Annex B
(informative)
Use cases

Contents

This annex describes the use cases that were used as a basis for the development of this data specification.

In order to identify priority areas for the specification of meteorological data, the TWG selected the following three high level use cases:

1. Use of meteorology in support of environmental emergency response
2. Flood forecasting
3. Climate assessment (with past or predicted data).

These cases have been selected after reviewing a list of Use cases considered for conceptual modelling by the OGC Met Ocean Domain Working Group. It was felt that they were all highly relevant to environmental protection, and that they would all require significant and possibly challenging cross boundary as well as cross-theme cooperation. Detailed use cases have been developed under these three categories:

- Under 1:
  - Plume prediction in support of emergency response

The weather can have a major influence on the release of a pollutant into the atmosphere, from incidents such as large fires, chemical releases, biological incidents, nuclear releases and volcanic eruptions. The latest observations and sophisticated computer predictions can be used to provide plume predictions, ranging immediately after release (to allow safe approach to an incident) through to longer-range predictions of areas at risk, as well as information on local weather conditions. These services support the activities of emergency services and other government departments, as well as to the international community.

- Under 2:
  - Flash flood management

Intense and localized rain events are commonly observed in the Mediterranean area. Because of the short response time of the basins, these events lead to flash flood, likely to cause serious damages, especially over urban areas. That is why the need for systems able to help authorities in related crisis management is increasing. The meteorological data inputs for such systems are mainly rainfall

observations and nowcasting, from radars, ground based sensors; input data from very high resolution non hydrostatic models is also becoming available.

  - Short and medium range flood forecasting

Severe (transnational) fluvial floods frequently occur and have large impact on societies. To reduce the impacts of floods early warning systems have been setup simulating hydrological processes in river basins and providing flood information for stakeholders. Different meteorological datasets are input for the models: weather observations, deterministic forecasts and ensemble forecasts.

- Under 3:
  - Finding the most interesting locations for new wind farms

Wind power companies planning on building wind turbines need several estimated wind parameters like wind speed distribution, vertical wind profile, turbulence intensity, gustiness and maximum wind speed. for drafting early plans for the best places as well as the most suitable properties of the wind farms The parameters should be visualised in a way appropriate for quickly finding the most promising areas for production in the time frame 2015-2020.

  - Climate impacts

Organisations are becoming more aware of their sensitivity to weather, and to climate change, particularly those concerned with water, agriculture, food production, ecosystems, biodiversity, utilities, transport, energy, health, economics, natural disasters and security. Past climate data (climatological observation records, gridded climatologies, and re-analyses) can be used to calculate the existing risks due to current weather and climate, before climate projections for various horizons are used to assess the likely change in the future. The main parameters of interest are temperature and precipitation, with ensembles helping to provide estimates of uncertainty.

B.1 Use Case 1 - Plume Prediction in Support of Emergency Response

Description

The weather can be the cause of an emergency and/or have a major influence on its impact. Thus, meteorological organisations (such as national meteorological services) can play a key role in providing expert advice on the interpretation and impact of the weather during an emergency, as well as assisting in the development and maintenance of risk registers, providing input into exercise and planning processes and attending incident command and control centres. Specialist forecasters can provide specialist meteorological information to deal with a variety of environmental incidents to the emergency services and other government departments, as well as to the international community and citizens.

Meteorological organisations can provide plume predictions during emergencies, with specialist forecasters interpreting data from the latest observations as well as from sophisticated computer models to deduce the local weather conditions and the areas at risk from the pollutant. Local variations in wind speed and direction are the main influencers on dispersion. Rain at the scene or downwind can also wash the pollutant out of the atmosphere leading to higher concentrations on the ground. The vertical temperature profile of the atmosphere also affects the stability of the air and this determines how high the plume is likely to rise, which subsequently affects the distance it might travel and its behaviour close to hills. This service covers a range of incident types which can result in the release of a potentially hazardous plume:

- Fire (e.g. fire at a chemical plant or oil refinery);
- Chemical Release (e.g. chemical spillage or a road traffic accident in which a hazardous substance has either escaped or ignited);
- Biological Incidents (e.g. foot & mouth, blue tongue)
- Nuclear Release (e.g. accident at nuclear power plant);
- Volcanic Eruption (i.e. prediction of ash plume).

Numerical atmospheric dispersion modelling environments can utilise a Lagrangian approach to determine the location of a plume: pollutants are represented by a large number of model ‘particles’ which are released into the modelled atmosphere at the source location. These particles are affected by the local wind speed, atmospheric turbulence, precipitation, and other processes. Each model ‘particle’ can have its own characteristics, represent different compounds, chemicals and real particulate sizes, and can be affected by temporal and spatial variations in the meteorology including turbulence and loss processes such as precipitation. Such models are able to simulate highly complex dispersion events, predicting the movement of a wide range of pollutants in the atmosphere.

Although these ‘model particles’ can be shown output directly, either as plots showing each particle at a given time (possibly with colouring used to show height) or as particle trajectories, they are usually accumulated into three-dimensional cells on a regular grid, to give concentration (potentially at different vertical levels and times). They may alternatively be shown in terms of standard deviation from the mid-plume value at a given radius from the release site, a so-called “Area at Risk Map” (usually with at least two threshold values); this is important for early predictions, where the details of release concentrations can be limited, and a prediction of an actual concentration could be misleading.

On notification of an incident, the specialist forecasters will run an atmospheric dispersion model, having input all information provided about the release, to predict the movement, deposition and dispersal of large plumes of material for periods of time ranging from hours to several days. The model produces a geographical display of the movement of the plume showing the area at risk. The response time for providing such information can vary from tens of minutes for small scale events to hours for a predictions running out to a week or more. The models can be re-run as more detail becomes available following an accident, providing more precise concentration and deposition values. However,

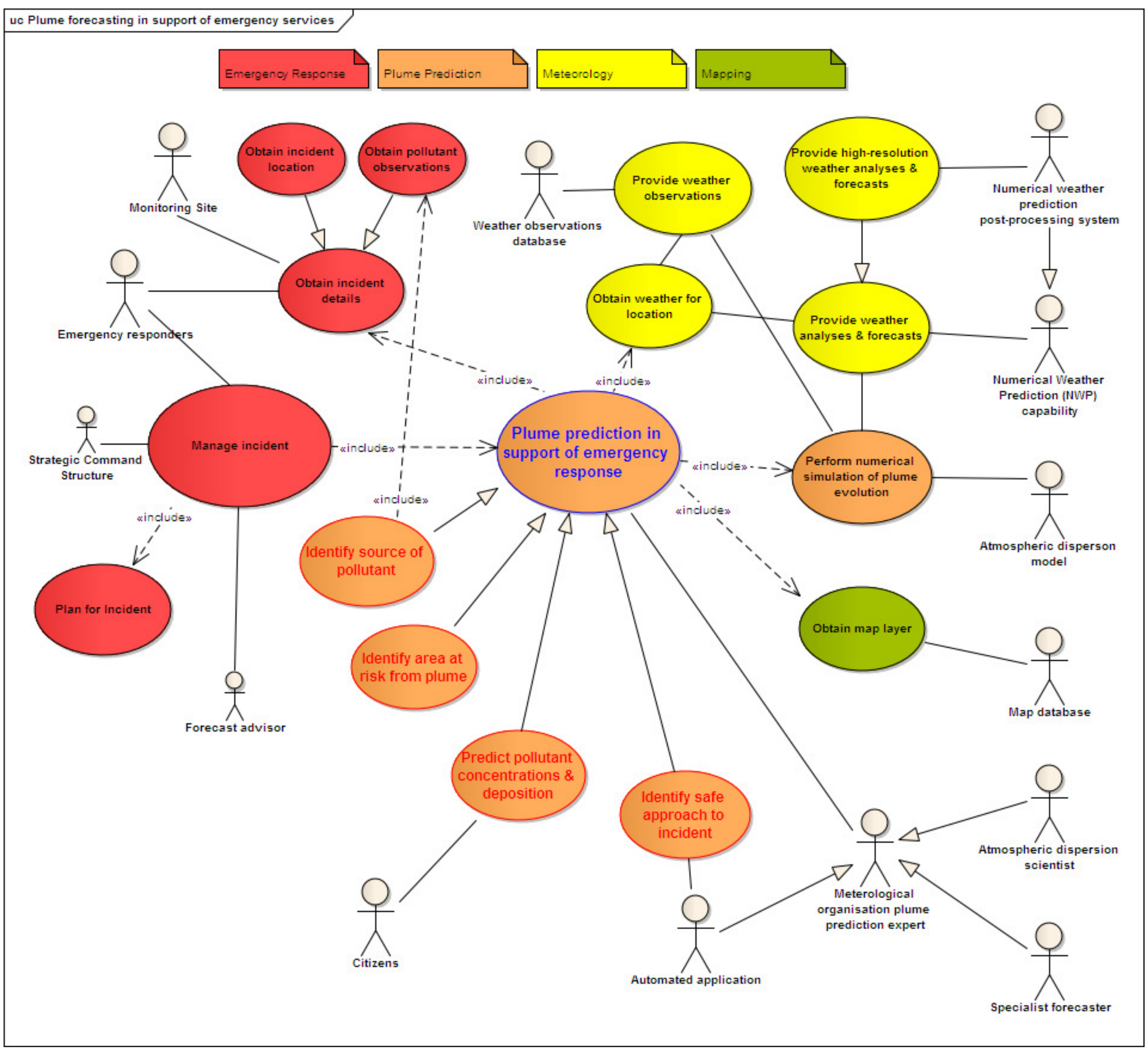
in most incidents it is at least hours into an event before the composition of chemicals or substances involved is fully known.

Typically, the models are highly configurable, and for more involved situations or non-standard cases, the atmospheric dispersion research scientist will become involved in the process of running the model. Unlike NWP models, the output is not usually a 'complete set', but only those parameters, heights, times, etc that are of interest (and for efficiency, zero values are not output).

Typically, services provided range from an immediate prediction of the direction of the plume, to allow safe approach to an incident (e.g. a large fire), through to short-range predictions of areas of risk (e.g. from chemical release) and longer-range prediction of areas at risk (e.g. from volcanic ash) and the identification of the likely origin of particular pollutant (e.g. for a nuclear incident).

High Level Use Case

The Use Case diagram below shows all the use cases and actors considered. Use cases are colour-coded to indicate their focus, with blue writing used to show the 'super use case' for plume prediction and red writing used to show the four main more specific use cases, which are described in the following section; all other use cases are not explicitly detailed, but may appear as a step within the main use cases. Large actors are involved in the detailed use cases; small actors are included to provide a wider context, but are not involved directly in the detailed use cases.



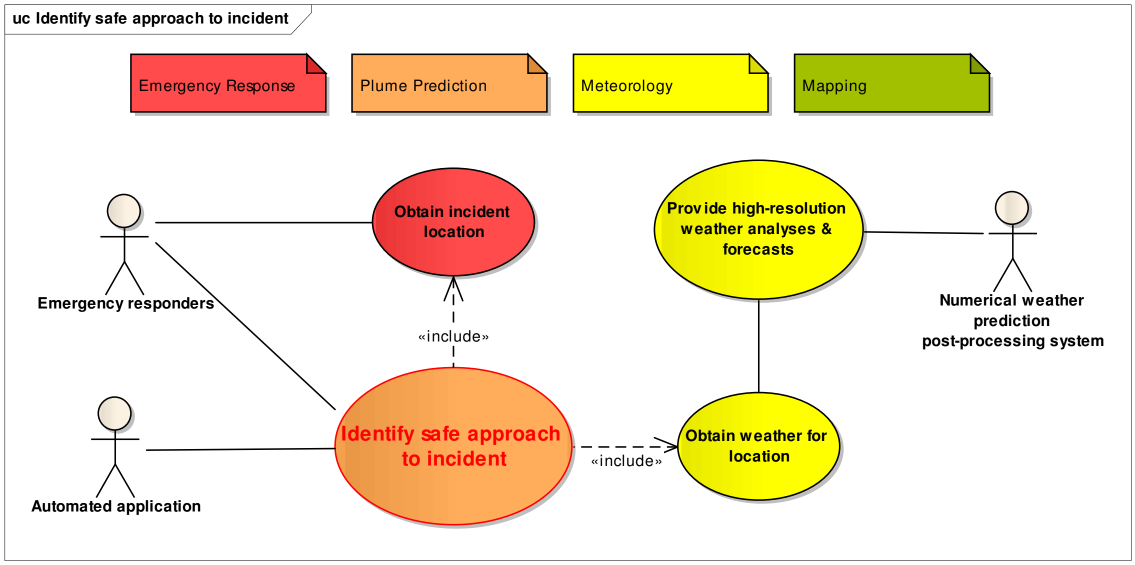
Actors

- **Emergency Responder** – organisations heavily involved in managing incident; for example, emergency services, local authorities, health service bodies, health and safety agencies, transport and utility companies (although exactly which organisations will depend on the nature of the incident)
- **Monitoring Site** – site measuring a particular pollutant
- **Strategic Command** – a general class of actor used to describe the range of groups which may come together to carry out a strategic role in the management of an incident. This includes a range of levels (depending of the severity of the event):
    - Operation command at incident site (police or fire officer)
    - Tactical command within site of incident (usually senior police office)
    - Strategic command and control centre remote from incident (chief police constable)
    - Central government crisis response committee
    - Scientific and technical advisory groups established to coordinate multi-agency specialist advice to central government
- **Citizens**
- **Forecast advisors**
- **Meteorological Organisation Plume Prediction Expert** – a general class of actor used to describe the experts involved in providing plume prediction services:
    - **Automated Application** – used to quickly provide automated guidance
    - **Specialist Forecaster** – provide routine operational guidance
    - **Atmospheric Dispersion Scientist** – provide operational input in more specialist situations
- **Weather Observations Database** – source of real-time weather observations
- **Numerical Weather Prediction (NWP) Capability** – range of NWP models and post-processing, which provides automated weather forecasts at a range of scales, including:
    - **NWP Post-Processing Systems** – applications employing down-scaling and rapid updates (nowcasts) to provide a high-resolution (kilometre-scale) weather forecasts
- **Atmospheric Dispersion Model** – Lagrangian model used to determine the location of a plume
- **Map Database** – Database of map overlays at wide range of scales.

Detailed Structured Description of Plume Prediction Use Cases

The plume prediction use cases are presented in more detail using a standard template in the following sections, with primary example (and other examples) indicated in brackets in the title.

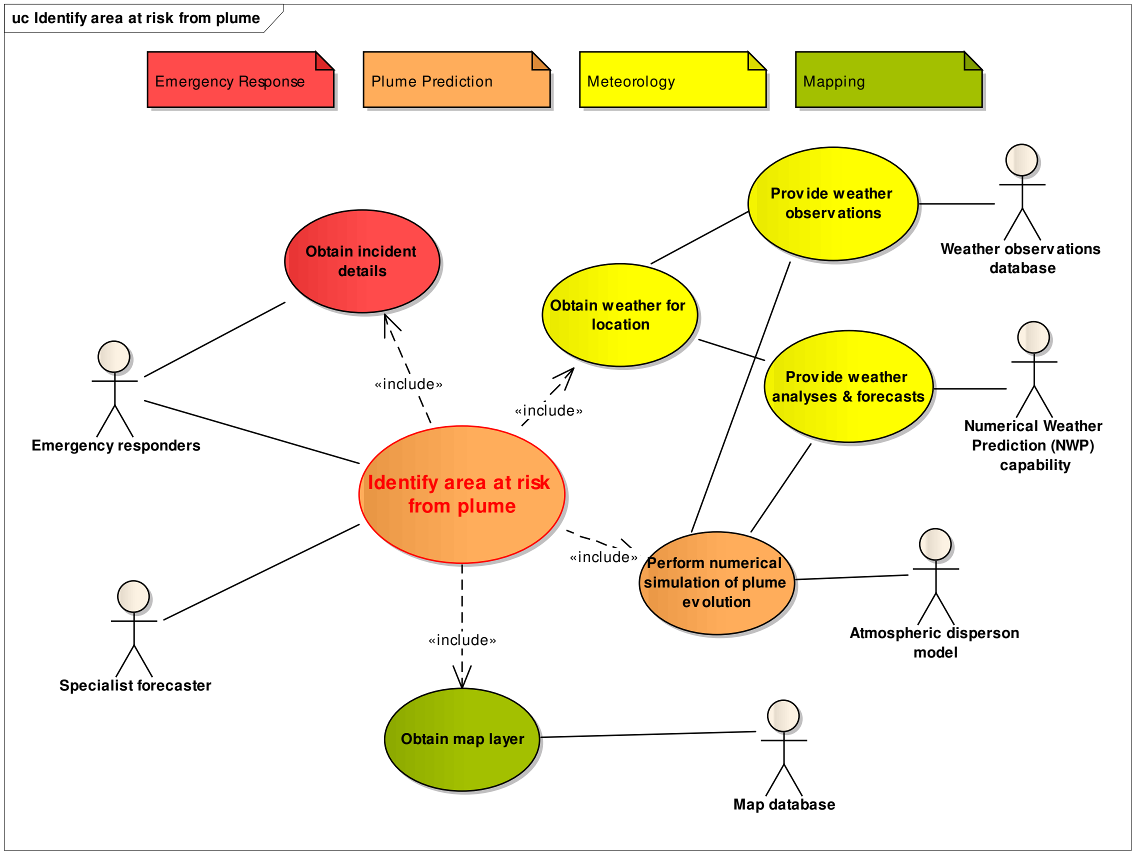
Use Case 1.1: Identify Safe Approach to Incident



Use Case 1.1	Identify safe approach to incident
Priority	High
Description	Provide Fire and Rescue Service (FRS) responders with the latest weather information to help them identify a safe approach when dealing with a major incident. Provides immediate access to forecast conditions, before a more detailed area at risk product is available. This is realised through the use of an automated application, with a web interface, available to all FRS incident command units, mobilising centres and the national coordination centre.
Pre-condition	An incident releasing a plume has occurred.
Flow of Events - Basic Path	
Step 1	***Emergency Responders*** provide the Incident Location via webpage
Step 2	***Automated Application*** automatically obtains **Current Weather** data by interpolating from the **High-Resolution Post-Processed Model Analysis/Forecast** provided by ***NWP Post-ProcessingCapability***
Step 3	***Automated Application*** automatically generates **Hazard Sector** visualisation, with supporting text, and a presentational form of **Current Weather** (table & graph) on the webpage
Step 4	***Emergency Responders*** review the **Hazard Sector** and **Current Weather** products on a Webpage
Post-condition	***Emergency Responders*** understand the safe approach directions to the incident.
Data Source: Incident Location	
Description	Location of incident as: • Place name or Postcode (e.g. EX1 3PB) • Country map grid reference (e.g. GB Ordnance Survey: SX500534) or grid coordinates (e.g. UK eastings, northings: 377400, 399500) • Latitude & Longitude
Data Provider	Fire and Rescue Service (FRS) responders
Geographic Scope	Point (or Polygon as proxy for point)
Thematic Scope	Addresses (AD), Coordinate Reference Systems (RS)
Scale, resolution	*Point* or *Polygon*
Delivery	Webpage entry
Documentation	None
Data Source: Current Weather	
Description	Point interpolation from high-resolution post-processed model analysis / forecast provided as: • Table (text) of Temperature, Humidity, Precipitation Type, Precipitation

	rate, Hazard Sector, wind speed Wind direction; • Graphs of Precipitation rate, Temperature and Humidity against time. Example shown in figure (b)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*PointSeries* (hourly data for 6-hour window centred on current hour)
Delivery	Webpage
Documentation	For example, see: *http://www.metoffice.gov.uk/corporate/pws/emergency_response.pdf* (section 3.8 FireMet)
Supporting Data Source: High-Resolution Post-Processed Model Analysis/Forecast	
Description	High-resolution NWP model analyses and forecasts post-processed to produce gridded data accounting for local topographic effects.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area around specific point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (km resolution; hourly, past times as analyses, forecasts out to 12 hours or more)
Delivery	Standard output in a standard meteorological (e.g. netCDF or GRIB) or bespoke format
Documentation	For example, see: *http://www.metoffice.gov.uk/research/areas/numerical-modelling/post-processing* *http://www.metoffice.gov.uk/science/creating/daysahead/nwp/um_config.html*
Data Source: Hazard Sector	
Description	Point interpolation from high-resolution post-processed model analysis provided as: • Visualisation of 'Hazard Sector', with wind speed and direction • Table with text information on Hazard Sector and wind (in range of formats) Example shown in figure (b)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*Point; TimeInstant* (current hour)
Delivery	Webpage
Documentation	For example, see: *http://www.metoffice.gov.uk/corporate/pws/emergency_response.pdf* (section 3.8 FireMet)

