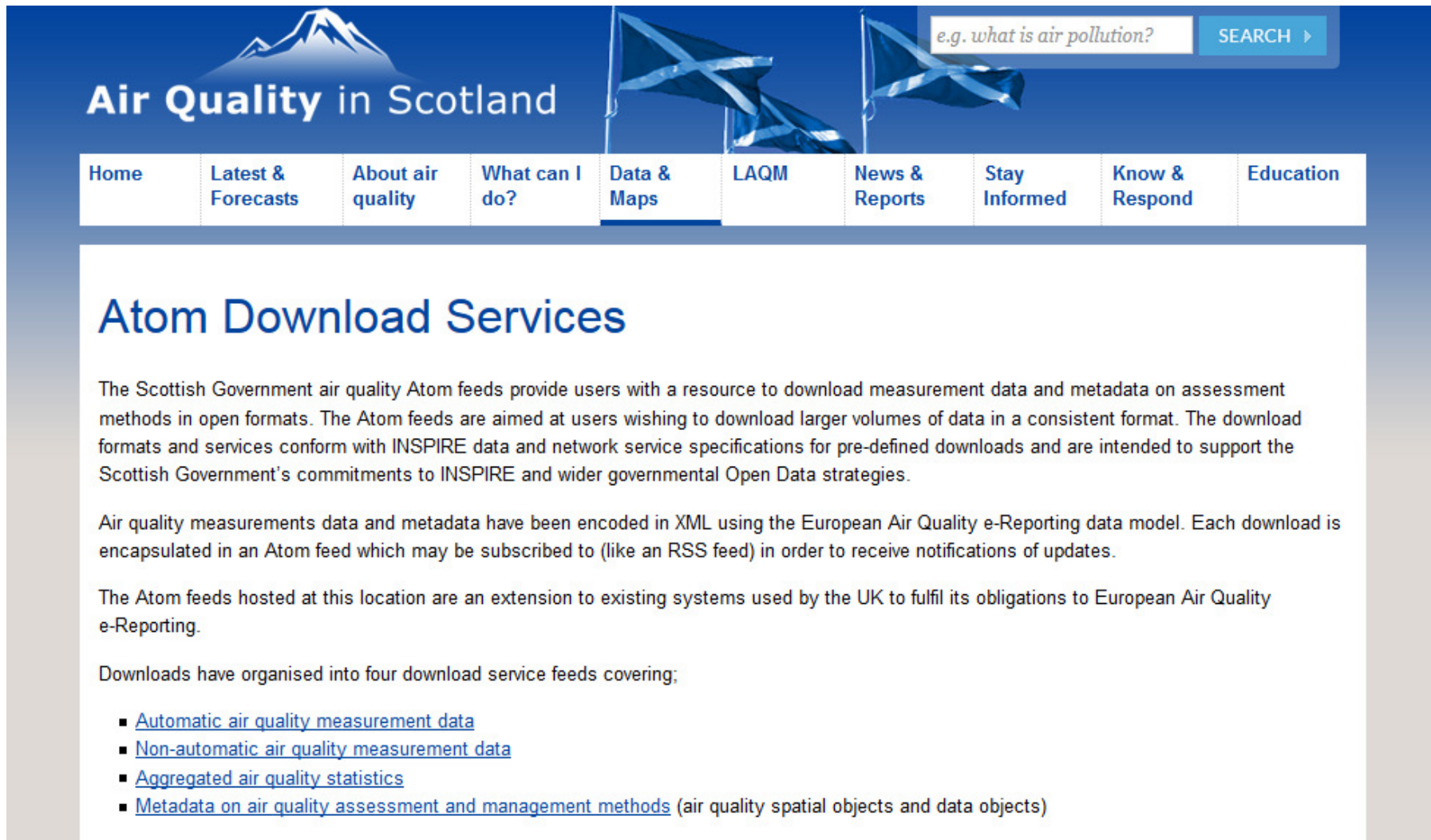
gml:id	SCT_Station_ABD	
base:Identifier	base:localId	SCT_Station_ABD
	base:namespace	http://www.scottishairquality.co.uk/data/so
	base:versionId	17-03-2016
ef:name	Aberdeen Errol Place	
gml:Point/srsName	urn:ogc:def:crs:EPSG::4258	
gml:Point/gml:pos	57.157360 -2.094278	
aqd:municipality		
ef:measurementRegime	http://dd.eionet.europa.eu/vocabulary/inspire/M MeasurementRegimeValue/continuousDataCollection	
ef:mobile	false	
gml:TimePeriod	gml:beginPosition	1999-09-18T12:00:00Z
	gml:endPosition	
ef:belongsTo	http://www.scottishairquality.co.uk/data/so/SCT_Network_1	
aqd:natlStationCode	Aberdeen Errol Place	
aqd:EUStationCode	not-applicable	
aqd:stationInfo	http://www.scottishairquality.co.uk/latest/site-info?site_id=ABD	
aqd:areaClassification	http://dd.eionet.europa.eu/vocabulary/aq/areaclassification/urban	
aqd:altitude	5	
aqd:areaClassification	http://dd.eionet.europa.eu/vocabulary/aq/areaclassification/urban	

