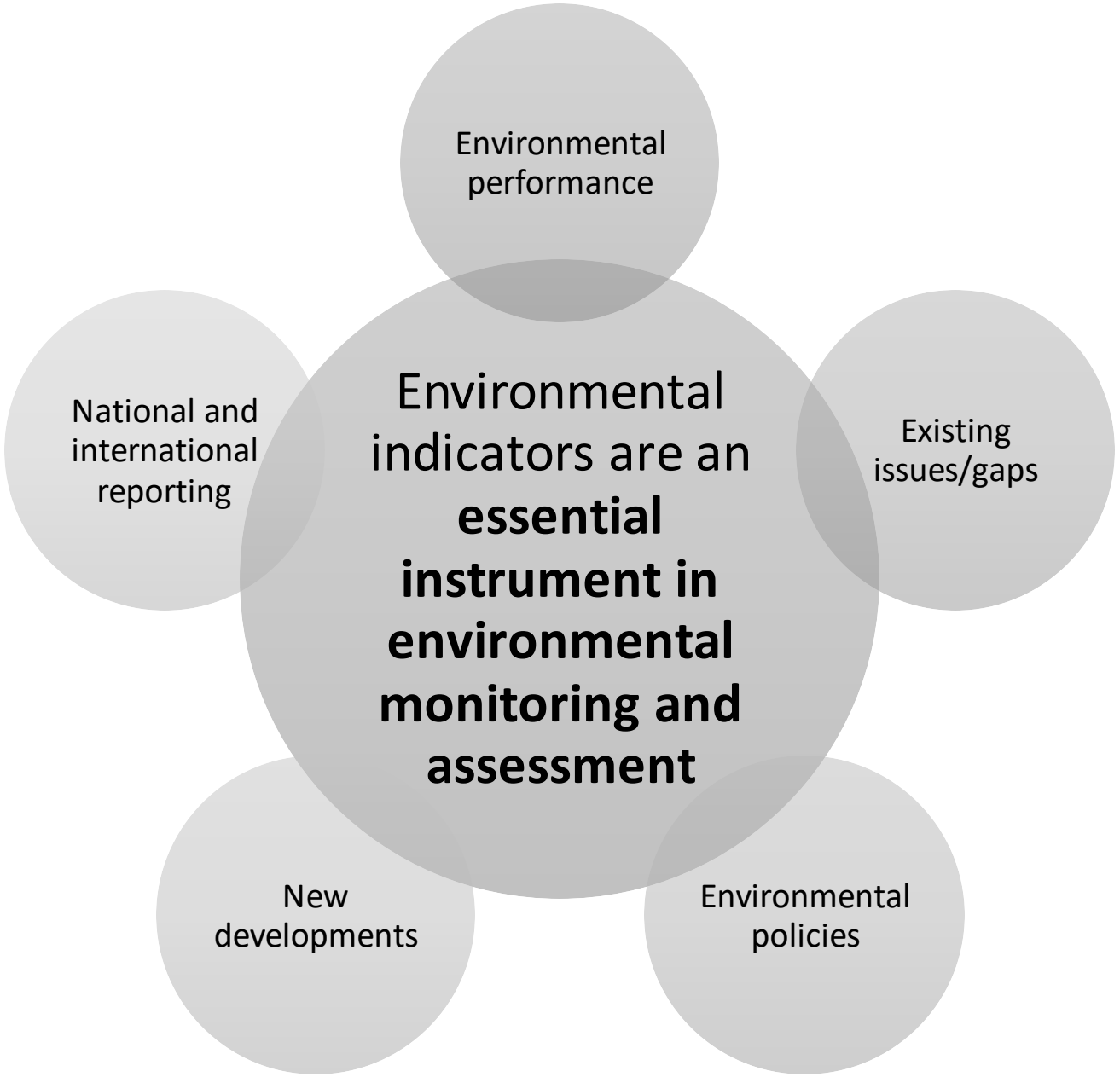
TRAINING MATERIALS

The Revised ECE Environmental Indicators

Air quality

UNECE

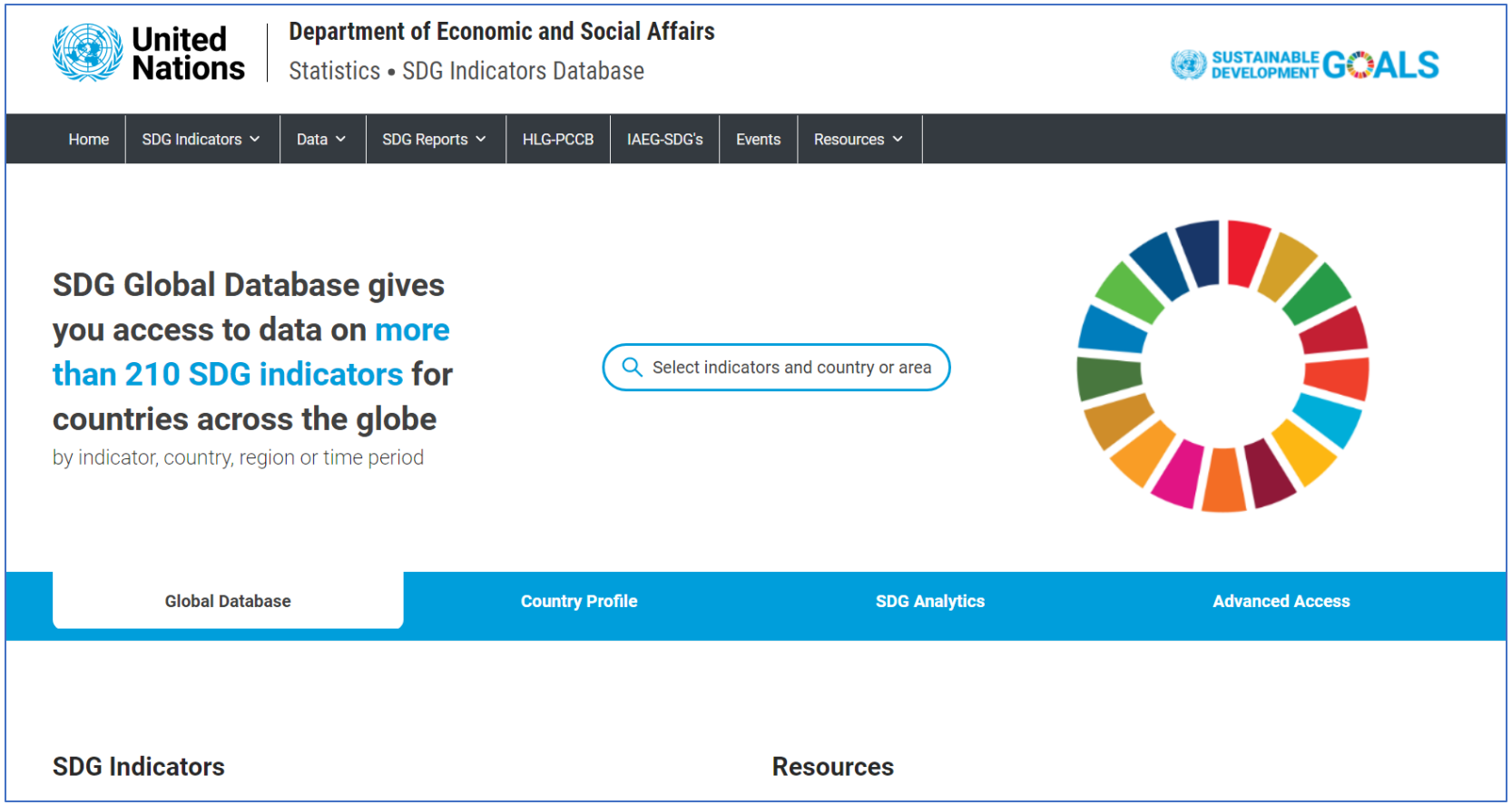
UN environment programme


Environmental performance
National and international reporting
Existing issues/gaps
Environmental indicators are an **essential instrument in environmental monitoring and assessment**
New developments
Environmental policies

The UNECE Revised Guidelines is the crucial instrument for the countries to maintain the sound quality of reporting while meeting international requirements and standards.

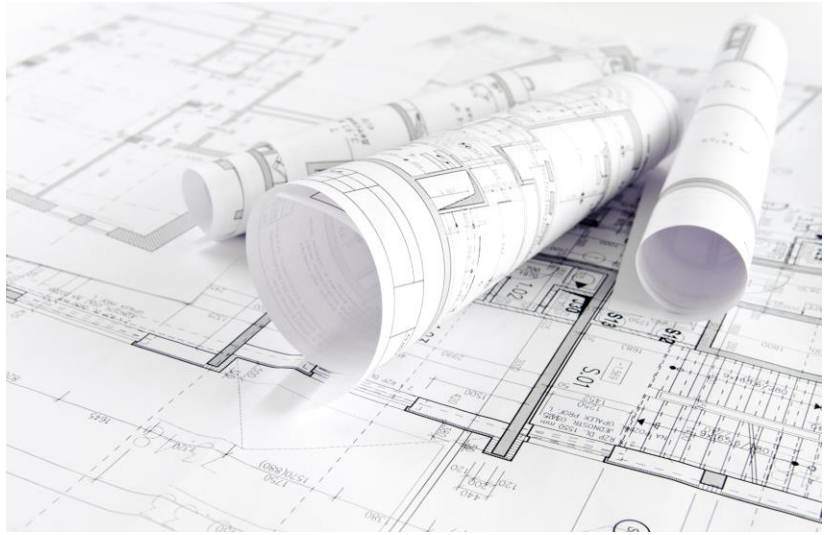
UN Statistics

Sustainable Development Goals Indicators



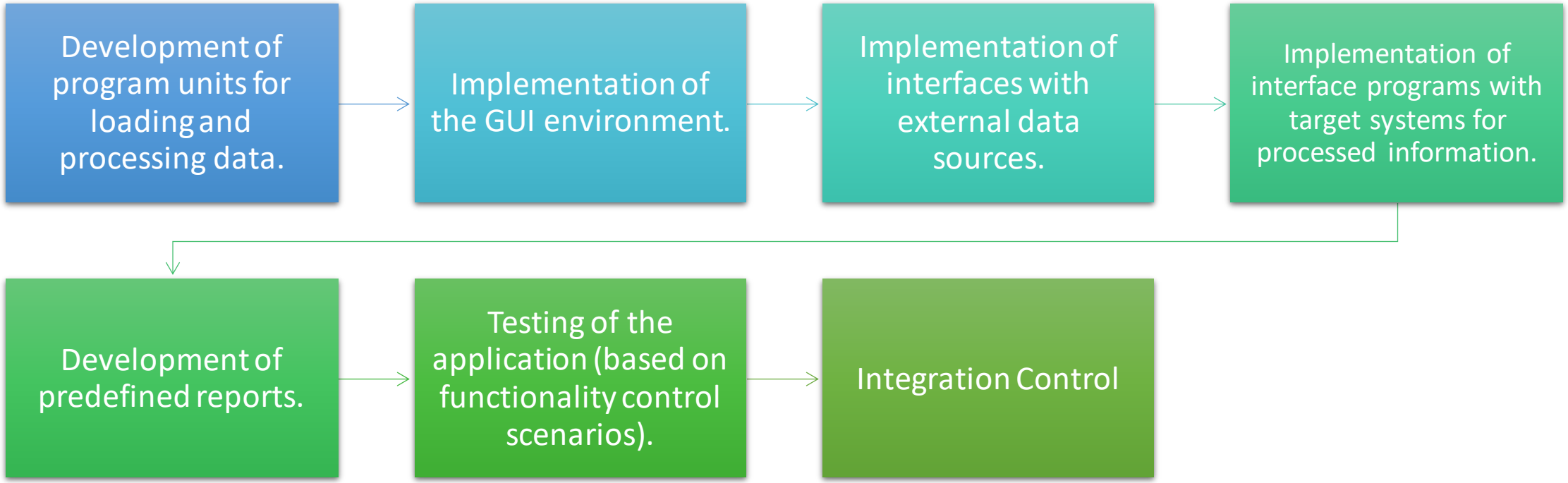
Design

System design



- Requirement Analysis
- Database Modeling and Design
- Development
- Control

Application development



Air Quality

Worldwide an increasing number of citizens live in urban areas, where high population densities and economic activities cause high levels of air pollution.

The exposure to high levels of air pollution is linked to adverse health effects, such as respiratory and heart problems, and cancer. Particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and benzo[α]pyrene (BaP) are associated with serious health problems

Air Quality

The World Health Organization (WHO) has issued recommendations regarding the acceptable levels of air pollution.

The levels recommended in the latest edition of the WHO air quality guidelines from 2021, based on the latest scientific evidence, are very strict.