Use Case 1.2: Identify area at risk from plume

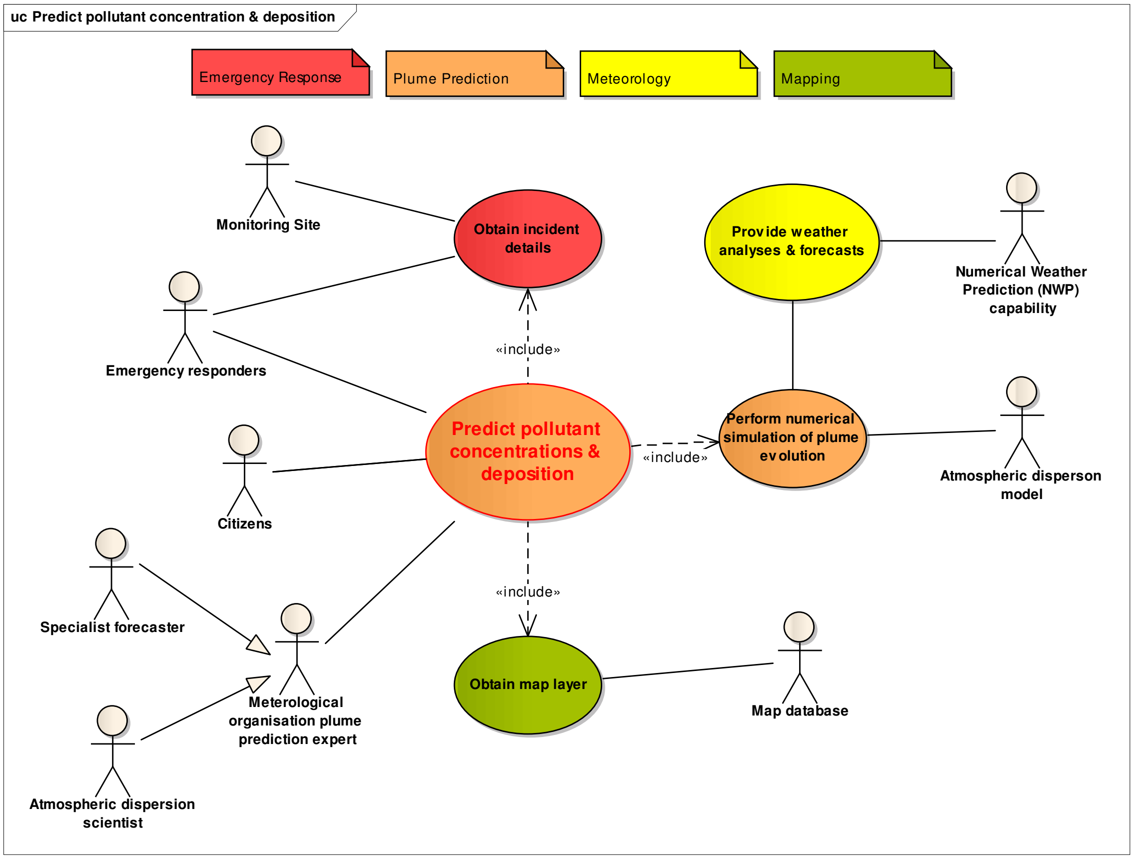


Use Case 1.2	**Identify areas at risk from plume**
Priority	High
Description	Identify the areas at risk from the plume and the local weather conditions for the next few hours in the form of a snapshot.
Pre-condition	An incident releasing a plume has occurred.
Flow of Events - Basic Path	
Step 1	***Emergency Responders*** provides **Incident Details** by phone, which are recorded.
Step 2	A ***Specialist Forecasters*** use the ***Incident Details*** to initialise the ***Atmospheric Dispersion Model.***
Step 3	***Atmospheric Dispersion Model*** runs to generate a **Forecast,** using either: ▪ **Model Analyses/Forecasts** generated by the ***Numerical Weather Prediction (NWP) Capability***; or: ▪ **Weather Observations** provided by ***Weather Observations Database***.
Step 4	***Atmospheric Dispersion Model*** generates an **Area At Risk Map** using a **Map Overlay** obtained from the **Map Database**.
Step 5	**EMARC** generates **Forecast of Relevant Meteorological Parameters**, using either the **Model Analyses/Forecasts** or **Weather Observations**.
Step 6	The ***Specialist Forecaster*** delivers **Area At Risk Map** and **Forecast of Relevant Meteorological Parameters** to the ***Emergency Responders*** by website, email or fax.
Post-condition	***Emergency responders*** have received and understood briefing material.
Data Source: Plume Incident Details	
Description	Details including: • Location of incident as: ○ Place name or Postcode (e.g. EX1 3PB);

	◦ Country map grid reference (e.g. GB Ordnance Survey: SX500534) or grid coordinates (e.g. UK eastings, northings: 377400, 399500); or: ◦ Latitude & Longitude • Time of the event • Any additional information on the chemicals involved • Site characteristics (Urban, Rural, Coastal) • Nature of Release (Continuous , Instantaneous, Fire at site) • If available, details of the current weather at the site
Data Provider	Emergency Services
Geographic Scope	Point
Thematic Scope	Addresses (AD), Coordinate Reference Systems (RS), Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*Point; TimeInstant*
Delivery	Phone
Documentation	See for example: *http://www.metoffice.gov.uk/publicsector/CHEMET/*
Data Source: Atmospheric Dispersion Model Forecast	
Description	4-dimensional (3d space & time) predictions of pollutant concentration. The concentrations of the tracked parcels of air are mapped onto regular grid-boxes. Note that only the required data are output, resulting, resulting in limited sets of variables & levels, and 'sparse' grids (values only held where non-zero)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area around specific point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (spatial and temporal resolution depends on area of interest)
Delivery	Standard output as netCDF, GRIB or text, suitable for visualisation in a GIS environment.
Documentation	For example, see: *http://www.metoffice.gov.uk/environment/name.html*
Data Source: Model Analysis/Forecast	
Description	A range of NWP models provide automated weather forecasts as 4-dimensional (3d space & time) fields.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area around specific point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (km resolution; hourly, past times as analyses, forecasts out to 12 hours or more)
Delivery	Standard output in a standard meteorological (e.g. netCDF or GRIB) or bespoke format
Documentation	For example, see: *http://www.metoffice.gov.uk/science/creating/daysahead/nwp/um_config.html*
Data Source: Weather Observations	
Description	Observations of the weather from a nearby observing site, in WMO BUFR format.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Point, but representative of local area of interest
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*Point* or *PointSeries*
Delivery	n/a
Documentation	None
Data Source: Map Overlay	
Description	High-resolution geographical map
Data Provider	Map provider
Geographic Scope	Area of interest
Thematic Scope	Cadastral Parcels (CP)
Scale, resolution	*Polygons* provided as raster image (at, e.g. 1:50,000)

Delivery	Website, email or fax (as part of ***Area at Risk Map*** product)
Documentation	None
Data Source: Area At Risk Map	
Description	Product generated by ***Atmospheric Dispersion Model*** showing the prediction of the plume extent, for two threshold values of standard deviation from the concentration at the centre of the plume for a given radial distance from the release site. This is visualised in combination with a **Map Overlay.** Example shown in figure (c)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*Grid; TimePeriod* (representing area of interest; typically <6 hour validity period (but left to the forecaster's discretion), with updates as necessary before existing forecast expires)
Delivery	Website, email or fax
Documentation	For example, see: *http://www.metoffice.gov.uk/publicsector/CHEMET/*
Data Source: Forecast of Relevant Meteorological Parameters	
Description	Product generated ***Model Analyses/Forecasts*** covers: ▪ Surface wind direction (8-point compass degrees true) ▪ Wind speed at 10 metres above ground level (kilometres per hour.) ▪ Indication of the behaviour of the plume due to weather conditions while the chemical is assumed to have neutral buoyancy ▪ Total cloud cover (oktas), with height (in feet above ground level) of the lowest significant cloud layer (5 oktas or more) ▪ Temperature ▪ Relative humidity. ▪ Intensity & type of precipitation ▪ Depth of the mixing layer ▪ Mean wind in the mixing layer ▪ Estimate of the vertical stability of the atmosphere using the Pasquill Stability Index Any changes during the period are given remarks sections.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Point, but representative of local area of interest
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*Point* or *Polygon; TimePeriod* (representing area of interest; typically <6 hour validity period (but left to the forecaster's discretion), with updates as necessary before existing forecast expires)
Delivery	Website, email or fax
Documentation	For example, see: *http://www.metoffice.gov.uk/publicsector/CHEMET/*

Use Case 1.3: Predict pollutant concentrations & deposition

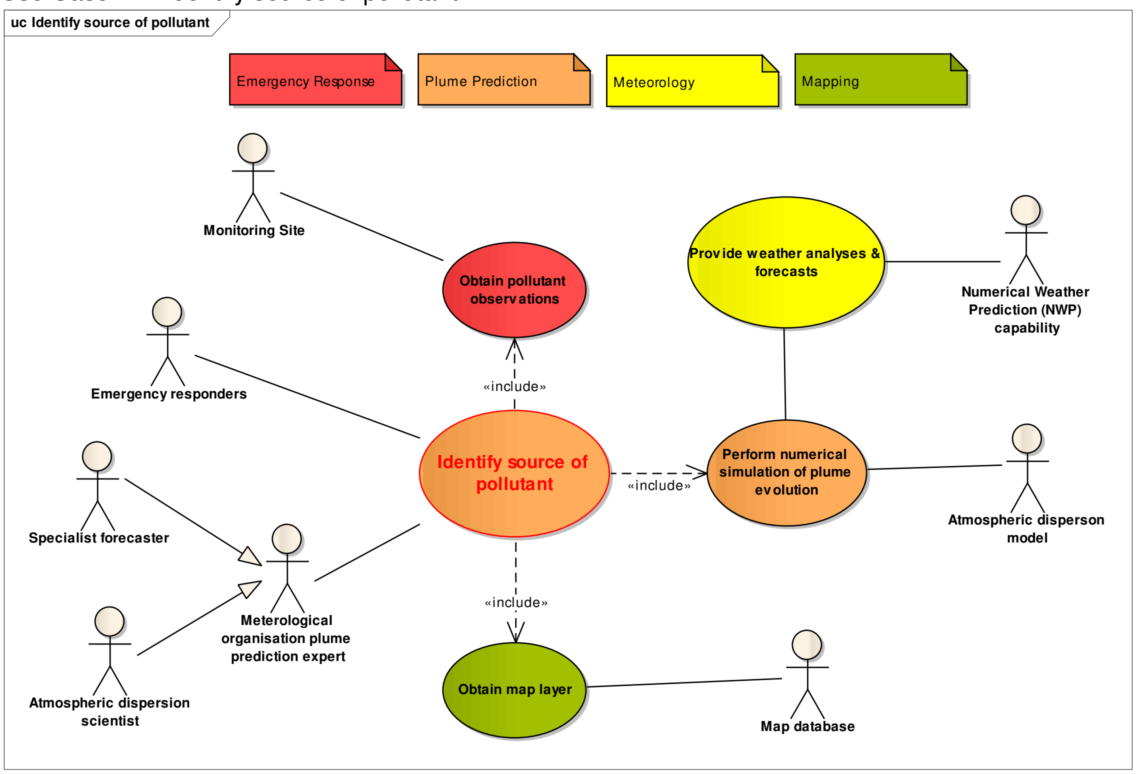


Use Case 1.3	Predict pollutant concentrations & deposition
Priority	High
Description	Provide predictions of the pollutant concentrations and deposition of the pollutant from the plume incident out from a few hours to a week ahead in the form of an animation (or series of snapshots). N.B. Only pollutant concentration product is described below, but similar products can be generated for deposition.
Pre-condition	Either incident is already being monitored, or large-scale incident is detected or notified (e.g. volcanic eruption).
Flow of Events - Basic Path	
Step 1	***Monitoring Site*** *(e.g. Volcanic Ash Advisory Centre)* (or possibly ***Emergency Responders***) provide **Incident Details**.
Step 2	A ***Specialist Forecaster*** uses the ***Incident Details*** to initialise the ***Atmospheric Dispersion Model*** (including specification of incident area, plume height, chemical species or particle size distribution, etc).
Step 3	***NAME*** runs to generate a ***NAME Forecast*** using from the **Model Analyses/Forecasts** provided from the ***Numerical Weather Prediction (NWP) Capability***.
Step 4	The ***Atmospheric Dispersion Model*** generates **Pollutant Concentrations Forecast** using a **Map Overlay** obtained from the **Map Database**
Step 5	The ***Specialist Forecaster*** delivers **Pollutant Concentrations Forecast** to the ***Emergency Responders*** *(*and possibly the ***Citizens***) by either WMO GTS, website, email or fax.
Post-condition	***Emergency responders*** (and ***General Public***) have received and understood briefing material.
Flow of Events - Alternative Path 1	
Replace Step 2	An ***Atmospheric Dispersion Scientist*** carries out more complex

	configuration and initialisation of ***Atmospheric Dispersion Model*** using the **Incident Details.**
Flow of Events - Alternative Path 2	
Additional Step 4a	The ***Specialist Forecaster*** draws simpler polygons around the **Pollutant Concentration Forecast** to generate a variant of this product.
Data Source: Plume Incident Details	
Description	Details including: • Location • Time of the event • As much information on the plume characteristics as possible
Data Provider	Monitoring Site, Volcanic Ash Advisory Centres (with initial identification by eye witnesses or volcanic eruption detection system)
Geographic Scope	Point, potentially anywhere on the globe
Thematic Scope	Coordinate Reference Systems (RS)
Scale, resolution	*Point*
Delivery	Phone
Documentation	*http://www.metoffice.gov.uk/aviation/vaac/eruption_detection.html*
Data Source: Atmospheric Dispersion Model Forecast	
Description	4-dimensional (3d space & time) predictions of pollutant concentration. The concentrations of the tracked parcels of air are mapped onto regular grid-boxes. Note that only the required data are output, resulting, resulting in limited sets of variables & levels, and 'sparse' grids (values only held where non-zero)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (spatial and temporal resolution depends on area of interest)
Delivery	Standard output as netCDF, GRIB or text, suitable for visualisation in a GIS environment.
Documentation	For example, see: *http://www.metoffice.gov.uk/environment/name.html*
Data Source: Model Analysis/Forecast	
Description	A range of NWP models provide automated weather forecasts as 4-dimensional (3d space & time) fields.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (representing area of interest which may extend outside the UK, and time scales of interest out to 5 days or more)
Delivery	Standard output in a standard meteorological (e.g. netCDF or GRIB) or bespoke format
Documentation	For example, see: *http://www.metoffice.gov.uk/science/creating/daysahead/nwp/um_config.html*
Data Source: Map	
Description	Geographical map at appropriate scale
Data Provider	Map provider
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Cadastral Parcels (CP)?
Scale, resolution	*Polygons* provided as raster image
Delivery	Website, email or fax (as part of ***Pollutant Concentrations Forecast*** product)
Documentation	None
Data Source: Pollutant Concentrations Forecast	
Description	Generated product from ***NAME Forecast*** shows sequence of charts showing the predicted evolution of the plume extent at different heights and different times for multiple thresholds. These are shown as raster, filled contour or polygons (which also may be colour-filled); the polygons are also produced as a text product. This is visualised in combination with an appropriate **Map Overlay.**

	Examples of the three forms shown in figure (a), (d) and (e) respectively.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* or *PolygonSeries* (representing area of interest which may extend outside the UK, and time scales of interest out to 5 days or more)
Delivery	(WMO) Global Telecommunications System (GTS), website, email or fax
Documentation	For example, see: *http://www.metoffice.gov.uk/aviation/vaac/forecasting.html*

Use Case 1.4: Identify source of pollutant



Use Case 1.4	Identify Source of Pollutant
Priority	High
Description	Identify the likely area of origin in of a particular measured pollutant as area-based probability
Pre-condition	A particular pollutant has been detected at one or more monitoring sites.
Flow of Events - Basic Path	
Step 1	***Monitoring Site*** provides **Pollutant Observations** data.
Step 2	A ***Specialist Forecaster*** or the ***Atmospheric Dispersion Scientist*** uses the **Pollutant Observations** to initialise the ***Atmospheric Dispersion Model***.
Step 3	The ***Atmospheric Dispersion Model*** runs 'backwards' to generate a ***Forecast*** using from the **Model Analyses/Forecasts** provided from the ***Numerical Weather Prediction (NWP) Capability***.
Step 4	The ***Atmospheric Dispersion Model*** generates **Plume Origin Prediction** from **forecast** using a **Map Overlay** obtained from the **Map Database**.
Step 5	The ***Specialist Forecaster*** delivers ***Plume Origin Prediction*** to the ***Emergency Responders*** by either website, email or fax
Post-condition	***Emergency responders*** have received and understood briefing material.
Data Source: Pollutant Observations	
Description	Measurement of a particular pollutant by a sensor at a particular site.

	Detection of the pollutant at multiple sites would usually be required.
Data Provider	Various monitoring organisations (depending on pollutant type)
Geographic Scope	Point
Thematic Scope	Environmental Monitoring Facilities (EF)
Scale, resolution	*PointSeries* (a number of points, with time period depending on what is available)
Delivery	Various
Documentation	None
Data Source: Atmospheric Dispersion Model Forecast	
Description	4-dimensional (3d space & time) predictions of pollutant concentration. The concentrations of the tracked parcels of air are mapped onto regular grid-boxes. Note that only the required data are output, resulting, resulting in limited sets of variables & levels, and 'sparse' grids (values only held where non-zero).
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (spatial and temporal resolution depends on area of interest)
Delivery	Standard output as netCDF, GRIB or text, suitable for visualisation in a GIS environment.
Documentation	For example, see: *http://www.metoffice.gov.uk/environment/name.html*
Data Source: Model Analysis/Forecast	
Description	A range of NWP models provide automated weather forecasts as 4-dimensional (3d space & time) fields.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area around specific point
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (km resolution; hourly, past times as analyses, forecasts out to 12 hours or more)
Delivery	Standard output in a standard meteorological (e.g. netCDF or GRIB) or bespoke format
Documentation	For example, see: *http://www.metoffice.gov.uk/science/creating/daysahead/nwp/um_config.html*
Data Source: Map	
Description	High-resolution geographical map
Data Provider	Map provider
Geographic Scope	Area of interest
Thematic Scope	Cadastral Parcels (CP)
Scale, resolution	*Polygons* provided as raster image (at, e.g. 1:50,000)
Delivery	Website, email or fax (as part of ***Area at Risk Map*** product)
Documentation	None
Data Source: Plume Origin Prediction	
Description	Generated product from the ***Atmospheric Dispersion Model Forecast***, shows the likelihood of a plume originating from within the area of the cell of a raster map, as a probability (most cells will have a zero probability). This is visualised in combination with an appropriate **Map Overlay.** Example shown in figure (f)
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	Variable, depending on area of interest
Delivery	Webpage, email or fax
Documentation	For example, see: *http://www.metoffice.gov.uk/corporate/pws/emergency_response.pdf* (section 3.6 Source Identification)

B.2 Use Case 2.1 - Flash flood management

High level Use Case

Intense and localized rain events are commonly observed, especially in the Mediterranean area. When occurring over short response time basins, these events lead to flash flood, likely to cause serious damages, especially over urban areas. That is why the need for systems able to assist authorities in related crisis management is critical.