- Supports machine readable content
- http://preview.scotarc.aeat.com/data/so/SCT_Station_ABD?format=application/xml

```
- <gml:FeatureCollection xsi:schemaLocation="http://dd.eionet.europa.eu/schemaset/id2011850eu-1.0 http://dd.eionet.europa.eu/schemas/id2011850eu-1.0/AirQualityReporting.xsd" gml:id="SCT_Station">
- <gml:featureMember>
- <aqd:AQD_Station gml:id="SCT_Station_ABD">
- <ef:inspireId>
- <base:Identifier>
- <base:localId>SCT_Station_ABD</base:localId>
- <base:namespace>http://www.scottishairquality.co.uk/data/so</base:namespace>
- <base:versionId>17-03-2016</base:versionId>
- </base:Identifier>
- </ef:inspireId>
- <ef:name>Aberdeen Errol Place</ef:name>
- <ef:mediaMonitored xlink:href="http://inspire.ec.europa.eu/codeList/MediaValue/air"/>
- <ef:geometry>
- <gml:Point srsName="urn:ogc:def:crs:EPSG::4258" gml:id="Point_1">
- <gml:pos srsDimension="2">57.157360 -2.094278</gml:pos>
- </gml:Point>
- </ef:geometry>
- <ef:measurementRegime xlink:href="http://dd.eionet.europa.eu/vocabulary/inspire/MasurementRegimeValue/continuousDataCollection" xsi:nil="true"/>
- <ef:mobile>>false</ef:mobile>
- <ef:operationalActivityPeriod>
- <ef:OperationalActivityPeriod gml:id="StationActivity_1">
- <ef:activityTime>
- <gml:TimePeriod gml:id="TimePeriod_content_1">
- <gml:beginPosition>1999-09-18T12:00:00Z</gml:beginPosition>
- <gml:endPosition indeterminatePosition="unknown"/>
- </gml:TimePeriod>
- </ef:activityTime>
- </ef:OperationalActivityPeriod>
```

Air Quality Scotland Atom feeds

- Support bulk download of historical data
- <http://preview.scotarc.aeat.com/data/atom-dls/>



The screenshot shows the 'Air Quality in Scotland' website. The header features a mountain logo and the title 'Air Quality in Scotland'. A search bar contains the text 'e.g. what is air pollution?'. A navigation menu includes links for Home, Latest & Forecasts, About air quality, What can I do?, Data & Maps (which is highlighted), LAQM, News & Reports, Stay Informed, Know & Respond, and Education.

Atom Download Services

The Scottish Government air quality Atom feeds provide users with a resource to download measurement data and metadata on assessment methods in open formats. The Atom feeds are aimed at users wishing to download larger volumes of data in a consistent format. The download formats and services conform with INSPIRE data and network service specifications for pre-defined downloads and are intended to support the Scottish Government's commitments to INSPIRE and wider governmental Open Data strategies.

Air quality measurements data and metadata have been encoded in XML using the European Air Quality e-Reporting data model. Each download is encapsulated in an Atom feed which may be subscribed to (like an RSS feed) in order to receive notifications of updates.

The Atom feeds hosted at this location are an extension to existing systems used by the UK to fulfil its obligations to European Air Quality e-Reporting.

Downloads have organised into four download service feeds covering;

- [Automatic air quality measurement data](#)
- [Non-automatic air quality measurement data](#)
- [Aggregated air quality statistics](#)
- [Metadata on air quality assessment and management methods](#) (air quality spatial objects and data objects)

- Supports automated user configured data of discrete data sets
- <http://preview.scotarc.aeat.com/data/sos/about/>



The screenshot shows the 'Air Quality in Scotland' website. The header features a mountain logo and the title 'Air Quality in Scotland'. A search bar contains the text 'e.g. what is air pollution?' and a 'SEARCH' button. A navigation menu includes links for Home, Latest & Forecasts, About air quality, What can I do?, Data & Maps (which is highlighted), LAQM, News & Reports, Stay Informed, Know & Respond, and Education. The main content area is titled 'The Scottish Government's Sensor Observation Service (Beta release)'. It contains two paragraphs of text describing the service and its capabilities, followed by a section titled 'SOS Capabilities' with further details.

Air Quality in Scotland

e.g. what is air pollution? [SEARCH](#)

- Home
- Latest & Forecasts
- About air quality
- What can I do?
- Data & Maps**
- LAQM
- News & Reports
- Stay Informed
- Know & Respond
- Education

The Scottish Government's Sensor Observation Service (Beta release)

The Scottish Government's Air Quality Sensor Observation Service (SOS) provides a machine readable access point for air pollution measurements hosted on Air Quality in Scotland. The service supports the Scottish Government's Open Data Policy.