Air Quality

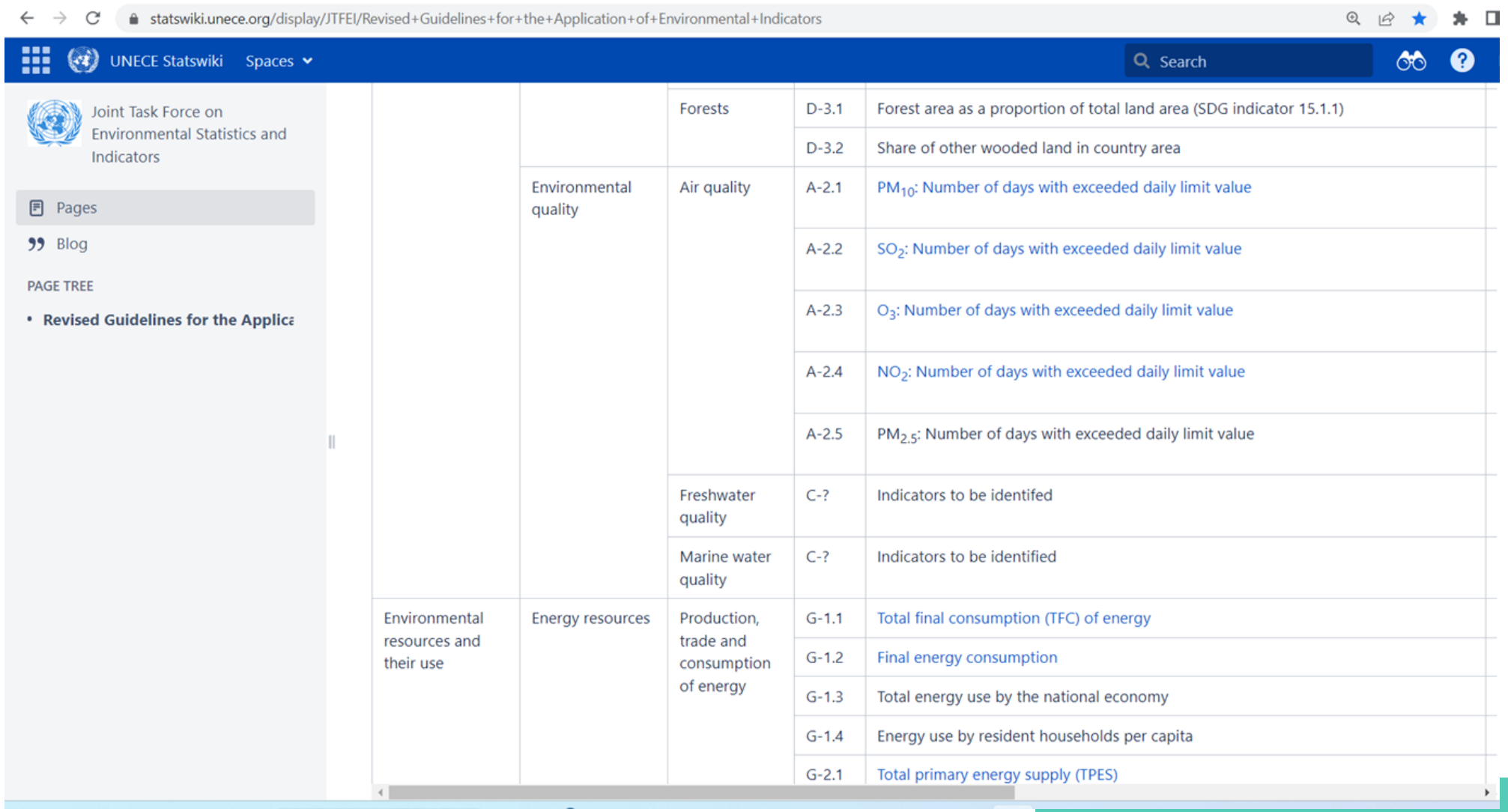
The long-term objective could be set to achieve zero exceedances of the WHO guideline levels for human health.

The World Health Organization recommendations has led many governments to issuing air quality legislation related to the protection of human health

Apart from direct emissions of pollutants, O_3 is a secondary pollutant formed from other pollutants in the presence of solar light. Its levels are determined by emissions and meteorology.

UNECE

Environmental indicators that cover Air quality



		Forests	D-3.1	Forest area as a proportion of total land area (SDG indicator 15.1.1)
			D-3.2	Share of other wooded land in country area
	Environmental quality	Air quality	A-2.1	PM_{10}: Number of days with exceeded daily limit value
			A-2.2	SO_2: Number of days with exceeded daily limit value
			A-2.3	O_3: Number of days with exceeded daily limit value
			A-2.4	NO_2: Number of days with exceeded daily limit value
			A-2.5	$PM_{2.5}$: Number of days with exceeded daily limit value
		Freshwater quality	C-?	Indicators to be identifed
		Marine water quality	C-?	Indicators to be identified
Environmental resources and their use	Energy resources	Production, trade and consumption of energy	G-1.1	Total final consumption (TFC) of energy
			G-1.2	Final energy consumption
			G-1.3	Total energy use by the national economy
			G-1.4	Energy use by resident households per capita
			G-2.1	Total primary energy supply (TPES)

Design

Code	Indicator	Priority
A-2.10	PM_{10}: Annual mean concentration in cities*	Yes
A-2.8	Annual mean level of PM_{10} in cities (population weighted) (SDG indicator 11.6.2)*	Yes
A-2.1	PM_{10}: Number of days with exceeded daily limit value	
A-2.9	$PM_{2.5}$: Annual mean concentration in cities*	Yes
A-2.7	Annual mean level of $PM_{2.5}$ in cities (population weighted) (SDG indicator 11.6.2)*	Yes
A-2.5	$PM_{2.5}$: Number of days with exceeded daily limit value	
A-2.11	SO_x: Annual mean concentration in cities*	Yes
A-2.2	SO_2: Number of days with exceeded daily limit value	
A-2.3	O_3: Number of days with exceeded daily limit value	
A-2.12	NO_x: Annual mean concentration in cities*	Yes
A-2.4	NO_2: Number of days with exceeded daily limit value	

Air quality

System design

Definition of the parameters to be measured

Definition of the measuring instruments for each measuring station

Definition of the number of necessary measuring stations to cover fully the areas of interest (major cities, industrial areas, airports etc.)