The system can be broadly described in five steps:

1. **Acquisition of input data for the numerical model**
   Rainfall data from rain gauges and radars (for instance polarized X-Band radars), short term rainfall forecasts ("nowcasting"), discharge data.

2. **Calculate the flood extent and its short term evolution**
   Running a "rainfall-runoff" model over the area of interest

3. **Identify a flood risk scenario**
   On the basis of expected discharges, past flooding events and vulnerability.

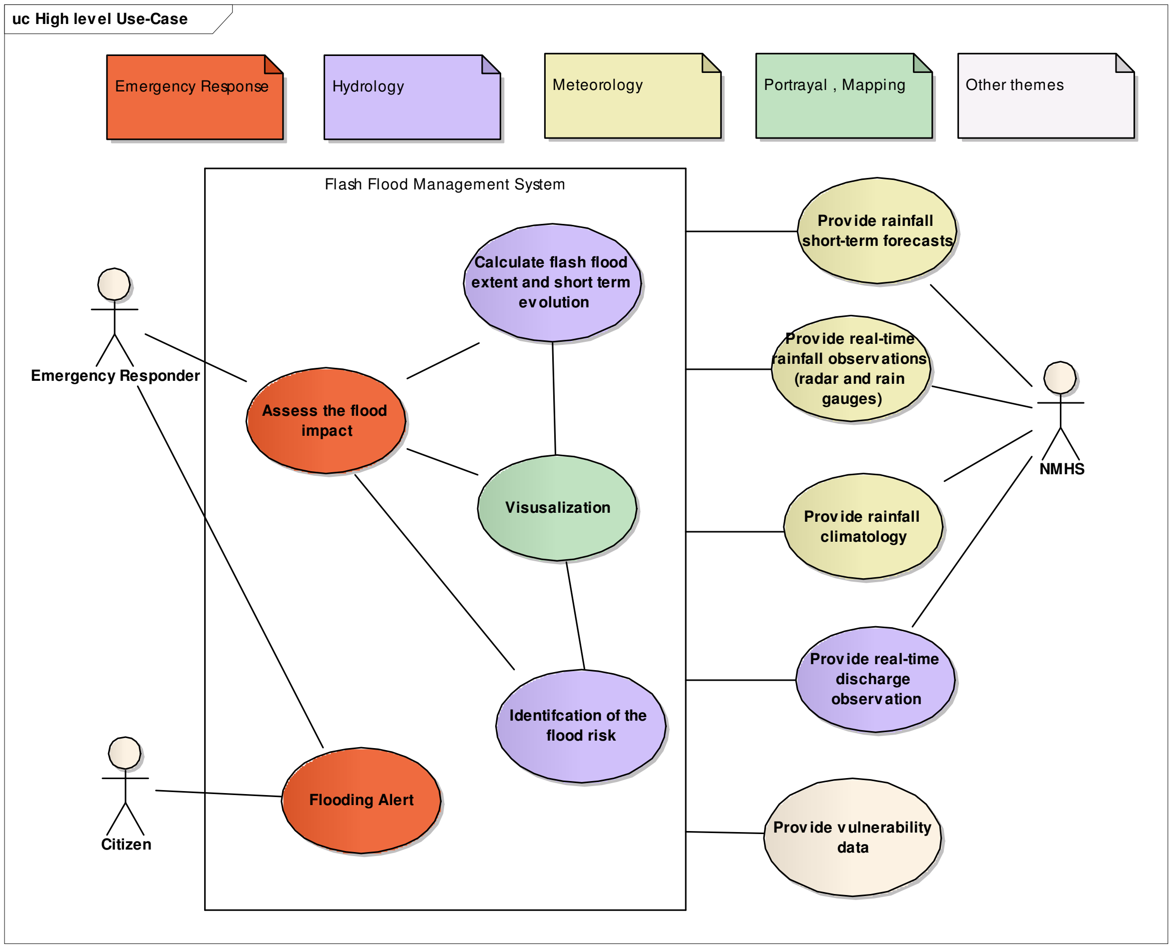
4. **Human assessment of the results**
   Real-time data, model output, risk map visualisation for human assessment of the risk of flooding and risk scenarios.

5. **Activation of the warning plan depending on the risk**

Actors

- **Emergency Responder**
  Organisations involved in managing the flood event (local authorities, civil protection authorities)
- **Citizens:**
  The target of flood warnings and safety plans when a flood risk has been identified and assessed by the emergency responder.
- **NMHS (National Meteorological & Hydrological Service)**
  NMHS provides :
  - Radar production environment from radar network infrastructure and reflectivity measurements, post processing etc. to consolidated rainfall estimations.
  - Surface observation environment from sensor networks, in-situ acquisition systems, hubs etc. to consolidated rainfall measures, including databases and archives (past data).
  - Numerical simulation environment: data assimilation, high resolution non hydrostatic model run on supercomputers, post-processing.
  - Databases, data access services and / or dissemination systems

High level UML Diagram



Hydrology is actually the core activity of this use-case, the meteorological sub-cases are intended to provide weather data (mainly rainfall data and very short-range forecasts). So, the overall use-case has been split in order to isolate sub-cases related to the INSPIRE themes “Atmospheric Conditions” and “Meteorological Geographical Features”.

Detailed Structured Description of Flash flood management Use Cases

Use Case 2.1.1 - Calculate flash flood extent and its short term evolution

Use Case Description	
Name	Calculate flash flood extent and its short term evolution
Primary actor	Rainfall – Runoff model
Goal	Predict the flash-flood extent
System under consideration	Flash flood information system
Importance	High
Description	Hydrological models used to calculate flash-floods extents are usually rainfall-runoff models. The meteorological data input for such models is mainly radar rainfall data, calibrated with surface rain gauges measurements when available. Recently, high resolution non hydrostatic models are able to provide accurate short-term rainfall forecasts. Finally, real-time rainfall data is compared against

Use Case Description	
	rainfall and flow information climatology to identify a flood scenario.
Pre-condition	- Operational network of surface rain gauges - Operational network of radars (and post processing system to convert measured reflectivities into spatial rainfall data) - Operational nowcasting system to predict rainfall (fine mesh model or other method) - Rainfall and flow climatology in order to calibrate the Rainfall-Runoff model - Operational Rainfall-Runoff model
Post-condition	Flood extent and water velocity dataset
Flow of Events – Basic Path	
Step 1.	Collect rainfall data from surface gauges within the spatio-temporal domain of interest
Step 2	Collect rainfall radar data within the spatio-temporal domain of interest
Step 3	Calibrate spatial radar data with surface gauges measurements
Step 4	Collect short-term rainfall forecasts on the spatio–temporal domain of interest
Step 5	Collect rainfall and flow climatology on the domain of interest
Step 6	Run the Rainfall-Runoff model
Step 7	Make available the probable flood extent and its short term evolution
Data set: Surface rain gauge data	
Description	Rainfall time series from surface gauges within the spatio-temporal domain of interest. The dataset consist of rainfall measures on an irregularly distributed set of points (the location of the rain gauges)
Type	Input
Data provider	Meteorological organisation (e.g. national meteorological service)
Geographic scope	Limited area: ~100 km2
Thematic scope	Atmospheric Conditions (observed)
Scale, resolution	Typically 30 rain gauges over the area of interest
Delivery	Online (FTP, WFS, SOS) or routine dissemination
Documentation	Metadata
Data set: Radar data	
Description	Spatial rainfall radar data. Rainfall is computed from reflectivities measured by a network of radars covering the area of interest (for instance polarized X-Band radars). The dataset consist of rainfall measures on a regularly distributed set of grid points. When the dataset is an image, each pixel corresponds to a grid-point.
Type	Input
Data provider	Meteorological organisation (e.g. national meteorological service)
Geographic scope	Limited area: ~100 km2
Thematic scope	Atmospheric Conditions (AC - observed)
Scale, resolution	1 km
Delivery	Online (FTP, WCS) or routine dissemination
Documentation	Metadata

Use Case Description	
Data set: Short term forecasts	
Description	Short-term rainfall forecast data calculated by a fine mesh non hydrostatic model. The dataset consist of rainfall forecasts values on a regularly distributed set of grid points.
Type	input
Data provider	Meteorological organisation (e.g. national meteorological service)
Geographic scope	Limited area: ~100 km2
Thematic scope	Atmospheric Conditions (AC - nowcasting)
Scale, resolution	1 - 2 km
Delivery	Online (FTP, WCS), routine dissemination
Documentation	Metadata
Data set: Rainfall and flood climatology	
Description	Rainfall and flood reference climatology and derived products (for instance return period of observed / predicted rainfall data) For instance, the dataset will consists of return period values on a regularly distributed set of grid points.
Type	input
Data provider	Meteorological organisation (e.g. national meteorological service)
Geographic scope	Limited area: ~100 km2
Thematic scope	Atmospheric Conditions (AC - climatology)
Scale, resolution	1km
Delivery	Online (FTP, WCS, WFS) or routine dissemination
Documentation	Metadada
Data set: Probable flood scenario	
Description	Product showing the total extent of the flood and its short term evolution
Type	Output
Data provider	Meteorological organisation (e.g. national meteorological service)
Geographic scope	Limited area: ~100 km2
Thematic scope	Natural Risk Zone
Scale, resolution	1km
Delivery	Online (FTP, WCS), routine dissemination
Documentation	Metadada

Mapping UC datasets to AC-MF model (Informative)

Dataset: Surface rain gauge data

AC-MF	Value
Case **MultiPointObservation**:	
phenomenonTime	"2011-04-11T12:00:00Z"
resultTime	"2011-04-11T12:02:30Z"
observedProperty	ObservableProperty
result	ReferenceableGridCoverage or DiscreteCoverageGeometryValuePairs
procedure	Process
featureOfInterest	SF_SamplingSurface (not detailed. Could be defined as the polygon surrounding the network of rain gauges)
Case **PointTimeSeriesObservation**:	
phenomenonTime	"2011-04-11T12:00:00Z/2011-04-11T13:00:00Z"
resultTime	"2011-04-11T13:02:30Z"
observedProperty	ObservableProperty
result	MultiTimeInstantCoverage
procedure	Process
featureOfInterest	SF_SamplingPoint (not detailed)
Process	
inspireId	Identifier (not detailed)
name	"SurfaceRainGaugeNetwork"
responsibleParty	CI_ResponsibleParty (ISO 19115 element not detailed)
type	"InSituMeasurement"
ObservableProperty	
label	"5mn Precipitation Amount"
basePhenomenon	CF_StandardNamesValue
uom	UnitOfMesure
statisticalMeasure	StatisticalMeasure
StatisticalMeasure	
statisticalFunction	StatisticalFunctionTypeValue
aggregationTimePeriod	"PT5M"
StatisticalFunctionTypeValue	"sum" (CF cell_methods)
CF_StandardNamesValue	"http://vocab.nerc.ac.uk/collection/P07/current#precipitation_amount"
UnitOfMeasure	"kg/m2"

Dataset: Radar data

AC-MF	Value
GridObservation	
phenomenonTime	"2011-04-11T12:00:00Z"
resultTime	"2011-04-11T12:03:47Z"
observedProperty	ObservableProperty
result	RectifiedGridCoverage or ReferenceableGridCoverage (ex grid domain definition : 2d geodetic or projected)
procedure	Process
featureOfInterest	SF_SamplingSolid (not detailed. Could be defined as a volume surrounding the grid)
Process	

inspireId	Identifier (not detailed)
name	"post-processing system of radar reflectivity"
responsibleParty	CI_ResponsibleParty (ISO 19115 element not detailed)
type	"RemoteSensingMeasurement"
ObservableProperty	
label	"5mn Precipitation Amount"
basePhenomenon	CF_StandardNamesValue
uom	UnitOfMesure
statisticalMeasure	StatisticalMeasure
StatisticalMeasure	
statisticalFunction	StatisticalFunctionTypeValue
aggregationTimePeriod	"PT5M"
StatisticalFunctionTypeValue	"sum" (CF cell method)
CF_StandardNamesValue	"http://vocab.nerc.ac.uk/collection/P07/current#precipitation_amount"
UnitOfMeasure	"kg/m2"

Dataset: Short Term Forecast

AC-MF	Value
GridSeriesObservation	
phenomenonTime	"2011-04-11T12:00:00Z/2011-04-11T14:00:00Z"
resultTime	"2011-04-11T12:05:47Z"
observedProperty	ObservableProperty
result	RectifiedGridCoverage or ReferenceableGridCoverage (ex grid domain definition : 2d geodetic or projected + 1d temporal)
procedure	Process
featureOfInterest	SF_SamplingSolid (not detailed. Could be defined as a volume surrounding the grid)
parameter	NamedValue
NamedValue	
name	"http://inspire.jrc.ec.europa.eu/inspire/processParameterValue.html#AnalysisTime"
value	"2011-04-11T12:00:00:00Z"[1]
ObservableProperty	
label	"15mn Precipitation Amount"
basePhenomenon	CF_StandardNamesValue
uom	UnitOfMesure
statisticalMeasure	StatisticalMeasure
StatisticalMeasure	
statisticalFunction	StatisticalFunctionTypeValue
aggregationTimePeriod	"PT15M"
StatisticalFunctionTypeValue	"sum" (CF cell method)
CF_StandardNamesValue	"http://vocab.nerc.ac.uk/collection/P07/current#precipitation_amount"
UnitOfMeasure	"kg/m2"
Process	
inspireId	Identifier (not detailed)

IR Requirement 1 1 Or model « run »

name	"Numerical model x"
responsibleParty	CI_ResponsibleParty (ISO 19115 element not detailed)
type	"Numerical Simulation"
processParameter	ProcessParameter
ProcessParameter	
description	"the time instant for the initial conditions of a numerical weather simulation. The analysis Time is chosen from a time-instant toward the middle of the assimilation window where the model state is considered to be more realistic"
name	ProcessParameterValue
ProcessParameterValue	"http://inspire.jrc.ec.europa.eu/inspire/processParameterValue.html#AnalysisTime"

Dataset: Radar data climatology (case return period of observed rainfall)

AC-MF	Value
GridObservation	
phenomenonTime	"2011-04-11T13:00:00Z"
resultTime	"2011-04-11T13:17:50Z"2
parameter	NamedValue
observedProperty	ObservableProperty
result	RectifiedGridCoverage or ReferenceableGridCoverage (ex grid domain definition : 2d geodetic or projected)
procedure	Process
featureOfInterest	SF_SamplingSolid (not detailed. Could be defined as a volume surrounding the grid)
NamedValue	
Name	"http://inspire.jrc.ec.europa.eu/inspire/processParameterValue.html#ReferenceTimePeriod"
value	"1980-01-01T00:00:00:00Z/2010-01-01T00:00:00Z" 3
ObservableProperty	
label	"Return period of 1 hour Precipitation Amount"
basePhenomenon	CF_StandardNamesValue
uom	UnitOfMesure
statisticalMeasure	StatisticalMeasure
StatisticalMeasure	
statisticalFunction	StatisticalFunctionTypeValue
aggregationTimePeriod	"PT1H"
StatisticalFunctionTypeValue	"sum" (CF cell method)
CF_StandardNamesValue	"http://vocab.nerc.ac.uk/collection/P07/current#precipitation_amount"
UnitOfMeasure	Duration (ie : ISO8601 "P50Y" – 50 years)
Process	
type	"Statistical"
documentation	CI_Citation (ISO 19115 metadata object)
responsibleParty	CI_ResponsibleParty (ISO19115 metadata object)
processParameter	ProcessParameter
ProcessParameter	
description	"Time Period used for statistics"
name	ProcessParameterValue

IR Requirement 2	2 The time at which statistics are published
IR Requirement 3	3 Period used for statistics (here 30 years)

ProcessParameterValue	"http://inspire.jrc.ec.europa.eu/inspire/processParameterValue.html#ReferenceTimePeriod"

B.3 Use Case 2.2 – Flood forecasting short and medium range

Background description

Severe (transnational) fluvial floods frequently occur and have large impact on societies. The European Environment Agency (EEA) estimated that the large flooding events that occurred in Europe between 1998 and 2002 caused 700 deaths, displacement of half a million people and 25 billion € insured economic losses.

To reduce the impacts of floods several early warning systems have been setup by hydrological and meteorological institutes, recently reinforced by the EU Floods Directive (EU 2007). These systems simulate hydrological processes in river basins from local to global scales and provide flood information for stakeholders. A variety of meteorological datasets (observations, model forecasts) and hydrological datasets are input for the models. The system described in this use case has two main objectives:

- To complement European Member States activities on flood preparedness and to achieve longer warning times.
- To provide the European Commission with an overview of ongoing and expected floods in Europe for improved international aid and crisis management in the case of large transnational flood events that might need intervention on an international level.

The system is set up for the whole of Europe on a 5-km grid. Twice daily it provides the national hydrological centres with medium-range ensemble flood forecasting information. In addition, when a high probability for flooding is forecast, the end users are alerted by e-mail and advised to monitor the development of the situation using the information system. Forecasts with lead times of 3 to 10 days are achieved through the incorporation of ensemble and deterministic forecasts.

High Level Use Case

The process can be broadly described as follows:

1: Ingestion of meteorological data

- Observations.
- Deterministic forecasts
- Ensemble forecasts
- Notification of event (non-meteorological)

2: Preprocessing of meteorological data for use in the flooding model:

- Internal procedures (spatial interpolation of point data)
- Pre-processing application for potential evapotranspiration

3: Running the flooding model
4: (Automatic) evaluation of results
5: Visualisation of results

- Hydrographs
- Threshold exceedance maps
- Time series diagrams
- Threshold exceendance tables
- Risk/warning maps

6: In case of flooding event: notification of end users.

Actors

- Operators

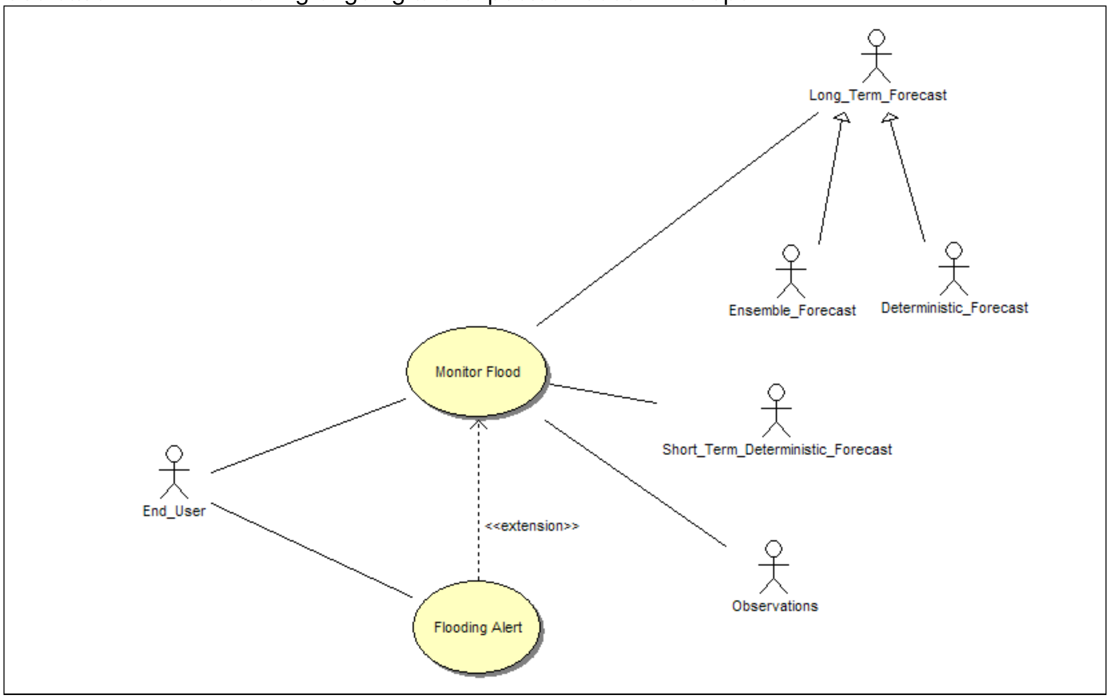
- End users: experts from national hydrological and meteorological services

Data Requirements

The flooding model makes use of static data layers that should be available within INSPIRE at European scale, such as land use, soil type and texture, river network. The flooding model simulates canopy and surface processes, soil and groundwater system processes and flow in the river channel.