The Scottish Air Quality SOS is based on the Open Geospatial Consortium's (OGC) Sensor Observation Service standard which has been extended to conform with INSPIRE download service specifications. The service provides an AaPI type interface to Scottish Air Quality for developers and machine to machine data transfer in open, machine readable data formats. It is not aimed at the general public nor traditional desktop air quality data users. We still recommend the resources on Air Quality in Scotland's data archive for desktop activities.

SOS Capabilities

The SOS aggregates readings from live, in-situ air quality monitoring stations and provides an interface to make sensors and sensor data archives accessible via an interoperable web based interface. The Scottish Air Quality SOS is built on a [52°North SOS implementation](#) which supports the OGC SOS versions 1.0.0, 2.0.0 and the European Air Quality e-Reporting data model (AQD version 1.0.0). A REST API is also supported.

The OGC SOS 2.0 specification has four extensions defined, three are include in the Scottish Air Quality SOS; Core, Enhanced and Result Handling. The Transactional extensions is not implemented.

A full description of the Scottish Air Quality SOS capabilities can be found at its end point using a [GetCapabilities](#) request. A brief description is provided below.

- Send a request to the SOS via URL form or POST request

<http://sos.staging.ricardo-aea.com/sos-scotland/service?service=AQD&version=1.0.0&request=GetObservation&observedProperty=http://dd.eionet.europa.eu/vocabulary/aq/pollutant/5&temporalFilter=om:phenomenonTime,After,2016-01-01T00:00:00.000Z>

<http://sos.staging.ricardo-aea.com/sos-scotland/service?service=AQD&version=1.0.0&request=GetObservation&observedProperty=http://dd.eionet.europa.eu/vocabulary/aq/pollutant/5&temporalFilter=om:phenomenonTime,After,2016-03-21T00:00:00.000Z>

```
-<gml:FeatureCollection xsi:schemaLocation="http://www.opengis.net/om/2.0 http://schemas.opengis.net/om/2.0/observation.xsd http://dd.eionet.europa.eu/schemas/id2011850eu-1.0
http://dd.eionet.europa.eu/schemas/id2011850eu-1.0/AirQualityReporting.xsd http://www.opengis.net/swe/2.0 http://schemas.opengis.net/sweCommon/2.0/swe.xsd http://www.opengis.net/gml/3.2
http://schemas.opengis.net/gml/3.2.1/gml.xsd" gml:id="fc_5087CF5512B06B7F4E6DF951D9BBDD5F07159DEA">
  -<gml:featureMember>
    -<aqd:AQD_ReportingHeader gml:id="CCACEAED1DCDE9EB64FF557579082E682FF13CCE">
      <aqd:change>false</aqd:change>
      <aqd:changeDescription/>
    -<aqd:inspireId>
      -<base:Identifier>
        <base:localId>SCT_E2a#</base:localId>
        <base:namespace>http://www.scottishairquality.co.uk/data/so</base:namespace>
        <base:versionId xsi:nil="true" nilReason="missing"/>
      </base:Identifier>
    </aqd:inspireId>
    -<aqd:reportingAuthority>
      -<base2:RelatedParty>
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        </base2:individualName>
        -<base2:organisationName>
          -<gco:CharacterString>
            Scottish Government, Directorate For Environment & Forestry, Environmental Quality
          </gco:CharacterString>
        </base2:organisationName>
      </base2:RelatedParty>
    </aqd:reportingAuthority>
  </gml:featureMember>
</gml:FeatureCollection>
```

Standardisation

- Modern IT & open standards
- Harmonised data model for Europe

INSPIRE compliance

- INSPIRE compliant data specifications
- INSPIRE compliant download services

Alignment with Open Data Strategies

- Air quality e-Reporting & INSPIRE align well with Governmental & Departmental strategies

Better Governance

- Rigorous data model
- Data model optimised for air quality

Better sharing

- More choice
- Modern IT & open standards
- Machine readable

Some useful URLs to similar initiatives

- **European Air Quality e-Reporting Portal**

<http://www.eionet.europa.eu/aqportal>

- **European up-to-date data viewer**

<http://maps.eea.europa.eu/hub/AirQuality/>

- **European Air Data Explorer (AIDE)**

[http://aide.apps.eea.europa.eu/?source={%22query%22:{%22match_all%22:{%22sort%22:\[{%22Namespace%22:{%22order%22:%22asc%22}},{%22ReportingYear%22:{%22order%22:%22asc%22}}}}}](http://aide.apps.eea.europa.eu/?source={%22query%22:{%22match_all%22:{%22sort%22:[{%22Namespace%22:{%22order%22:%22asc%22}},{%22ReportingYear%22:{%22order%22:%22asc%22}}}})

- **European up-to-date data download service**

<http://discomap.eea.europa.eu/map/fme/AirQualityUTDExport.htm>

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Apertum Consulting
tony.bush@apertum.co.uk

Questions?