Establishment of the position of the measuring stations

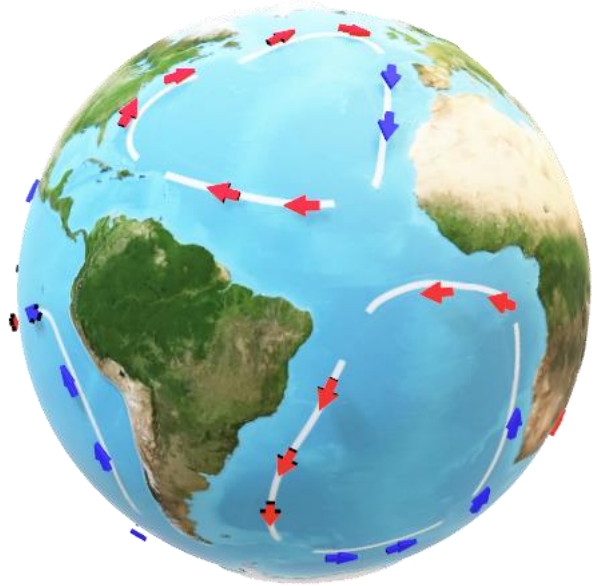
Definition of the method for data transmission to the database

Geographic Information System

- Software for the display of information on maps
- Connection with the parameters' measurements database

Geographic Information Systems - GIS

Attributes



- Position on the map for the sampling point (Georeferenced)
- Differentiate depiction dependent on the parameter value
- Interoperability with the database

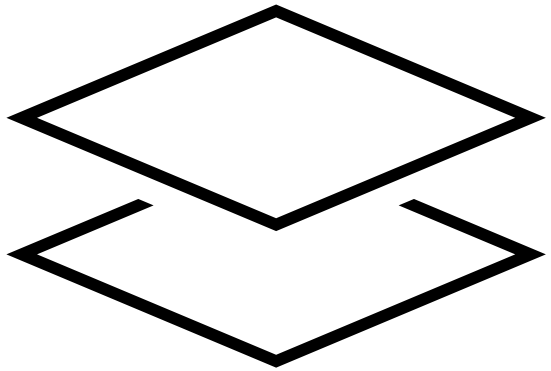
GIS

Attributes

- Geodetic reference system
- Resolution
- Topology structure of the vector data models: points, lines and polygons

GIS

Types of data



- Base Map
- Geographic Database
- Raster data
- Vector data
- Geographic data

GIS – Base map

Definition of scale for the whole territory (e.g. 1: 250.000, 1: 100.000, 1: 50.000)

Definition of scale for urban areas (e.g. 1:5.000)

Data in both vector and raster format is required to allow use of GIS analysis tools

Homogenization of the data

Sources: Satellite imaging, Orthophoto maps

Digital Terrain Model (DTM)

Attention to copyright issues

GIS – Vector data

- Naming rules
- Road network with names, numbering from-to, left-right and postal code
- Building blocks with population data for urban areas
- Boundaries of municipalities, prefectures and regions
- Coastline, Rivers, Lakes, Plains, Altitude zones, Settlements

GIS

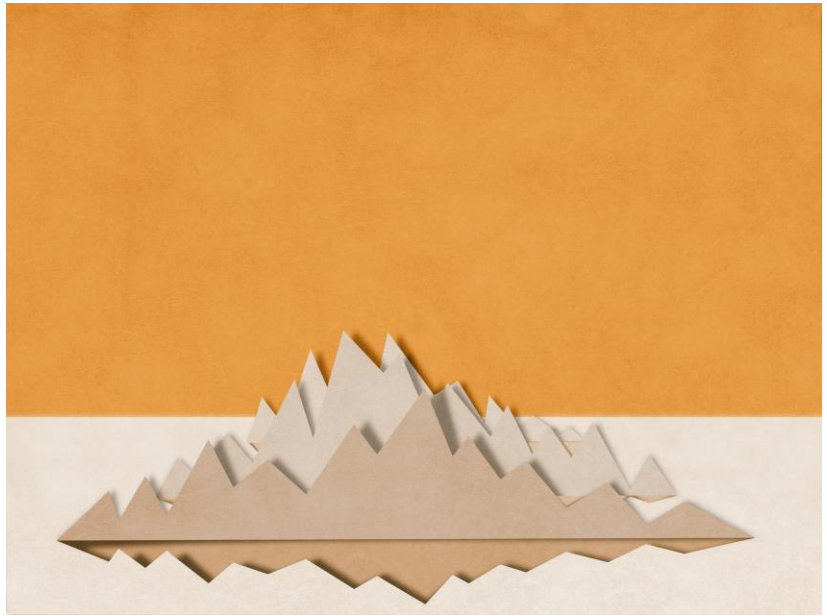
Raster data is a pixel-based picture data (e.g. JPG, PNG, TIFF) that is stored in the GIS

Geographic database: Spatial information + Descriptive information, connected by a common key

Geographic data refers to data (environmental data in this case) that is associated with a specific location

GIS

Layers of geographic information necessary for the correct display of environmental data



- Naming information for the whole territory
- Road network
- Settlements
- Coastline, Rivers, Lakes
- Plains, Elevation Zones
- Road network with naming, numbering from-to, left-right and postal code for the major metropolitan areas
- Building blocks for the major cities, with population data
- Protected areas
- Geotopes, Geoparks
- Archaeological sites

Air quality

GIS functionality

Display air pollutant concentration values for a selected measuring station

Allow the registration of the location of a new measuring station

Air quality

Geographical data

Air pollution measuring stations

Registration of the location of all measuring stations in the urban complex on a base map of a chosen scale (e.g. 1: 5.000)

GIS - Metadata

- Geographic data is supplemented by Metadata ("Information for Information
- The metadata describes elements of identification, ownership, content, structure, availability and method of delivery.
- For the integration of downloaded data to the host database and to ensure appropriate use depending on the host application, the following data information and quality indicators should be provided:
  - Data source
  - Accuracy (position and thematic properties)
  - Data relevance
  - Logical data consistency
  - Completeness

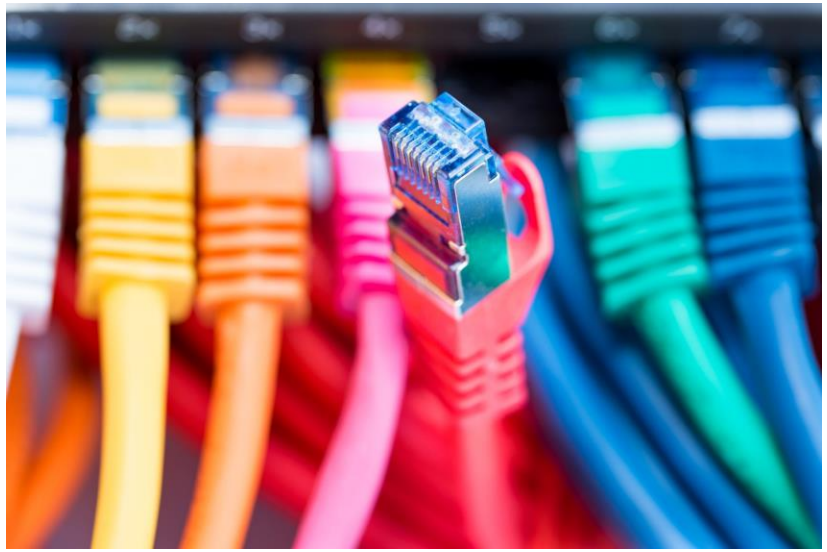
Collection of data

Method

- Automated
- Manual data entry
- Sample collection
- Recurring studies
- Collection of data from other sources
- Questionnaires