Detailed Structured Description of Flood forecasting short and medium range Use Case

Use case 2.2.1 - Monitoring ongoing and expected floods in Europe.



Use Case Description	
Name	Monitoring ongoing and expected floods in Europe.
Priority	High
Description	Monitoring ongoing and expected floods in Europe, provide monitoring information and alerts end users.
Pre-condition	System running operationally.
Flow of Events - Basic Path	
Step 1	Run flooding forecasts (twice daily). 1.1 Ingest meteorological data. 1.2 Pre-process meteorological data. 1.3 Run flooding model. 1.4 (Automatic) evaluation of results. 1.5 Visualisation of results.
Step 2	Provide results to end users. 2.1 Alert for flooding .
Post-condition	Results successfully delivered to end users.
Data Source: Short term Deterministic forecast	
Description	Temporal resolution: staggered, 1h (1-3 days), 3h (4-7 days). Spatial resolution: staggered, 7km (1-3 days), 40 km (1-3 days).

	Times provided: 12:00, 00:00. Input fields: 1 (P,T,E). Bias removal: none. Down-scaling: dynamic.
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Europe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Features (MF)
Scale, resolution	Temporal resolution: staggered, 1h (1-3 days), 3h (4-7 days). Spatial resolution: staggered, 7km (1-3 days), 40 km (1-3 days). Times provided: 12:00, 00:00.
Delivery	FTP
Documentation	
Data Source: Long term Deterministic forecast	
Description	Temporal resolution: staggered, 3h (1-3 days), 6h (4-10 days). Spatial resolution: +- 40 km Times provided: 12:00, 00:00. Input fields: 1 (P,T,E). Bias removal: none Down-scaling: none
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Europe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Features (MF)
Scale, resolution	Temporal resolution: staggered, 3h (1-3 days), 6h (4-10 days). Spatial resolution: +- 40 km (TL511L60). Times provided: 12:00, 00:00.
Delivery	FTP
Documentation	
Data Source: Ensemble forecast	
Description	Temporal resolution: 6h (1-10 days). Spatial resolution: +- 80 km (TL255L40) Times provided: 12:00, 00:00. Input fields: 50+1 (P,T,E). Bias removal: none. Down-scaling: none.
Data Provider	Meteorological organisation
Geographic Scope	Europe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Features (MF)
Scale, resolution	Temporal resolution: 6h (1-10 days). Spatial resolution: +- 80 km (TL255L40). Times provided: 12:00, 00:00.
Delivery	FTP
Documentation	
Data Source: Meteorological observations	
Description	Temporal resolution daily Spatial resolution: 50 km (gridded) Times provided: irregular: typically 23:00

	Input fields: P,T,E_0, ES_0, ET_0. Bias removal: none Down-scaling: none
Data Provider	Meteorological organisation (e.g. national meteorological service)
Geographic Scope	Europe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Features (MF)
Scale, resolution	Temporal resolution daily Spatial resolution: 50 km (gridded) Times provided: irregular: typically 23:00
Delivery	FTP
Documentation	

References

EU. (2007). "Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance)." Retrieved 13/07/2010, from *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT*.

B.4 Use Case 3.1 - Finding the most interesting locations for new wind farms

High-level Use Case

This use case is mainly based on information provided by a pilot project. The steps described in the use case description are adapted to a near future scenario, where the necessary data sets are available from the EU member states using the INSPIRE SDI and the delivery methods specified by it. As of writing, the necessary input data sets are gathered from various, mostly off-line sources by the users.

The process for finding new wind farm locations is basically an iterative data mining and decision making task, an thus it's difficult to formulate it as a step-wise process. Int the scenario selected for this use case the wind farm planning engineer does the following rough work steps:

1. Planner finds the most promising geographic areas from the target area using map visualizations of wind-related geophysical parameters. The existing wind farm locations act as verification data.
2. The initial set of candidate areas are reduced based on information about existing transfer networks, high-power electricity networks, land use and natural protection zones in the vicinity of the candidate areas. The existing infrastructure also helps in pin-pointing the best wind farms locations within the candidate areas.
3. The potential new wind farm locations and the optimal turbine heights are submitted to a detailed analysis within the company's planning process.

Actors

- The electricity companies and specialized wind power planning companies in Europe.
- Public sector organizations at national level providing statistical meteorological information about wind, temperature and humidity conditions from the ground level up to 200m above the ground.
- Public sector organizations at national and sub-national level providing information about the existing wind power facilities, transport networks, electricity networks, land use, and natural protection zones.

Detailed Structured Description of finding the most interesting locations for new wind farms use case.

Use case 3.1.1 - Find new promising locations for building wind power farms in Europe.

Use Case Description	
Name	Find new promising locations for building wind power farms in Europe.
Primary actor	Companies planning on building new wind power
Goal	Planners working for the company have found an initial set of the most promising new wind farm locations to be included in the detailed analysis.
System under consideration	Desktop GIS systems used for wind farm planning able to retrieve geospatial information from INSPIRE SDI data servers via Internet.
Importance	Medium
Description	Wind power engineers use sophisticated models for planning the new wind farms. To be able to decide the best potential locations for new wind farms, they need many kinds of information besides the actual measured and predicted wind conditions, like possibility of ice formation on the blades, proximity of electricity and transport networks, cost of land, building rights and whether there is an existing or planned natural protection area overlapping the planned location.
Pre-condition	The cost/benefit ratio for the planned wind turbines at certain wind conditions, the

	approximate cost of building new electricity transfer network, the approximate cost of building new roads to access the planned location for certain land type, existing wind farms locations with owner information. The planner has a GIS workstation able to display layers of a map information over Europe.
Post-condition	An identified set of locations worth a more detailed benefit/cost analysis based on more detailed information.

Flow of Events – Basic Path	
Step 1.	The planner asks the workstation to display the basic map layer over the Europe.
Step 2.	The planner asks the workstation to display the existing locations for all the wind farms as well as known planned farms to be taken into use within the next 10 years.
Step 3.	The planner asks the workstation to display set statistical wind parameters visualized as coloured map layers. The planner evaluates the values of these parameters at different possible vertical turbine heights (50m, 100m, 200m) and compares them with the optimal values from the specifications of the planned turbines by the company, and identifies the most suitable locations not already in wind farm use as well as the existing wind farms with most potential to build new turbines possibly at different heights than the existing ones. The work includes zooming the map back and forth to verify the findings on a higher resolution map (up to 1:20000). Note that it's not necessary to have the wind-related statistical data to be available in highest resolutions. It's pixels will be scaled up if the background data resolution is higher than the wind data. The interesting locations are marked on the map with annotations.
Step 4.	The planner asks the workstation to display the most accurate cartographic information about existing transport networks, primary electricity transfer networks, existing and planned natural protection areas, land type, land use planning, and approximate cost of land at the selected locations. The most expensive locations as well as those overlapping natural protection zones are excluded.
Step 5.	The planner sends the data set containing the potential wind farms locations to be used as input in the detailed investment analysis.

Flow of Events – Alternative Paths	
	NONE

Data set: Basic map data for Europe	
Description	Basic background maps covering Europe
Type	*Input*
Data provider	National mapping agencies across the Europe
Geographic scope	Europe
Thematic scope	Coast lines, rivers, lakes, mountain areas, geographical names
Scale, resolution	1:500000 – 1:20000
Delivery	Online (WMS)
Documentation	

Data set: Existing wind farms and public plans for new farms	
Description	Information about the locations and the ownership of the existing wind power farms and public plans for building new ones.

Data set: Existing wind farms and public plans for new farms	
Type	*Input*
Data provider	National and sub-national level agencies responsible for energy planning.
Geographic scope	Europe
Thematic scope	Wind farms
Scale, resolution	1:20000
Delivery	Online (WFS)
Documentation	

Data set: Monthly statistical wind speed distribution	
Description	Colour maps visualisations for monthly average wind speeds for a typical month ranging from below 4 m/s to more than 13.5 m/s at 50, 100 and 200 meters above the ground. This gridded data is based on high resolution weather model re-analysis of the past weather observations for selected, statistically representative months.
Type	*Input*
Data provider	National Weather Agencies across the Europe
Geographic scope	Europe
Thematic scope	Atmospheric Conditions, statistical wind speed coverage
Scale, resolution	250m horizontal resolution (grid cell size), 3 vertical levels
Delivery	Online (WMS or WCS)
Documentation	

Data set: Monthly maximum wind speed (over 50 years)	
Description	Colour maps visualisations for monthly maximum wind speeds ranging from below 4 m/s to more than 13.5 m/s at 50, 100 and 200 meters above the ground. This gridded data is based on high resolution weather model re-analysis of the past weather observations for selected, statistically representative months.
Type	*Input*
Data provider	National Weather Agencies across the Europe
Geographic scope	Europe
Thematic scope	Atmospheric Conditions, statistical wind speed coverage
Scale, resolution	250m horizontal resolution (grid cell size),3 vertical levels
Delivery	Online (WMS or WCS)
Documentation	

Data set: Monthly statistical strength of wind turbulence	
Description	Colour maps visualisations for monthly average wind turbulence at 50, 100 and 200 meters above the ground. This gridded data is based on high resolution weather model re-analysis of the past weather observations for selected, statistically representative months.
Type	*Input*
Data provider	National Weather Agencies across the Europe
Geographic scope	Europe

Data set: Monthly statistical strength of wind turbulence	
Thematic scope	Atmospheric Conditions, statistical wind turbulence coverage
Scale, resolution	250m horizontal resolution (grid cell size), 3 vertical levels
Delivery	Online (WMS or WCS)
Documentation	

Data set: Monthly statistical wind gustiness	
Description	Colour maps visualisations for monthly average wind gustiness at 50, 100 and 200 meters above the ground. This gridded data is based on high resolution weather model re-analysis of the past weather observations for selected, statistically representative months.
Type	*Input*
Data provider	National Weather Agencies across the Europe
Geographic scope	Europe
Thematic scope	Atmospheric Conditions, statistical wind gust coverage
Scale, resolution	250m horizontal resolution (grid cell size), 3 vertical levels
Delivery	Online (WMS or WCS)
Documentation	

Data set: Monthly statistical vertical wind profile	
Description	A set of statistical monthly wind speed and direction values at different heights ranging from the ground level to 200m above ground at each grid point.
Type	*Input*
Data provider	National Weather Agencies across Europe
Geographic scope	Europe
Thematic scope	Atmospheric Conditions, statistical wind speed and direction coverage
Scale, resolution	250m horizontal resolution (grid cell size), 20m vertical resolution
Delivery	Online (WFS or WCS)
Documentation	

Data set: Number of months per year for significant blade ice formation probability	
Description	Statistical probability for significant ice formation on surfaces similar to wind turbine blades at different vertical heights (50, 100, 200m). Reported as the average number of months per year with these kind of conditions expected.
Type	*Input*
Data provider	National Weather Agencies across Europe
Geographic scope	Europe
Thematic scope	Atmospheric Conditions, statistical wind speed, air temperature and humidity coverages
Scale, resolution	250m horizontal resolution (grid cell size), 3 vertical levels
Delivery	Online (WMS or WCS)
Documentation	

Data set: Existing High-voltage electricity transfer networks	
Description	High-voltage electricity transfer networks for connecting new power stations.
Type	*Input*
Data provider	National and sub-national level agencies responsible for energy planning.
Geographic scope	Europe
Thematic scope	Energy transfer networks
Scale, resolution	1:500000 – 1:20000
Delivery	Online (WFS)
Documentation	

Data set: Existing transport networks	
Description	Road, rail and water networks able to support the construction and servicing of a wind farm.
Type	*Input*
Data provider	National mapping agencies across the Europe
Geographic scope	Europe
Thematic scope	Transport networks
Scale, resolution	1:500000 – 1:20000
Delivery	Online (WFS)
Documentation	

Data set: Land use, planning and building rights	
Description	Land use, plans for land use and building right information
Type	*Input*
Data provider	National and sub-national level agencies responsible for land use planning
Geographic scope	Europe
Thematic scope	Land use, Area management/restriction/regulation zones & reporting units
Scale, resolution	1:500000 – 1:20000
Delivery	Online (WFS)
Documentation	

Data set: Natural protection zones	
Description	Existing and planned natural protection zones where building of new wind turbines is not allowed.
Type	*Input*
Data provider	National environment agencies
Geographic scope	Europe
Thematic scope	Natural protection zones
Scale, resolution	1:500000 – 1:20000
Delivery	Online (WFS)
Documentation	

B.5 Use Case 3.2 - Climate Impacts

Description

The meteorological organisations (such as national meteorological services) have a history of providing advice on weather impacts to customers across many sectors, and the provision of climate impacts advice is a natural extension of these existing activities. Existing and potential customers and stakeholders, both in government and private sector, are now focusing significantly on climate impacts. Many sectors are becoming more aware of their weather sensitivity, and climate change means that we cannot assume that the statistics of weather derived from the historical record are applicable now and certainly not so in the future.

Some of the organisations or systems for which climate impact assessments are of particular relevance are:

- Water, Agriculture, Food production;
- Ecosystems, Biodiversity;
- Utilities, Transport, Energy;
- Health, Economics;
- Natural disasters, Security.

The requirements of the users of climate research have changed; rather than simply requiring evidence for the human contribution to climate change and scenarios of its potential future magnitude, an increasing number of stakeholders are beginning to require assessment of the likely impacts of climate change. In general, this is either to inform decisions on the level and nature of action to mitigate climate change, or to help plan for adaptation. In the latter case, this can be related to both long-term and short-term changes or variability in climate arising from either natural or anthropogenic causes.

Here, the term “Climate Impacts” refers to anything which is a consequence of climate change. Some customer requirements relate to improving resilience against change and variability on seasonal to decadal timescales – these can often be addressed with similar techniques to those used to assess the impacts of longer-term climate change. It is for this reason that we use the term “climate impacts” as opposed to “climate change impacts”. Indeed, impacts assessments are required over a very large range of time and space scales, from local impacts over timescales of seasons to the next few years, to global impacts several decades or more into the future. While there are some exceptions, in general the short-term, local assessments are required for adaptation while long-term, large-scale assessments are for informing mitigation.

Most direct impacts are on “natural” process (either physical processes such as river flows, or biological processes such as ecosystem changes) and these can then exert further impacts on humans and their economy and society. In some cases, climatic or meteorological processes can have impacts directly on humans, e.g.: rising temperatures leading to heat stress, or changes in storminess causing damage to infrastructure with further financial or economic consequences.

In the near term, products will be delivered through the application of existing climate models to existing impacts models or analysis methods. This bespoke climate and impacts model analysis for customers ensures that the data and techniques are being applied appropriate for the question from end to end. This could include new simulations with existing climate models as well as new analysis of the large number of existing climate model simulations. As well as involving the application of climate model output to offline impacts models or impacts-focussed climate metrics (e.g.: heat stress, growing season onset), we will also analyse climate model outputs which relate more directly to impacts, such as runoff and vegetation productivity.

In the longer term, global scale impacts assessments will be provided using both general circulation models (GCMs) and Integrated Assessment Models (IAMs), which will allow the simulation of crops, ecosystems, water resources, flooding, irrigation, glaciers, and chemistry impacts all interactively, thus facilitating internally-consistent impacts assessment including non-climatic drivers such as land use change and atmospheric chemistry.

In the approach described for this use case (which is used by the Met Office Hadley Centre Climate Impacts Analysis team), past climate data are used to 'baseline' the 'climate risk', before the predictions of the future climate are analysed to identify the future risk. The **Climate Impacts and Risk assessment Framework**, or CIRF (pronounced as "serf") [1], represents the standard process of doing a risk assessment for an organisation or system.

Step 1: Identify the needs, objectives and extent of the project, including the required outcomes and expectations
Step 2: Explore how available datasets can meet the key requirements
Step 3: Assess existing risks due to the current weather and climate
Step 4: Assess in detail how the key risks identified in step 3 are likely to change in the future
Step 5: Work with the customer to explore suitable adaptation options associated with the key risks
Step 6: Communicate clearly the project results and outcomes
Step 7: Review that the assessment has met the customer's requirements, and identify future steps to be taken.

Steps 2, 3 & 4 (in blue above) require the input of weather and climate information, both past data and future projections.

The main parameters of interest are:

- Temperature
- Precipitation

Although, there are a number of other parameters (e.g. wind, humidity, pressure), which may be useful for particular impact assessments, and the Global Climate Observing System (GCOS) has defined a much wider set of Essential Climate Variables (ECVs) [2].

Gridded datasets in the form of time series or long term averages (e.g. 10 year and 30 year) with extremes and probabilities of exceeding threshold (of interest to the particular organisation/system) are most useful, as they provide the coverage required, and allow matching of past and future data. However, past observations may be useful for particular locations and the assessment of specific incidents.

Baselining the current climate risk requires past climate data, in the form of:

- **Climatological observation records** (e.g. Met Office Hadley Centre observations datasets [3])
- **Gridded climatologies**,
  e.g. for the UK UKCP09 5km x 5km grids:
    - Daily datasets (1960 to 2006)
    - Metrics of precipitation
    - Monthly datasets (currently updated to the end of 2005)
    - Annual datasets (1961 to 2000)
    - Baseline average datasets (1961 to 1990)
  - e.g. for Europe the ENSEMBLES daily gridded observational dataset (E-OBS RT5; 0.22 to 0.50 degrees resolution) from the European Climate Assessment & Dataset (ECA&D) [8]:
    - Cloud cover
    - Wind direction
    - Wind speed
    - Wind gusts

        - Relative humidity
        - Sea level pressure
        - Precipitation amount
        - Snow depth
        - Sunshine
        - Mean temperature
        - Minimum temperature
        - Maximum temperature
- **Re-analyses**, e.g.:
    - ERA-Interim, ERA40 (ECMWF) [5]
    - ACRE [6]

The future climate risk analysis requires **Climate projections** for various horizons out to 2100, including single and multi-model ensembles (with probabilities) and down-scaling using regional models. e.g.:

- **UKCP09** [4], which are based on the Met Office Hadley Centre climate model HadCM3, using perturbed physics ensembles, with:
    - Annual, seasonal and monthly climate averages.
    - Individual 25 km grid squares, and for pre-defined aggregated areas.
    - Seven 30 year time periods.
    - Three emissions scenarios.
    - Projections are based on change relative to a 1961–1990 baseline.
- **WCRP[4] CMIP3[5] multi-model dataset** [7], which provides climate projections[6] from a large number of groups in support of IPCC AR4[7].

(Seasonal and decadal forecasts are also useful tools to provide a full range of future predictions.)

The process identifies Risk Indicators (a measure of some quantity of interest to the customer, e.g. fire incidents per day), which are a function of the Hazard (e.g. fire) and the Vulnerability (e.g. population density). Note that Vulnerability here includes Exposure, which is sometimes treated separately.

The Hazard can be related to the climate variables (e.g. for fire incidents, it may be related to the number of days with the temperatures above a certain threshold and the precipitation below a certain threshold). This relationship may be given by an existing model, or past data provided by the customer can be used to define the relationship.

Vulnerability data may also be provided by the customer or by another competent authority (e.g. social scientists).

The baseline and future risks are usually shown as a raster plot against and appropriate map overlay, with time series at a location being used to shown variability over time. Plots with 'error bars' and probability distribution functions may also be used to show the variability against a mean (either past or projected).

High Level Use Case

The Use Case diagram below shows all the use cases and actors considered. Use cases are colour-coded to indicate their focus.

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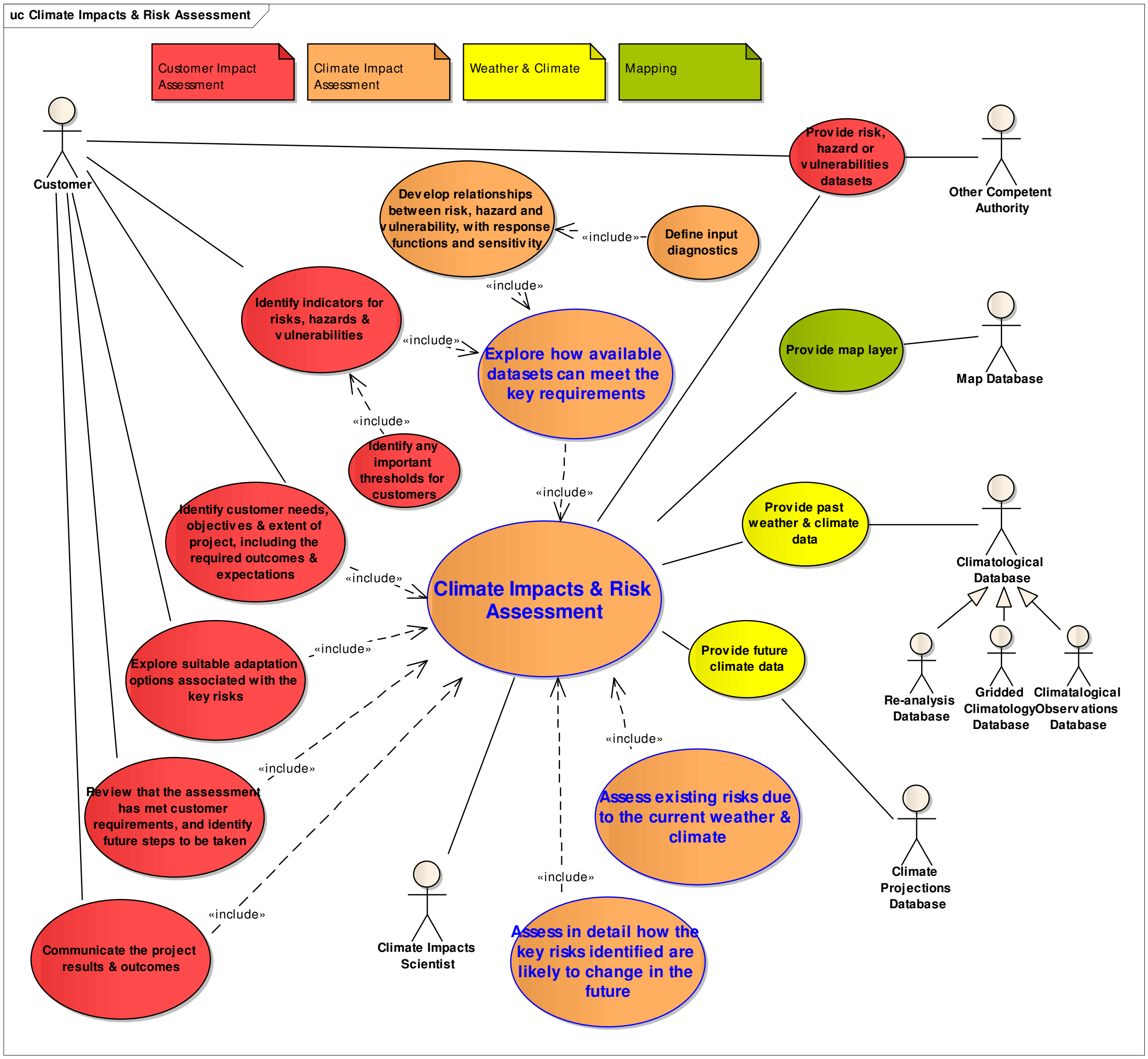
[4] World Climate Research Programme
[5] Phase 3 of the Coupled Model Intercomparison Project
[6] Projections against various emissions scenarios
[7] Fourth Assessment Report of the Intergovernmental Panel on Climate Change



uc Climate Impacts & Risk Assessment
Customer Impact Assessment
Climate Impact Assessment
Weather & Climate
Mapping
Customer
Provide risk, hazard or vulnerabilities datasets
Other Competent Authority
Develop relationships between risk, hazard and vulnerability, with response functions and sensitivity
«include»
Define input diagnostics
«include»
Identify indicators for risks, hazards & vulnerabilities
«include»
Explore how available datasets can meet the key requirements
Provide map layer
Map Database
«include»
Identify any important thresholds for customers
«include»
Identify customer needs, objectives & extent of project, including the required outcomes & expectations
«include»
Climate Impacts & Risk Assessment
Provide past weather & climate data
Climatological Database
Explore suitable adaptation options associated with the key risks
«include»
Provide future climate data
Re-analysis Database
Gridded Climatology Database
Climatalogical Observations Database
«include»
«include»
Review that the assessment has met customer requirements, and identify future steps to be taken
Assess existing risks due to the current weather & climate
Climate Projections Database
«include»
«include»
Communicate the project results & outcomes
Climate Impacts Scientist
Assess in detail how the key risks identified are likely to change in the future

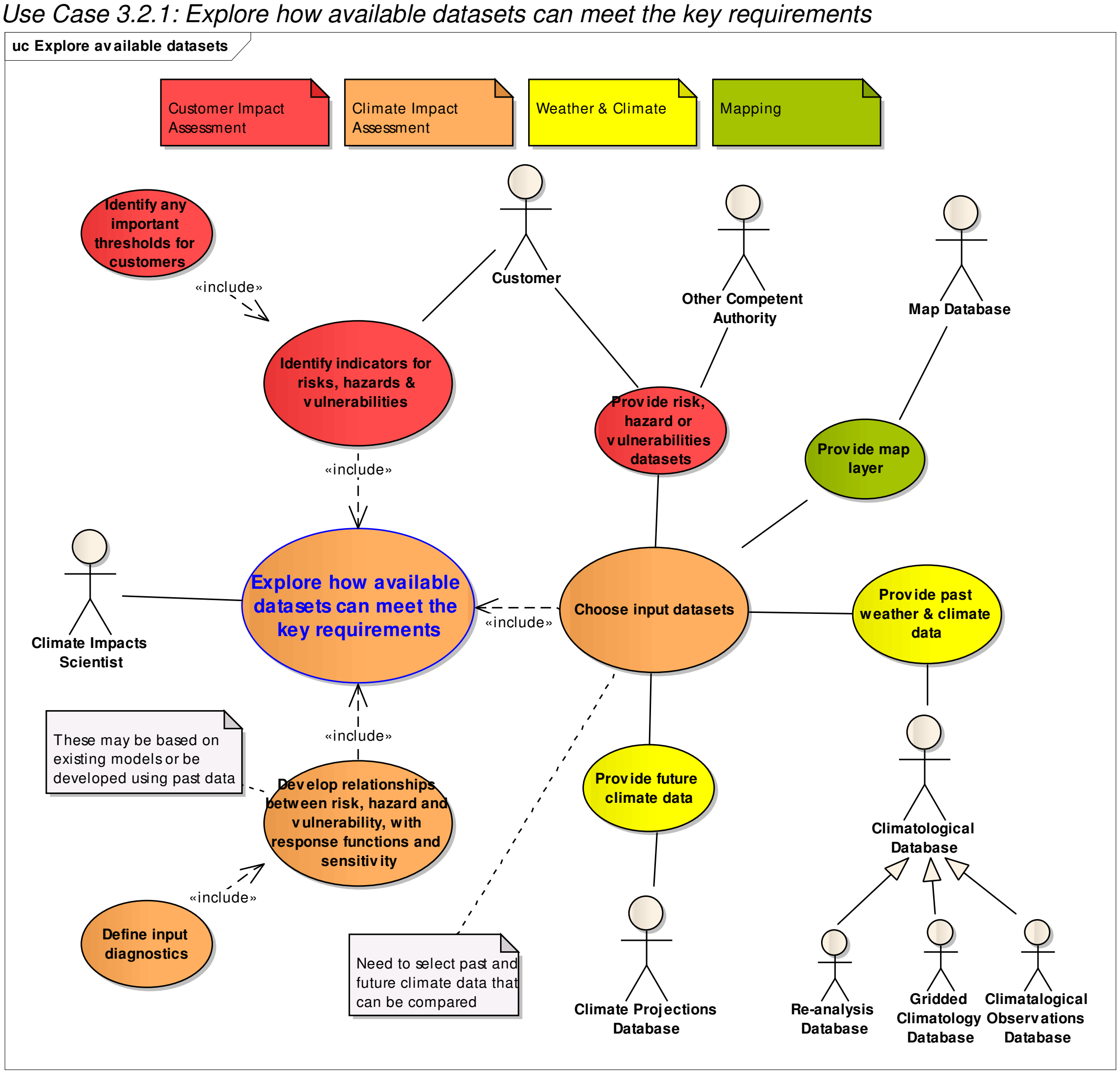
Actors

- **Climate Impacts Scientist** – scientists involved in providing assessing climate impact and risk
- **Customer** – general class of actor used to describe a wide range of customers
- **Other Competent Authority** – some agency other than the customer qualified to provide information required for the impact and risk assessment
- **Climatological Database** – set of past weather and climate data available
  - **Climatological Observations Database** – time series of point weather and climate observations
  - **Gridded Climatology Database** – gridded datasets derived from observations
  - **Re-analysis Database** – gridded datasets derived using an NWP model data assimilation scheme to analyse the observations
- **Climate Projections Database** – set of future climate projections using difference scenarios (this includes single and multi-model ensembles)
- **Map Database** – Database of map overlays at wide range of scales.

Detailed Structured Description of Climate Prediction Impact Use Cases

The climate impact use cases are presented in more detail using the standard template in the following sections.

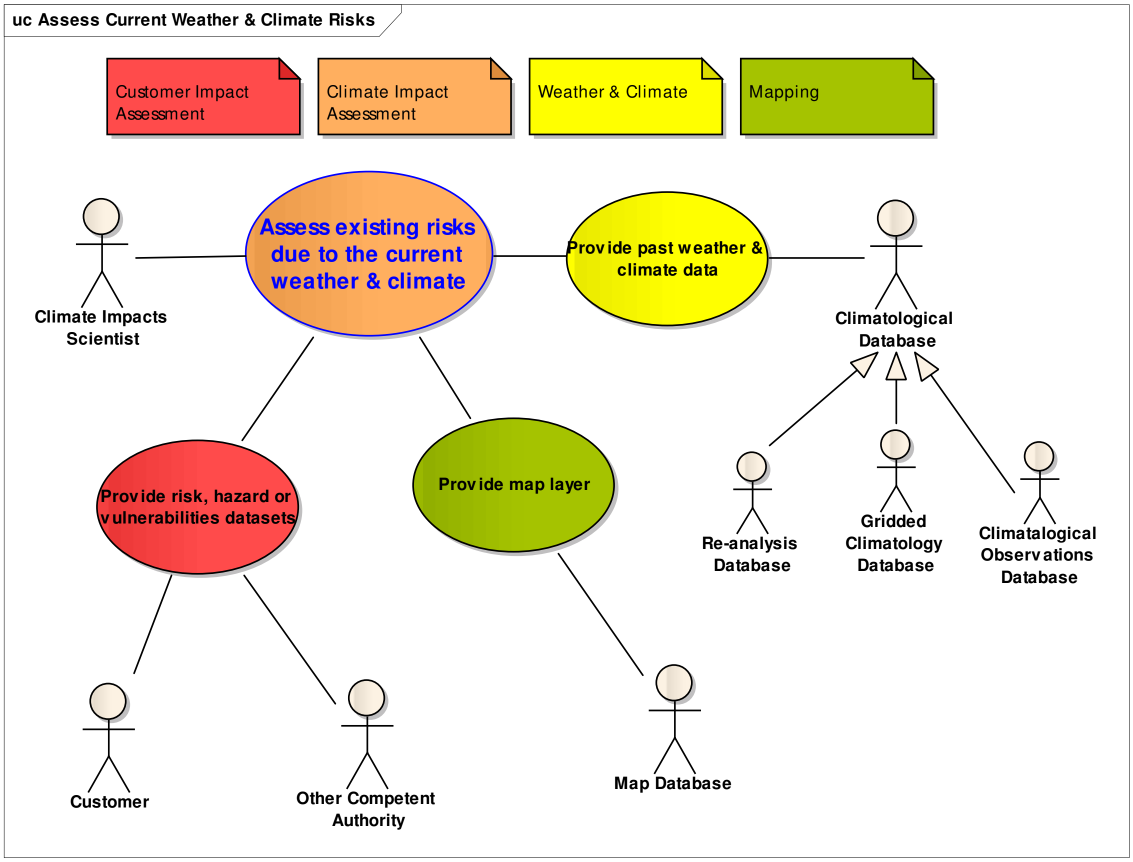
Use Case 3.2.1: Explore how available datasets can meet the key requirements



Use Case 3.2.1	**Explore how available datasets can meet the key requirements**
Priority	High
Description	Climate Impact Scientist works with the customer to decide on the set of past weather & climate, future climate and other data should be used to assess the climate impact and risk for a particular customer. They also develop the relationships between the risk, hazard and vulnerabilities, with assessment of the response function and the sensitivity, using existing models or past data.
Pre-condition	Customer needs, objectives & extent of project, including the required outcomes & expectations, for the climate impact and risk assessment have been identified.
Flow of Events - Basic Path	
Step 1	***Climate Impacts Scientist*** works with the ***Customer*** to identify the **Risks, Hazards and Vulnerabilities Indicators** of important to their area of concern.
Step 2	***Customer*** identifies and important threshold values.
Step 3	***Climate Impacts Scientist*** develops the relationship between the risk, hazard and vulnerabilities, including the response function and an assessment of the sensitivity.
Step 4	***Climate Impacts Scientist*** defines the input diagnostics required for the risk function (including the inputs to the hazard model)
Step 5	***Climate Impacts Scientist*** chooses the datasets to provide the input diagnostics for the risk function, and for the calibration of the hazard model, if required. This includes **Past Weather & Climate Data (Climatological Observations, Gridded Climatologies, Re-analyses)**, **Future Climate Projections** and **Risk, Hazard & Vulnerability Data**
Post-condition	Identified set of input climate and vulnerabilities datasets and a calibrated hazard model.
Flow of Events - Alternative Path	
Additional Step 6	If necessary, the ***Climate Impacts Scientist*** develops the hazard model relationship with the input diagnostics.
Data Source: Risk, Hazards & Vulnerabilities Indicators	
Description	Risk, hazard and vulnerabilities indicators of importance for the customer's area of concern, including any important threshold values.
Data Provider	Customer
Geographic Scope	n/a
Thematic Scope	n/a
Scale, resolution	n/a
Delivery	Consultation
Documentation	None – dependent on customer
Data Source: Risk, Hazards & Vulnerabilities Datasets	
Description	Various datasets characterising the risk, hazard and vulnerabilities of importance for the customers area of concern
Data Provider	Customer, Other Competent Authority
Geographic Scope	Area of interest (may be national, regional or global)
Thematic Scope	Various (depending on customer area of concern)
Scale, resolution	Various, but likely to include *PointSeries* and *GridSeries* (spatial and temporal resolution depends on area of interest)
Delivery	Various
Documentation	None
Data Source: Climatological Observations	
Description	Point weather and climate observations
Data Provider	Competent authorities in the weather and climate domain
Geographic Scope	Area of interest (potentially global)
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*PointSeries* (typically daily max, min, mean or accumulation, but could be over various periods)

Delivery	Typically space-delimited text files as download
Documentation	For example, see: *http://www.hadobs.org/*
Data Source: Gridded Climatologies for the Country of Interest	
Description	Grids of climate parameters interpolated from observations
Data Provider	Competent authorities in the weather and climate domain
Geographic Scope	Country of interest
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (various, but for example for the UK: 5km, daily, monthly, annual and 30 year means)
Delivery	Typically space-delimited text or netCDF files as download
Documentation	For example, see: *http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcp09/index.html*
Data Source: Gridded Climatologies for Europe	
Description	ENSEMBLES daily gridded observational dataset (E-OBS)
Data Provider	European Climate Assessment & Dataset (ECA&D)
Geographic Scope	Europe
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (0.22 – 0.50 degrees, daily 1950 – present)
Delivery	netCDF
Documentation	For example, see: *http://eca.knmi.nl/download/ensembles/ensembles.php*
Data Source: Re-analyses	
Description	Grids derived using an NWP model data assimilation scheme to analyse the observations
Data Provider	Competent authorities in the weather and climate domain
Geographic Scope	Global
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (various spatial & temporal resolutions)
Delivery	Typically netCDF file download
Documentation	For example, see: *http://www.ecmwf.int/research/era/do/get/Reanalysis_ECMWF*
Data Source: Future Climate Projections	
Description	Set of gridded data of future climate projections using difference scenarios (this includes single and multi-model ensembles)
Data Provider	Competent authorities in the weather and climate domain
Geographic Scope	Global
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF)
Scale, resolution	*GridSeries* (various spatial & temporal resolutions)
Delivery	Typically netCDF file download
Documentation	For example, see: *http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php*
Data Source: Map	
Description	Geographical map at appropriate scale
Data Provider	Various
Geographic Scope	Area of interest, potentially anywhere on the globe
Thematic Scope	Cadastral Parcels (CP)
Scale, resolution	*Polygons* provided as raster image
Delivery	As part of visualisation of other data
Documentation	None

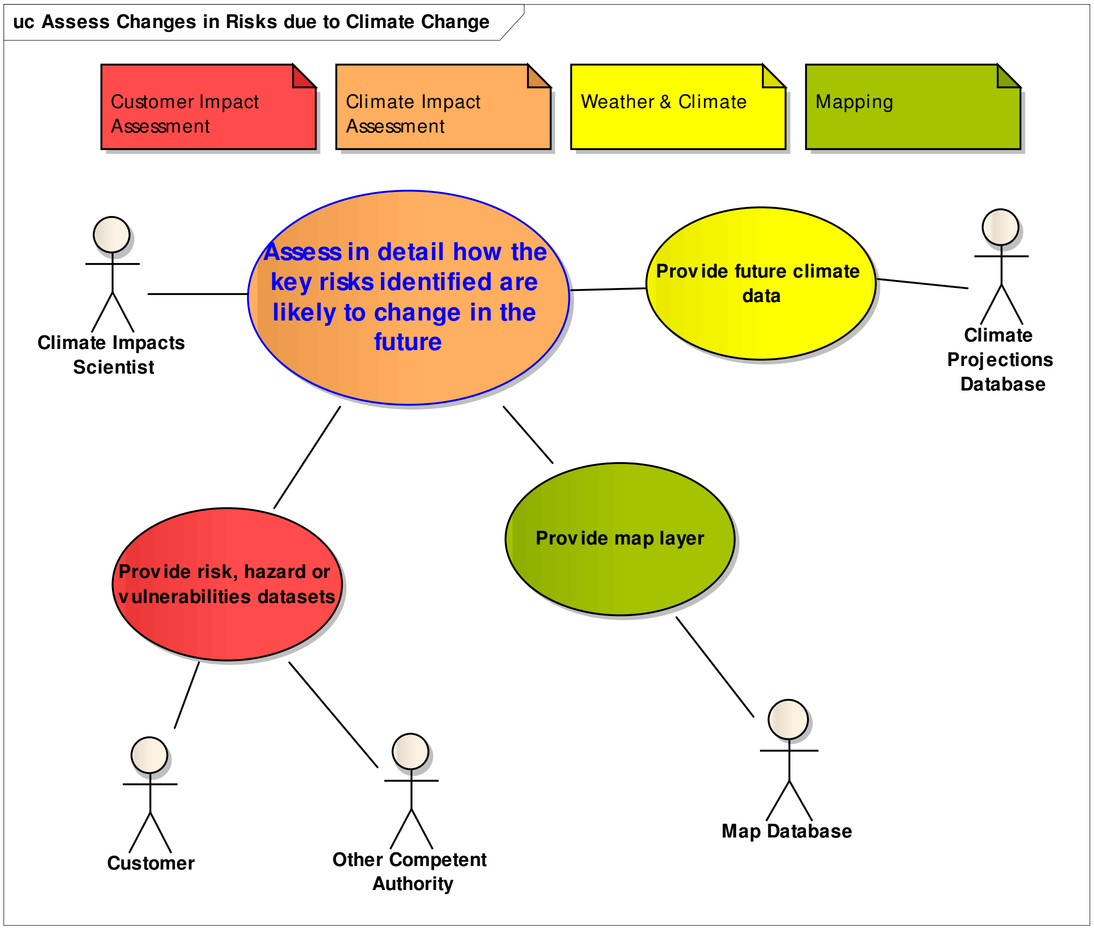
Use Case 3.2.2: Assess existing risks due to the current weather & climate



Use Case 3.2.2	**Assess existing risks due to the current weather & climate**
Priority	High
Description	Climate Impacts Scientist assesses the current customer expose to climate impacts and risks using past climate and weather data. They also calibrate/baseline the risk function relationship.
Pre-condition	Identified set of input climate and vulnerabilities datasets and a calibrated hazard model.
Flow of Events - Basic Path	
Step 1	***Climate Impacts Scientist*** uses the **Past Weather & Climate Data (Climatological Observations, Gridded Climatologies, Re-analyses)** and **Risk, Hazard & Vulnerability Data** within the risk function and hazard model relationships to assess the current exposure (and calibrate/baseline the relationships) to climate and weather.
Step 2	***Climate Impacts Scientist*** reviews the results using various **Visualisations of Risk Indicators**
Post-condition	Current (baseline) risk understood. Risk function calibrated.
Flow of Events - Alternative Path	
Additional Step 1a	If relevant the ***Climate Impacts Scientist*** may use Climatological **Observations** with the **Risk, Hazard & Vulnerability Data** to investigate specific events to gain further insight to the hazard model relationship with the input diagnostics.
Data Source: Climatological Observations (as per Use Case 3.2.1)	
Data Source: Gridded Climatologies (as per Use Case 3.2.1)	
Data Source: Re-analyses (as per Use Case 3.2.1)	
Data Source: Risk, Hazards & Vulnerabilities Data (as per Use Case 3.2.1)	
Data Source: Visualisations of Risk Indicators	
Description	Visualisation of risk indicators, as maps (usually filled gridboxes), time series (possibly with error/range bars) or probability distribution functions (PDFs).