Input of data to the data storage

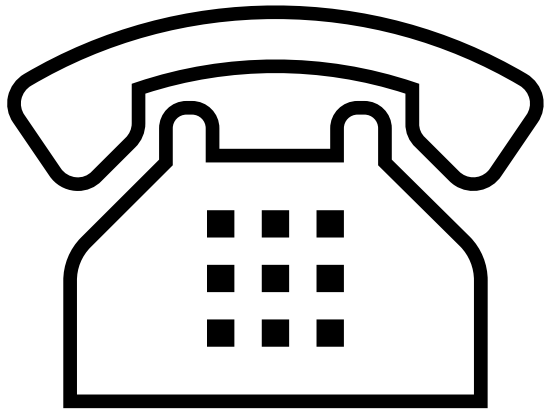
Method



- Using a system link to/from the measuring device
- Using a user interface software tool
- Using bulk download
- Direct entry of the data to the data storage device through mobile systems
- Collecting data from the responsible authority

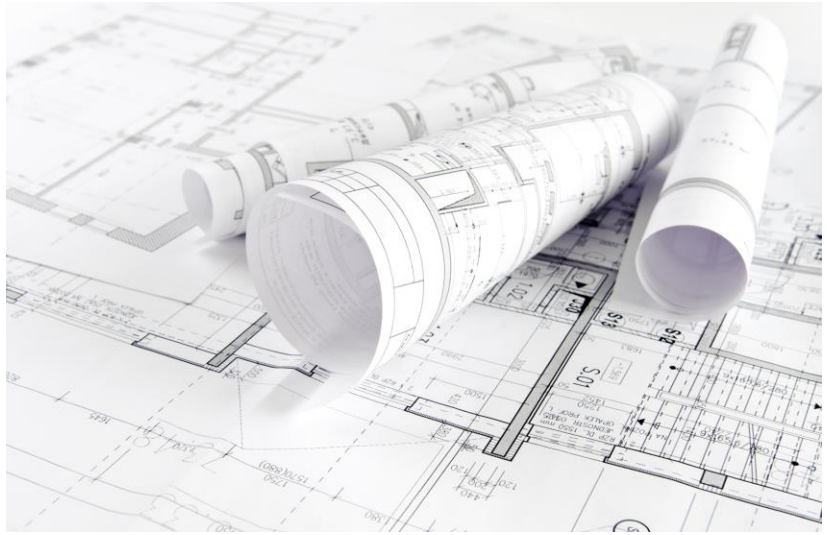
Air Quality

Data collection



- Network of measuring stations
- Direct communication link from the measuring station to the database site
- Dedicated software for the transmission of the recorded pollutant data on the station, to the database
- GIS data : Air pollution measuring stations, point topology

Accreditation



The use of certified equipment ensures the validity and comparability of the measurements.

Certification may be obtained by an accredited certifier.

EN ISO/IEC 17025 is the standard for testing and calibration laboratories

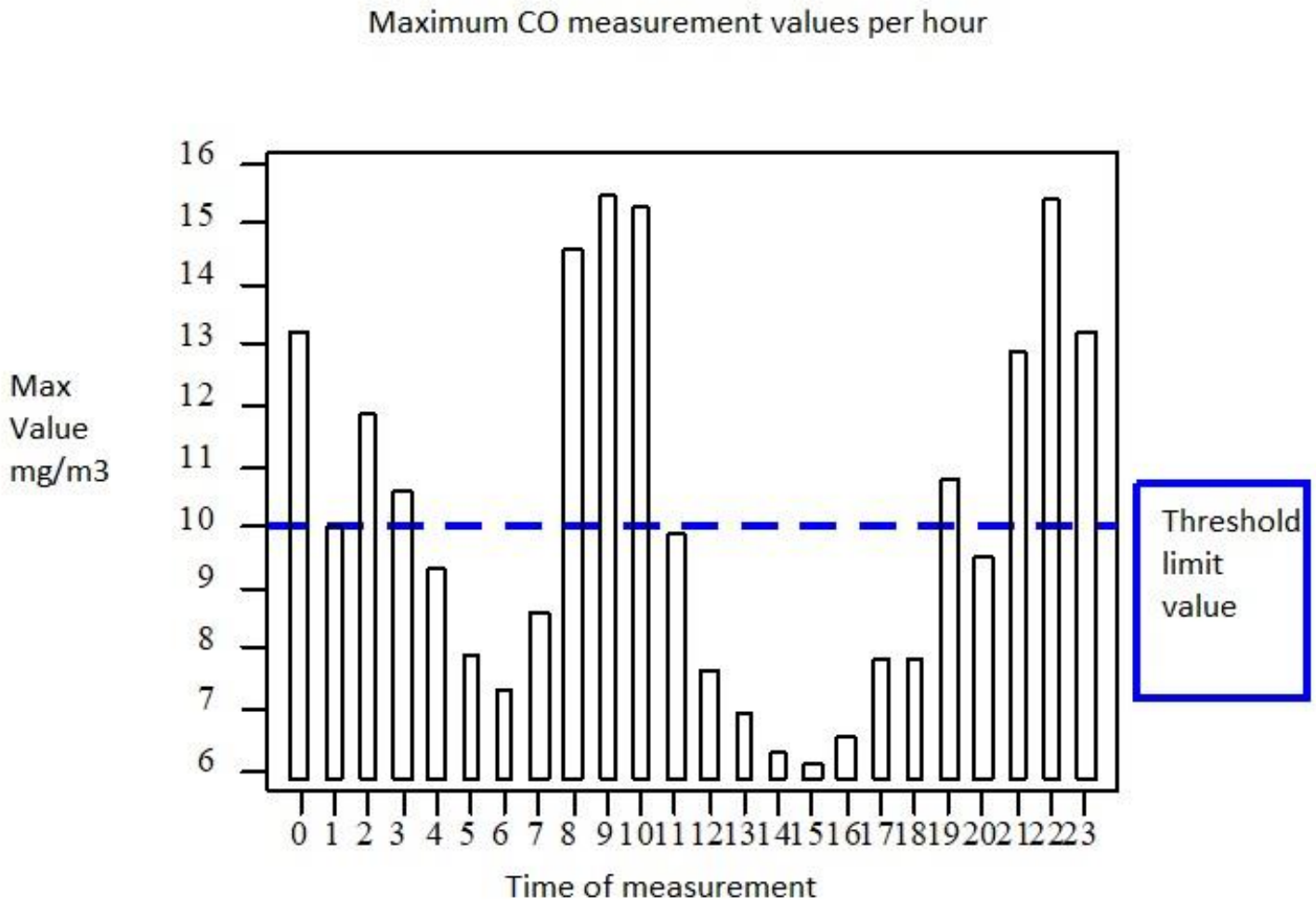
Data validation

Statistical tools

- Mean
- Standard deviation
- Relative standard deviation.
  Coefficient of variation
- Histogram
- Scatter diagram
- Control chart
- Range chart
- Run Chart
- Multivariate analysis

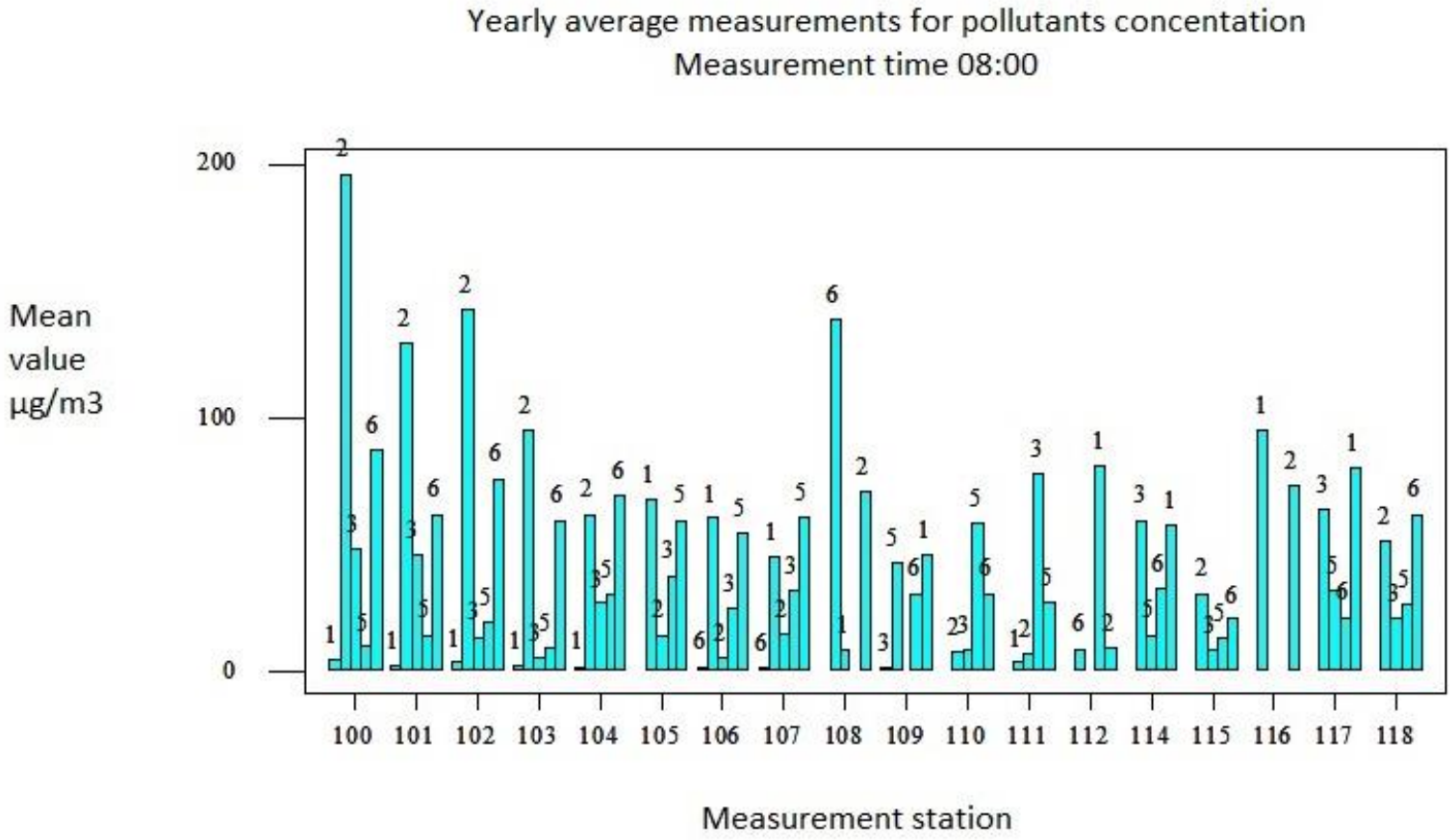
Statistical tools
Air quality

Maximum value variation



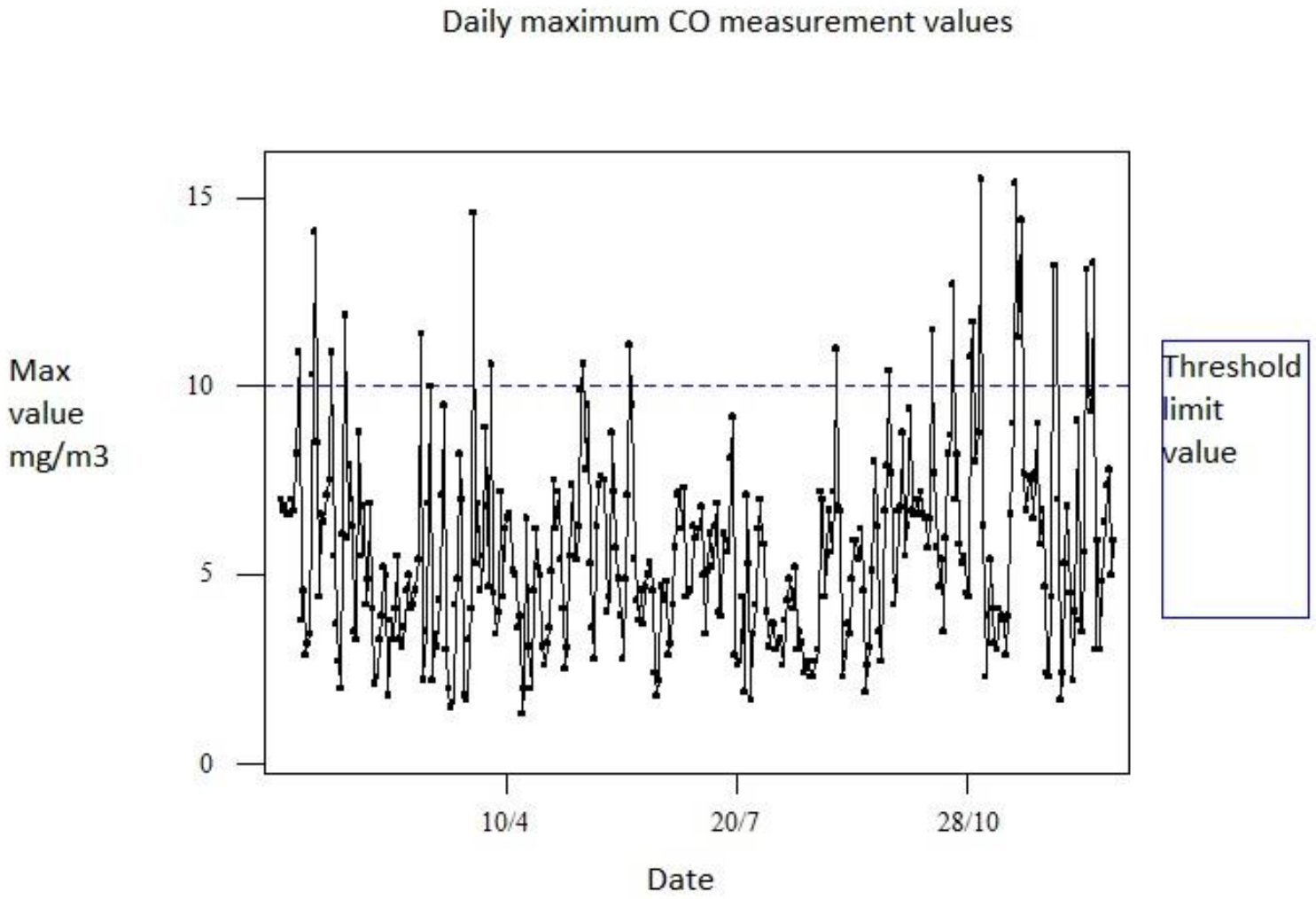
Statistical tools
Air quality

Comparison between measurement stations



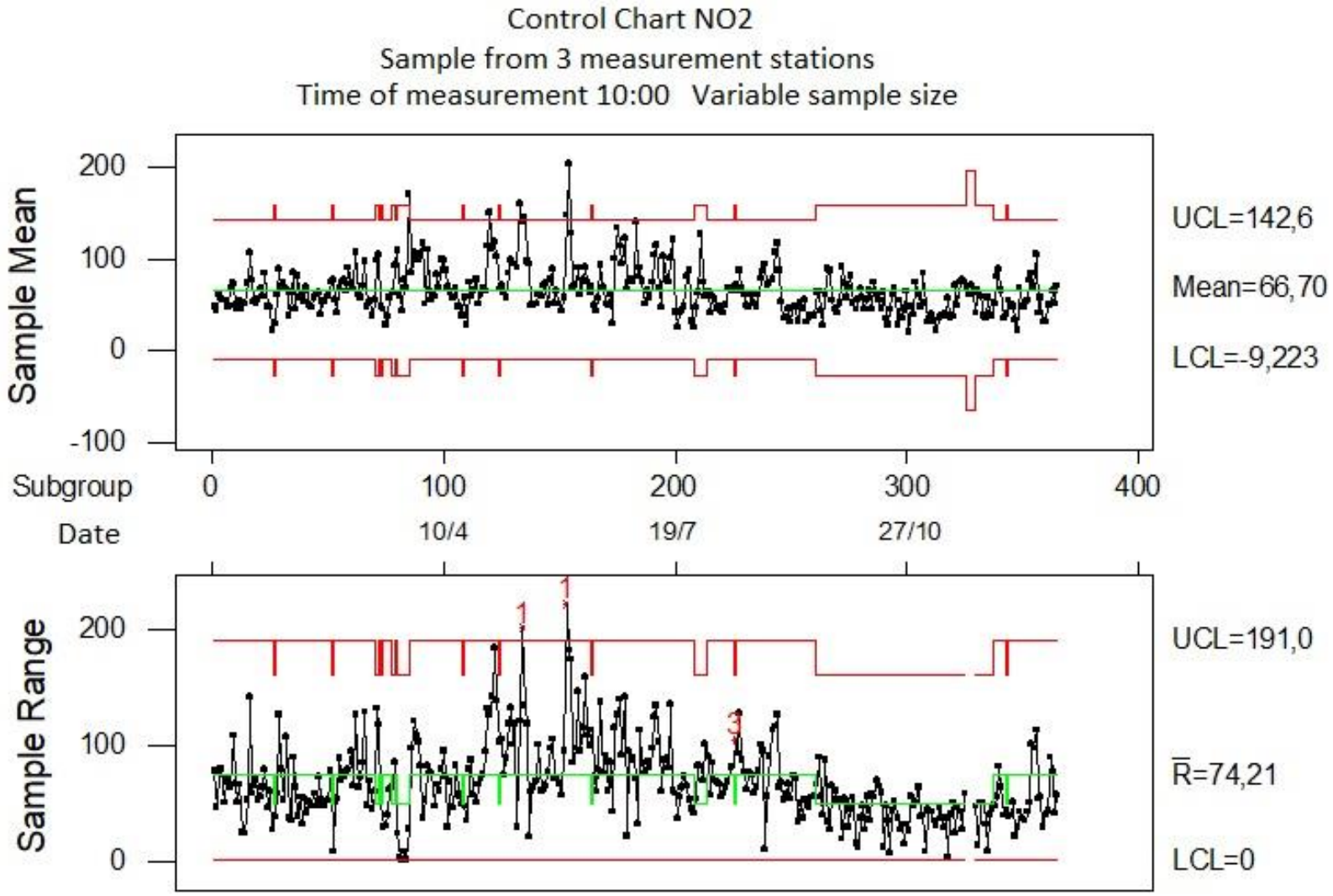
Statistical tools
Air quality

Daily measurements max values over a year



Statistical tools
Air quality

Control Chart



Environmental Information

Indicators

Dynamic reports that present information from the database in a highly consolidated form

Easy graphical end-user interface that allows the detection of deviations from predefined goals or from previous time periods

Features to facilitate the detection of exceptions and to drill down to more detailed data

Environmental Information

Analysis and display

- Dedicated internet site
- Indicator based reports
- State of the environment reports
- Benchmarking
- SQL Reporting tools
- Spatial analysis tools
- Trends and future projections

Statistical Tools for Environmental Data Analysis

Correlation analysis

Example : Air quality

Correlation analysis between NO and O_3 for all measurement stations in a city over a year. The low value of R-Sq means that the two pollutants are weakly related.