Data Provider	Competent authorities in the weather and climate domain
Geographic Scope	Area of interest (may be national, regional or global)
Thematic Scope	Atmospheric Conditions (AC), Meteorological Geographic Features (MF) and various others (depending on customer area of concern)
Scale, resolution	*Grid, Point , PointSeries* (spatial and temporal resolution depends on area of interest)
Delivery	GIS tool, webpage or as part of a report
Documentation	None
Data Source: Map (as per Use Case 3.2.1)	

Use Case 3.2.3: Assess in detail how the key risks identified are likely to change in the future



Use Case 3.2.3	**Assess in detail how the key risks identified are likely to change in the future**
Priority	High
Description	Climate Impact Scientists assesses the future customer expose to climate impacts and risks using climate projections.
Pre-condition	Current (baseline) risk understood. Risk function calibrated.
Flow of Events - Basic Path	
Step 1	***Climate Impacts Scientist*** uses the **Future Climate Projections** and **Risk, Hazard & Vulnerability Data** within the risk function and hazard model relationships to assess the exposure to future changes in climate and weather.
Step 2	***Climate Impacts Scientist*** reviews the results using various **Visualisations of Risk Indicators**
Post-condition	Future risk understood.
Data Source: Future Climate Projection (as per Use Case 3.2.1)	
Data Source: Risk, Hazards & Vulnerabilities Data (as per Use Case 3.2.1)	
Data Source: Visualisations of Risk Indicators (as per Use Case 3.2.2)	
Data Source: Map (as per Use Case 3.2.1)	

Applicability to other themes

The “Climate Impacts” use case can potentially be applied to many of the other INSPIRE themes, depending on their scope. The following themes currently refer to use of climate data for impacts evaluation:

- Buildings mentions climate data in several use cases, but does not explicitly reference it as a data source.
- Environmental Monitoring Facilities mentions climate data in the use case related to the oceans in relation to climate change monitoring and the Marine Strategy Framework Directive, but does not explicitly reference AC-MF.
- Natural Risk Zones defines a “Climate” risk category and explicitly refers to the need for AC-MF climate data in forest fires danger mapping use case.
- Soil explicitly references climate data in two of the use cases, and may have applicability to further use cases.

There are also a number of themes that do not refer to climate data, but appear to need it for impacts evaluation:

- Energy Resources appears to have a dependency on climate data for the use cases related to wind and solar power.
- Human Health and Safety appears to have a dependency on climate data a whole range of use cases (specific examples include the air quality, and the development and transmission of diseases), but there is no reference to it.
- Ocean Geographic Features coastal flood hazard map use case could potentially need climate data, but it is not referenced as a data source.
- Habitats and Biotopes needs climate information in relation to the distribution, the extent and the “quality” of habitats, but there is no reference to it.
- Bio-geographical Regions needs climate data for analysis and classification of bio-geographical regions.

References

[1] **Prepare: Understand your weather and climate related risks** (Climate Impacts and Risk assessment Framework (CIRF) Data Sheet): *http://www.metoffice.gov.uk/publicsector/cirf-datasheet.pdf*

[2] **Essential Climate Variables (ECV) Data Access Matrix** (GCOS): *http://gosic.org/ios/MATRICES/ECV/ecv-matrix.htm*

[3] **Met Office Hadley Centre observations datasets**: *http://www.hadobs.org/*

[4] **UK Climate Projections** (UKCP09): *http://ukclimateprojections.defra.gov.uk/content/view/868/531/*

[5] **Reanalysis at ECMWF** (ERA): *http://www.ecmwf.int/research/era/do/get/Reanalysis_ECMWF*

[6] **Atmospheric Circulation Reconstructions over the Earth** (ACRE): *http://www.met-acre.org/*

[7] **WCRP CMIP3 multi-model dataset** (IPCC AR4): *http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php*

[8] **European Climate Assessment and Dataset** (ECA&D): *http://eca.knmi.nl/*

B.6 Reporting and exchanging of Air Quality data under 2011/850/EU

Introduction

A number of EU legal instruments require EU Member States to monitor and report air quality data; this information is collated and disseminated by the European Environment Agency (EEA). At present much of the data is reported electronically by countries, but not necessarily in the best integrated fashion.

The recent introduction of 2011/850/EU (Commission Implementing Decision of 12 December 2011 laying down rules for Directives 2004/107/EC and 2008/50/EC as regards the reciprocal exchange of information and reporting on ambient air quality) provides an opportunity to examine the reporting process overall to determine how it can be modernised to improve data quality, facilitate data sharing, and reduce the administrative burden of reporting.

The Air Quality Directives' (AQD) implementing provisions[8] (AQD IPR) will apply from the end of a 2-year transitional period commencing at the date of their adoption. Consequently, the decision applies from 1 January 2014. In order to successfully manage and facilitate the transition process, the countries' reporting agencies, their data providers, and the EEA operational services will need to work closely together to establish, test and commission a new reporting process. Directive 2008/50/EC (AQD) requires that the procedures are compatible with Directive 2007/2/EC (INSPIRE).

Reporting and exchange of air quality information under the AQD IPR are of relevance to at least four of the INSPIRE Annex II/III data specification areas:

- D2.8.II/III.5 Human Health and Safety (HH),
- D2.8.III.7 Environmental Monitoring Facilities (EF),
- D2.8.III.11 Area management/restriction/regulation zones and reporting units (AM) and
- D2.8.III.13-14 Atmospheric Conditions and Meteorological Geographical Features (AC-MF).

Future electronic reporting of Air Quality data in Europe will therefore need to use the data specifications from all these thematic areas and it is essential that all four consider the use case of Air Quality data, which now includes both measurement and modelled data, into account.

Reporting of Air Quality data under implementing decision 2011/850/EU

Emerging logic and optimisation techniques

The anticipated organisation of AQD data flows under the IPR is set out in this section. In populating the logic for this new system the individual instruments (Articles within the AQD IPR) have been evaluated and mapped against current reporting data flows. No discrimination has been made between the administrative scales or hierarchies of the responsible parties involved; under the IPR, the schemata to be supplied for transmitting and organising reporting data flows are assumed to be equally applicable to all scales of responsible parties (local, regional, national or federal). Indeed it is this concept that underpins the realisation of much of the data flow streamlining to be achieved by the emergent system.

An evaluation of the IPR Articles has been performed and is summarised in the AQD IPR data model presented in Figure 1. Further details on the individual data flows are also provided – it should be noted that the diagrams are preliminary and still subject to testing and further developments. As part of this analysis, the Articles were mapped to current reporting requirements as specified by the FWD, AQDDs and EoI Decision(s). From this work it is evident and perhaps important to stress, that the overall content of data flows (existing and emergent) have remained broadly consistent, albeit with some modifications to the mandatory and voluntary contents, timing and frequency of data flows and mechanisms or formats for reporting. What is clear is that the organisation of the data flows and their contents has changed in the effort to remove or reduce duplication in data reporting and to promote efficient and discrete management of similar data types. More information is provided in the EEA

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[8] *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF*

Technical report 'Reporting and exchanging air quality information using e-Reporting'[9]. As shown in Figure 2, the data model needs to take all these data flows into account. Figures 3 – 14 describe the different data flows in more detail. Table 1 shows how the different data flows relate to the various INSPIRE data specification themes.
The IPR decision (2011/850/EU) contains a number of articles that describes how the Air Quality data that is requested by the directives (2008/50/EC) and (2004/107/EC) shall be delivered and how data flow shall be implemented. Articles 1 to 5 are introductory while articles 6 to 14 provide information on data flows that shall be put in place. As shown in Figure 1, the data model needs to take all these data flows into account.

Overview of data flows

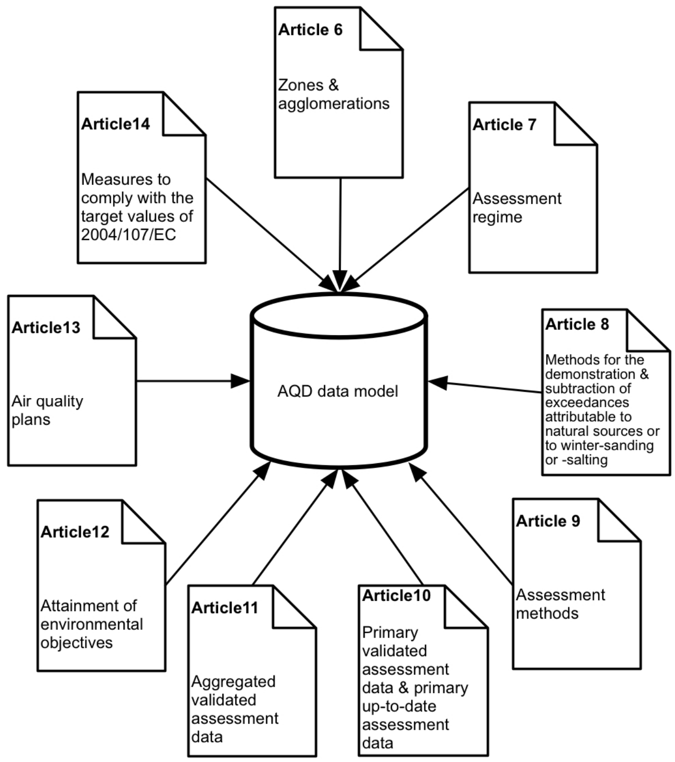

Figure 1: Overview of emergent AQD IPR data model and data flows

Table 1: Overview of the different air quality data flows and how they are related to the different INSPIRE Annex III themes.

Article no./data flow	AC-MF	EF	HH	AM
Information on zones and agglomerations (Article 6)				**X**
Information on the assessment regime (Article 7)	**X**	**X**		**X**

9 *http://www.eea.europa.eu/publications/reporting-and-exchanging-air-quality*

"Methods for subtraction of exceedances" (Article 8)	**X**	**X**		**X**
Information on the assessment methods (Articles 8 and 9)	**X**	**X**		
Information on primary validated assessment data (Article 10)	**X**			
Information on generated aggregated data - primary validated measurements (Article 11)	**X**			
Information on the attainment of environmental objectives (Article 12)			**X**	**X**
Information on air quality plans (Article 13)	**X**			**X**
Information on measures (Articles 13 and 14)	**X**			**X**

Article 6 Zones and agglomerations

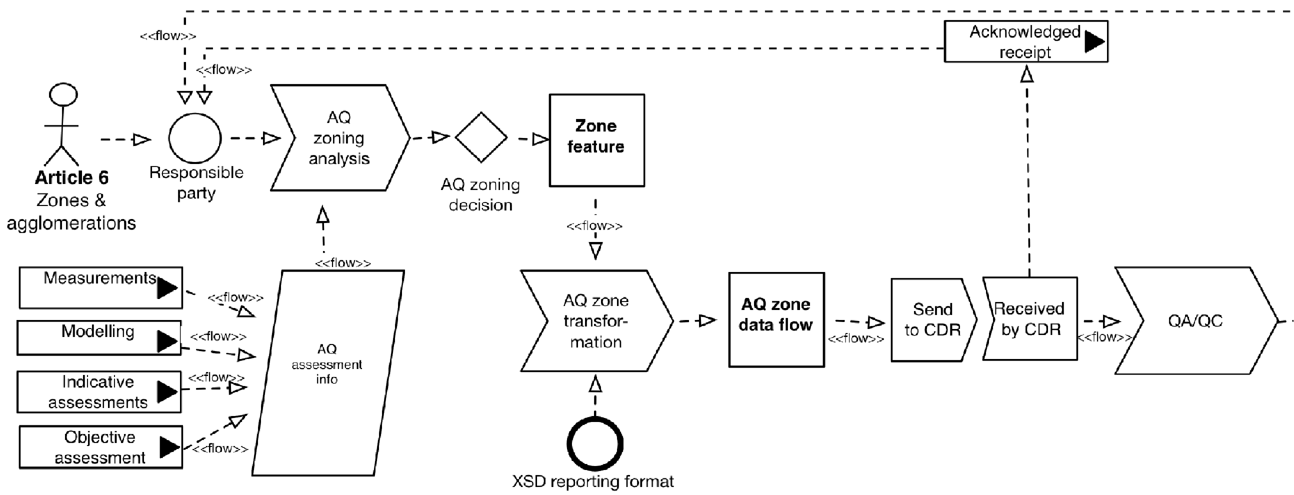

Figure 2: Data flow for reporting of zones and agglomerations within the Air Quality Directive

Table 2: Reporting of zones and agglomerations.

Name	Information on zones and agglomerations (Article 6)
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Provision of information on delimitation and types of zones and agglomerations
Pre-conditions	Quality checked information on the boundaries and typologies of zones and agglomerations for air quality management are available in national system
Post-condition	The information on the assessment regime to be applied in the following calendar year for each pollutant within individual zones and agglomerations
Flow of events – Basic path	
Step 1	Transform information on the assessment regime into agreed reporting format
Step 2	Carry out post transformation quality checks on data in agreed reporting format
Step 3	Make data in agreed reporting format available (upload to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)
Step 5	If results are negative, make required changes in national system.
Background Documentation	
AQD IPR 2011/850/EU	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF*
E-reporting	*http://www.eionet.europa.eu/aqportal*

Article 7 Assessment regimes

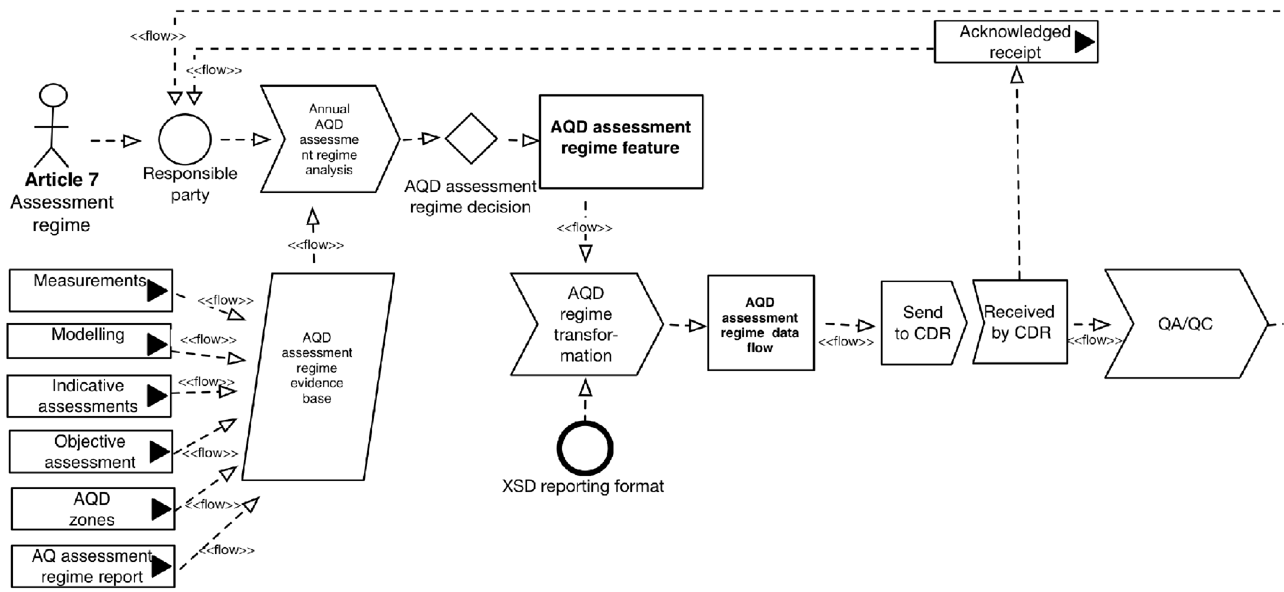

Figure 3: Data flow for reporting of Assessment regimes within the Air Quality Directive

The different steps of the reporting for Article 7 are also presented in the table below.

Table 3: Reporting of assessment regime.

Name	Reporting information on the assessment regime (Article 7)
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Member States shall make available the information on the assessment regime to be applied in the following calendar year for each pollutant within individual zones and agglomerations
Pre-conditions	• Assessment thresholds for each individual zone and agglomeration in accordance with Article 4 of Directive 2004/107/EC and Articles 5 and 9 of Directive 2008/50/EC.are available in national system • Meta information for operational measurement networks including quality procedures in national air quality system and meta information for models including quality procedures in national air quality system (Articles 8 and 9) reported. • Information on zones and agglomerations (Article 6) reported
Post-condition	The information on the assessment regime to be applied in the following calendar year for each pollutant within individual zones and agglomerations
Flow of events – Basic path	
Step 1	Transform information on the assessment regime into agreed reporting format
Step 2	Carry out post transformation quality checks on data in agreed reporting format
Step 3	Make data in agreed reporting format available (upload to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)
Step 5	If results are negative, make required changes in national system.
Background Documentation	
AQD IPR 2011/850/EU	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF*
AQ Directive	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT*

2008/50/EC	
4th Daughter Directive 2004/107/EC	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0107:en:NOT*
E-reporting	*http://www.eionet.europa.eu/aqportal*

Article 8 Methods for the demonstration and subtraction of exceedances attributable to natural sources or to winter- sanding or –salting and Article 9 Assessment methods

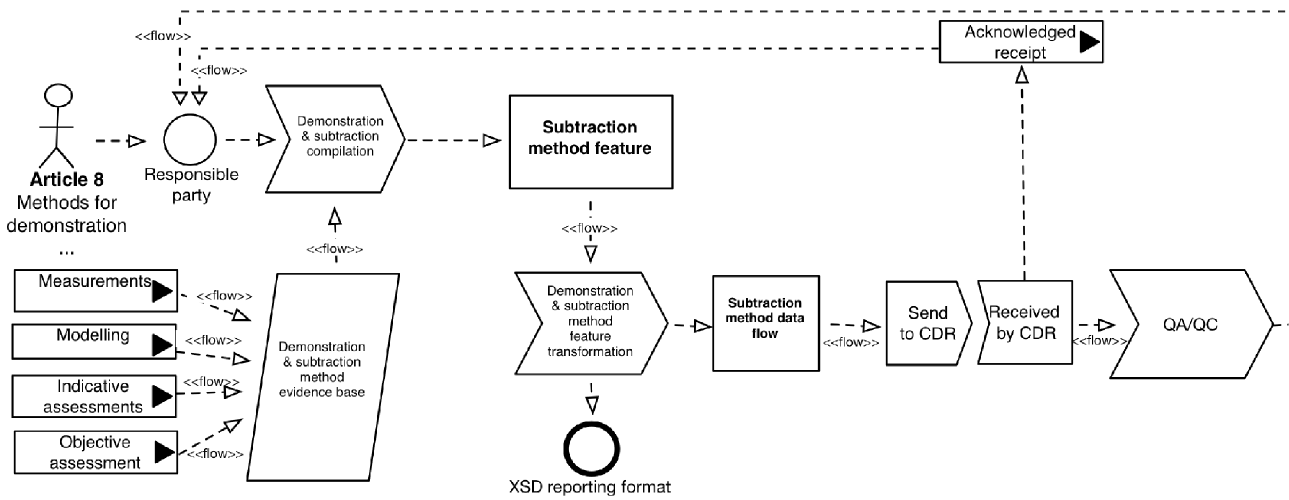

Figure 4: Data flow for reporting of methods used for subtraction of measurements exceeding legal Air Quality thresholds. Measurements exceeding thresholds that can be proved to be attributable to natural or external sources will not be taken into account when number of days with exceedences are summarised for a year

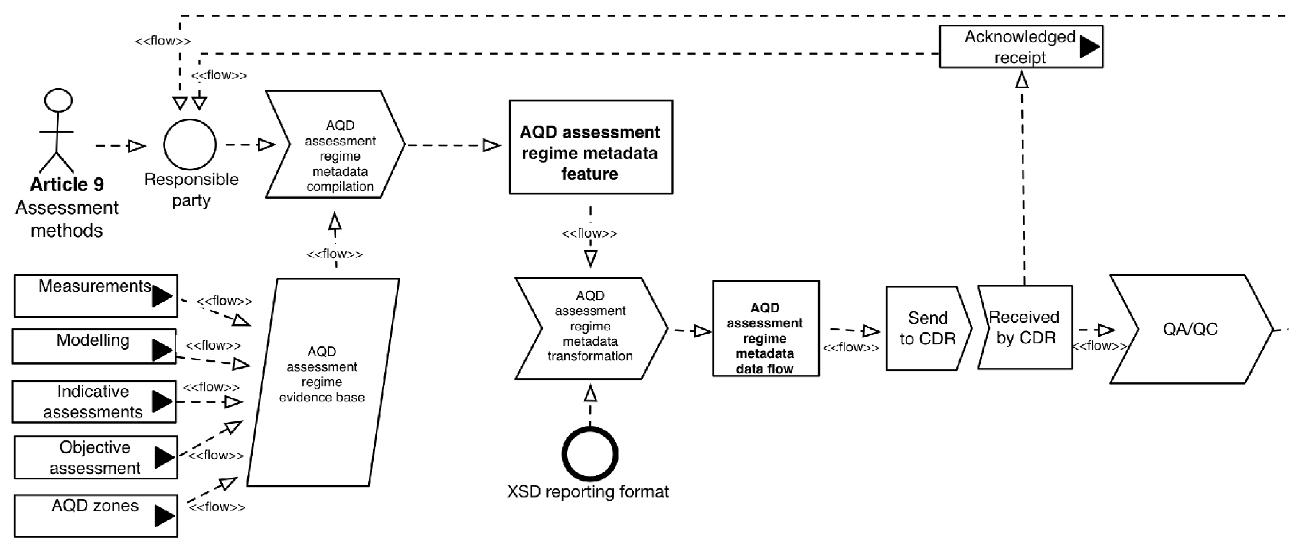

Figure 5: Data flow for reporting of Air Quality assessment methods

The different steps required for reporting of assessment methods are also described in the table below. This combines both articles 8 and 9.

Table 4: Reporting of assessment methods

Name	Reporting **of information on the assessment methods (Articles 8 and 9)**
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Provision of metadata for the assessment, describing the methods and the supporting information.
Pre-conditions	• **Meta information for operational measurement networks including quality procedures in national air quality system** • **Meta information for models including quality procedures in national air quality system**
Post-condition	The assessment methods (metadata for networks, stations, instruments, analytical methods for measurements and metadata for models) for the primary data are available in order to provide traceability for subsequently reported primary data
Flow of events – Basic path	
Step 1	Transform meta information inventories relating to primary data from national air quality system into agreed reporting format
Step 2	Carry out post transformation quality checks on data in agreed reporting format
Step 3	Make data in agreed reporting format available (upload to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)
Step 5	If results are negative, make required changes in national system.
Background Documentation	
AQD IPR 2011/850/EU	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF
E reporting	*http://www.eionet.europa.eu/aqportal*

Article 10 Primary validated assessment data and primary up-to-date assessment data

Three type of primary assessment data are covered in this section: validated measurements from fixed stations, validated measurements obtained from air models and preliminary measurements from fixed stations. Preliminary measurements have not yet undergone the full set of quality controls but are made available in order to provide up-to-date data.

Primary validated measurement data

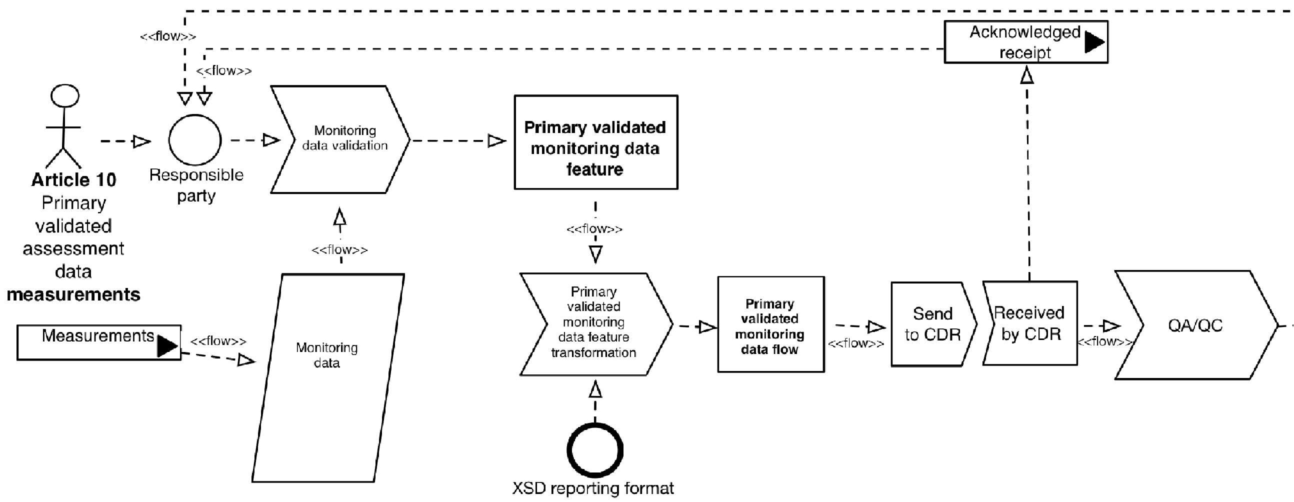

Figure 6: Validated measurement data

The different steps required for reporting of primary validated measurement data are also described in the table below.

Table 5: Reporting of primary validated measurement data

Name	**Reporting of information on primary validated assessment data -measurement (Article 10)**
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Provision for reporting of validated un-aggregated concentration levels from fixed stations in order to maintain the existing EoI exchange mechanism on fixed monitoring stations and related data that feeds into AirBase
Pre-conditions	• **Operational measurement networks including quality procedures in place** • **Validated measurements results for relevant components (pollutants) available in national air quality system** (pollutant/component measured, measurement value, time stamp, validity flag plus key to retrieve metadata (networks,stations,instruments,methods) reported under Articles 8 and 9) • **Information on zones and agglomerations (Article 6)** reported • **Information on the assessment regime (Article 7)** reported • **Information on the assessment methods (Articles 8 and 9) reported**
Post-condition	**Information on primary validated assessment data -measurements** are available in air quality data repository (CDR) and are consistent with information under Articles 6,7, 8 and 9 as documentation of the calculation of exceedances in air quality management zones
Flow of events – Basic path	
Step 1	Transform validated primary measurement data from national air quality system into agreed reporting format
Step 2	Carry out post transformation quality checks on data
Step 3	Make data in agreed reporting format available (deliver to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)
Step 5	If results are negative, make required changes to data in national system.
Documentation	

AQD IPR 2011/850/EU	**http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF**
E reporting	*http://www.eionet.europa.eu/aqportal*

Primary validated model data

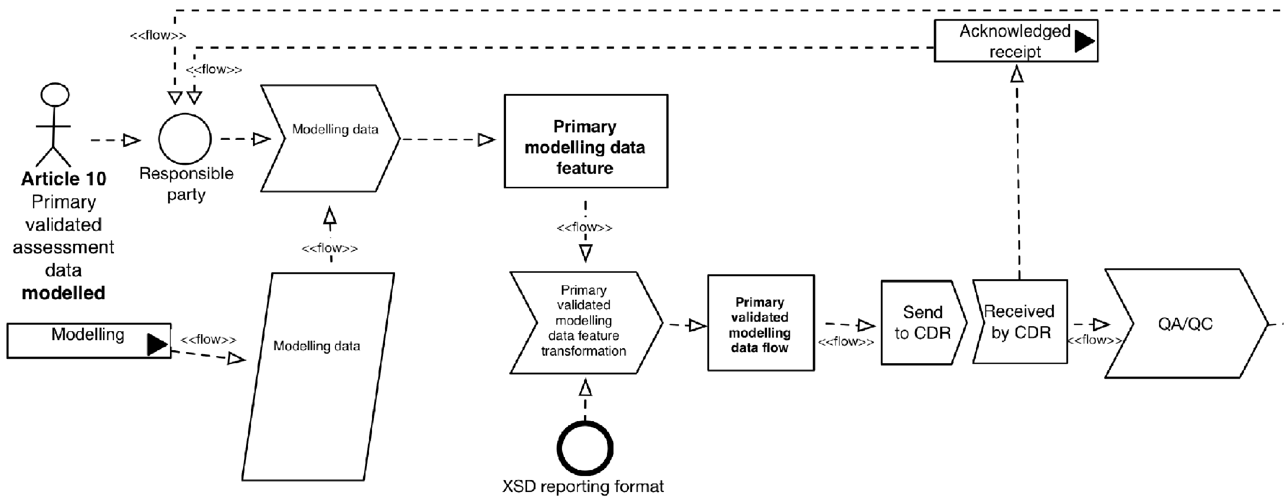

Figure 7: Validated modelled data. Note that the diagram is still not adapted to the special features of model data.

The different steps required for reporting of primary validated modelled data are also described in the table below.

Table 6: Reporting of validated modelled data

Name	**Reporting of information on primary validated assessment data -modelled (Article 10)**
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Provision for reporting of un-aggregated concentration levels from AQ modelling
Pre-conditions	• **Appropriate modelling capacity including quality procedures are in place** • **Validated results of modelling exercise** (pollutant/component (s) modelled, modelled values, time stamp, validity flag plus key to retrieve metadata for model reported under Articles 8 and 9) **available in national air quality system** • **Information on zones and agglomerations (Article 6)** reported • **Information on the assessment regime (Article 7)** reported • **Information on the assessment methods (Articles 8 and 9) reported**
Post-condition	**Information on primary validated assessment data -modelled** are available in air quality data repository (CDR) and are consistent with information reported under Articles 6,7, 8 and 9 for documentation of the calculation of exceedances in air quality management zones
Flow of events – Basic path	
Step 1	Transform modelled primary data from national air quality system into agreed reporting format
Step 2	Carry out post transformation quality checks on data in agreed reporting format
Step 3	Make data in agreed reporting format available (upload to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)

Step 5	If results are negative, make required changes in national system.
Background Documentation	
AQD IPR 2011/850/EU	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF
E reporting	*http://www.eionet.europa.eu/aqportal*

Primary up-to-date data

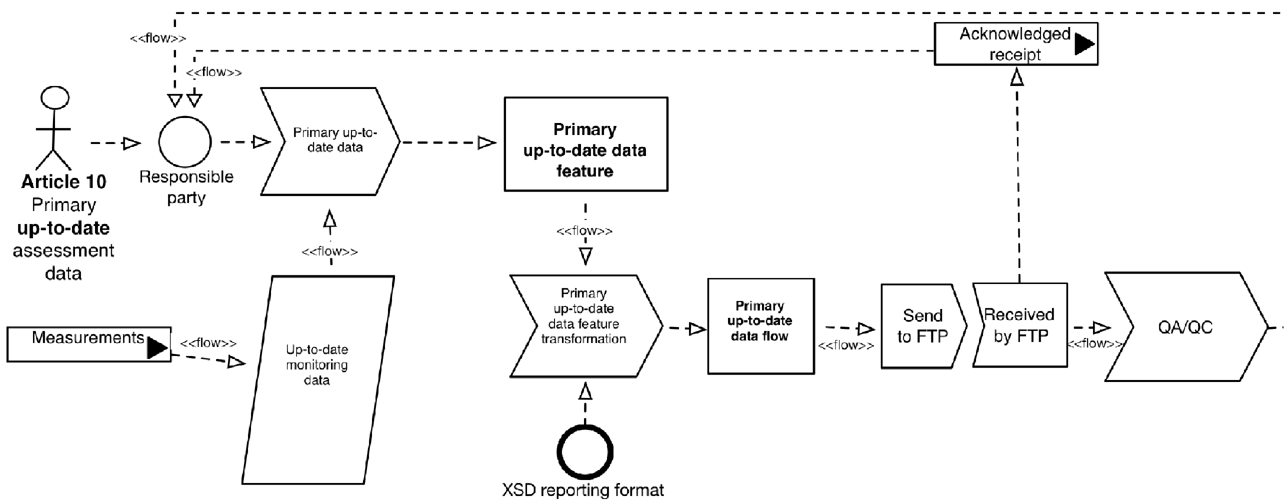

Figure 8: Primary up-to-date measurement data. The term Near Real Time (NRT) data has previously been used for such data.

The different steps required for reporting of primary up-to-date measurement data are also described in the table below.

Table 7: Reporting of up-to-date measurement data

Name	**Reporting of information on primary up-to-date assessment data -measurement (Article 10)**
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU
Importance	High
Description	Provision for reporting as soon as possible of un-aggregated concentration levels from fixed stations. The measurement results have not yet passed the full range of quality checks and therefore are subject to change.
Pre-conditions	• Operational measurement networks including quality procedures in place • Up-to-date measurements results for relevant components (pollutants) available in national air quality system (pollutant/component measured, measurement value, time stamp, validity flag plus key to retrieve metadata (networks,stations,instruments,methods) reported under Articles 8 and 9) • Information on zones and agglomerations (Article 6) reported • Information on the assessment methods (Articles 8 and 9) reported
Post-condition	Primary up-to-date assessment data -measurements are available at an agreed internet location and are consistent with information under Articles 6, 8 and 9

Flow of events – Basic path	
Step 1	Transform up-to-date primary measurement data from national air quality system into agreed reporting format
Step 2	Carry out post transformation quality checks on data
Step 3	Make data in agreed reporting format available at agreed internet location.
Step 4	Receive results of post delivery quality checks
Step 5	If results are negative, make required changes to data in national system.
Documentation	
AQD IPR 2011/850/EU	**http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF**
E-reporting	*http://www.eionet.europa.eu/aqportal*

Article 11 Aggregated validated assessment data

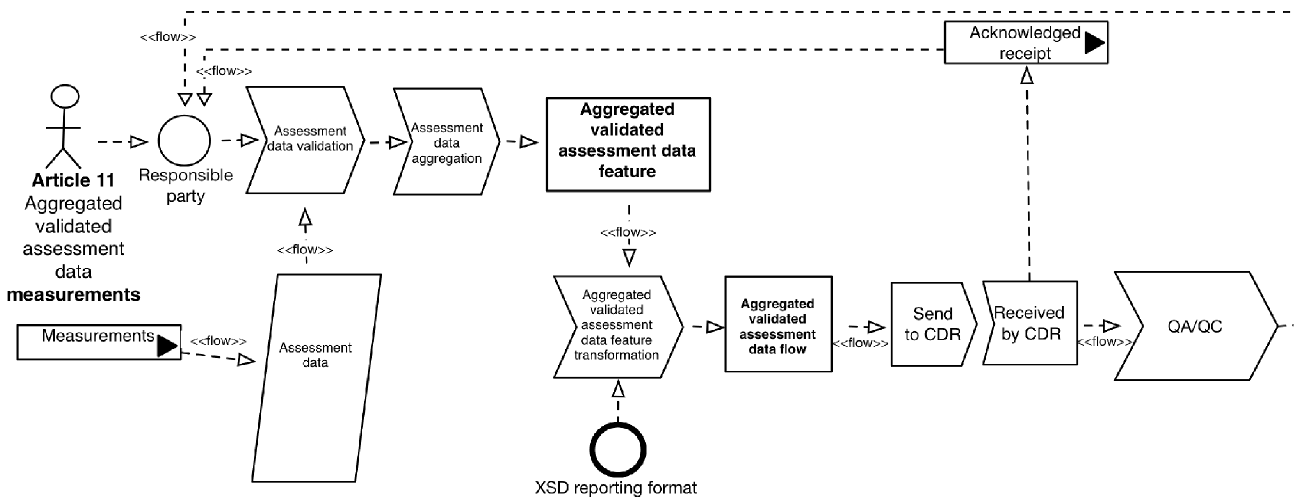

Figure 9: Validated aggregated measurement data.

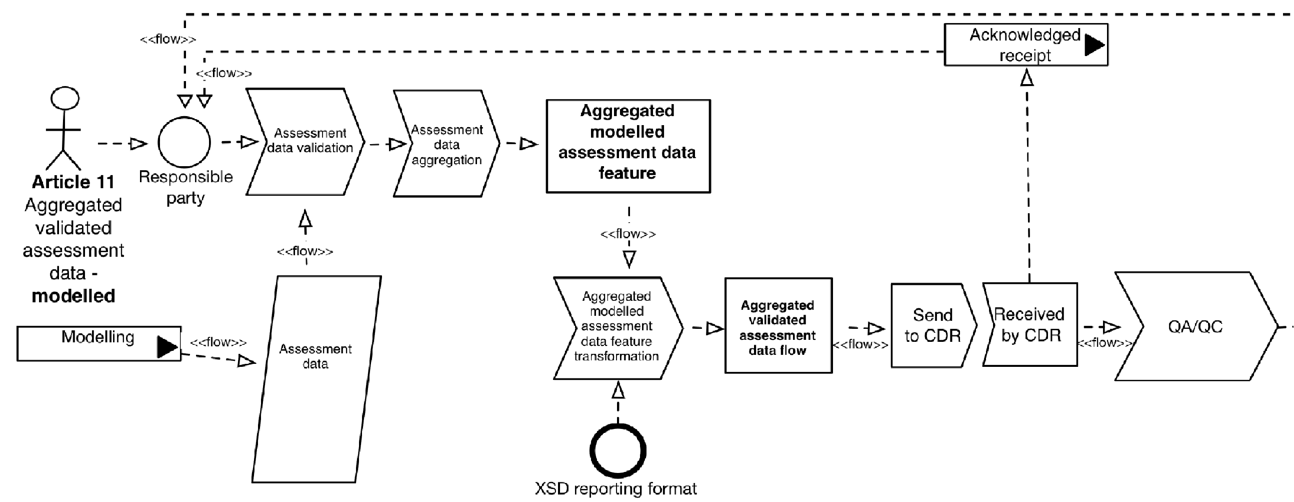

Figure 10: Validated aggregated modelled data. Note that the diagram is still not adapted to the special features of model data.