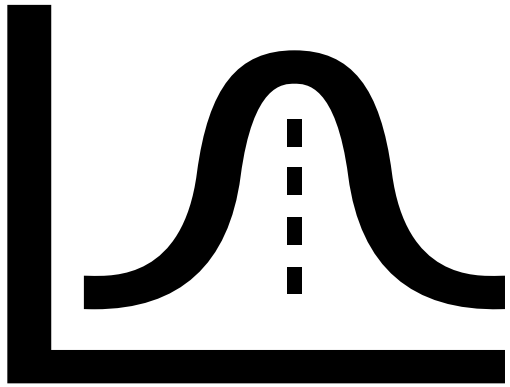
Regression Analysis: LOGE(5) versus LOGE(2)
The regression equation is
LOGE(5) = 5,10 - 0,656 LOGE(2)
32998 cases used 1346 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	5,09533	0,00887	574,36	0,000
LOGE(2)	-0,656026	0,002936	-223,45	0,000

S = 0,8051 R-Sq = 60,2% R-Sq(adj) = 60,2%

Statistical Tools for Environmental Data Analysis

Hypothesis testing



- Locating the measuring station with the highest air pollution load
- Comparison per pollutant
- Overall comparison between all measuring stations in a city

Levels of access to information

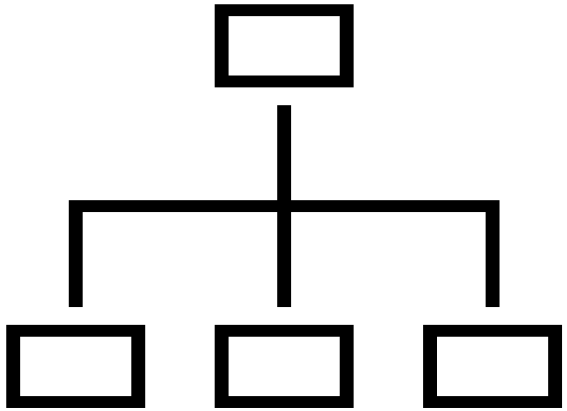
Policy makers

Dedicated reports

Time series

Levels of access to information

Public administration



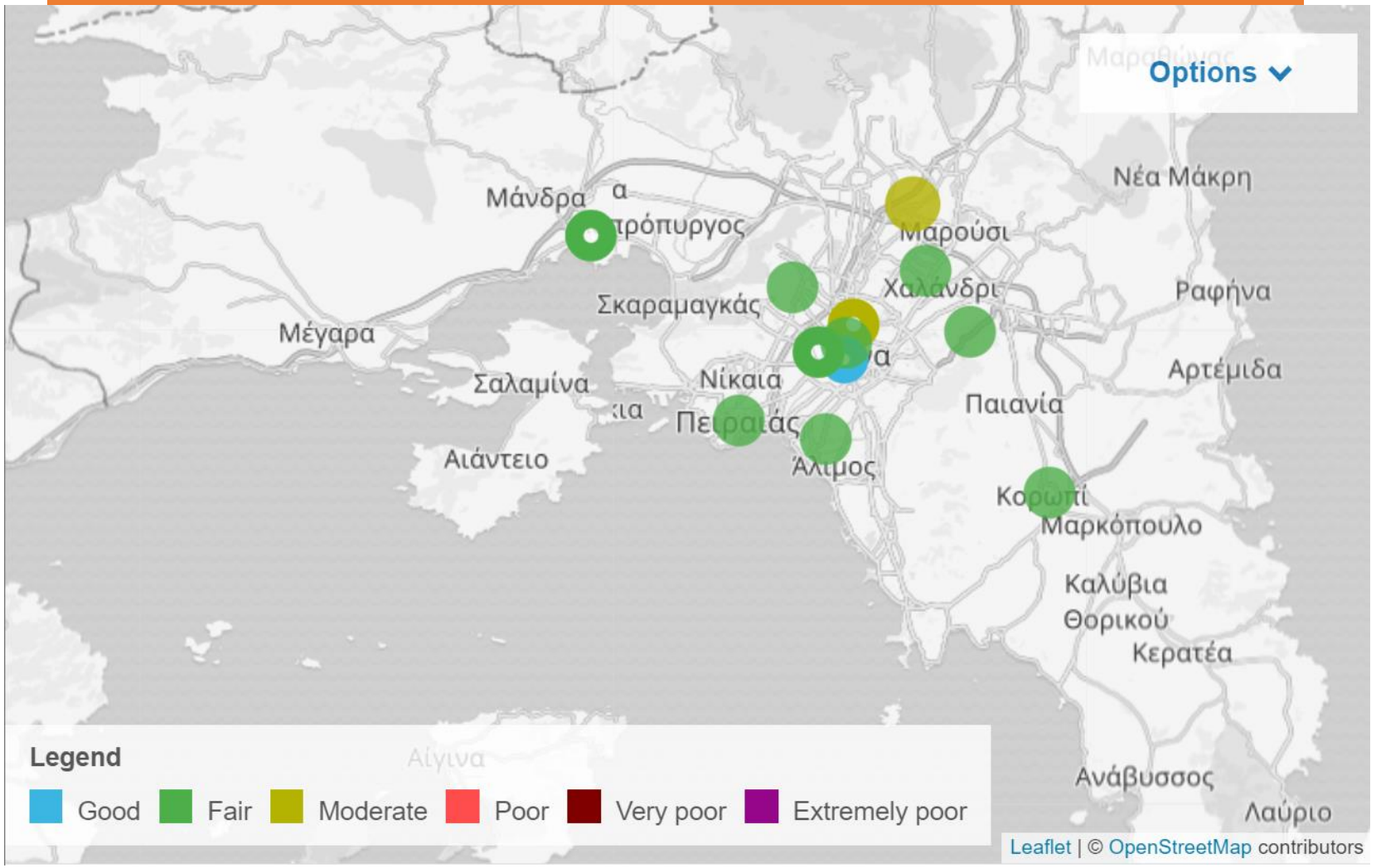
Availability of data to other Agencies (Ministries, Institutes, Universities, Research Centres) and Data Schemes within the country

Levels of access to information

Public Website

- Time series
- Aggregated data
- Ready to display graphics and GIS maps

Athens area Air quality monitoring network



Use indicators values to produce State of Environment Reports

Communication activities

- Social media
- Launch event
- Seminars
- Publicity material (e.g. posters, fliers)

Air Quality Reports

Department
for Environment
Food & Rural Affairs

Air Pollution in the UK 2021

September 2022

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ΥΠΟΥΡΓΕΙΟ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΚΑΙ ΕΝΕΡΓΕΙΑΣ
ΓΕΝ. Δ/ΝΣΗ ΠΕΡΙΒΑΛΛΟΝΤΙΚΗΣ ΠΟΛΙΤΙΚΗΣ
Δ/ΝΣΗ ΚΛΙΜΑΤΙΚΗΣ ΑΛΛΑΓΗΣ & ΠΟΙΟΤΗΤΑΣ ΑΤΜΟΣΦΑΙΡΑΣ
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ΙΟΥΝΙΟΣ 2022

References

- European Environment Agency Indicators
- Hellenic Ministry of Environment
- World Health Organization

Thank you for your attention!

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