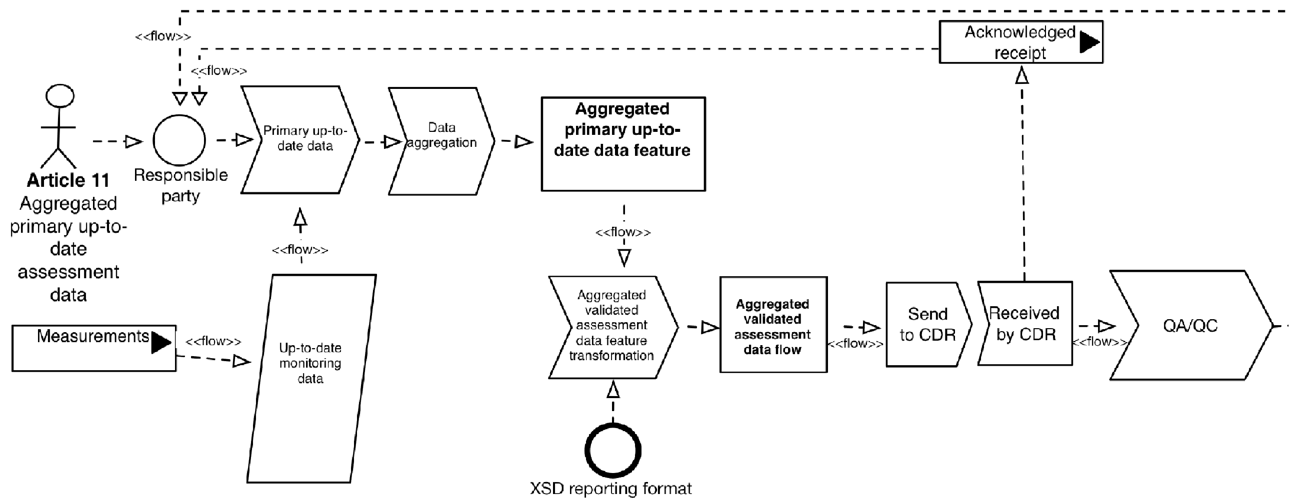

Figure 11: Aggregated up-to-date measurement data. The term Near Real Time (NRT) data has previously been used for such data.

Article 12 Attainment of environmental objectives

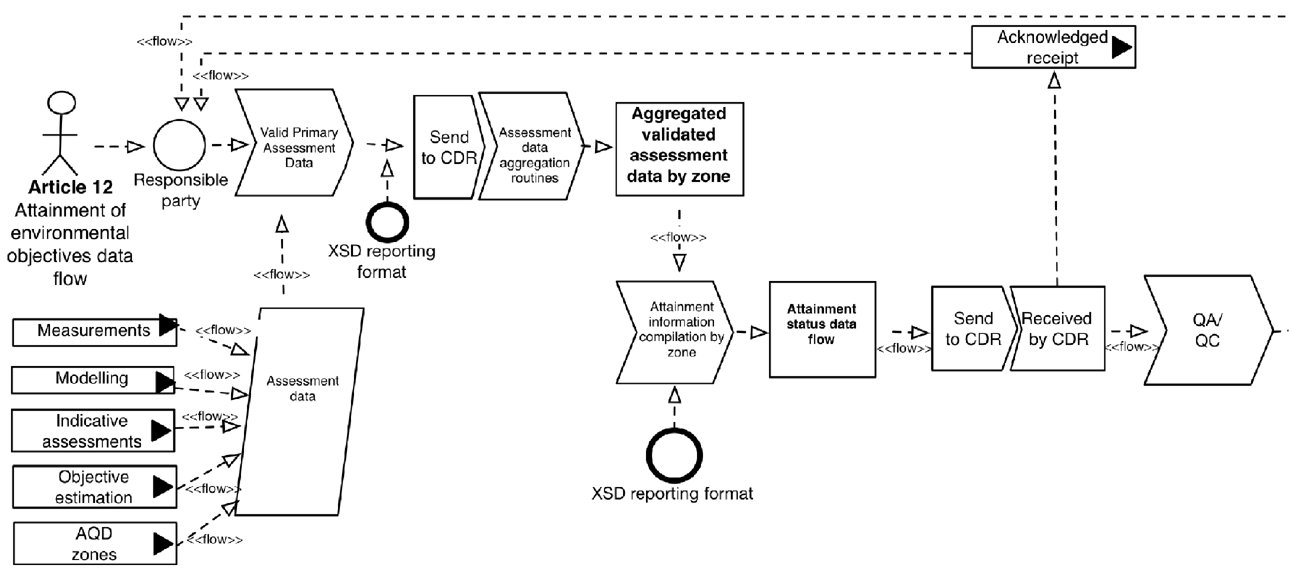

Figure 12 Attainment of environmental objectives. Examples of the required environmental objectives for selected pollutants are provided in Section 3.1

Table 8: Reporting of information on the attainment of environmental objectives

Name	Reporting of information on the attainment of environmental objectives (Article 12)
Primary actor	National AQ data reporter
Goal	The need to reduce pollution to levels which minimise harmful effects on human health, paying particular attention to sensitive populations, and the environment as a whole, to improve the monitoring and assessment of air quality including the deposition of pollutants and to provide information to the public.
System under consideration	Reporting of air quality under AQD IPR 2011/850/EU

Importance	High
Description	Declaration for individual zones and agglomerations as to whether the relevant environmental objectives have been met.
Pre-conditions	• Information on the attainment of environmental objectives for individual zones and agglomerations is available in the national system • Information on zones and agglomerations (Article 6) reported • Information on the assessment regime (Article 7) reported • Information on the assessment methods (Articles 8 and 9) reported • Information on the primary validated data (Article 10) reported • Information on the aggregated primary validated data (Article 11) reported
Post-condition	• The information on the attainment of environmental objectives is available for each zone and agglomeration and the data underpinning the declaration is traceable, consistent and available. • In cases where the environmental objective is a limit value which is in force, the information shows whether the Member State is in compliance with the Air Quality Directive 2008/50/EC.
Flow of events – Basic path	
Step 1	Transform information on the attainment of environmental objectives for individual zones and agglomerations from national air quality system into agreed reporting format
Step 2	Carry out post transformation quality checks on data in agreed reporting format
Step 3	Make data in agreed reporting format available (upload to CDR).
Step 4	Receive results of post delivery quality checks (carried out in CDR)
Step 5	If results are negative, make required changes in national system.
Background Documentation	
AQ Directive 2008/50/EC	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT*
4th Daughter Directive 2004/107/EC	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0107:en:NOT*
AQD IPR 2011/850/EU	*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF*
E reporting	*http://www.eionet.europa.eu/aqportal*

Article 13 Air quality plans

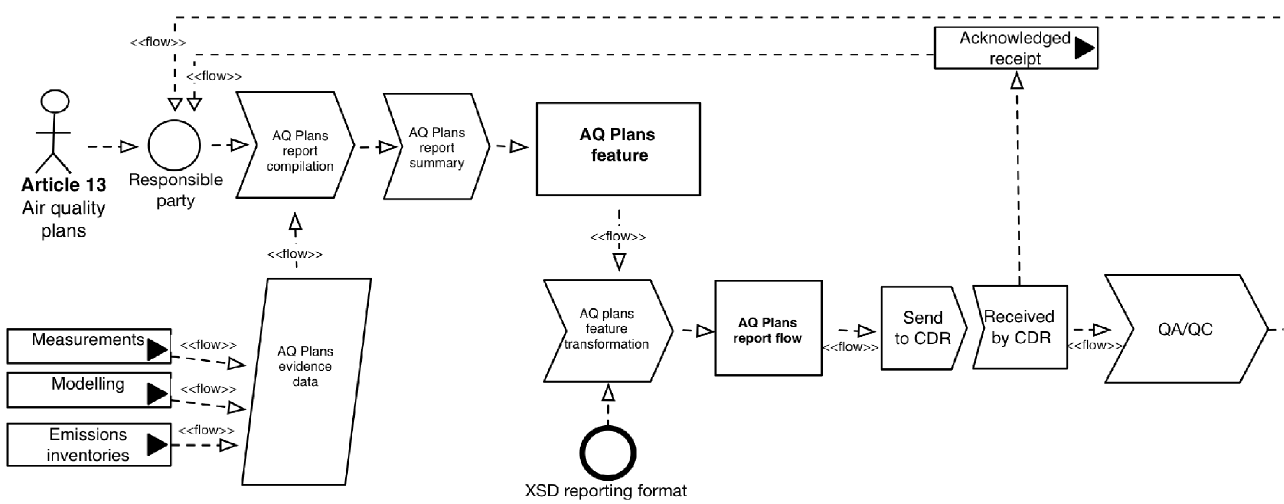

Figure 12: Data flow for reporting of Air Quality plans.

Article 14 Measures to comply with the target values of Directive 2004/107/EC

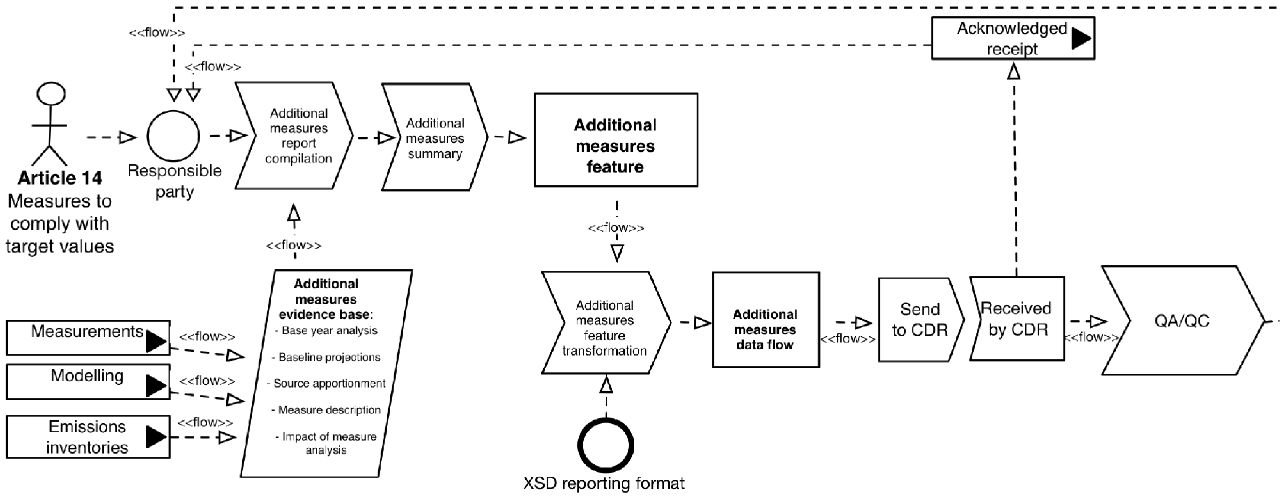

Figure 13: Data flow for reporting of measures to comply with the target values of Directive 2004/107/EC (reporting of arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air).

Air Quality pollutants with monitoring requirements referred to in Directives 2004/107/EC and 2008/50/EC

The air quality directives describe a number of pollutants that shall be monitored by the Member States. These are given in the table below. Pollutant names are listed together with chemical formula and unit. Information on the observable property value for reporting under INSPIRE will be made available at the portal *http://www.eionet.europa.eu/aqportal*.
Note: A list of further pollutants on which Member States shall have reciprocal data exchange, as available, is kept by the European Environment Agency and is made available at the portal *http://www.eionet.europa.eu/aqportal*.

Table 9: Overview of pollutants with monitoring requirements in the Directives 2004/107/EC and 2008/50/EC.

Pollutant name	Pollutant formula	Units
Sulphur dioxide	SO_2	µg/m³
Nitrogen dioxide	NO_2	µg/m³
Nitrogen oxides	NOx[1]	µg/m³
Ozone	O_3	µg/m³
Carbon Monoxide	CO	mg/m³
Particulate matter less than 10 microns	PM_{10}	µg/m³
Particulate matter less than 2.5 microns	$PM_{2.5}$	µg/m³
Sulphate in $PM_{2.5}$	SO_4^{2+} in $PM_{2.5}$	µg/m³
Nitrate in $PM_{2.5}$	NO_3^- in $PM_{2.5}$	µg/m³
Ammonium in $PM_{2.5}$	NH_4^+ in$PM_{2.5}$	µg/m³
Elemental Carbon in $PM_{2.5}$	elem. C in $PM_{2.5}$	µg/m³

Organic Carbon in $PM_{2.5}$	org. C in $PM_{2.5}$	µg/m³
Calcium in $PM_{2.5}$	Ca^{2+} in $PM_{2.5}$	µg/m³
Magnesium in $PM_{2.5}$	Mg^{2+} in $PM_{2.5}$	µg/m³
Potassium in $PM_{2.5}$	K^{+} in $PM_{2.5}$	µg/m³
Sodium in $PM_{2.5}$	Na^{+} in $PM_{2.5}$	µg/m³
Chloride in $PM_{2.5}$	Cl^{-}in $PM_{2.5}$	µg/m³
Lead in PM_{10}	Pb in PM_{10}	µg/m³
Cadmium in PM_{10}	Cd in PM_{10}	ng/m³
Arsenic in PM_{10}	As in PM_{10}	ng/m³
Nickel in PM_{10}	Ni in PM_{10}	ng/m³
wet/total Pb deposition	Pb deposition	µg /m².day
wet/total Cd deposition	Cd deposition	µg /m².day
wet/total As deposition	As deposition	µg /m².day
wet/total Ni deposition	Ni deposition	µg /m².day
wet/total Hg deposition	Hg deposition	µg /m².day
elemental gaseous Mercury	Hg^{0}	ng/m³
Total gaseous Hg	Hg^{0} + Hg-reactive	ng/m³
reactive gaseous Mercury	Hg-reactive	ng/m³
particulate Mercury	Hg in PM_{10}	ng/m³
Benzo(a)pyrene in PM_{10}	B(a)P in PM_{10}	ng/m³
Benzo(a)anthracene in PM_{10}	Benzo(a)anthracene in PM_{10}	ng/m³
Benzo(b)fluoranthene in PM_{10}	Benzo(b)fluoranthene in PM_{10}	ng/m³
Benzo(j)fluoranthene in PM_{10}	Benzo(j)fluoranthene in PM_{10}	ng/m³
Benzo(k)fluoranthene in PM_{10}	Benzo(k)fluoranthene in PM_{10}	ng/m³
Indeno(1,2,3,-cd)pyrene in PM_{10}	Indeno(1,2,3,-cd)pyrene in PM_{10}	ng/m³
Dibenzo(a,h)anthracene in PM_{10}	Dibenzo(a,h)anthracene in PM_{10}	ng/m³
Benzo(a)pyrene deposition	B(a)P	µg /m².day
Benzo(a)anthracene deposition	Benzo(a)anthracene	µg /m².day
Benzo(b)fluoranthene deposition	Benzo(b)fluoranthene	µg /m².day
Benzo(j)fluoranthene deposition	Benzo(j)fluoranthene	µg /m².day
Benzo(k)fluoranthene deposition	Benzo(k)fluoranthene	µg /m².day
Indeno(1,2,3,-cd)pyrene deposition	Indeno(1,2,3,-cd)pyrene	µg /m².day
Dibenzo(a,h)anthracene deposition	Dibenzo(a,h)anthracene	µg /m².day
Benzene	C_6H_6	µg/m³
Ethane	C_2H_6	µg/m³
Ethene (ethylene)	C_2H_4	µg/m³
Ethyne (acetylene)	$HC{\equiv}CH$	µg/m³
Propane	$H_3C\text{-}CH_2\text{-}CH_3$	µg/m³
Propene	$CH_2{=}CH\text{-}CH_3$	µg/m³
n-butane	$H_3C\text{-}CH_2\text{-}CH_2\text{-}CH_3$	µg/m³
2-methylproprane (i-butane)	$H_3C\text{-}CH(CH_3)_2$	µg/m³

1-butene	$H_2C=CH-CH_2-CH_3$	µg/m³
trans-2-butene	$H_3C-CH=CH-CH_3$	µg/m³
cis-2-butene	$H_3C-CH=CH-CH_3$	µg/m³
1,3-butadiene	$CH_2=CH-CH=CH_2$	µg/m³
n-pentane	$H_3C-(CH_2)_3-CH_3$	µg/m³
2-methylbutane (i-pentane)	$H_3C-CH_2-CH(CH_3)_2$	µg/m³
1-pentene	$H_2C=CH-CH_2-CH_2-CH_3$	µg/m³
2-pentene	$H_3C-HC=CH-CH_2-CH_3$	µg/m³
2-methyl-1,3-butadiene (isoprene)	$CH_2=CH-C(CH_3)=CH_2$	µg/m³
n-hexane	C_6H_{14}	µg/m³
2-methylpentane (i-hexane)	$(CH_3)_2-CH-CH_2-CH_2-CH_3$	µg/m³
n-heptane	C_7H_{16}	µg/m³
n-octane	C_8H_{18}	µg/m³
2,2,4-trimethylpentane (i-octane)	$(CH_3)_3-C-CH_2-CH-(CH_3)_2$	µg/m³
Toluene	$C_6H_5-C_2H_5$	µg/m³
Ethyl benzene	m,p-$C_6H_4(CH_3)_2$	µg/m³
m,p-xylene	o-$C_6H_4-(CH_3)_2$	µg/m³
o-xylene	$C_6H_3-(CH_3)_3$	µg/m³
1,2,4-trimethylbenzene	$C_6H_3(CH_3)_3$	µg/m³
1,2,3-trimethylbenzene	$C_6H_3(CH_3)_3$	µg/m³
1,3,5-trimethylbenzene	$C_6H_3(CH_3)_3$	µg/m³
total non methane Hydrocarbons	THC(NM)	µg/m³
Methanal (formaldehyde)	CH_2O	µg/m³

Environmental Objectives

The table shows the environmental objectives for selected pollutants. See 2011/850/EC Annex 1(B) for full list of environmental objectives.

Table 10: Environmental objectives for selected pollutants.

Formula	Protection target	Environmental Objective type	Averaging period of assessments	Reporting metric of environmental objective	Numerical values of the environmental objective (allowed number of exceedances)
Pollutants for which up-to-date and validated data have to be reported					
NO_2	Health	Limit value (LV)	1 hour	Hours in exceedance in a calendar year	200 µg/m 3 (18)
NO_2	Health	Limit value plus margin of tolerance (LVMT)	1 hour	Hours in exceedance in a calendar year	200 µg/m 3 (18)
NO_2	Health	Limit value	1 calendar	Annual average	40 µg/m 3

		(LV)	year		
NO_2	Health	Limit value plus margin of tolerance (LVMT)	1 calendar year	Annual average	40 µg/m 3
NO_2	Health	Alert threshold (ALT)	1 hour	Three consecutive hours in exceedance (at locations representative of air quality over at least 100 km 2 or an entire zone or agglomeration, which ever is smaller)	400 µg/m 3
NO_x	Vegetation	Critical level (CL)	1 calendar year	Annual average	40 µg/m 3
PM_{10}	Health	Limit value (LV)	1 day	Days in exceedance in a calendar year	50 µg/m 3 (35) Percentile of 90,4
PM_{10}	Health	limit value (LV)	1 calendar year	Annual average	40 µg/m 3
PM_{10}	Health	Assessment of winter-sanding and -salting (WSS)*	1 day	Deducted days in exceedance in a calendar year	n/a
PM_{10}	Health	Assessment of winter-sanding and -salting (WSS)*	1 calendar year	Deduction of annual average	n/a
PM_{10}	Health	Assessment of natural contribution(NAT)*	1 day	Deducted days in exceedance in a calendar year	n/a
PM_{10}	Health	Assessment of natural contribution (NAT)*	1 calendar year	Deduction of annual average	n/a
Pollutants for which only validated data have to be reported					
Benzene	Health	Limit value (LV)	1 calendar year	Annual average	5 µg/m 3
Lead	Health	Limit value (LV)	1 calendar year	Annual average	0.5 µg/m 3
Cadmium	Health	Target value (TV)	1 calendar year	Annual average	5 ng/m 3

Arsenic	Health	Target value (TV)	1 calendar year	Annual average	6 ng/m 3
Nickel	Health	Target value (TV)	1 calendar year	Annual average	10 ng/m 3
B(a)P	Health	Target value (TV)	1 calendar year	Annual average	1 ng/m 3

* No up-to-date data is to be made available